Book of abstracts

VLIZ Young
Scientists' Day

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Preface

The Flanders Marine Institute (VLIZ) supports marine scientific research in Flanders. VLIZ offers logistic support, promotes expertise internationally, and serves as an interface between the scientific community, governmental bodies, and the public at large. VLIZ wants to give exposure to marine, coastal and estuarine research in Flanders, whereby coordination and dissemination of information play key roles.

Marine research in Flanders is carried out by the six Flemish universities, research institutes and departments of the Flemish and federal authorities, and to a lesser extent by private enterprises. The major broad disciplines covered are: biology, earth sciences, chemistry, physics, aquaculture and fisheries, engineering, and maritime affairs. Annually, VLIZ bundles the scientific contributions of the Flemish marine researchers in the 'VLIZ Collected Reprints'. VLIZ increases the visibility of marine research in Flanders by producing publications, organizing symposia and granting scientific awards.

On Friday, 2 March 2007, the seventh 'VLIZ Young Scientists' Day' (170 pre-registered participants) was organized in Provinciehuis Boeverbos, Sint-Andries (Brugge), Belgium.

Programme:

- two plenary lectures by senior scientists

- four oral presentations by young scientists

- poster competition for young scientists

- photo contest

- demonstrations of marine and coastal databases and services

- presentation by laureates of 'VLIZ aanmoedigingsprijzen mariene wetenschappen 2006' and 'Annual VLIZ North Sea Award 2006'

This 'VLIZ Special Publication 39' comprises the abstracts of the oral, poster and demo presentations as well as the summaries submitted by the laureates and applicants of the 'VLIZ aanmoedigingsprijzen mariene wetenschappen 2006' and 'Annual VLIZ North Sea Award 2006'.

Dr Jan Mees
Director VLIZ

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Annual VLIZ Thesis Awards Marine Sciences 2006

Every year VLIZ awards two marine Master theses. Fundamental as well as applied marine researchers in all disciplines of marine sciences can apply. The prize amounts to 500 EUR and is reserved for young scientists that are graduated at a Flemish university or college for higher education.

The 2006 winners of the annual VLIZ Thesis Award Marine Sciences are:

Katrien Broekaert
(UGent, Marine Biology Section)
for the thesis entitled:

Cryptic genetic diversity in the genus *Mesopodopsis* (Crustacea, Mysidacea)

Robby Caspeele
(UGent, Afdeling Weg- en Waterbouwkunde)
for the thesis entitled:

Generation of irregular long and short crested waves in a numerical model for wave propagation: implementation, validation and application

CRYPTIC GENETIC DIVERSITY IN THE GENUS *MESOPODOPSIS* (CRUSTACEA, MYSIDACEA)

Broekaert Katrien

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Genetic biodiversity is dynamic, species and their environment undergo continuously evolutionary changes. The start of these evolutionary changes always takes place at the population level. Genetic (allele) variation is caused by mutation, intraspecific and interspecific recombination. The survival of these new alleles is determined by selection, genetic drift and gene flow. Since molecular techniques have become more accessible in diversity research, it became clear that genetic biodiversity is strongly underestimated. The existence of cryptic genetic diversity has been revealed in numerous marine taxa (Knowlton, 2000). Next to the dispersal potential of a species other factors (such as hydrodynamic currents, dispersal limitation by larval behaviour, selection by local adaptation and historical barriers) have an important influence on population genetic divergence.

Mesopodopsis slabberi is one of the most common mysids along the European coasts. The lack of pelagic larvae and the broad geographic distribution of the species, makes it an interesting model organism for evolutionary research on patterns of cryptic speciation (Remerie *et al.*, 2006). In the present study, the degree and causes of cryptic speciation within the species *M. slabberi* were further investigated. By analysing populations of different habitats (lagoons, surf zones, estuaria, marshes) and by focusing on the Atlantic–Mediterranean transition zone, we tried to create a better vision about the contemporary and historical phenomena and the ecological background behind the observed genetic diversity. The phylogeographic patterns among populations were analysed by means of DNA sequencing of a fragment of the mitochondrial cytochrome c oxidase subunit 1 (COI) and the 16S ribosomal RNA genes. We concluded that a high level of cryptic speciation was present within *Mesopodopsis slabberi*, with at least 6 cryptic lineages (2 Atlantic, 3 Mediterranean and 1 Black Sea). These levels of cryptic diversity are discussed in a contemporary and historical framework.

References

Knowlton N. 2000. Molecular genetic analysis of species boundaries in the sea. Hydrobiologia 420:73-90.

Remerie T., T. Bourgois, D. Peelaers, A. Vierstraete, J. Vanfleteren, and A. Vanreusel. 2006. Phylogeographic patterns within the mysid *Mesopodopsis slabberi* (Crustacea, Mysida): evidence for high molecular diversity and cryptic speciation. Mar. Biol. 149:465-481.

GENERATION OF IRREGULAR LONG AND SHORT CRESTED WAVES IN A NUMERICAL MODEL FOR WAVE PROPAGATION

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MildWAVE (Troch, 1998) is a numerical mild-slope wave propagation model which is able to generate linear water waves over a mildly varying bathymetry and to calculate instantaneous surface elevations throughout the domain. Wave transformation processes such as refraction, shoaling, reflection, transmission and diffraction are simulated intrinsically.

Characterising the wave climate in coastal regions using regular waves is mostly unsatisfactory. Irregular long crested waves are most often used to represent the real sea state. In reality the sea state is however short crested and the waves propagate in multiple directions. So, short crested wave generation is the best approach to model real waves. Both irregular long and short crested wave generation has been implemented in MildWAVE. In order to validate the numerical wave generation module, tests were run in a numerical wave flume and wave tank. The use of the so-called energy velocity appears to be a necessity when using the mild-slope equations.

The result of the thesis is a multifunctional numerical model that can be used for different applications, for example to estimate the risk of flooding in a harbour due to wave penetration and overtopping or to predict the influence of coastal engineering structures on the wave propagation. The possibilities of the new MildWAVE model were demonstrated with an extensive application for the Harbour of Ostend. The present situation and two future designs with breakwaters have been compared for both long and short crested waves and for different storm scenarios.

References

Caspeele R. 2006. Generation of irregular long and short crested waves in a numerical model for wave propagation: implementation, validation and application. Thesis (in Dutch), Dept. of Civil Engineering, Ghent University.

Troch P. 1998. MildWAVE - A numerical model for propagation and transformation of linear water waves. Internal Report, Dept. of Civil Engineering, Ghent University.

Annual VLIZ North Sea Award - 2006

Each year the Flanders Marine Institute (VLIZ) awards a scientific prize to foster innovative fundamental or applied research on the structure and functioning of the North Sea ecosystem, with emphasis on coastal and estuarine aeas of the Southern Bight and the Channel. The prize is awarded to a researcher (or a research team) working and residing in a country bordering the North Sea. The prize amounts to 1000 EUR and is indivisible. It is granted to reward a recent original scientific contribution, preferably having relevance to the sustainable management of the area concerned. Studies pertaining to the biodiversity of the local ecosystem are equally welcomed. The contribution has to be of postgraduate or postdoctoral level.

The Annual VLIZ North Sea Award 2006 is awarded to:

Eric Stienen
for his scientific contribution entitled:

Living with gulls – trading of food and predation in the Sandwich Tern *Sterna sandvicensis*

LIVING WITH GULLS – TRADING OF FOOD AND PREDATION IN THE SANDWICH TERN STERNA SANDVICENSIS

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Rationale for the study

The low-lying, sandy areas along the Dutch coast offer important breeding opportunities for Sandwich Terns *Sterna sandvicensis*. Throughout the twentieth century Sandwich Terns nested here in fluctuating numbers. The Dutch population suffered from a major kill in the 1960s due to pesticide pollution causing the number of breeding pairs to drop from over 35,000 in the 1950s to 875 in 1965. After the spill of pesticides had stopped the numbers slowly increased but after 40 years the population has not yet fully recovered. The slow and incomplete recovery of the Dutch population was a source of concern and the present study aimed at a better understanding of the factors regulating the size of the Dutch Sandwich Tern population. Following the crash in the 1960s, the size of the Dutch population positively correlated with the amount of young herring present in the North Sea (Brenninkmeijer and Stienen, 1994). This relationship suggests that the Dutch Sandwich Tern population is limited by food availability. For this reason we concentrated the study on the feeding ecology of Sandwich Terns, hoping to find links with population dynamics.

Outline of the thesis

In this thesis, I concentrate on the feeding ecology of Sandwich Terns during the breeding season and how Black-headed Gulls *Larus ridibundus* interfere with the food input into the colony and consequently shape the foraging decisions of the terns. The impact of variation in food availability and the impact of the gulls are dealt with in terms of fitness costs. Although some data were gathered in a Danish breeding colony and some in the wintering areas of the terns, the study is largely based on observational data that were gathered in the breeding colony on Griend, the Netherlands. This island of about 57ha is situated in the Dutch part of the Wadden Sea, and harbours Europe's largest population of Sandwich Terns.

During the study period (1992-1999), the number of pairs fluctuated between 5,000 and 8,300, but further increased afterwards to 11,275 pairs in 2004. For the study I could elaborate on the study of Veen (1977), who very precisely described various functional aspects of the nest distribution in Sandwich Terns on Griend. Veen studied the associative nesting behaviour of the terns and found that the non-aggressive terns profit from the presence of Black-headed Gulls (or other aggressors) for the protection of their eggs and chicks. For that reason Sandwich Terns intentionally settle near or in the middle of a Black-headed Gull colony. The associative nesting with the gulls means that the gulls themselves sometimes rob a tern egg or a chick and steal fish that is meant for the tern chicks. During the breeding season Sandwich Terns are highly gregarious and breed in large, very dense colonies. Within a (sub)colony egg laying is highly synchronised and consequently most chicks hatch at about the same date. The chicks are semi-precocial and some days after hatching the social structure of the

colony slowly disintegrates. Parents and their chicks start walking around and seek new hiding places; first inside the colony but soon also in its direct surroundings. This behaviour makes it very difficult to study individual chick feedings and growth for a longer period. Previous studies on feeding ecology of Sandwich Tern chicks therefore only describe short periods and often involved smaller chicks (e.g. Pearson, 1968; Isenmann, 1975; Veen, 1977; Campredon, 1978; Garthe and Kubetzki, 1998). To prevent the chicks from leaving the colony site we held them inside enclosures of chicken wire, where they could be followed from hatching until fledging.

Food specialists

Being strictly piscivorous, Sandwich Terns are near the top of the marine food chain. They predominantly feed on an exclusive diet dominated by a few marine fish species with a high nutritive value. This restricted choice makes them extremely vulnerable to variation in the abundance and/or the availability of their food. This makes the Sandwich Tern a good indicator of the prevailing food situation. In chapter 2 we describe some general patterns in the amount and the composition of the food that is transported to the Sandwich Tern colony on Griend. Due to the specialised food choice of the parents and the fact that they bring fish to the colony one by one, changes in the availability of the prey fish are likely to be instantly reflected in the diet composition of the chicks.

Kleptoparasitising gulls

Sandwich Terns are single prey loaders that carry the fish one at a time to their nestlings holding it crosswise in the bill with the fish's head held on one side. The feeding areas may be up to 25km from the colony and in some colonies even further. When arriving in the colony prey-carrying parents are often heavily attacked by Black-headed Gulls that try to steal the fish. Prey stealing or kleptoparasitism is relatively common in seabirds (Brockmannn and Barnard, 1979; Furness, 1987). Gulls are frequent kleptoparasites, whereas species that nest in highly concentrated colonies and conspicuously carrying their prey are frequent victims (Brockmann and Barnard, 1979; Duffy, 1980; Barnard and Thompson, 1985). Sandwich Terns evoke kleptoparasitism even more than other hosts, because they intentionally seek the presence of Black-headed Gull colonies to build their nests. As a consequence they are forced to live with the consequences of high rates of food loss to kleptoparasitising Black-headed Gulls.

In chapter 3 the consequences of the prey stealing behaviour of the gulls are treated from the perspective of a tern chick. We describe how prey stealing evolves with the aging of the tern chicks and how it depends on the food choice of the adult terns as well as on weather conditions. Finally the effects of prey loss to the gulls are expressed in terms of growth and survival of the chicks. It is assumed that animals seek to maximise forage intake and that individuals that forage more effectively than others will be at an advantage (Schoener, 1971; Krebs, 1973; Charnov, 1976). Animals that must return to a central place in order to feed their young are restricted by travel time costs because they must perform round-trips between the breeding ground and the foraging patches. Single prey loaders must return to a central place each time they catch a prey and are thus even more restricted (Orians and Pearson, 1979; Lessels and Stephens, 1983). Sandwich Terns are specialist central place foragers with a restricted choice of prey species and prey size. They are single prey loaders that perform long foraging trips and face additional costs of losing prey to kleptoparasitising gulls when arriving in the

colony. In chapter 4 it is explained how this influences the foraging decisions of Sandwich Tern parents nesting on Griend. Parent terns are largely able to buffer fluctuations in food availability and counterbalance the negative effects of the food losses to the gulls.

Birds have adopted several behavioural strategies to reduce food loss through kleptoparasitism (Barnard,1984). They may tolerate the losses, compensate for them by increasing their foraging effort or evade the attacks. The avoidance strategy includes faster handling of prey, shifting the diet, synchronizing feeding activities and increasing the distance from the pirates (Amat, 1990). Sandwich Tern parents often lead their chicks away from the nesting site (Cullen, 1958; Chestney, 1970; Veen, 1977; Campredon, 1978) and thus away from the kleptoparasitising gulls, but the reason for this behaviour is not well understood. In chapter 5 we experimentally tested whether leaving the colony site might be an evasive strategy that leads to a reduced incidence of robbery by the gulls. Because seabirds depend on highly unpredictable food resources that show large temporal and spatial variations one would expect them to be very flexible in the growth of their chicks. In many bird species slow growth can, however, increase chick mortality and may have negative effects on post-fledging survival or recruitment (Gebhardt- Henrich and Richner, 1998).

In chapter 6 the fitness consequences of growth rate variation in Sandwich Tern chicks are explored. We suspected that the chicks had wide margins within which body mass could vary without having strong effects on pre- or postfledging mortality. We also examined if variation in growth rate during the nestling phase had effects on the size an individual reached as an adult.

In chapter 7 we focus on the various causes of chick loss in relation to the laying sequence of the egg from which the chick originated and the chick's rank within the brood. We try to answer the question why Sandwich Terns that lay normally two egg-clutches seldom raise two chicks to fledging.

Wadden Sea versus wintering area
Sandwich Terns spend most of the year in the wintering areas and only a few months in the breeding colonies. Most European Sandwich Terns winter along the west coast of Africa, with Ghana and Senegal being the major strongholds (Müller, 1959; Møller, 1981; Noble-Rollin and Redfern, 2002). A minority of the birds spend the winter in the Mediterranean and some travel around South Africa to winter along the African east coast.

In chapter 8 we search for evidence of food stress in the wintering areas and for that reason we studied the feeding ecology of terns in the coastal waters of Guinea Bissau. These waters hold important numbers of western Palaearctic terns as well as local tern species. The different feeding strategies of Little Tern *S. albifrons,* Sandwich Tern and Royal Tern *S. maxima* are discussed and placed in an energetic context. In the final chapter of this thesis the underlying causes for population fluctuations in the Sandwich Tern are examined in the light of my own study. My conclusion is that the recovery of the Dutch population after the collapse in the 1960s due to the pollution of the coastal waters with organochlorine was initially halted by poor prey stock availability. Afterwards, marked changes in the Dutch Wadden Sea population correlated with

fluctuations in the availability of herring and sprat indicating that the growth of the population is limited by the availability of prey fish. The distribution of Sandwich Terns over the different populations in Europe is probably determined by changes in the North Atlantic Oscillation being the driving force that changes the distribution and composition of fish stocks in the North Sea and ultimately determines food availability for European Sandwich Terns.

ORAL PRESENTATIONS

VISIONS ON THE HIDDEN FACE OF THE EARTH: PERSPECTIVE OF THE EXPLORER – OBJECTIVE OF THE COACH

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1857: Eduard Suess inaugurates his course in geology in Vienna. In 1878, he undertakes his magnus opus, 'Das Antlitz der Erde', 'The Face of the Earth'. In his earlier, most influential booklet 'Die Entstehung der Alpen', he had transported the reader mentally to the top of an Alpine peak. In 'The Face of the Earth', Suess invites the reader to imagine himself to be a visitor from space, pushing aside the clouds to contemplate the global scene of continental structures. The ocean realm, however, would still remain veiled by a thick cover of clouds, for decades. In his 'Bathyfolages' (1954), Théodore Monod would playfully evoke the cloud screen, in debating the fragmentary sampling through sounding and dredging.

1937: Auguste Piccard designs FNRS 2. After WW II, he resumes work with Cosyns. High time for me to get born. Man's voyage to the 'Hidden Face of the Earth' begins. I would miss the FNRS 2 taxi, but get in time to join Jacques Piccard in diving with 'Forel', and to dive with 'Nautile' in Fracture Zone Kane, 4650m deep, through the Earth's crust – into the Earth's mantle. Jules Verne's 'Voyage au Centre de la Terre' and 'Vingt mille lieux sous les mers' in one promotional ticket.

1957: Sputnik! Gagarin follows, remembering Suess. The International Geophysical Year heralds Global Earth Science. Tack: Space and the Antarctic. June '59: at the end of my school year I am awarded exciting books: 'Verovering van de diepzee', 'Jagers voor de wetenschap'. Cinema Capitole features a free access documentary, sponsored by BP: rugged Sno-cats cross the Antarctic, shooting seismics with big dynamite blasts. Thrilled, I write to BP, and get in return a letter of two pages narrating exploration seismics. An exploration geophysicist is born, keen to hunt for science, from abyss to pole. Public outreach works. My first paper – ocean drilling – gets published in Iris, our school journal (1962, IF: 0, citations: 0).

1967: Plate Tectonics move out of abyss. All geology books have to be re-written. 1977: Zeebrugge harbour development leads our first steps in marine seismics. 1987: Belgium returns to the Antarctic. Tack: due South. RCMG is born. 1997: Margin Research gets momentum under MAST – discovery of the 'Belgica' carbonate mounds in Europe's Western Frontier. 'Geosphere-Biosphere Coupling Processes' (IOC) move to the foreground. 'Biosphere'… a word coined by Suess.

2007: while the IGY 1957-1958 had unveiled the Antarctic realm, the International Polar Year (IPY) 2007-2008 largely polarizes interest on the Arctic. The melting of the ice cover unveils the last 'Hidden Face of the Earth'. Science and Industry move in fast. Visionary vessel projects, like 'Aurora Borealis', break through scepsis. For young

scientists in Ocean and Polar Science, both an area and an era of exciting training through research opportunities are luring. Tack: due North.

FLOATING SEAWEED AS A VECTOR FOR TRAVELING ORGANISMS

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The neuston, *i.e.* the fauna inhabiting the upper layer of oceans and seas, is strongly influenced by the occurrence of floating patches composed of detached coastal seaweed fragments. Ephemeral floating seaweeds harbour a diverse fauna originating from attached seaweeds, the strandline of beaches, the surrounding and underlying water column, the seafloor or the air. These organisms colonise the seaweeds for various reasons, usually including the provision of shelter, food or attachment substrate. The association behaviour of these organisms and their use of the resources offered by floating seaweeds potentially have important ecological consequences, such as the possibility of passive dispersal of associated fauna to new, distant locations by means of rafting.

During this study, different aspects of raft-associated ecology were addressed. The results demonstrate that the habitat formed by floating seaweeds is very complex. Although the presence of floating seaweeds in the neuston can, to a certain degree, be seasonally predicted (storms, seasonal release of fertile structures), the habitat that they form is still very patchy and unstable. Consequently, most species found in association with ephemeral floating seaweed patches are opportunistic of nature. The association behaviour of the encountered species and their (optimal) use of the transient resources offered by floating seaweeds can, in certain circumstances, result in the passive dispersal of associated fauna to new, and distant locations by means of rafting. The process of rafting strongly depends on the longevity of the seaweed raft, which is in turn significantly influenced by temperature and grazing pressure. In favorable conditions, seaweed rafts can potentially cover great distances, carrying with them rafting fauna that are able to survive a long journey in the neuston.

HYDRAULIC DESIGN OF COASTAL STRUCTURES: INVENTING THE WORLD ON A SMALL SCALE

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The hydraulic design of coastal structures is a complex task. Physical models are employed as design tools in almost all major coastal engineering projects. Design physical models have the goal of attempting to predict prototype behaviour by reproducing as good as possible all the features and forces of an actual prototype situation (e.g. breakwater stability, wave penetration in harbours).

Physical models can also be used to study a physical process in detail in order to develop new understanding about the physics (e.g. flow or wave forces on piles).

Besides, physical models are applied to verify or extend numerical models. These validation models may not resemble anything in the real world because often they are idealized and simplified to minimize scale effects and to provide a test case that more closely fits the assumptions of numerical models (e.g. rectangular harbour with perfectly reflecting vertical side walls).

In the oral presentation the different goals and types of physical models will be presented. Advantages, disadvantages and complementary design tools (field measurements and numerical models) will be discussed briefly. A number of photos of physical models and videos of model tests will illustrate the possibilities of physical modelling.

References

Hughes S. 1993. Physical models and laboratory techniques in coastal engineering. Advanced series on ocean engineering 7. 568p.

OCCURRENCE OF HORMONES IN THE SCHELDT ESTUARY: AN ANALYTICAL CHALLENGE!

Noppe Herlinde

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In recent years, scientific concern, public debate and media attention has risen about the presence of natural and synthetic compounds in the environment. This is due to the observation that low environmental concentrations may affect human and wildlife.

The aim of the presented study was to develop and evaluate analytical approaches for the detection of different groups of endocrine disrupting chemicals in environmental matrices, e.g. water, sediments, suspended solids and biota. More specific, the aim was to develop analytical methods for the detection of these compounds in the low $ng.l^{-1}$ or $ng.g^{-1}$ level.

At first, the issue of endocrine disruption will be introduced. This study was carried out within an interdisciplinary research project, Endis-Risks (http://www.vliz.be/projects/endis). This four-year project focused on the distribution, exposure and effects of endocrine disrupting chemicals in the Scheldt Estuary (B-Nl). In this presentation, the emphasis will be laid on the detection of estrogens. In order to understand the possible risks of the environmental occurrence of these compounds, their chemistry, their use, their potential for endocrine disruption and their environmental occurrence will be presented.

Next, the development and validation procedure for the analytical methods that enable (routine) analysis of environmental samples for estrogens in concentrations in the low $ng.l^{-1}$ or $ng.g^{-1}$ range will be described. The methods included speedisk or ASE extraction and detection with gas chromatography coupled to multiple mass spectrometry (GC-MS^2).

Finally, the results of a four-year-(2002-2005) research on the occurrence of oestrone (E1), estradiol (E2) and ethinylestradiol (EE2) in the Scheldt Estuary will be presented. Similar to what has been reported for fresh water environments and waste waters, it was demonstrated that estuarine waters and the associated suspended matter and sediments are contaminated with the same estrogenic compounds and within the same order of magnitude. Oestrone (E1), the degradation product of E2, the most important female hormone was detected most frequently and in the highest concentrations. Low $ng.l^{-1}$ and $ng.g^{-1}$of E1 and β-E2 (β isomer of E2) were detected both in water, sediment and suspended matter samples, whereas concentrations of EE2 were below the limit of quantification (LOQ).

FROM DATA TO QUOTA IN FISHERIES RESEARCH

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Many European countries are exploiting common fish resources in the EU community waters and hence the management of their fisheries is highly governed by the European Common Fisheries Policy (CFP). The main objective of the CFP is that it 'shall ensure exploitation of living aquatic resources that provides sustainable economic, environmental and social conditions ' (Council Regulation 2371/2002, p61). Since the establishment of the CFP in 1983, the application of Total Allowable Catches (TACs) has been a key element in achieving the CFP's objectives. Each year in December, the TACs for the coming year are negotiated between the European Commission and the Council of Ministers for Fisheries, and all Member States receive a fixed share or quota from the agreed TACs.

Setting TACs is the final step of an annual process, which starts with the collection of fishery- and stock-related data at the national level. Data gathering is subjected to the provisions of the Data Collection Regulation (DCR; Council Regulation 1543/2000 and Commission Regulations 1639/2001 and 1581/2004) and ILVO-Fisheries is one of the partners who carries out the DCR for Belgium. Fishery independent data (derived from surveys at sea with research vessels) and fishery dependent data (e.g. landings and discard statistics, length and age compositions of fish caught by fleet segments, etc.) are used to assess the status of the stocks. The assessment of stocks in the North East Atlantic occurs under the umbrella of ICES, the International Council for the Exploration of the Sea. It is also ICES who advises the European Commission on the fishing opportunities for the coming year(s). The Commission makes use of the advice to formulate the TAC proposals for the Council of Ministers in December.

SIGNALS AND SCENARIOS OF CLIMATE CHANGE IN EUROPEAN SEAS

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The Northern Hemisphere has been warmer since 1980 than any time during the last 2000 years, with a stronger temperature increase at northern than southern latitudes. Although marine ecosystems have been influenced by many other factors such as overfishing and eutrophication, every sea in Europe has shown at least some changes related to recent climate change. Even moderate climate scenarios are expected to further alter the marine environment. In the northern Arctic and Barents Seas, the most obvious temperature-related changes for marine life are due to a decline in sea ice cover. In general, it is expected that in open systems there will be a (further) northward movement of marine organisms resulting in a shift from Arctic to Atlantic species in the more northern seas and from temperate to more subtropical species in southern waters. Increased river runoff and subsequent freshening of the Baltic Sea will lead to shifts from marine to more brackish and even freshwater species. Temperature-induced loss of endemic species from enclosed systems, such as the Mediterranean and Black Sea, will enhance the introduction of non-native organisms. A better mechanistic understanding of impacts will be essential for development of adaptive strategies to address the inevitable consequences of climate change for our marine waters.

Reference

Philippart C.J.M., R. Anadón, R. Danovaro, J.W. Dippner, K.F. Drinkwater, S.J. Hawkins, T. Oguz and P.C. Reid. 2007. Climate change impacts on the European marine and coastal environment. Marine Board-ESF Position Paper (and references herein).

POSTER & DEMO PRESENTATIONS

OPTIMAL ENERGY PRODUCTION OF INTERACTING WAVE POWER DEVICES

Beels Charlotte, Peter Troch and Julien De Rouck

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The need for renewable energy is rising at light-speed. The increasing energy demand, the greenhouse effect and the approaching exhaustion of conventional energy resources, forces humanity to use energy more economically and to develop alternative energy supplies, a.o. wave energy. A Wave Energy Converter (WEC) converts the kinetic and potential energy in ocean waves into electricity. A single WEC, with a capacity comparable to a classic power plant (e.g. 400MW), is technologically impossible. Therefore arrays of smaller devices, placed in a geometric configuration or 'farm', are needed.

WECs in a farm interact and the overall power absorption is affected. An optimal pattern of WECs in order to maximise the power absorption is of major importance in the design of a wave farm.

At Ghent University, a mild-slope wave propagation model MildWAVE has been developed (Troch, 1998), e.g. to study diffraction patterns in a harbour (Geeraerts *et al.*, 2003) or to study the effect of short-crested waves on wave penetration (Caspeele, 2006). The phase-resolving model is able to generate linear water waves over a mildly varying bathymetry and to calculate instantaneous surface elevations (and velocity potential) throughout the domain. Wave transformation processes such as refraction, shoaling, reflection, transmission and diffraction are simulated intrinsically. The existing model is adapted by simulating the energy extraction and radiation of a WEC through sponge layers (Beels *et al.*, 2006).

The adapted numerical model MildWAVE, as presented in this poster, is used to study the optimal lay-out and electricity production of a farm.

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FISH DISEASES AND PARASITES ON THE BELGIAN CONTINENTAL SHELF

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During spring and autumn, ILVO-DVI carries out sea-going surveys for environmental monitoring purposes. Fish disease quantification is an integral part of biological and chemical monitoring. The aim of the present study was to monitor if higher prevalence of diseases and parasites could be detected on dredge spoil disposal sites on the Belgian Continental Shelf (BCS) in the period 2004-2005. Therefore, an important number of infectious and parasitical anomalies of the epidermis, the gills and the mouth of several fish species are recorded since 1995.

Severe diseases such as skin ulcers, nodules, skeletal malformations and lymphocystis, which can indicate effects of pollution, are rare on the investigated zones of the BCS. No significant differences could be detected between the dumping sites and the reference zones. Most of the observed anomalies were due to parasites, which show considerable variation in spatial and temporal distribution, and could not be related to a specific zone.

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HET SCHELDE INFORMATIECENTRUM: EEN INFORMATIEPLATFORM VOOR HET SCHELDE-ESTUARIUM – THE SCHELDT INFORMATIONCENTER: AN INFORMATION PLATFORM FOR THE ESTUARY OF THE RIVER SCHELDT

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Het Schelde InformatieCentrum is een Vlaams-Nederlandse organisatie die fungeert als een informatieplatform voor het Schelde-estuarium. Het centrum informeert en documenteert over het getij-gebonden deel van de Schelderivier, dit is het deel tussen Gent (B) en de monding in Vlissingen (NL).

Het hoofddoel van het Schelde InformatieCentrum is het versterken van de **kennis** over en het **inzicht** in het Schelde-estuarium (en de functie ervan voor mens en natuur). Het centrum stelt hiervoor informatie ter beschikking voor iedereen die geïnteresseerd is in het onderwerp, zowel particulier als professioneel. Een belangrijk communicatiemiddel is de website www.scheldenet.be. Het profileert zich als aanspreekpunt voor alles wat betrekking heeft op het Schelde-estuarium. Het centrum coördineert (al dan niet in samenwerking met andere instanties) een aantal projecten zoals een educatieve website met lespakket voor scholen, cursussen voor Scheldegidsen en infopunten bij bezoekerscentra langs het estuarium. Het Schelde InformatieCentrum geeft de Schelde Nieuwsbrief uit, een kwartaaluitgave voor belangstellenden en belanghebbenden. De jaarlijkse Scheldekrant heeft dan weer als doelgroep het grote publiek. In de informatievoorziening en in de projecten staan de verschillende functies van het estuarium (natuur, economie, recreatie en cultuur), de veiligheid en het beleid en beheer van de Schelde centraal.

Ook het versterken van de binding van de bevolking met het estuarium is een belangrijke doelstelling van het Schelde InformatieCentrum. Door een grotere betrokkenheid te bevorderen, hopen we bij te dragen tot een duurzame ontwikkeling van het Schelde-estuarium.

Het Schelde InformatieCentrum heeft een vestiging in Vlaanderen en in Nederland sinds januari 2003. Meer informatie is te vinden op www.scheldenet.be.

The Scheldt InformationCenter acts as an information platform for the estuary of the River Scheldt. This center is active in The Netherlands and in Flanders. Its area of interest concerns the tide-related part of the River Scheldt, i.e. from Ghent (B) to the mouth in Vlissingen (NL).

The main task of the Scheldt InformationCenter is putting information about the estuary area at the disposal of everybody interested in the subject. Additionally, the institute acts as a contact point. The Scheldt InformationCenter coordinates (with or without cooperation of other institutes) Scheldt-related projects. In all activities, the different functions of the estuary, safety, policy and management are central issues.

By informing everybody about the River Scheldt, the institute hopes to enlarge the involvement and public awareness of this estuary, a river so important for the delta-area in the South-West of The Netherlands as well as for Flanders, Belgium.

SIMPLE ONLINE ACCESS TO MARINE SURVEY DATA USING THE IMERS WEB INTERFACE

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IMERS (or Integrated Marine Environmental Readings and Samples), the data system used at VLIZ for storing marine survey data, is in continuous growth. In the previous year, some important progress was made in the realisation of online access to the data that is stored in the data system. With the development of a web interface for the IMERS database users now have the ability to query the database through the internet and to export the retrieved data in various common formats.

The interface that was set up consists out of three main parts. First, there is a querying interface that allows people to build and submit their queries based on various criteria like, parameter, temporal scope, geographical scope and taxonomy. Secondly, there is a results page displaying the results or readings retrieved from the database. Finally, there is a webpage dedicated to the details of each of the readings. On the results page, some export functionalities are provided, allowing the user to extract the data from the database in a desired format and to draw maps of the relevant stations.

ATMOSPHERIC NITROGEN INPUT INTO THE NORTH SEA: ORGANIC NUTRIENT DETECTION

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The levels of gaseous organic nitrogen compounds (alkyl nitrates - ANs)   together with identification of the possible sources of these compounds in the air were studied. Seasonal trends were investigated by conducting the sampling campaigns during the spring, summer and winter time. The air-mass backward trajectories (BWTs) were calculated for the sampling periods by Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model (Draxler and Rolph, 2003). These BWTs were considered for the determination of the influence of the Atlantic Ocean, the North Sea and the continent as possible sources of ANs. An adapted set-up for low and high volume samplings, extraction and minimized clean-up, identification and quantification capabilities resulting from the complementary use of GC-ECD and GC-MS methods is reported. The AN levels were found to be in the range of a few to 7400 $pg.m^{-3}$ in the air. The AN fraction consisted of primarily the 2C4, C5 and C6 isomers, which contribute largely to the total AN level. The N-fluxes by ANs were more pronounced for the summer periods than for the winter/spring months, organic nitrates were the most abundant in the Atlantic/Channel/UK air-masses.

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DEVELOPMENT OF THE ENCORA PORTAL: AN INTERNET BASED FACILITY SUPPORTING EU-WIDE CONTACT SEARCH FOR ICZM RELATED SCIENCE, PRACTICE, AND POLICY COMMUNITIES

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One of the main objectives of the European FP 6 Coordination action ENCORA (=European Network for Coastal Research) is to address fragmentation of and difficult communication between coastal science, practice and policy across Europe. Together with the establishment of national, thematic and affiliated networks, ENCORA developed the ENCORA Portal to support dissemination activities and to share ICZM knowledge through the Web among scientists, practitioners and policy makers (users).

The ENCORA Portal was built upon existing technologies and software tools integrating three main different, interlinked database systems. The Integrated Marine Information System (IMIS) served as the searchable contact database of coastal professionals, institutes and projects. The different national and thematic ENCORA networks have started to feed the database and additionally an online edit tool is foreseen for the near future. A State of the Art Coastal Directory is embedded is the Wikipedia software and linked with the contact database. Striking about the ENCORA Portal is the link between registered users of the Coastal Wiki and the contact database, allowing only fully registered users to upload information in the Wiki Coastal Directory and hence allowing an improved authority and quality control. The link and synchronization between the different relational database systems was established through an in-house developed system and will serve as link to any future systems that may need quality control or authorization. A Thematic and National Forum which can be used as discussion and information exchange platform within the coastal community was also integrated in the Portal and is linked with the other systems.

The ENCORA Portal can be consulted at http://www.encora.eu.

FIELD EVALUATION OF ETHOXY-RESORUFINE-O-DE-ETHYLASE (EROD) AS A MONITOR FOR MARINE POLLUTION

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The regional and annual variations of the ethoxy-resorufine-O-de-ethylase (EROD) activity in relation to the fat content and organochlorine (polychlorinated biphenyls (CBs), hexachlorobenzene (HCB) and p,p'-dichlorodiphenyldichloroethylene (p,p'-DDE)) concentrations in dab (*Limanda limanda*) liver were examined. The biochemical data combined with the chemical data revealed that: (1) a significant EROD induction took place in March and was followed by a rapid decrease in activity in May and September; (2) very few regional differences in EROD activity were observed; (3) the fat content in September was 2.5 fold higher than in March, which indicates that fat was degraded in winter probably due to starvation; (4) the CB content in liver fat remained constant during the year; (5) subsequently the CB and fat content varied in a constant ratio; (6) the CB behavior indicates a saturation condition; (7) the seasonal variation of p,p'-DDE was similar to that of CBs; (8) the liver HCB concentration remained more or less constant during the year; (9) the HCB concentration in the fat was roughly 2.5 fold lower in September than in March, indicating that its partitioning is in a state of equilibrium; (10) the EROD activity varies inversely as the CB and p,p'-DDE content in the liver; (11) the EROD inductions in early spring are probably caused by the mobilization of CBs (and other contaminants) during fat metabolization; (12) the decrease in EROD activity and the simultaneous increase in liver CBs in May and September indicate that the mechanism of CB uptake is well isolated and not available for induction; (13) no correlations between the EROD activity and the organochlorine concentrations were found; (14) no sex differences in EROD activities were observed; (15) migration of dab might influence the interpretation of EROD data. The annual variation in activity of hepatic 7-ethoxy-resorufine-O-de-ethylase (EROD) in dab was used as the basis for the design of a model to predict marine pollution. An attempt was made to interpret these EROD measurements in the light of chemical analysis. How other factors (apart from contaminants) affect the EROD activity was also examined.

CONNECTIVITY AND DEMOGRAPHIC STABILITY OF NORTH SEA SOLE POPULATIONS

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Several commercial marine fish stocks show signs of collapse due to the synergy between climate change and adverse human impacts, such as habitat degradation and overfishing. Besides the reduction in abundance of the exploited species, intense fishing activities have an array of additional ecological impacts. Fisheries may cause irreversible evolutionary changes in life history traits and the genetic structure of populations. One of the species for which such phenotypic-genetic changes are likely to occur is common sole (*Solea solea*). This project aims at studying the connectivity and demographic stability of sole populations in the North Sea and adjacent waters before and after heavy (beam trawl) fishing.

First, we will characterize the spatial and temporal connectivity of the different life stages of *Solea solea*. Are the spawning populations of *Solea solea* separated in time and space or are they well mixed? Do adult fish spawn near the nursery ground where they grew up? Do they return to the same spawning ground year after year? Through the combined analysis of otolith microchemistry and neutral genetic markers, we will answer these questions and investigate the extent to which spawning grounds, nursery areas and feeding grounds are linked. The level of gene flow between different populations will be estimated and adult fish from the feeding grounds will be assigned to their nursery origin. As such, we will evaluate the relative importance of different North Sea nurseries to adult populations.

Secondly, we will analyze the long-term demographic stability of the sole population in the North Sea. Using DNA extracted from historical otolith collections (1960's-1990's), we will investigate possible fluctuations in genetic variability through time, in relation to fishery pressure and methods. The evolution of the effective number of breeding fish will be followed through time, providing a good indicator for the 'genetic health status' of the North Sea stock(s).

Results will improve our understanding of the population genetic structure and the connectivity of spawning grounds, nurseries and feeding grounds of common sole. This knowledge is relevant for fisheries management, in order to identify appropriate management units and to evaluate the benefits of marine protected areas.

WAVE ENERGY EXTRACTION IN THE NORTH SEA BY A HEAVING POINT ABSORBER

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Ocean and sea waves contain a lot of unexploited energy. This energy can be absorbed by wave energy converters (WECs). Wave energy is a renewable energy type that is becoming more and more important. Several systems have been invented, among them point absorber systems which are wave energy converters consisting of small (floating) bodies oscillating with one or more degrees of freedom. They can either operate with respect to a fixed reference, or with respect to a floating reference. The latter principle has been adopted in a novel way in the wave energy converter that is studied in the SEEWEC project, where multiple point absorbers are combined in a floating, moored platform [Seewec web site].

The performance of such a heaving point absorber in a floating platform is analysed in a linear way. The boundary element method (BEM) package Wamit [Wamit manual] is used to determine the hydrodynamic behaviour of both the platform and the oscillating point absorbers. The equation of motion of the point absorber is solved, taking into account the Response Amplitude Operators (RAO) of the platform, calculated by Wamit. Different buoy geometries are evaluated to obtain the ideal values of size, draft and shape with regard to power absorption for different sea states. The natural frequency of the point absorber is changed by adding supplementary mass in order to tune the point absorber to the wave climate (Vantorre, Banasiak *et al.*). In waves characterized by $H_s = 1\text{-}2m$, which have a high occurrence frequency on the Belgian Continental Shelf, a point absorber with a diameter of 4m can absorb about 20 to 30kW.

Two different restrictions are applied to the heave motion of the point absorber. The first one is imposed by the limited stroke of the mechanical system connecting the point absorber to the platform; the second condition is required to decrease the probability of occurrence of slamming.

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COMMUNITY STRUCTURE AND TROPHIC RELATIONS IN AN EAST AFRICAN COUPLED MANGROVE-SEAGRASS ECOSYSTEM

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In Gazi Bay (Kenya), the abundance, diversity and stable isotope signatures of the benthic fauna was compared between the adjacent mangrove, seagrass and non-vegetated sand flats. Replicate cores were taken from each habitat in three sampling stations, during the period February-March 2005. Mangrove and seagrass meadows showed on average higher densities (11500 ind.m^{-2}) than sand flats (3800 ind.m^{-2}), while only seagrass showed a high species diversity (up to 23 spp.m^{-2}). All stable isotope signatures ranged between -28.6 and -10.1‰ for δ^{13}C and -1.3 and 7.5‰ for δ^{15}N, the mean δ^{13}C value was -19.1‰. In this study, there was no direct evidence for mangrove or seagrass tissue consumption by the macrobenthic species sampled in Gazi Bay. Most species seem to feed non-selectively on microalgae and seagrass detritus or selectively on microalgae. The higher δ^{15}N values were found in omnivorous polychaetes and filter-feeders. Spatial shifts were investigated between the stations and habitats. Only polychaete density and diversity varied significantly between the stations, possibly mediated by diversity in seagrass features in the local seagrass beds. δ^{13}C enrichment of the species tissue was observed between the river mouth and the seaward side of the bay. Despite the large differences in isotope signatures of the dominant local primary producers, we found no consistent gradient in consumer δ^{13}C signatures between the different habitats.

THE BACTERIAL STORAGE COMPOUND PHB PROTECTS *ARTEMIA FRANCISCANA* FROM PATHOGENIC *VIBRIO CAMPBELLII*

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Infections caused by luminescent vibrios can cause dramatic losses in aquaculture. These infections are often hard to treat with antibiotics because of the spread of resistant strains and therefore, alternative control strategies are urgently needed. We previously found that the short-chain fatty acid 3-hydroxybutyrate protects *Artemia* from pathogenic *Vibrio campbellii*. In this study, we investigated whether the homopolymer of the fatty acid, the well-known bacterial storage compound poly-3-hydroxybutyrate (PHB), could be used to protect the nauplii from the pathogen.

A starvation experiment learned us that the addition of 1000mg.l^{-1} PHB particles (average diameter 30μm) to the culture water of starved *Artemia* nauplii significantly enhanced their survival. This indicated that the nauplii could obtain energy from the PHB. In order to provide the nauplii from energy, the PHB must have been at least partially degraded into water-soluble products (*i.e.* 3-hydroxybutyrate monomers and oligomers). Subsequently, an *in vivo* challenge test was performed with the PHB particles and *Artemia* nauplii challenged to *Vibrio campbellii* LMG21363. The addition of the PHB particles (at 100mg.l^{-1} and 1000mg l^{-1}) to the *Artemia* culture water together with the pathogen significantly enhanced the survival of the infected nauplii. A complete protection (no significant difference in survival with uninfected nauplii) was observed at the highest concentration. If the PHB particles were added 1 day after the addition of the pathogen, a similar but less pronounced effect was noticed.

In a second in vivo challenge test, we investigated the effect of the addition of a PHB-accumulating *Brachymonas denitrificans* strain on the survival of infected nauplii. The strain, added either untreated or pasteurised at 10^{7}CFU ml^{-1}, completely protected the nauplii from the pathogen if it had a high PHB content (32% of the VSS). No protection was observed if the strain had a low PHB content.

TRANSLATION OF BIOLOGICAL AND SEDIMENTOLOGICAL POINT DATA TOWARDS HABITAT SUITABILITY MAPS OF BIOLOGICAL COMMUNITIES AND EUNIS LEVEL 5 MAPS. PART 1: FROM POINT DATA TOWARDS FULL COVERAGE HABITAT SUITABILITY MAPS OF MACROBENTHIC COMMUNITIES

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If full coverage maps of the physical habitat are available and if the relationships between the physical and the biological habitat are known, it is possible to create a full coverage map of the biological habitat. Predictive modelling or the prediction of physical and biological information in areas with gaps, is a hot topic in the framework of habitat mapping and nature protection.

The study area is the Belgian Continental Shelf where full coverage maps were produced for both the physical and biological habitat.

Sedimentological point data of median grain size and silt-clay percentage were interpolated towards full coverage maps. For the map of the median grain size, a multivariate geostatistical technique was used (Kriging with an external drift), taking into account the bathymetry to assist into the interpolation (Verfaillie et al., 2006). The silt-clay percentage was interpolated using Ordinary Kriging with directional variograms for the anisotropy of the data.

A predictive model based on discriminant function analysis (Degraer et al., in prep.) was used for 1) detecting the environmental variables that are discriminating between different macrobenthic communities (based on the biological point data) and 2) deriving classification functions for assigning samples, for which only physical information is available (from the sedimentological point data) to a certain macrobenthic community. The output of the model is a set of four classification functions (for each macrobenthic community) consisting of three discriminant functions: median grain size, silt-clay percentage and an interaction term between both (median grain size x silt-clay percentage). The discriminant functions have community specific weights.

With the classification functions, the full coverage maps of median grain size and silt-clay percentage were translated towards four full coverage habitat suitability maps of the macrobenthic communities.

IMERS, A GENERAL DATA SYSTEM FOR STORAGE OF MARINE SURVEY DATA ANNO 2007

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The IMERS database or Integrated Marine Environmental Samples and Readings database was set up at the Flanders Marine Institute (VLIZ) in response to the growing need for a general repository that could store the data resulting from sampling campaigns in a uniform way. The database has been designed for storing measurement data based on sampling of water, sediment, suspended matter and biota.

The measurement data, the so-called readings, are stored together with a maximum of information on the actual sampling event that lay at the basis of the measurement. This way, for example biotic readings can be queried together with the environmental readings that were registered during the same visit of a station.

The design of the database can be split up into three major parts. The first part is based on the general concept of sample-taking and the main tables here are 'Trips', 'Visits', 'Events', 'Samples', 'GranRecords', 'BioRecords', 'Specimens' and 'Readings'. The second part of the database structure is built around the table 'ReadingTypes'. This part documents the reading and stores information on what parameter, unit, matrix is measured and what method is used. Each record in the 'Readings' table is linked to a readingtype. The third part of the database structure is built around the table 'ReadingAdministration'. This part of the database stores information on the origin of a reading (file and data set), who is the author of the reading and what restrictions apply to it. All data can be traced back to their origin through a link with this table. In order to be able to group data coming from various sources and to be able to make data selectively visible, a system of context labeling was built into the database. The one-to-many relationship between the ReadingAdministration and these context labels make it possible for each reading to be part of one or more contexts.

There is a maximum of integration of the database with the other databases managed at the Flanders Marine Data and Information Centre. All species records in the IMERS database are directly linked to the APHIA database (VLIZ's marine species register for the North Sea (http://www.vliz.be/Vmdcdata/aphia/index.htm). The persons and institutes in the IMERS database are linked to IMIS (Integrated Marine Information System; http://www.vliz.be/Vmdcdata/imis2/index.php). Where relevant the trips in the IMERS database are linked to the trips in MIDAS (Marine Information and Data Acquisition System; http://www.vliz.be/Vmdcdata/midas/index.php).

For own use and to allow external users of the database to manually input data into the IMERS system, an input tool has been developed. This input programme can be used for both online and offline input. In the case of offline input (for example on board of a research vessel) the data is temporarily stored in a local database before it is uploaded to the server database.

Currently the IMERS database contains over 230,000 biotic records and more than 31,000 records for environmental parameters. A web interface allowing online consultation of the public part of these data can be found on http://www.vliz.be/vmdcdata/imers/

A MARINE BIOLOGICAL VALUATION MAP FOR THE BELGIAN PART OF THE NORTH SEA

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Policy makers and marine managers request reliable and meaningful biological baseline maps to be able to make well-deliberated choices concerning sustainable use and conservation in the marine environment. When such maps are lacking one is often obliged to base value assessments on the best available expert judgment. Biological valuation maps compile and summarize all available biological and ecological information for a marine area and allocate an integrated biological value to subzones. Derous *et al.* (in press) developed a valuation concept around a selected set of valuation criteria (rarity, fitness consequences, aggregation, naturalness and proportional importance). The concept allows the assessment of the intrinsic value of the subzones within an area, on a relative basis. In order to develop a marine biological valuation map for the Belgian part of the North Sea (BPNS), a protocol for the practical application of this valuation concept was developed. After dividing the area into subzones and collecting the available biological data, the protocol allows the scoring of the valuation criteria by answering specific assessment questions. These questions are relevant for the different criteria and incorporate all organizational levels of biodiversity (from the genetic to the ecosystem level). Applying this protocol to the data of the BPNS allowed producing a full-coverage biological valuation map for the area, which integrates knowledge on seabirds, macrobenthos, demersal fish and epibenthos. Separate valuation maps for each ecosystem component are also available, next to reliability maps for each valuation map. These maps can be used as baseline maps for future spatial planning in the BPNS.

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ENVIRONMENTAL IMPACTS RESULTING FROM THE DISPOSAL OF DREDGED MATERIAL AT THE S1 DUMPING SITE, BELGIAN CONTINENTAL SHELF

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To guarantee a safe access to harbours, dredging of the maritime access channels is needed. Moreover, shipping channels have to be adapted to the continuously increasing size of vessels. In some cases, the dredged material is reused for beach nourishments or infrastructure projects, but mostly, it is dumped on offshore dumping sites. The efficiency of a dumping place is determined by economic, physical and ecological criteria: (1) dumping places need to be situated close to the navigation channels; (2) a low recirculation of the dumped material towards the dredging places is aimed at; and (3) a negligible effect on the ecosystem should be ensured. The goal of this research is providing baseline information on the impact of dumping on the morphology, sedimentology and biology and the adaptation after cessation of dumping. Both the dumping site as its environment have been considered.

The investigated dumping site S1, the largest on the Belgian Continental Shelf, and its surroundings were surveyed with a multibeam echosounder (RV Belgica) providing bathymetrical and backscatter data. Additionally, seabed samples were taken for sedimentological/biological analyses with a box corer, a Reineck corer or Van Veen grab. Finally, chrono-sequential single-beam echosounding was used to investigate the morphodynamic evolution from 1995 until 2002.

Generally, the results reveal that on a short- and medium-term, the impact of the dumping of dredged material on the morphology, sedimentology and ecology is drastic, but localised. After the cessation of the disposal of dredged sediments, it seems that the site has restored a morphodynamic equilibrium, both from a morphological, sedimentological point of view, however this is hard to say for the biology (*cf.* nine stations are devoid of macrobenthos).

CO$_2$ MEASUREMENTS IN SEA ICE

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The impact of sea ice on the interactions between the atmosphere, the ocean and the biosphere is well known in the polar area. However, sea ice has been assumed to be an impermeable and inert barrier to air sea exchange. But Golden *et al*. (1998) showed that sea ice is a highly permeable medium for gases under some conditions (T= -5°C, Salinity = 5). Accordingly, uptake of atmospheric CO$_2$ over the sea ice cover in the Arctic and Southern Ocean were recently reported.

Data on gas composition in sea ice are scarce and analytical methods are thought to be sensitive to CO$_2$ contamination in relation with carbonates system in the brines of sea ice. A new analytical method has been tested on experimental abiotic sea ice. It consists in equilibrating sea ice with a standard atmosphere (Verbeke, 2005).

These measurements were carried out at different temperatures in order to follow the carbonates system displacement in bulk sea ice.

When temperatures increase, the partial pressure of CO$_2$ (pCO$_2$) remains stable up to a temperature threshold and then decreases down to values below to pCO$_2$ of the standard atmosphere.

This can mainly be explained by the dilution of brine during the increase of temperatures. Pure ice crystals melt and lead to the dilution of brine and related decrease of pCO$_2$.

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ASSESSMENT OF THE WATER SOLUBLE IONIC SPECIES OF SUSPENDED PARTICULATE MATTER, COLLECTED AT A COASTAL SPOT, DE HAAN, BELGIUM

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Chemical characterisation of suspended particulate matter (SPM) is very useful for broadening the knowledge concerning processes which are active in the atmosphere (e.g. Lin, 2002). Continental air-masses were found to contain high levels of anthropogenic emitted species, while these levels decreased when the influence changed to an oceanic atmosphere. The high levels of NH_4^+, NO_3^- and non-sea-salt (NSS) SO_4^{2-} in the fine SPM fraction of continental air-masses (0.38, 0.15μg.N.m^{-3} and 0.59μg.m^{-3}, respectively) stresses the importance of secondary aerosol formation as a source for SPM. The dominant appearances of Na^+, Cl^-, Mg^{2+} and Ca^{2+} in coarse maritime air masses show the presence of sea-salts and soil dust in the atmosphere at the coastal region. Neutralisation ratios higher than unity (1.20-1.59) for the fine SPM fraction suggested an excess of NH_4^+, which was most probably present in the form of NH_4Cl due neutralisation of HCl. The latter was formed in atmospheric reactions with sea-salt particles (Kadowaki, 1977), during which HCl escapes (0.13 and 0.58% lost sea-salt chloride for winter and summer, respectively). Correlation analysis showed that warm and dry summer conditions eliminated some influence of sea-salts on atmospheric processes, that where found to be active during winter. NSS SO_4^{2-} was the dominant S-contributor in the fine fraction (83%). During winter, a total SOR value of 0.61 was reached, while summer gave a significant lower value (0.24). These values classified the sampling-site at the Belgian coast as a combined receptor-source area, accepting pollution from the continent and its local surroundings (Shaw and Rodhe, 1982).

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EXPLORING GLACIAL AND PRESENT EVOLUTIONARY PATTERNS OF A MARINE GOBY, *POMATOSCHISTUS MINUTUS*

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A classical understanding of marine fishes is that they have high effective population sizes and high levels of dispersal due to an apparent lack of barriers in the marine environment. The realization of a genetic population structure is therefore thought to be a slow process. To gain insights in this process, it is a challenge to disentangle the interaction between selection, gene flow, population history and genetic drift.

The sand goby (*Pomatoschistus minutus*), which is an important ecological but non-commercial species, was chosen to distinguish between natural and anthropologically induced processes. A spatio-temporal analysis with samples from different localities throughout the species distribution and with two types of genetic markers was performed to assess the neutral genetic population structure. Phylogeographical patterns were studied by sequence cytochrome *b* (mtDNA). Nine new nuclear microsatellites were developed and used to describe the current genetic diversity and population structure.

The genetic structure of the sand goby is best explained by a combination of present and historic factors. Due to its high potential for dispersion and high effective population size, it shows the typical features of a marine fish with a high level of diversity and a limited degree of genetic differentiation. The large genetic distance between the Venetian and all other samples shows that the sand gobies from the Adriatic Sea should be considered as a distinct cryptic species of the genus *Pomatoschistus*. Low but significant differentiation is observed between Atlantic and western Mediterranean *P. minutus*. In the Atlantic and Baltic basins, there is evidence for a postglacial range expansion and a weak pattern of isolation-by-distance. Furthermore the results support the hypothesis of a glacial refugium and a fine-scale genetic structure in the southern North Sea.

The neutral genetic pattern will be compared with putatively adaptive loci in order to study the genomic characteristics of local adaptation in the marine environment. This should provide a better understanding of how fish respond to changes in the environment.

STANDARDIZATION OF PROTOCOL FOR *VIBRIO* CHALLENGE IN SPECIFIC PATHOGEN-FREE (SPF) SHRIMP (*LITOPENAEUS VANNAMEI*)

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This study was conducted to standardize the protocol for *Vibrio* challenge in specific pathogen-free (SPF) shrimp (*Litopenaeus vannamei*). Shrimp, from postlarvae15 to juvenile, were challenged with *Vibrio campbellii*, *V. harveyi* 642, *V. harveyi* E022, *V. harveyi* E2, and *V. penaeicida* by immersion and injection in normal as well as stress conditions. For immersion challenge, shrimp were immersed in seawater containing 10^3, 10^5, and 10^7 CFU mL^{-1} of bacterial cells. They were fed with *Artemia* nauplii, *Artemia* charged with *V. campbellii*, a piece of shrimp meat which was injected with the *Vibrio campbellii* or artificial feed during five days experiment. Bacterial density in the water and shrimp samples was determined at the end of experiment. There was no significant difference in mortality between the control and *Vibrio* challenged groups in normal conditions ($p > 0.05$). Therefore, different stress factors were tested such as starvation, salinity and ammonium. 12h exposure to 40 and 50 mgL^{-1} NH$_4^+$ (pH = 7.9-8.1) were found as sublethal doses for postlarvae and juvenile shrimps respectively. Starvation, ammonium stress (before and during challenge periods), and salinity stress at 5, 10, 20 gL^{-1} did not enhance the susceptibility of shrimp to *Vibrio* challenge by immersion.

In absence of stress, SPF shrimp is not susceptible to *Vibrio* either by immersion or injection. Only in ammonium stress, SPF shrimp is susceptible to Vibrios to a large extent by injection with 10^6 CFU shrimp^{-1}. *Vibrio campbellii* was found as the most virulent strain towards SPF shrimp among five tested strains.

1-D MODEL OF THE MARINE ECOSYSTEM OF THE CALVI BAY

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The ecological and economic values of the oceans are a matter of concern. The understanding of the anthropogenic disturbances on coastal marine ecosystems generally require important investments, whereas local authorities are interested in fast answers to specific questions about their particular environment, which is obviously in contradiction with the time needed to obtain an exhaustive data set and with the elevated costs associated with these analyses. For these reasons, the setting up of a sustainable management procedure is very critical. In this framework, the RACE (Rapid Assessment of the marine Coastal Environment) project aims at developing diagnostic tools to detect and predict changes in the coastal ecosystems threatened by human activities, by means of an interdisciplinary approach taking benefit of the numerous data collected for decades at the STARESO observatory in Calvi (Corsica) and the modeling tools developed at the University of Liège.

As a first step of this vast project, we have developed a 1-D ecosystem model that aims to reproduce the seasonal cycles of the plankton and of an endemic seagrass *Posidonia oceanica*. In addition to its high primary production, this macrophyte performs many functions in marine areas, provision of food to the coastal food web and of oxygen to the water column and the sediment, atmospheric carbon sequestration, organic carbon export, sediment stabilization, shoreline protection, habitat for microbes and (in)vertebrates, often endangered or commercially important, trapping and cycling of nutrients, etc. and is considered as a good indicator for bio-monitoring, because of its wide distribution, reasonable size, sedentary habit, easy collection and sensitivity to modifications of the littoral zone.

We here present the results of our model simulations and briefly discuss them. Model validation has been performed, allowing us to now test scenarios.

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INDICATORS AND INFORMATION SYSTEMS IN SUPPORT OF INTEGRATED COASTAL ZONE MANAGEMENT IN BELGIUM, THE SOUTHERN NORTH SEA AND EUROPE

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High-quality information and scientifically underpinned data is needed in support of decision taking and good governance in coastal zones. Good governance does not only pursue effective policies and efficient administration. It also aims at building capacity and commitment within society, by supporting a flow of objective and reliable information towards the stakeholders and the wider public, and in a format that is useful and relevant for its purpose. A set of sustainability indicators (SI) addressing the complexity of ecological, environmental and socio-economic issues involved in achieving an integrated coastal zone management (ICZM) can provide an answer in a format that is useful for policymakers and is an effective communication tool towards a wider range of stakeholders.

In a demonstration session, the sustainability indicators (SI) for coastal zones are presented and interactive tools to search, visualize and download data, are displayed. The SI form part of a wider information system for Belgium, as developed by the Co-ordination Centre for ICZM (www.kustbeheer.be); the SAIL partnership in the southern North Sea (www.vliz.be/projects/SAIL) and European DEDUCE project (INTERREG IIIC South – www.deduce.eu). The initiatives are developed within the framework of the objectives as set forward in the EU Recommendation concerning the implementation of ICZM.

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INDICATORS FOR SUSTAINABLE DEVELOPMENT AND INFORMATION SYSTEMS IN SUPPORT OF INTEGRATED COASTAL ZONE MANAGEMENT IN BELGIUM, THE SOUTHERN NORTH SEA AND EUROPE

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Growing concerns about the state of the coast in Europe prompted the European Commission and the Parliament to approve the Recommendation concerning the implementation of Integrated Coastal Zone Management, (2002), calling for an integrated approach to monitor and measure the sustainable development of the coastal zone and addressing the need for relevant, credible and reliable information. DEDUCE (Développement Durable des Zones Côtières Européennes) is a transnational project supported by the INTERREG IIIC-South Community Initiative Programme. Its main objective is to evaluate the utility of sustainability indicators (SI) for optimal decision making on the coast, following the principles of the EU recommendation on ICZM, at all levels: European, national, regional and local. The specific objectives include:

- Characterisation, calculation and comparison of the use and compatibility of the 28 SI (as approved by the ICZM Expert Group) in the territories represented by the partners (Poland, Latvia, France, Belgium, Spain, Malta).
- Evaluation and comparison of the current (web)GIS for the analysis and viewing of the state of the environment in Europe.
- Establishing an indicators-based model of reporting on the state of sustainability of the coastal zones in Europe.
- Guidelines for the use of SI for examining the development of the state of the coast and for decision making of the governments (European, national, regional and local) based on ICZM principles.
- Feasibility study for a European observation network specialising in information and data and information management for the coast.

The partners in the project represent European, national, regional and local entities, allowing to evaluate whether the methodology defined by the calculation of the indicators is useful and feasible for the various territorial levels and existing information systems. The Province of West-Flanders, Flanders Marine Institute, the Co-ordination centre for ICZM-Belgium, the Flemish Agency for Maritime Services and Coast and the SAIL partnership, are partners in the local network representing the Belgian partner in this project. (www.deduce.eu).

BIODIVERSITY OF THE MEIOFAUNA WITH SPECIAL EMPHASIS ON HARPACTICOID COPEPODS IN TROPICAL SEAGRASS BEDS IN PUJADA BAY, THE PHILIPPINES

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Species diversity varies with the spatial scale on which it is studied; the three different spatial levels of biodiversity are alpha, beta and gamma diversity. Alpha diversity measures packing within a community reflecting how finely species divide ecological resources. Beta diversity is used to measure the amount of turnover along environmental gradients, showing habitat selection or specialization. Gamma diversity is similar to beta diversity but it describes a much larger spatial scale, it illustrates the degree of provinciality or endemicity in the biota, the allopatric distribution of closely related taxa as well as the changes in the physical environment within a given habitat type.

This study describes the meiofauna biodiversity of Pujada Bay's seagrass beds with special emphasis on harpacticoid copepods, complementing global scale studies of this group with an outcome that may be used to test and discuss the hypothesis of 'high diversity in the East-Indian region'.

ENDOCRINE DISRUPTORS IN THE SCHELDT ESTUARY: DISTRIBUTION EXPOSURE AND EFFECTS

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The Scheldt Estuary is known as one of the more polluted estuaries in Europe (OSPAR, 2000). The major compartments of the estuary, *i.e.* water, suspended solids, sediments and biota, are all affected by common POPs (persistent organic pollutants). In the framework of the ENDIS-RISKS project these compartments were frequently sampled during the last four years and analysed for these POPs indicated as possible endocrine disruptors. As such, the concentration levels of 22 different polycyclic aromatic hydrocarbons (PAHs), 18 polybrominated diphenylethers (PBDEs), 5 organochlorine pesticides (OCPs), 16 polychlorinated biphenyls (PCBs) and 6 organotin compounds e.g. TBT were determined by the MUMM laboratory. Their distribution (speciation within different compartments), concentration and geographic distribution are assessed. For the biota compartment, mysids were selected as an indicator organism for this particular ecosystem. In these invertebrates, the highest levels ever found for TBT were noted, with concentrations of up to $2500 \mu g.kg^{-1}$ on a dry weight basis (or approx. $100 \mu g.kg^{-1}$ on a wet weight basis). In the same species, $\sum PCB_7$ levels varying from 200 to $1400 \mu g.kg^{-1}$ on dry weight were noted. OCPs and PAHs concentrations varied from 5 to $100 \mu g.kg^{-1} dw$. The geographic distribution - along the salinity gradient of the Scheldt Estuary – of the body burdens of these compounds in mysids are discussed. Finally, the observations were compared to internationally accepted 'Ecotoxicological Assessment Criteria' used to assess the potential adverse effects on the ecosystem.

MANGROVE SPECIES AND STAND MAPPING IN GAZI BAY (KENYA) USING QUICKBIRD SATELLITE IMAGERY

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Stand recognition (delineation and labelling) and species mapping are cornerstones of forest inventory mapping and key elements to forest management decision making. We present an automated method for mangrove stand recognition and species mapping based on fuzzy per-pixel classification techniques.

Mapping of the present distribution of mangrove species in Gazi Bay (Kenya) was done using supervised Maximum Likelihood fuzzy classification of a QuickBird satellite image. Species recordings were obtained during a field mission in July-August 2003 with the Point-Centred-Quarter-Method (PCQM). The overall accuracy if the species map is 72%, where the two socio-economically most important species are mapped with user accuracies above 85%. Mangrove stand maps are obtained through supervised fuzzy classification of the multispectral satellite image, convolution of an appropriate window size and subsequent elimination of patches covering less than 0.05ha. The automated stand boundaries were compared to visual delineations done by an expert interpreter. The quality of the correspondence between visual and automated stand boundaries was assessed based on the quantity of overlap one has with the other. The correspondence varied from perfect, over good, to poor matches. An overall correspondence of 64% was obtained for visual labelling of stands *versus* automated labelling (classification) based on dominant species and total cover. When only dominant species were taken into account, the overall accuracy of stand labelling increased to 86%. Automated stand delineation and labelling are of a quality suitable for operational use in mangrove forest management.

MANGROVE PLANTATION EXPERIMENTS FOR CONTROLLING COASTAL EROSION AT GAZI BAY, KENYA

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The existence of zones parallel to the coastline, in most cases monospecific is evident in mangrove ecosystems. In Gazi Bay, there are nine mangroves species with *Rhizophora mucronata* mainly found in the second zone just after *Sonneratia alba* zone. With increased need for mangrove goods and services worldwide, there is a need to develop best possible ways of reforestation. A deforested area previously under *S. alba* was to be replanted in Gazi bay to control coastal erosion. However, due to the difficulties associated with the establishment of the species, *R. mucronata* was chosen as the next possible option.

This experiment was conducted with an objective of testing the growth performance of *Rhizophora* saplings planted in a low inundation class. It involved planting of propagules in bamboo straws of three diameter classes (large, medium and small). Some propagules were planted without bamboo straws between two bamboo embedded lines to serve as control. A spacing of 0.5m by 1m between crops was used in a block (10mx10m) replicated three times. Monitoring was done for: mortality, shoot height increment, diameter at second internode, leaf number and branching.

Preliminary results showed no significant difference in growth performance between different bamboo encasement sizes. There was however a significant difference between the 'encased' plants and direct planting. Survival was higher in the controls than the encased plants (64.5% vs 18.7%). Annual mean increment in shoot height (42.08±9.33 vs 34.79± 7.53cm), diameter (6.13±0.87 vs 5.20±0.88mm), leaf numbers (14.82±7.23 vs 7.90±3.48) and branching (2.47±1.61 vs 1.01±1.25) was also higher in the control than in the encased. The site could therefore possibly be planted with *R. mucronata* propagules not necessarily in encasements and still ensure a relatively high survival of saplings.

RECOGNIZING THE SEAFLOOR'S CHARACTERISTICS USING HABITAT SIGNATURES

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Seafloor images become increasingly available, both derived from video or photographs and from acoustic remote sensing. Very-high resolution acoustic imagery has indeed the potential of depicting a recognisable sign on an image that relates to a physical and biological nature, *i.e.* its habitat signature.

Still, most of this information is stored at institutes or universities and no up-to-date comprehensive compilation is yet available. Moreover, the acoustic imagery often remains hard to interpret; this is mainly because of the multitude of factors influencing the image and the lack of reference material. When an interpreter studies a remote sensing image, he indeed needs to refer to particular textures and patterns that are recognisable on the image and relate that to reality. Ground truthing remains crucial; still comparison with a large number of similar cases is a necessity. In the framework of marine environmental issues this becomes increasingly important and the need for sound interpretations is real.

To anticipate on this need, a web-based catalogue of seabed habitat signatures is being built in the framework of the MESH project (Mapping European Seabed Habitats), for both scientists and non-scientists. The catalogue contains a collection of images produced by different remote sensing techniques (acoustic and optically derived images, photographs and video). As such, the results of the different techniques can be compared and can strengthen interpretations in view of seabed assessments. The catalogue has a comprehensive list of metadata per habitat signature, both in terms of its physical and biological environment and the conditions under which the signatures were generated.

The web catalogue is easy manageable. Habitats can be searched using their own name or by typing a key word or choosing a EUNIS code or making a query on physical factors. For every habitat one or more significant locations in the Mesh area are chosen and every location displays all the signatures available. Every location is identified by its coordinates (lat., long.) to be easily positioned on the MESH webGIS (http://www.searchmesh.net/webGIS).

The signatures are presented as little thumbnails to let the web user have an easy overview. These link to a page where a description of the image, an enlarged image and all technical data referred to it can be found.

The catalogue will largely increase the visibility of how the seafloor looks like, but above all it is hoped that it will assist in the interpretation of newly acquired data in view of

environmental assessments. Any potential contributor to this catalogue is invited to share their images to a wider European community.

The web-catalogue is developed at Ifremer (http://www.ifremer.fr/mesh-malo/essai_signatures). RCMG is responsible for the input of imagery related to the Belgian part of the North Sea.

EVALUATION OF WIND-WAVE GENERATION FORMULATIONS FOR SEPARATING WIND SEA AND SWELL AT THE GULF OF TEHUANTEPEC

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Measurements of atmospheric and oceanographic parameters have been taken by the CICESE from an offshore location at the Gulf of Tehuantepec. The relevant features in the area are its particular meteorological and wave conditions. Due to a geographical depression of the mountain chain that goes along the isthmus a wind system 'Tehuanos' is formed. This wind system forces a sea that travels southwards offshore, where the wave climate is to a great extent dominated by the presence of swells that propagate typically northwards to the coast. Different methods for separating wind sea and swell have been tested. Namely (a) a constant split up frequency, (b) Drennan *et al.*, formulation, (c) Komen *et al.* formulation, (d) Janssen's theory which is the wind-wave generation mechanism of the WAM model, and (e) spectral partitioning in combination with (c). A constant split up frequency appears to be accurate in this case given that swell and wind sea systems are very well defined in the frequency domain. The use of spectral partitioning has also output satisfactory results. Inconsistencies due to the artificial splitting of the spectrum were found for methods (b), (c) and (d), for which the actual energy of the wind sea is not properly estimated. There was no substantial difference found on the energy-frequency evolution of wind seas for Tehuanos and non-Tehuanos winds.

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CATEGORISATION OF LAND-COVER AND LAND-USE ADJACENT TO A SRI LANKAN MANGROVE LAGOON USING OBJECT-BASED CLASSIFICATION: STATE-OF-THE-ART

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This research deals mainly with the changes in land cover and their impact on the environment (the soil, the infiltration and drainage of water, evapotranspiration, flora and fauna) in and around Chilaw Lagoon, a Sri Lankan mangrove site. This requires research on the space-time dynamics in soil use and land cover to estimate and predict the human influences on the ecological changes. It examines how the fishing and the shrimp farms can (co-)exist on a sustainable manner in particular. A tool getting more and more crucial in the detection, description, quantification and observance of changes in the landscape and land use, is remote sensing (e.g. Dahdouh-Guebas *et al.*, 2005a). In combination with geographical information systems (GIS) and field work, this is an effective management tool, particularly useful in the detection of ecological degradation (Dahdouh-Guebas *et al.*, 2005b). It is very important to detect cryptic ecological degradation to mitigate loss of ecological functions, such as the protection function of mangroves (Dahdouh-Guebas *et al.*, 2005c; Dahdouh-Guebas and Koedam, 2006). In addition, mangroves function as a source for timber and non-timber forest products for subsistence users, and as a nursery for numerous marine species (Ewel *et al.*, 1998).

Our research implements the following activities: (1) Characterisation of the actual land cover by means of remote sensing (Ikonos images) before the field work; (2) Verification on the field of the results of the image classification: land cover, land use, habitats, vegetation assemblages, individual species; (3) Field work on the vegetation structure; (4) Evaluation of the perception of the local population concerning the actual situation of the wood and fishery resources and in particular the cultivation of shrimps; and (5) By analysis of the image processing, the ecological footprint of the shrimp farms and the fishery, a calculation will be attempted of the area of the mangrove forests that are needed for a sustainable management of the shrimp farms and of the mangrove forests.

There appears to be a conflict between the shrimp farms and the mangrove forests. One cuts down mangroves to build shrimp farms. But, on the other side shrimp farms cannot survive without mangroves because the gravid females used for stocking the shrimp ponds are dependent on the mangroves.

A first expected result is an extensive classification of a very high Ikonos satellite image of Chilaw-Lagoon, with an interpretation key. This will give a good view on land cover and land use in the lagoon which will be used for land management. A second expected result is to give guidelines, based on the ecological footprint of shrimp farms,

for reforestation of mangroves. And by this way to give a solution for the conflicts between adjacent land use.

The research is ongoing, but this presentation discusses the state-of-the-art in the light of the above objectives and the expected results.

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'DE ZEE VAN TOEN' (YESTERDAY'S SEA), AN ORAL HISTORY PROJECT ON THE HISTORICAL ECOLOGY OF THE SOUTHERN NORTH SEA 1930-1980, AS TOLD BY FLEMISH PROFESSIONAL FISHERMEN (BELGIUM)

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The title says it all. This is only to inform you on the existence of this project, started January 1st, 2007. It does not present any results at this stage.

The basic aim is to add to a better understanding of this part of the North Sea, the Belgian Continental Shelf and to an extent the Southern Bight, by means of interviewing retired former professional fishermen in Flanders (Belgium). The interviews are taken according to present-day rules of good conduct in 'oral history' projects. The period is set at between 1930 and 1980. The former limit is derived from realism in finding 90+-year-old people with a reliable memory, the latter is set to keep a reasonable distance from present-day fisheries practice.

The interviews ideally yield many biologically and ecologically relevant data. The themes and questions are chosen accordingly but leave room for the unexpected.

The main bulk of information is expected to be related to commercial species. Since early data on fisheries landings are lacking or incomplete as concerns amount, species composition and origin, additional oral information is welcomed. Especially the eldest spokesmen, whose experience goes back to before WWII, will prove extremely useful.

Selected fishermen are queried on target species, used appropriate fishing techniques, seasonal or temporal shifts in availability of target species, shifts in target species composition, shifts in fishing grounds, but also on their knowledge of non-commercial fish species, sea mammals, non-target invertebrates, any interesting biological or ecological oddity...

The project touches many other fields such as coastal heritage and local history, social history, linguistics, wellness of seniors,…

Results will be used to produce a scientific report. In addition educational products can and will be developed in the realms of nature education, environmental education and coastal/maritime/fisheries heritage.

ENDIS-RISKS: ENDOCRINE DISRUPTION IN THE SCHELDT ESTUARY – A FIELD STUDY

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ENDIS-RISKS, a multidisciplinary research project with five institutes, evaluates the distribution, exposure and effects of endocrine disruptors in the Scheldt Estuary. This estuary is known to be one of the most polluted estuaries in the world. Untreated domestic wastewater and effluents of the industrial areas of Ghent and Antwerp are to a large extent responsible for this pollution. During an intensive field study of four years, eight sampling campaigns were executed on seven sampling points along the Scheldt Estuary. A detailed analysis of the distribution of endocrine disrupting substances in the Scheldt Estuary was executed. Water, sediment, suspended solids and biota were analysed for seven groups of chemicals: estrogens, pesticides, organotins, polyaromatic components, polyaromatic hydrocarbons and phenols. Special attention was given to the estuarine mysid shrimp *Neomysis integer*. Its ecotoxicology and population characteristics were studied in detail. A selection of results of this field study is put forward. Water samples, tested *in vitro* for their potential to bind with estrogen, revealed more estrogenic activity in the more upstream stations. Concentrations of chlorotriazine herbicides in water samples, were higher in the upstream reaches compared to the downstream sites. Analyses of TBT in mysid shrimps revealed high concentrations ($>2mg.kg^{-1}$ dry weight) which suggests a high bioaccumulation capacity. Population characteristics results of *N. integer* show that it has a broader distribution range, with a shift more upstream, in comparison with historical data (Mees *et al.*, 1995). On the other hand, length distribution of developmental stages of *N. integer* along the estuary indicates some environmental stress, caused by the estuarine gradient or by pollutants. Some hypotheses will be put forward to explain these patterns.

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Keywords: Endocrine disruption; Neomysis integer; Scheldt Estuary; Field study.

GAS HYDRATE SYSTEMS RESPOND SLOWLY TO SEAFLOOR WARMING

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In a marine environment, gas hydrates are stable at certain pressure (sea level) and temperature (bottom water temperature) conditions. Changes in these conditions may result in the destabilization of the gas hydrates. In this study we investigate the temporal response of a continental margin gas hydrate reservoir to changes in the pressure and/or temperature regime, considering the latent heat of hydrate dissociation and the long response times to conductive heat transport in submarine sediments.

Gas hydrates and the surrounding sediments do not instantly respond to changing environmental conditions. A vertical subsoil column without gas hydrates needs more than 5,000 years to adapt its temperature profile to an increase in seafloor temperature. A vertical subsoil column containing gas hydrates has the same response time if the stability of the hydrates is not affected. Although, when gas hydrates stability is affected due to changes in their environment, the response time to these changes is extended. Destabilized gas hydrates will dissociate into methane gas and water. The dissociation process happens at a constant temperature and requires a lot of energy (heat). Dissociation of gas hydrates thus delays the response time of the surrounding subsoil; up to 100,000 years may pass before the temperature profile completely adapted to the changed environmental parameters.

Because of this slow response to changes in environmental parameters, gas hydrate dissociation cannot be regarded as the trigger to global warming at the end of glacial and stadial periods and gas hydrate dissociation cannot be responsible for the high observed atmospheric methane concentrations in ice core records, as has been postulated in a number of high-profile publications.

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TRANSLATION OF BIOLOGICAL AND SEDIMENTOLOGICAL POINT DATA TOWARDS HABITAT SUITABILITY MAPS OF BIOLOGICAL COMMUNITIES AND EUNIS LEVEL 5 MAPS. PART 2: FROM HABITAT SUITABILITY MAPS OF BIOLOGICAL COMMUNITIES TOWARDS EUNIS LEVEL 5 MAPS

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The full coverage habitat suitability maps of the macrobenthic communities serve as an input to apply the EUNIS classification on the Belgian Continental Shelf and to translate the maps into EUNIS habitat types (EUNIS level 5 maps). The whole analysis was performed within a GIS (Geographic Information System).

The habitat suitability maps were classified by means of the natural breaks classification scheme. Two derivative maps were generated, respectively exceeding probabilities of 60% and 70%. Subsequently, the derived habitat suitability maps were translated into EUNIS habitat types.

A large proportion of the Belgian shelf is covered and assigned to EUNIS classes. Each defined EUNIS habitat type has a habitat suitability percentage exceeding 60%. So far, only the *Macoma balthica* community matches within the current EUNIS classification. The other communities do not exactly match classes within the EUNIS classification. As such, only temporary codes are created and those need an expert review. The Habitat model (Degraer *et al.*, in prep.) does not foresee transitional communities; as such they cannot be mapped. Once these are defined, a complete full coverage EUNIS map can be attained.

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2 YEARS-LONG MONITORING OF *CODIUM ELISABETHAE* POPULATION DYNAMICS IN THE AZORIAN REEF ECOSYSTEM (FAIAL ISLAND) WITH SEABED IMAGERY

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In the Site of Community Interest (Natura, 2000) of Monte-da-Guia (Faial, Azores), two sites were delimited in order to investigate particularly the links between habitat characteristics, population structure, distribution and dynamics of the green alga *Codium elisabethae*. The first site is a large protected rocky seafloor of an ancient volcano crater (20m deep) and classified as no-go reserve. It shows very high density stands of *Codium elisabethae* (up to 105 ind.m^{-2}), representing the main vegetal biomass. At similar depth but distant of about two kilometers, the second site is in a more exposed area, where a sparse population (about 13 ind.m^{-2}) occupies rocky tables and boulders emerging from shallow sandy deposits. These contrasting densities reflect different population dynamic equilibrium resulting from the particular environmental pressures of each site. A two year population survey started in August 2003, aiming principally at building submarine image mosaics of each site on a seasonal basis. Further, a computer assisted detection is run on the images to derive valuable information about the studied macroalgae. This technique allows to study a comparatively large zone regarding to the diving time invested so as to integrate spatial patchiness and to focus on the temporal evolution of well identified individuals. The imagery methodology was validated with *in situ* measurements, confirming the adequacy of the 1cm precision size histograms produced, when considering individuals larger than 5cm diameter. Seasonal fluctuations of growth rate (from 0.5 to 3cm.month^{-1}) and primary production (from 1 to 15kg.m-^{2}.month^{-1}) could be described. For both sites studied, density, biomass and cover rate seemed affected by a seasonal variation with reduction starting in end summer early autumn. In both sites, the reduction was sharp in the fall 2003 and population density didn't recover completely in spring and summer 2004. During the following year, population of the protected site could maintain density and biomass, while population of the exposed site dropped continuously all year. Last processing step will search to relate statistically these different population evolutions to the benthic environmental constraints measured in both sites during the year 2004-2005 (temperature, currents, turbidity, photosynthetic active radiation, nutrients). Differences in hydrodynamic exposure of both sites could be part of the answer, but observed differences in the reproduction intensity of these two populations is an important factor, and remains unexplained.

IN SILICO DETECTION OF SINGLE NUCLEOTIDE POLYMORPHISMS IN EXPRESSED SEQUENCE TAGS OF EUROPEAN SEA BASS

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As a multitude of sequence data are published, discovering polymorphisms bioinformatically becomes a valid option. *In silico* Single Nucleotide Polymorphism (SNP) detection is based on the analysis of multiple alignments. Each column of an alignment is considered a slice containing one base of every sequence aligned. If a mismatch is detected, the slice is further analysed and the mismatch may be reported as a candidate SNP. Around 30,000 European sea bass (*Dicentrarchus labrax*) Expressed Sequence Tags (ESTs) have been sequenced and processed at the Max Planck Institute for Molecular Genetics. Since 55.1% (16,117) ESTs are redundant, they provide a resource for *in silico* SNP discovery. To prevent the detection of sequencing errors, a redundancy of 2 is required for a mismatch to be considered a candidate SNP (Picoult-Newberg *et al.*, 1999). Thus, only contigs containing more than 4 overlapping sequences are analysed. 974 (21.3%) contigs qualify for *in silico* SNPs discovery, representing 5,548 (19%) ESTs and 478,232 base pairs. Various tools are used to detect candidate SNPs; so far, 2 software packages have been tried. 246 candidate SNPs, of which 56 indels, were proposed by SNPServer using default parameters (Savage *et al.*, 2005). Less stringent parameters lead to the discovery of 1027 candidate SNPs, of which 267 indels. PolyBayes (Marth *et al.*, 1999) selected 772 candidates SNPs, of which 231 indels. The Primer3 software is used to design primers flanking each candidate SNP, which are validated in the laboratory by sequencing. Polymorphisms will be mapped, used for selection in aquaculture and the study of adaptation in natural populations.

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BIOGEOCHEMICAL CYCLE IN A COCCOLITHOPHORID BLOOM

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The biogeochemical properties of an extensive bloom of the coccolithophore, *Emiliania huxleyi*, at the shelf break in the northern Gulf of Biscay was investigated in June 2006. Total Alkalinity (TA) values in the water column showed strong non-conservative behaviour indicative of the impact of calcification, with the highest TA anomalies (up to 26μmol.kg^{-1}) in the high reflectance coccolith patch. Partial pressure of CO_2 (pCO_2) values ranged from 250 to 338μatm and the area was found to act as a sink for atmospheric CO_2. Overall, pCO_2@13°C (pCO_2 normalized at a constant temperature of 13°C) in the water column was negatively related to TA anomalies in agreement with an overall production of CO_2 related to calcification. Hence, the calcifying phase of the *E. huxleyi* bloom decreased the sink of atmospheric pCO_2, but did not reverse the direction of the flux. Rates of pelagic respiration up to 5.5mmol O_2.m^{-3}.d^{-1} suggested a close coupling between primary production and respiration and/or between organic carbon content and respiration. Benthic respiration rates were quite low and varied between 2 and 9mmol O_2.m^{-3}.d^{-1}, in agreement with the fact that the study area consists of sandy sediments with low organic matter content. Benthic respiration was well correlated to the chlorophyll a content of the top 1cm of the sediment cores. Evidence was found for dissolution of $CaCO_3$ due to the acidification of superficial sediments in relation to the production of CO_2 and the oxidation of H_2S in the oxic layers.

SEASONALITY OF THE PELAGIC ICHTHYOFAUNA IN THE LAZAREV SEA

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The Southern Ocean is characterised by an extreme seasonality which is best observed by the huge variation in sea ice extent. It expands from a minimum extent of 4 million square kilometres in February to a maximum of 19 million square kilometres in September and influences the physics and chemistry of the surface layers and the corresponding life histories of organisms. Reduced light condition and sea ice cover have a pronounced impact on primary production and predation risk in the pelagic zone. Here we present comparison of the distribution of fish in the Lazarev Sea correlated to biotic an abiotic features.

Samples were collected in the framework of three LAKRIS (Lazarev Krill Study) campaigns onboard RV Polarstern during summer, fall and winter. The main focus was on factors affecting krill distribution. As such a wide variety of biotic and abiotic measures were made. Fish and fish larvae were collected from trawls from the upper 200m during both seasons.

Both during summer and winter larval composition was dominated by pre-metamorphic *Electrona antarctica* and *Notolepis coatsi*. Post-metamorphic *E. antarctica* showed a pronounced seasonal difference in occurrence.

DIFFERENCES IN SHELL MORPHOLOGY AND REPRODUCTIVE IMPAIRMENT IN *LITTORINA LITTOREA* ALONG THE BELGIAN COAST

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In this study we evaluated the condition of *Littorina littorea* along the Belgian coast using shell morphology and reproductive impairment (*i.e.* female intersex and sterility; male penis shedding) characteristics. Periwinkles were collected at eight sites along the Belgian coast of which three were in the direct vicinity of the seaports of 'Zeebrugge', 'Oostende' and 'Nieuwpoort'. Standard shell parameters were measured, animals were sexed based on the p/a of the vesicula seminalis and reproductive impairment was determined for both sexes. Significant differences in the shell morphology and reproductive impairment could be detected among the sites. Indeed, periwinkles from 'Zeebrugge' were significantly larger and heavier compared to the specimens that were taken from the other sites. In addition, 'Zeebrugge' contained the largest number of penis shedded males (*i.e.* 61.11%) and intersex/sterile females (*i.e.* 100% and 95.24% respectively). The latter resulted in an ISI-index of 3.52, which is one of the highest ISI values ever recorded in *L. littorea*.

THE NIOO – APPROACH AS EVALUATION METHOD OF THE BENTHIC ECOLOGICAL QUALITY WITHIN THE WATER FRAMEWORK DIRECTIVE

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The EU Water Framework Directive (WFD) requires development of biological indicators and ecological classification for assessment of the ecological quality status of rivers, lakes, coastal and transitional waters. The NIOO – approach is developed to evaluate the ecological status of benthic invertebrates in coastal and transitional waters. This approach aims to be representative for the important structural and functional characteristics of coastal and estuarine ecosystems. The method uses a set of indicators that take into account the different scales of variability in coastal and transitional waters and evaluate the water body (ecosystem) as a whole and not by evaluating sampling station by sampling station. This approach evaluates the ecological status on three different levels (Escaravage *et al.*, 2004; Ysebaert and Herman, 2004). On the level of the whole ecosystem (e.g. a water body) one can evaluate if the benthic macrofauna fulfils the functional role one might expect given the current ecological circumstances. At this level also integration with other quality measures is most appropriate, and information on the water body can be summarised. On the subsequent level the distribution of habitats (habitat completeness, complexity and presence of certain eco-elements [e.g. mussel banks]) can be evaluated. Finally the biological quality of each distinguished habitat based on benthic macrofauna will be evaluated (within-habitat level), based on four indicators (biomass, density, species richness and species composition changes). These four indicators aim at providing a signal that is capable of showing significant changes/deviations from a certain defined reference state. The indicator results strongly depend on the sampling effort (sediment surface) that is deployed in a habitat and water body. Therefore, the reference values for the indicators were calculated per habitat from permutations executed over increased sampling surfaces. This allows estimating, for any given sampling surface, the reference value that can be expected. The expected reference values for each indicator, based on this randomisation, were determined for each ecological status boundary of the WFD. The ecological status for each indicator is finally determined by classifying the observed assessment value in the right ecological status class, based on their defined reference values. The NIOO – approach uses easily interpretable indicators that are evaluated separately. This allows a transparent assessment method and for any deviation of the overall ecological quality ratio from the reference condition the underlying responsible indicator can be easily traced back and evaluated individually. This tool is currently used by the Netherlands and Belgium to evaluate the ecological status of the benthos, following the requirements of the WFD.

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QUANTIFICATION OF EROSION/SEDIMENTATION PATTERNS TO TRACE THE NATURAL *VERSUS* ANTHROPOGENIC SEDIMENT DYNAMICS – QUEST4D

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Sustainable development requires the quantification of human impacts, against the seafloor's ecological value. Recent impact studies have shown only localised effects, though indications of a longer-term and broader-scale degradation of the seafloor exist. This is due possibly to cumulative anthropogenically-induced effects, but the natural evolution and the response of the seafloor due to sea-level rise are poorly known. Nonetheless, it is likely that changing wave climate and an increased storminess induce different erosion/sedimentation patterns. Such evolution needs to be evaluated against the impact of dredging, aggregate extraction, fisheries and beach replenishment on the ecosystem's physical functioning. The research proposal will focus on the sand and mud balance of the Belgian shelf, coupled to the Schelde Estuary and the coastal zone. The methodology will consist of: advanced modelling, validated with experiments; targeted observations/samplings, within the space, depth and time domain (4D); and various long-term datasets. Predictions will be made using different sea-level rise scenarios. The quantification of erosion/sedimentation processes is important for: the development of criteria for a sustainable exploitation/management and sustainable coastal protection schemes; allocating efficient dumping grounds; understanding coastal habitat change; and the prediction of sources/sinks of pollutants.

QUEST4D is a Belspo SPSDIII funded strategic research network.

CHLOROPHYLL-*A*, TOTAL SUSPENDED MATTER AND SEA SURFACE TEMPERATURE MAPS OF THE NORTH SEA AVAILABLE THROUGH THE BELCOLOUR PROJECT

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Since the launch of the first Ocean Colour sensors at the end of the previous century, much research has been devoted to transform Top of Atmosphere radiance measurements into reliable concentration maps of oceanographic parameters at the sea surface like e.g. chlorophyll content, total amount of suspended matter, sea surface temperature. While algorithms to determine chlorophyll in clear open water (so-called case 1 waters) are well established because this is the only parameter changing the spectral signal, they fail in coastal and turbid waters where the spectral signal is the result of the optical properties of a variety of constituents. The BELCOLOUR project improved the theoretical base for establishing concentration maps in coastal waters and developed quality control algorithms. Non reliable or unrealistic data are masked out in the final products to avoid misinterpretation of the data. The BELCOLOUR project worked mainly on satellite imagery from the Ocean Colour sensors SeaWiFS, MERIS and MODIS. All satellite data of the North Sea of these sensors (if not completely clouded) have been processed and transformed into quasi-true colour (RGB), chlorophyll (CHL), total suspended matter (TSM) and, for MODIS, sea surface temperature (SST) maps and made available for public through an easy browsing system on http://www.mumm.ac.be/BELCOLOUR.

The satellite data of MERIS and MODIS are processed in near real time in an automated way and the products are presented one day after the acquisition in the Near Real Time Database on the BELCOLOUR website (http://www.mumm.ac.be/BELCOLOUR/EN/Products/NRT/index.php), where they stay for 14 days. Later the data are reprocessed and archived in the BELCOLOUR Image Database (http://www.mumm.ac.be/BELCOLOUR/EN/OCDB/browse.php), also accessible through the BELCOLOUR website.

The images are available for different standard geographical areas (North Sea, Southern North Sea and the Channel, Southern North Sea) with both linear and logarithmical scales and are presented as jpeg-files. Different areas and file-formats can be processed by the Remote Sensing and Ecosystem Modelling team of MUMM on request.

BACTERIAL COMMUNITY STRUCTURE DURING A COCCOLITHOPHORID BLOOM IN THE NORTHERN GULF OF BISCAY

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As part of a study on the ecosystem dynamics and carbon fluxes (PEACE project) during a coccolithophorid (Prymnesiophyceae, Haptophyta) bloom, DNA samples were taken to assess the bacterial community structure associated with the bloom. Here we report on the bacterial community profiles, generated by DGGE fingerprinting of PCR products derived from 16S rRNA encoding genes, of seven different oceanographic stations located near the shelf slope area in the northern part of the Gulf of Biscay, each sampled at six different depths. Both the particle-associated ($>3\mu$m) and the free-living size fraction ($<3\mu$m) were analysed, showing a marked difference in bacterial community composition between the two size fractions. The bacterial assemblages tend to be specific for a particular oceanographic station, even after a one week sampling interval. Depth related variation in bacterial community profiles appeared only in two of the stations sampled. The influence of environmental variables, such as chlorophyll a, TEP (Transparent Exopolymeric Particles), POC, and PIC concentrations, on the observed variation in bacterial community structure is assessed as well.

ERROR ANALYSIS OF A HIGH-RESOLUTION PHYSICAL MODEL OF THE MEDITERRANEAN SEA

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We analyze the errors that are inevitably associated to hydrodynamic models, in a realistic case. The error of the GHER model in the Mediterranean Sea has already been studied in e.g. Beckers et al. (2000) by comparing it with other primitive equation models, or in Alvera (2004) by comparing the model with observations and with the climatology, using usual statistical methods and also wavelet decompositions. In this study, we rather study the sensitivity of the model to various variables using an ensemble of models. We chose a relatively high resolution, $1/16°$, corresponding to the resolution now used in operational OGCMs covering the Mediterranean, such as the MFS system (http://www.bo.ingv.it/mfs). We explain how we generated an ensemble of model simulations, where various more-or-less well known inputs are allowed to vary according to the uncertainty affecting them. Statistics calculated on this ensemble are, in fact, the response of the non-linear hydrodynamic system to errors on the forcing terms. When those statistics are calculated at a certain timestep, they allow us to provide a spatial analysis of the model error; statistics calculated over the time dimension will show whether errors are intensified by the system, or rather disappear. The model error is interesting as such. However, it can also be used for different purposes. For example, it allows using data assimilation techniques without needing the usual assumptions of reduced-rank Kalman Filters. It also allows studying the sensitivity of coupled models (biological, oil spill, search-and-rescue, …) to physical forcings.

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AN ISOTOPE DILUTION APPROACH TO ASSESS THE NUTRITIONAL VALUE OF DETRITUS

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Detritus represents an important, though heterogeneous, food source for benthic organisms. Bulk measurements such as C/N, lipids or amino acids are often used as food quality indicators. But what is taken up specifically from the detritus pool still stays largely unknown. Labelling food sources provides a powerful approach to study transfer in food webs, but due to its heterogeneity and unknown composition, it is difficult to produce labelled detritus.

We present an inverse approach: the deposit-feeding polychaete *Capitella capitata* was isotopically labelled by feeding them enriched ^{13}C and ^{15}N diatoms. After the enrichment period, the organisms were subjected to different treatments. When organisms take up carbon and nitrogen from unlabelled detritus, their isotope enrichment will decrease in proportion to the carbon and nitrogen availability of the food source to the deposit feeder.

In a preliminary experiment bulk $\delta^{13}C$ and $\delta^{15}N$ measurements were performed to investigate if we see the expected isotope dilution. Three treatments were applied: the labelled polychaetes were placed in either burnt sediment, which represents starvation, in high quality natural sediment, which represents a rather good food source, or in burnt sediment with algae, which represents an excellent food source. The expectations were that the amount of label would stay constant in the starvation treatment and decrease in the high quality sediment and algal treatment, with the latter treatment showing the highest degree of isotope dilution. The method does work, but there were differences between the dilution of $\delta^{13}C$ and $\delta^{15}N$.

In a second experiment not only bulk $\delta^{13}C$ and $\delta^{15}N$ measurements, but also isotope measurements of fatty acids and amino acids were performed to study which specific compounds are taken up from detritus. Four treatments were applied: burnt sediment (starvation), low and high quality natural sediments (resp. a rather poor and a rather good food source) and burnt sediment with diatoms (excellent food source). The compound specific analyses of the labelled polychaetes should enable us to discern which compounds are preferably taken up from the detritus by *Capitella capitata* and should give us an idea about the carbon and nitrogen availability of these compounds in the different treatments.

ACOUSTIC HABITAT MODELLING FOR THE MAPPING OF BIOLOGICAL COMMUNITIES

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In the framework of the MAREBASSE project ('Management, Research and Budgeting of Aggregates in Shelf Seas related to End-users', EV/02/18A, Van Lancker et al., 2005) and the MESH project ('Mapping European Seabed Habitats', Interreg IIIb), biologically relevant habitat maps are produced, based on acoustic datasets and ground truthed with physical and biological samples.

The habitat map production comprised the following four key steps: (1) getting the best out of the ground truth data; (2) selecting and deriving the best available input and most appropriate data coverages; (3) using the most appropriate techniques for interpreting the data through integration and modelling, and; (4) designing the map layout to create a map fit for purpose.

Emphasis is put on step 2 to optimally classify the acoustic data sets (both bathymetry and backscatter data) and to produce some derivatives (e.g. Bathymetric Position Index). Furthermore detailed full coverage maps of sedimentological parameters were produced, such as median grain size and silt-clay percentage, but also maps of the d90 and d10 of the sand fraction, sorting and skewness. In step 3 cross tabulation was used to correlate biological ground truthing data with the full coverage physical maps. Finally in step 4 habitat maps were produced, presenting biologically relevant classes of habitat suitability for different macrobenthic communities.

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APPLICANTS
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BIODIVERSITY OF THE MEIOFAUNA WITH SPECIAL EMPHASIS ON HARPACTICOID COPEPODS IN TROPICAL SEAGRASS BEDS IN PUJADA BAY, THE PHILIPPINES

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Species diversity varies with the spatial scale on which it is studied; the three different spatial levels of biodiversity are alpha, beta and gamma diversity. Alpha diversity measures packing within a community reflecting how finely species divide ecological resources. Beta diversity is used to measure the amount of turnover along environmental gradients, showing habitat selection or specialization. Gamma diversity is similar to beta diversity but it describes a much larger spatial scale, it illustrates the degree of provinciality or endemicity in the biota, the allopatric distribution of closely related taxa as well as the changes in the physical environment within a given habitat type.

This study describes the meiofauna biodiversity of Pujada Bay's seagrass beds with special emphasis on harpacticoid copepods, complementing global scale studies of this group with an outcome that may be used to test and discuss the hypothesis of 'high diversity in the East-Indian region'.

HET GEDRAG VAN GASHYDRATEN BIJ DRUK- EN TEMPERATUURS-WIJZIGINGEN IN EEN OCEANISCHE SEDIMENTLAAG

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Inleiding

Wat zijn gashydraten?

Gashydraat of clathraat is een natuurlijk voorkomende stof die sterk op ijs lijkt. Het grote verschil tussen beide is dat het gashydraat kan ontbranden. Net als ijs is het gashydraat opgebouwd uit een rooster van bevroren watermoleculen. Maar de meeste holtes of hokjes in het rooster van het gashydraat bevatten nog een molecule methaangas, waardoor het gashydraat brandbaar is. Natuurlijke gashydraten komen voor in permanent bevroren bodems en in de sedimentlaag op continentale hellingen.

Gashydraten en klimaatsverandering

Gashydraten zijn een zeer efficiënte manier om een grote hoeveelheid methaangas in een beperkt volume op te slaan. Wereldwijd wordt de hoeveelheid methaangas aanwezig in gashydraten geschat op $21*10^{15}$ m^3, wat maakt dat gashydraten een belangrijke component van de globale koolstofcyclus zijn en dat gashydraten een grote invloed op het klimaat kunnen uitoefenen. Indien het methaangas dat vrijkomt bij het smelten van gashydraten de atmosfeer bereikt, resulteert dit in een globale opwarming. Uit ijsboringen blijkt dat er een zeer goede relatie is tussen de variaties in temperatuur en de variaties in het atmosferisch methaangehalte doorheen het kwartair. De idee van het smelten van gashydraten op grote schaal en de injectie van het methaangas in de atmosfeer werd een sleutelelement in de verklaring van het plotse einde van de kwartaire ijstijden. De voorwaarden hiervoor zijn wel dat de oceanische gashydraatreserve snel moet reageren op temperatuurswijzigingen in het bodemwater en dat er voldoende methaangas in de atmosfeer vrijkomt. Bovendien wezen nieuwe observaties in de fossiele skeletten van benthische foraminiferen op de betrokkenheid van methaangas uit gashydraten in de klimaatsverandering zowel op millenniumschaal (zoals de afwisseling tussen ijstijden en interglaciale periodes) als op veel kleinere tijdschaal. Deze nieuwe observaties leidden tot de Clathrate Gun Hypothesis. De kerngedachte uit de Clathrate Gun Hypothesis is dat het ophopen van methaangas uit gesmolten gashydraten leidt tot afschuivingen van het sediment op de continentale hellingen, waardoor er een massale hoeveelheid methaangas uit de gashydraten in de oceanische sedimentlagen kan vrijkomen. In deze thesis wordt getest hoeveel tijd het gashydraatreservoir nodig heeft om te reageren op wijzigingen in de temperatuur van het bodemwater en of er voldoende methaangas vrijkomt uit de gashydraten om een afschuiving van het sediment te veroorzaken.

Werkwijze

De evenwichtscurve

Gashydraten zijn stabiel bij een lage temperatuur en onder voldoende hoge druk. Bij een hogere temperatuur en/of een lagere druk zijn gashydraten onstabiel en dissociëren (= smelten) ze tot methaangas en water. In de oceaan neemt de (hydrostatische) druk lineair toe met de diepte. De stabiliteit van het gashydraat op een bepaalde diepte onder de zeespiegel is dus enkel afhankelijk van de temperatuur op die diepte. De evenwichtscurve geeft het verloop weer van de smelttemperatuur met de diepte (Fig. 1). De gashydraten die voorkomen in de zone waar de temperatuur lager ligt dan de smelttemperatuur bevinden zich in de stabiliteitszone. Daar waar de smelttemperatuur hoger ligt, zijn gashydraten onstabiel. Eventuele gashydraten die zich in de onstabiele zone bevinden zullen smelten.
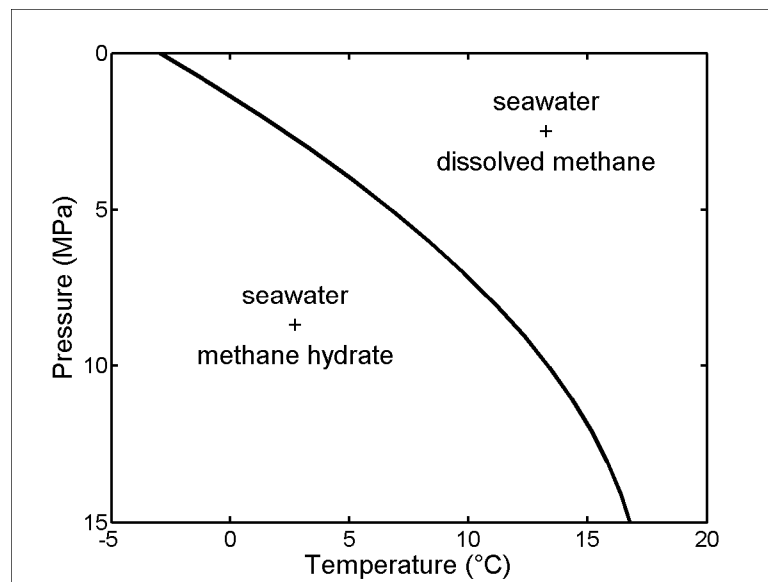
Fig. 1. Evenwichtscurve voor faseovergang van vast gashydraat naar methaangas en water geeft de smelttemperatuur van het gashydraat aan bij een bepaalde druk. In het gebied onder de curve is het gashydraat stabiel, boven de curve onstabiel. Bij de druk- en temperatuurscondities op de evenwichtscurve zelf komt het gashydraat samen met methaangas en water voor.

Het ééndimensionaal model

Om het effect van druk- en temperatuursveranderingen op het gashydraat na te gaan, werd gebruik gemaakt van een eenvoudig, ééndimensionaal model. Langsheen een verticaal traject doorheen de sedimentlaag wordt de temperatuur beschouwd. Het ééndimensionale model kent twee randvoorwaarden: de bovenste randvoorwaarde is de temperatuur van het bodemwater, de onderste randvoorwaarde wordt bepaald door de geothermale gradiënt, *i.e.* de temperatuurstoename per diepte-eenheid. Voor de beschouwde sedimentlaag wordt de geothermale gradiënt constant verondersteld. De bovenste randvoorwaarde bepaalt het verloop van het temperatuursprofiel doorheen de sedimentlaag. Een verandering in de temperatuur van het bodemwater veroorzaakt een

verschuiving van het temperatuursprofiel. De temperatuurswijziging gebeurt echter niet onmiddellijk, er treedt een aanzienlijke vertraging op omwille van de lage thermische geleidbaarheid van het sediment en omwille van de grote diepte waarop het gashydraat voorkomt. De verandering van het temperatuursprofiel doorheen de tijd wordt wiskundig beschreven met de ééndimensionale vergelijking voor warmtegeleiding (vgl. 6). Deze vergelijking heeft zowel een analytische als numerieke oplossing (vgl. 7, 8 en 9).

De latente warmte voor het smelten van gashydraten

Tijdens het opwarmen van een vaste stof stijgt de temperatuur van deze stof in verhouding tot de hoeveelheid warmte die aan de vaste stof wordt toegevoegd. Wanneer men nog warmte blijft toevoegen als de vaste stof haar smeltpunt bereikt heeft, dan merkt men dat men nog een bepaalde hoeveelheid warmte kan toevoegen zonder dat de temperatuur verder stijgt. De hoeveelheid warmte die men zo kan toevoegen is de latente warmte. De latente warmte wordt gebruikt om de kinetische energie van de moleculen te verhogen, zodat de vaste stof zich tot een vloeistof kan omzetten. Gashydraten die zich op de smelttemperatuur bevinden, nemen bijgevolg nog een deel van de toegevoerde warmte op zonder dat de temperatuur verder stijgt. Dit heeft belangrijke gevolgen voor het verloop van het temperatuursprofiel doorheen de sedimentlaag. De vergelijking voor warmtegeleiding dient uitgebreid te worden met een term voor de opname van latente warmte door de gashydraten. Aangezien we geen analytische oplossing kennen voor deze uitgebreide vergelijking, maken we gebruik van de numerieke oplossingsmethode (vgl. 13).

De opbouw van gasdruk in de sedimentlaag

Bij het smelten van het gashydraat komt er methaangas vrij in de sedimentlaag. Het methaangas kan maar moeilijk ontsnappen doorheen de sedimentlaag. Men verwacht dat de druk op bepaalde plaatsen in de sedimentlaag aanzienlijk kan toenemen waardoor er gevaar zou kunnen ontstaan voor afschuivingen. De grootte van de ontstane druk is afhankelijk van de hoeveelheid gesmolten gashydraat (vgl. 15 en 16). Gevaar voor een afschuiving ontstaat wanneer de ontstane druk groter wordt dan een kritische druk, welke bepaald wordt door de massa van het bovenliggende sediment. Hoe dieper het gashydraat zich in het sediment bevindt, hoe kleiner de kans op afschuivingen.

Het gedrag van gashydraten bij druk- en temperatuurswijzigingen

Het effect van een verandering in de temperatuur van het bodemwater kan dus direct ingeschat worden met behulp van het hierboven beschreven ééndimensionale model. Het effect van een verandering in druk (zeespiegelstijging of –daling) leidt tot een verandering van de smelttemperatuur van het gashydraat en kan dus ook met dit model beschreven worden.

Resultaten

Wijziging van het temperatuursprofiel

In deze thesis werden drie scenario's uitgewerkt. In de eerste twee scenario's wordt de respons van het temperatuursprofiel nagegaan op een stijging van het bodemwater met 4°C. De zeebodem bevindt zich op een diepte van 400m onder de zeespiegel en het temperatuursprofiel wordt gemodelleerd tot op een diepte van 300m onder de zeebodem. In het eerste scenario veronderstellen we dat er geen gashydraten in de sedimentlaag aanwezig zijn, in het tweede scenario zijn er wel gashydraten aanwezig. Bij afwezigheid van gashydraten duurt het bijna 1000 jaar vooraleer de temperatuursstijging van het bodemwater merkbaar is op een diepte van 300m en duurt het in totaal 10.000 jaar totdat het temperatuursprofiel zich helemaal aangepast heeft. Het valt te verwachten dat de aanwezigheid van gashydraten een vertragend effect heeft. Inderdaad, in het tweede scenario is het effect van de temperatuursstijging na 10.000 jaar nauwelijks merkbaar op een diepte van 300m en is er nog maar een zeer klein deel van de gashydraten gesmolten. Het duurt ongeveer 100.000 jaar vooraleer al het gashydraat gesmolten is en het temperatuursprofiel zich aangepast heeft. Uit deze twee scenario's leren we dat het gashydraat in een sedimentlaag zeer veel tijd nodig heeft om te smelten.

In het derde scenario wordt het gecombineerde effect van een temperatuursstijging in het bodemwater en van een zeespiegelstijging onderzocht. De grootte van de temperatuursstijging en de tijdstippen van de zeespiegelstijging (= drukverhoging) werden zo gekozen dat ze de situatie tijdens het einde van de laatste ijstijd zo goed mogelijk weergeven. De resultaten van dit scenario tonen duidelijk aan dat een zeespiegelstijging het gesmolten gashydraat weer stabiliseert, waardoor er minder methaangas vrijkomt. Het effect van een zeespiegelstijging op het gashydraat is dus tegenovergesteld aan het effect van een opwarming van het bodemwater.

De opbouw van gasdruk in de sedimentlaag

In de drie scenario's is de druk die ontstaat door het methaangas dat vrijkomt uit het gashydraat geenszins groot genoeg om een afschuiving van de bovenliggende sedimentlaag te veroorzaken.

Conclusie

In de Clathrate Gun Hypothesis wordt verondersteld dat de gashydraten in oceanische sedimentlagen snel reageren op een temperatuurswijziging in het bodemwater en dat het methaangas in grote hoeveelheden vrijkomt. De resultaten van deze modelleeroefening wijzen echter op een zeer langzame respons van het gashydraat. Bijgevolg lijkt het uitgesloten dat het gashydraat in de oceanische sedimentlagen de rol speelde tijdens de kwartaire klimaatsveranderingen die hen toegeschreven is door de Clathrate Gun Hypothesis.

APPLICANTS
VLIZ North Sea Award 2006

AN EXPERIMENTAL FIELD STUDY ON THE MIGRATORY BEHAVIOURS OF GLASS EEL (*ANGUILLA ANGUILLA*) AT THE INTERFACE OF FRESH AND SALT WATERS, WITH IMPLICATIONS TO THE MANAGEMENT AND IMPROVEMENT OF GLASS EEL MIGRATION

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Glass eel *Anguilla anguilla* (L.) migrate using ocean currents and Selective Tidal Stream Transport. Conventional fish ladders installed at the marine/fresh water interface, however, require the fish to actively swim upstream. We question the efficiency of these fish ladders for glass eel immigration, and propose a simple siphon over migration barriers, restoring the original Selective Tidal Stream Transport.

A conventional trap and our new siphon were tested concurrently at two sluice complexes in the Netherlands (Tholen, Nieuwe Statenzijl), in spring 2005. In all but one case, the siphon caught more glass eel than the trap, and more sticklebacks and other species. These results indicate that the natural immigration process can easily be restored, at low costs and low salt intrusion levels.

Our siphons were more successful than conventional traps. Follow up studies must focus on optimisation, and the effect of a passage on the hinterland stock.

INTERFERENCE COMPETITION AMONG FORAGING WADERS

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Competition is among the most studied topics in ecology, both theoretically and empirically. Nevertheless, understanding of competition is still wanting; ecologists are not quite able to tell why or to predict how much competing animals suffer from mutual interactions. This thesis strives to contribute to understanding of competition by studying the mechanisms of interference competition among waders (Charadrii), foraging in intertidal areas. It attempts to extend previous work by applying an experimental approach to the empirical study of interference competition and an evolutionary approach to its theoretical study.

The experiments presented in this thesis yielded the following results:

1. Chapter 2 reveals that (1) interference effects on intake rate are different for red knots (*Calidris canutus*) and ruddy turnstones (*Arenaria interpres*), (2) that the mechanistic basis of interference effects differed between these two species, but (3) that in neither of the two species interference effects resulted from kleptoparasitism (*i.e.* the stealing of food items), which is the most widely discussed interference mechanism.
2. Chapter 3 shows that the extent to which captive turnstones suffer from interference competition depends on both the spatial distribution of food and the relative social dominance status of focal individuals. When food is spatially clumped, interference competition may arise from the monopolisation of food clumps, and interference effects may be unrelated to the amount of agonistic behaviour. Chapter 4 shows that the spatial distribution of food affects the amount of agonistic behaviour and the distribution of free-living turnstones, but it does not affect the time focal individuals spent digging for food, which is taken as an approximation of intake rate.
3. Chapter 5 shows that the extent to which captive turnstones suffer from interference competition depends on the distribution of food and on the foragers' social dominance status (as before), but also on the divisibility of food, which is one of the differences between food items (indivisible) and food clumps (divisible).
Thus, interference competition among foraging waders need not result from the stealing of food items, but may also result from interactions over food clumps, and these two mechanisms may differ in a way that is essential to the interference process. The theoretical chapter of this thesis (chapter 6) reveals that models of interference competition have not yet reached consensus about the kinds of interference behaviour that can be expected to evolve. Although evolutionary models of interference competition appear to be similar, they yield strikingly different predictions regarding the evolutionary stability of various interference strategies. To unify previous approaches, a systematic event-based description of the foraging process is presented and the use of techniques from Adaptive Dynamics theory is promoted. Through a critical discussion of the setup, the assumptions and the way of analysis of some evolutionary models of

interference competition, crucial assumptions and potential pitfalls in modelling the evolution of interference behaviour are identified.

Together, these experimental and theoretical results contribute to a mechanistic and evolutionary understanding of interference competition. At the same time, they make it clear that we cannot claim having reached such an understanding yet. This implies that it still is premature to base models of population dynamics on presumed knowledge of the interference process.

SPATIO-TEMPORAL VARIABILITY WITHIN THE MACROBENTHIC *ABRA ALBA* COMMUNITY, WITH EMPHASIS ON THE STRUCTURING ROLE OF *LANICE CONCHILEGA*

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The Belgian Continental Shelf (BCS) is situated in the southernmost part of the North Sea and is characterized by a high geomorphological and sedimentological diversity in soft-bottom habitats. The combinations of the ecological and the socio-economic values of the BCS cause conflicts between both interests. Initiatives are being taken by the scientific community to optimize the integration of the ecological value of the BCS with those of the different user functions, like shipping, dredging, sand and gravel extraction, fishing and tourism. The government has made a start with the implementation of Marine Protected Areas into the law (framework law of 20/01/1999): proposals for such areas have been made and are under investigation. In the mean time, it is important to provide the policy makers with a scientific basis for the development of a sustainable management plan for the natural resources of the BCS. One of the most important components of the marine ecosystem is the macrobenthic fauna. This component is considered to be suitable to characterize and monitor the marine ecosystem because of its size (macroscopic), its relative immobility and its direct link with the sediment and with the processes that occur immediately above the seabed.

This study delivers information on the structure and functioning of the macrobenthos in the marine ecosystem of the BCS. More specified, it aimed to investigate the macrobenthic community structure on the BCS, the spatial and temporal variability within the ecologically most important macrobenthic community (*Abra alba* community) and the importance and population dynamics of an ecologically important species (the sand mason, *Lanice conchilega*) within this community. Based on the information of a part of the marine ecosystem (macrobenthos), some remarks on the conservation of ecologically important areas or species on the BCS can be formulated.

In Chapter 2, the different macrobenthic communities and their distribution on the BCS were characterized based on a large number of samples gathered between 1994 and 2000. These samples cover a diverse range of habitats: from the sandy beaches to the open sea, from the gullies between the sandbanks to the tops of the sandbanks, and from clay to coarse sandy sediments. To investigate the large-scale spatial distribution of the macrobenthos of the BCS, the data of 728 samples were combined and analysed. By means of several multivariate techniques, ten sample groups with similar macrobenthic assemblage structure were distinguished. Each sample group is found in a particular physico-chemical environment and has a specific species composition. Four sample groups are differing drastically, both in habitat and species composition, and are considered to represent four macrobenthic communities: (1) the muddy fine sand *Abra alba* – *Mysella bidentata* community is characterized by high densities and

diversity, (2) the *Nephtys cirrosa* community occurs in well-sorted sandy sediments and is characterized by low densities and diversity, (3) very low densities and diversity typify the *Ophelia limacina – Glycera lapidum* community, which is found in coarse sandy sediments and (4) the *Eurydice pulchra – Scolelepis squamata* community is typical for the upper intertidal zone of sandy beaches. Of course these macrobenthic communities are not isolated from each other, but are linked through six transitional species assemblages. The transition between the *A. alba – M. bidentata* community and the *N. cirrosa* community, is characterized by a reduction in the mud content and is dominated by *Magelona johnstoni*. The transition between the *N. cirrosa* and the *O. limacina – G. lapidum* community is distinctive by decreasing densities and coincides with a gradual transition between medium to coarse sandy sediments. From the *N. cirrosa* to the *E. pulchra – S. squamata* community, transitional species assemblages related to the transition from the subtidal to the intertidal environment, were found. Each community or transitional species assemblages was found over a specific range along the onshore-offshore gradient, four types can be discerned: (1) almost restricted to the near-shore area, but possible further distribution, (2) distributed over the full onshore-offshore gradient, (3) restricted to the near-shore area, and (4) restricted to the sandy beach environment. The diversity pattern on the BCS follows this division, with species rich and poor assemblages in the near shore area to only species poor assemblages more offshore. The distribution and diversity patterns are linked to the habitat type, discerned by median grain size and mud content.

The small- to large scale geographical pattern within the ecologically most important macrobenthic community (*A. alba* community) of the BCS was investigated in Chapter 3. The *A. alba* community is widely spread in the coastal zone of the English Channel and the Southern Bight of the North Sea. The community is located in shallow, fine muddy sands. Its spatial distribution is characterized by a number of isolated patches (Atlantic French, British and German coast) and one large continuous distribution area (northern France up to the Netherlands). The aim of this study was to investigate the geographical patterns within the macrobenthic *A. alba* community at different scales: the community's full distribution range (*i.e.* large scale) and a selected area with a continuous distribution of the *A. alba* community (*i.e.* small scale) in relation to structuring environmental variables. Therefore, an analysis of newly collected samples along the Belgian coastal zone was combined with available information on the *A. alba* community throughout its distribution range. Although the community structure shows a high similarity across the full distribution range of the *A. alba* community, large- as well as small-scale changes in community composition were observed: the BCS should be considered as a major transition from the rich southern to the relatively poorer northern distribution area of the *A. alba* community. At a large scale (*i.e.* full distribution range), the differences in community structure are expected to result from (1) the specific hydrodynamic conditions in the English Channel (Atlantic ocean waters) and the Southern Bight of the North Sea, with a consequent differential connectivity between the different areas and (2) the climatological and related faunal shift from temperate (English Channel) to boreal conditions (German Bight). At a small scale (*i.e.* within the continuous distribution area), structural and functional community aspects may result from geographic differences in (1) detrital food availability, related to riverine input and pelagic productivity, along and across the coastline and (2) the amount of suspended matter, impoverishing the *A. alba* community when excessively available.

The study in Chapter 4 outlines the seasonal and year-to-year variations in the *A. alba* community. This variation is typical for macrobenthic communities in temperate, shallow coastal waters and is investigated in the *A. alba* community on the BCS during nine years (1995-2003). During the investigated period, the community did not show a cyclic pattern, but a shift between the years 1995-1997 and 1999-2003, possibly triggered by changes in the hydroclimatic state of the North Sea and reflected by a small shift of the dominant species in the *A. alba* community.

In the years 1995-1997, the temporal pattern was dominated by strong year-to-year differences, coinciding with different successive events (strong recruitment, sedimentological changes, cold winters) and therefore those years were characterized as the unstable period. All those events had an effect on the macrobenthic density, diversity and species composition. The mass recruitment of *S. subtruncata* caused a decrease in the density and diversity of the macrobenthos, whereas the increase of mud content was responsible for a crash of the species richness and macrobenthic density. After those events, the *A. alba* community needed time to recover (1996-1998), which was possibly slowed down by a slow amelioration of the habitat conditions, unsuccessful recruitment and the occurrence of a cold winter. This period was followed by some years where the seasonal dynamics in the community superimposed the lower year-to-year variability and therefore those years were characterized as the stable period. The seasonal dynamics in the study at hand were characterized by high macrobenthic densities and diversity in spring and summer, with a decline in autumn towards the end of the winter. It can be concluded that mainly local factors were responsible for the short term variations within the community, whereas some global events (hydroclimatic, cold and mild conditions) caused the long term changes.

In Chapter 5, the population dynamics, recruitment and persistence of the *L. conchilega* populations in subtidal soft-bottom sediments along the Belgian coastline are described. An intensive sampling campaign (monthly-biweekly from April until August), the discrimination of different benthic stages and cohort analysis of the adult population enabled the discrimination of trends in recruitment patterns of *L. conchilega*. Three recruitment periods were defined based on the occurrence of peaks of aulophore larvae in the water column and peaks of recently settled individuals in the benthos: (1) spring recruitment period (April-July), (2) summer recruitment period (July-September), and (3) autumn recruitment period (September-November). The spring recruitment period was the most intense and was characterized by high densities of recently settled individuals and juveniles. These high densities resulted in an adult population, which consisted of different cohorts and which was characterized by a high turn over. The summer and autumn recruitments were less intense and did not occur at every station or in every year. Spatial and temporal variations in timing and intensity of settlement and recruitment were observed and described. Results indicate that *L. conchilega* is an opportunistic species, characterized by a long pelagic phase, high settlement of larvae and a high turn over in the adult population. Due to this recruitment strategy and the preferential settling of the larvae in adult patches, the studied *L. conchilega* population was able to maintain high abundances in moderately stable patches.

The tube building polychaete *L. conchilega* has a wide distribution and can form dense aggregations. Unfortunately, the effects of *L. conchilega* on the surrounding benthic community have received little attention, especially in subtidal areas. Therefore, the

effects of the presence of *L. conchilega* on the abundance, species richness, diversity and species composition of the North Sea benthos in relation to sedimentology and depth were evaluated in Chapter 6. The results show that *L. conchilega* does have an effect on the benthic density and species richness in soft-bottom sediments. The density of the benthic species increased and was significantly (positively) correlated with the density of *L. conchilega*. Furthermore, the species richness increased with increasing density of *L. conchilega*. This trend was, however, not consistent: the number of species no longer increased or even decreased after reaching a certain density of *L. conchilega* (>500 ind.m^{-2}). The same overall pattern was detected concerning the expected number of species. The N_1-diversity index showed similar or slightly higher values in *L. conchilega* patches compared to patches without *L. conchilega*. The effects on density and diversity were most pronounced in shallow fine sands, which are the preferred habitat of *L. conchilega*, and less in deep fine sands. The changes in benthic characteristics result from the alterations of the habitat by *L. conchilega* (hydrodynamics, sediment stability, improved oxygen) and the complex interactions between the benthic organisms and the biogenic structures consisting of *L. conchilega* tubes. A lot of benthic species can profit from the creation, modification and maintenance of that habitat by *L. conchilega*, which results in an increased density and species richness in *L. conchilega* patches compared to the surrounding soft-bottom sediments. Finally, the results indicated that *L. conchilega* has an effect on the benthos present in a particular habitat, rather than forming its own association.

The general conclusion, considering the macrobenthos, is that from a nature conservation viewpoint the coastal zone is of high ecological value. This is due to the high diversity of macrobenthic communities and the presence of the diverse *A. alba* community with the key-species *L. conchilega*. This high ecological value of the coastal zone is in conflict with the socio-economic interests of this zone and a focus on an integrated coastal zone management is necessary and in progress. This study delivers information on the structure and functioning of the macrobenthos on the BCS and can be used as scientific input in the nature conservation discussions.