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INTERNATIONAL COASTAL CONGRESS

KIEL, SEPTEMBER 1992

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SUMMARY

Eurocoast UK has the aim of providing a network for exchange of scientific and technical ideas relating to the coastal zone. In order to achieve this, the organisation produces a newsletter and is aware of conferences and workshops throughout Europe.

Between 6th-13th September 1992 the Internal Coastal Congress (ICC) was held at Kiel, Germany. This congress was multi-disciplinary and aimed to create cross-fertilisation between different scientific groups and countries.

The following report outlines areas of particular interest from presentations the author witnessed. Coastal Management is a common topic throughout Europe and many of the problems faced are similar from country to country. We can benefit from the experiences of other countries and contribute to the evolution of Coastal Management on an European scale. Understanding coastal processes and how to monitor was a common conference theme. The importance of crossing the divide between science and management was realised at the conference and exchange of ideas from theoretical to practical began to be achieved.

1.0 INTRODUCTION

The International Coastal Congress (ICC) was held at Kiel University in the Szchlezwig-Holstien area of Germany. The conference was conceived through the Eurocoast organisation and organised by Dr Sterr of Kiel University. The programme spanned many subject areas in the coastal zone and many specialist papers were presented. This report aims to provide an overview of the conference and to highlight areas of interest to the National Rivers Authority.

2.0 COASTAL MANAGEMENT

2.1 The IPCC Sub-group on Coastal Zone Management

The inter-governmental Panel on Climatic Change has established a sub-group to consider Coastal Zone Management (CZM). This is being headed by the Dutch (HILLEN, R). This group has established that there are approximately 1 million kilometres of coastline, 40% of which is populated with 60% of human activity within 60 km of the shore (main agricultural activity). With sea level rise this zone will come under increasing stress. The CZM sub-group has the tasks of:-

- Developing Management Strategies for the next 10-20 years
- Developing long-term strategies for the 198 countries involved

Three broad categories of response to sea level rise have been developed. The sub-group feels that these policies need to be adopted regardless of sea level rise. They will provide a structured approach to managing the coast.

- Retreat
- Accommodate
- Protect

2.1 Continued

In order to define how to apply policy a Global Vulnerability Study has been carried out. With 1 m of sea level rise, 70 million people will be affected by flooding; coastal wetlands will be lost; major food supplies (such as rice) will be destroyed with 50% of production in the flood area; saline intrusion and flooding will affect agriculture, fisheries and port activities. With this backdrop plans need to be developed now with common approaches and techniques being available to coastal managers. If sea level rise does not reach these proportions nothing will be lost as effective coastal management will result. This is a "no regret policy".

In November 1993 the Dutch will host a world conference on coastal zone management.

2.2 The Netherlands

In 1953 the Netherlands experienced severe flooding with over 1800 deaths and destruction of 14% of the GNP (HILLEN, R). This gave Dutch Engineers a mandate to act. Prior to 1990 this action produced ad-hoc works to defend land. In 1990 policies were launched for "Guaranteed Safety" (protection for 1:10,000 year probability event) and "Protection of Special Values". This policy was termed "Coastal Preservation". This policy appeared too fixed to conservationists and was amended to "Dynamic Preservation".

2.2 Continued

The Dutch coast is 350 km long with 250 km of sand dunes. Over the past 30 years profiles have been taken once a year from 200 m inland to 800 m offshore at 200 m spacing. (These have been supplemented with offshore data where suitable).

In 1990 this data was used to define a "Basal Coastline" and a "Transient Coastal Volume". The Basal Coastline creates a fixed line at 1990 beyond which erosion will not be allowed to take place. The policy stops all structural erosion, uses sand nourishment as a principal tool, and maintains the dynamic nature of dunes. The Transient Volume accepts that beach profiles will vary over time but the total volume must be maintained on the beach. This is defined from profile analysis. This analysis considers the previous 10 years of data and projects this to the Basal Coastline (this analysis thus takes an average condition, not storm profiles).

If the Basal Coastline has been bisected (or will be in the short term) beach nourishment is employed. The sand is all taken from offshore sources at a cost of approximately £20 million per year. Where sand accumulates on the coast (accretion), it is accepted as a 'natural' build-up and not re-distributed. The buffer of sand is maintained at the dune front for flood protection. The middle section is then kept free for nature conservation, the dynamic element of the programme.

2.2 Continued

The public have supported this programme, but certain educational problems still exist:-

- There is an amenity problem with the renourishment programme.
- The plan is not designed for storm activity but rather the semi-continuous erosion process.

In order to gain public support (and to get the message of the policies across) "Provincial Consultative Bodies" exist which provide a forum for public input and points of view.

It is accepted by the Dutch that the Basal Coastline represents a fixed policy for the coast. This position is probably untenable in the long-term and still leaves the coast exposed to storm damage. In 1995 the policy will be updated and a more flexible approach may be adopted in line with the IPCC sub-group thinking.

2.3 The European Union for Coastal Conservation (EUCC) and the Coastal Review Unit (CRU)

2.3.1 EUCC.

This organisation aims to promote conservation of the coastline. It is to provide a source of information and advise conservations on the implications of coastal activities upon conservation. To this end the EUCC is to define "Representative Sites" for particular

2.3.1 Continued

conservation interests throughout Europe. The EUCC Science Commission provides information on coastal resources, facilitates link across Europe, and identifies research needs for conservation. The Science Commission has 3 levels of approach:-

- Inventory
- Review
- Survey and monitoring

Under the EC Habitats Directive special sites must be identified. To this end inventories of existing resources are being developed; for example the SAND DUNE INVENTORY OF EUROPE by the Joint Nature Conservation Council. This broad overview is being focussed to individual sites to look at dunes, sandflats, mudflats, saltmarshes, shingle, lagoons, sea cliffs and other coastal habitats. A country-by-country description will identify such things as the importance of each site in the country, distribution in the country, types, designations and habitat make-up.

2.3.2 CRU.

The Coastal Review Unit is based in the Joint Nature Conservation Council (JNCC) for the UK (DAVIDSON, N). The CRU is to define rules for data collation, data collection, specifications, and data handling techniques. The unit will define procedures to link databases, manage data directly, develop monitoring and promote

2.3.2 Continued

schemes to fill in data gaps. From this data information will be produced in the form of reviews, inventories, databases and advice. This output will be on site, region and country levels. The aim is to achieve this within the JNCC and three statutory country conservation agencies and then to integrate other conservation bodies.

The integrated resource will link the conservation with the socio-economic and provide a management tool based on a GIS platform. This system will monitor how effective applied conservation policies are being in reality.

2.4 Shoreline Management

The NRA Anglian Region has embarked upon a programme to manage its shoreline more effectively (DOCUMENT PREVIOUSLY CIRCULATED: THE FUTURE OF SHORELINE MANAGEMENT, NRA 1991). This system was presented to the conference and was received with a very positive response. (Under the C6 R & D Programme, a review of this work will be undertaken in 1992/early 1993 to give guidance on establishing such a system).

2.5 Practical Management

2.5.1 Beach Nourishment on Barred Coasts

Shore - Parallel bars are found along many coastlines. BOCZAR considered nourishment projects along such coastlines and concluded that, rather than nourishing the upper beach, it was more effective to nourish the bars. A bar breaks down wave energy offshore from any structure or coastline asset. It can dissipate 50% of energy directly and redistribute most of the remainder. This effective buffer should be used by recharging the bar and allowing natural re-distribution of material.

2.5.2 Dune Erosion/Harbour Dredging

Sand dune erosion is a serious problem on the Portuguese coast. This is a combination of sea level rise and sediment starvation. The case cited demonstrated a lack of sediment due (in part) to a terminal groyne problem associated with a harbour. Sediment passing into the harbour is being dredged for navigation and dumped offshore (a familiar problem in the UK). The coastal protection authorities have no power to prevent this practice and are having to renourish the dune system. These dunes have eroded into a steep scarp on their landward side preventing aeolian transport into the dune field. The intention is to recreate the front slope to reinitiate wind transportation of sand. Another solution to such a problem is to by-pass sediment across the harbour mouth, or to move back the dune line.

2.5.3 Active Methods of Coastal Management

Two techniques were put forward for managing sand beaches (PARKS, J). The first method involves pumping water from a beach to dry it and stabilise it. This stabilisation method lowers the beach water table and reduces the strength of backwash from waves (MMG and BMT have systems in UK). This builds up sediment on the foreshore. The second technique inverts this principle by fluidising the beach in order to pump it to a new location. Fluidisation is achieved using high pressure water jets, either above or below water level. Below water level such a system is being tested by the US Army Corps of Engineers to keep a harbour entrance free from sand. The sediment is pumped 100 m down drift to by-pass the harbour. A bi-directional system would be needed on most coastlines to cope with reversal in drift.

2.5.4 Marine Debris

WILLIAMS has undertaken research into marine debris in conjunction with the Glamorgan Heritage coast and NRA Welsh Region. Marine debris comes in many forms and plays an active role on the coastline. Large items such as milk crates can form a nucleus for sand dune formation. Most impacts are, however, negative. These impacts affect fisheries, water quality and tourism (aesthetics). In estuarine locations, large sinks of debris have been found, often associated with sewage outfalls. These sinks represent a serious pollution problem.

2.5.4 Continued

In order to combat these problems, removal at site has been employed but proven ineffective. Two new approaches are suggested. The first involves tackling the problem at source. This may be outfalls, dumping at sea, or illegal disposal from shipping. The second approach involves a psychological approach to ensure removal at site and pressure for tackling the problem at source. This approach involves one, unified method for evaluating beach quality. This would mean only one type of award for beach cleanliness and appeal (encompassing the several that exist at present) which would have an increasing standard over time and positively encourage tourism to certain sections of coast. This economic benefit could feed-back to the source clean-up and encourage neighbouring resorts to similarly clean-up their beaches. At present, the number of 'Flag' awards has devalued them and provoked a sceptical public response. With a unified single award, credibility would be returned to such approaches.

2.5.5 Biological Protection

Much of the UK coastline was protected by large shellfish beds and the carbonate sediments derived from their shell material. HAIDON has set nets in the nearshore zone seeded with mussels. These nets are set vertically and shore parallel and spaced at half the wavelength of average waves. The shellfish grow on the 'nets' (fine mesh such as BONTERRA) and damp out wave energy as well as improving water quality (filtration) and supplying shells for sedimentation. It is suggested that such methods would also work with nets horizontally to form mussel banks thus stabilising the foreshore.

3.0 SEA LEVEL

3.1 Sea Level Rise and Mud Flat/Saltmarsh Morphology

DIEKMANN has found that where tidal flows exceed 1.3 m s^{-1} flood/ebb ridges can develop. These occur around mean low water mark and are formed along the line of flow in mudflat channels. These ridges reach a state of dynamic equilibrium with the hydrodynamics/sedimentation of the particular system they are found in. When such structures begin to decay (as they have over the last 30-40 years) a significant change in the hydrodynamics of an area is indicated. This gives warning of sea level rise impacts upon the coast.

STIEVE is similarly considering morphology and sea level rise impacts. Her work is trying to identify storm ridges within saltmarsh deposits. These ridges (Cheniers) are shell dominated and produce clear lamination, this research aims to correlate such horizons with storm events over the past 20 years to try and identify if storm frequency is increasing.

3.2 German Research into Sea Level Rise

The German Ministry of Science and Technology is aiming to integrate all influences on sea level to isolate particular elements and identify individual impacts

3.2 Continued

Sea level is often present as a smooth increase but the influence of storm makes the impacts like a staircase. Relatively consistent period of time (decade or longer) are followed by rapid change. This means that the defence of the coastline over the last 1000 years may no longer be tenable and "re-adjustment" of the coastline may be necessary. This realisation has led to a proposal to generate national definitions and guidelines in Germany which will be implemented on a local scale.

3.3 Long-Term Sea Level Change

The British Geological Survey (WINGFIELD, R) has been researching the sea level change in the Irish Sea. Gross morphological evidence, coupled with biological support, indicates large relative sea level changes in the Irish Sea. This has caused linkage and separation of the two islands over geological time frames. The BGS is developing a model which demonstrates this change and that sea level has been 100 m higher and lower (relative to land) than present sea level. This is associated with changing sea levels due to glaciation and changing land levels as the earth's coast responded to depression under glaciation and subsequent uplift. Such long-term views may place man-induced global warming into perspective and begin to explain the cyclic change in sea level over time.

4.0 PROCESSES

4.1 On-Shore Sandbanks

Study of the Middelkerke Banks 25 km off the Belgian coast has been considering their morphology and processes. These sand banks are similar to those found around the UK coast and experience similar forces upon them. The studies (STOLK, A) discovered a separation at 17 m depth between dynamic ripple movements and less dynamic activity. [This is a break-point often used (14-20 m depth) in UK waters for aggregate extraction]. The banks have a relict core which the British Geological Survey have identified previously. It appears that such banks become highly active in falling sea level conditions and feed sediment onshore. In deeper water these ridges become more stable but still dissipate energy and have sediment transport processes in depths of more than 17 m of water.

4.2 Cohesive Sediments

Erosion of saltmarshes and mudflats is becoming an increasing problem but research into cohesive sediments (mud) has been traditionally less attractive than non-cohesive (sand/gravel) studies. This balance is beginning to be redressed. One of the key considerations in cohesive sedimentology is the way flocs are generated and sustained. This process is primarily through chemical bonding. This links together several grains and enables deposition to take place. Once deposited these grains may be eroded in floc form (BLACK, K) to create a form of bedload or individual grains stripped from the surface.

4.2 Continued

It has also been recognised that biological activity affects mudflat stability. Black found that in quiescent water (insignificant wave action and low tidal flows) diatoms play a significant role in sediment stabilisation. This stabilisation is created through weak carbohydrate bonds from mucus. Destruction of diatoms increase the availability of sediment for transport by 50-150%. This stability is particularly marked in summer when the organisms enhance accretion of sediment on mudflats. This may mean that, under winter conditions, erosive forces have less impact. Clearly the role of micro-organisms has been little considered but if they are playing a significant role pollution could cause destabilisation of previously stable mudflats.

5.0 ANALYSIS TECHNIQUES AND MODELLING

5.1 2D Cost Benefit Analysis

Cost benefit analysis is commonly carried out on a broad-brush approach. This masks the significance of particular high value points on the coast and over-values areas in between. WINDT, H suggested a 2D grid system in which each grid cell would have an economic value. The grid resolution would be appropriate to the area so that conurbations would have a higher resolution. Having determined the value a process is then applied to the grid, such as erosion or flooding. As flooding proceeds into each cell, the value is accounted for on the basis of damage. This enables various scenarios to be tested and known projections to be applied. This combines the value on land with the impinging process over time.

5.2 Landsat Remote Sensing

Thematic mapping from satellite images has been on-going for some time. NOORBERGEN applied the technique to identify coastal changes. Where large scale changes take place, such a system can yield interesting results. However, the resolution of such a system is no better than 50 m and is therefore not a fine analysis tool. The system has been used to plot a tidal cycle for an estuary. Here the different tidal positions throughout an estuary (100 km) were defined and a time series produced. This was found useful in remote areas to identify the change in tidal prism over time.

5.3 Combined Wave/Tide Modelling

Delft Hydraulics (VAN OVEREEM) have been developing combined wave/tide models in order to determine the impacts from scheme proposals. They have been able to compare reality and the model, and have developed a concept of a "morphological tide". This is an 'average' tidal condition which, when utilised over time, recreates the existing morphology. At present such models cannot predict future change but work is being undertaken to try and numerically stabilise them.

5.4 Wave Calculations In Fetch Limited Areas

Wave generation from winds has been considered mainly from offshore propagation and bringing waves onshore. Where waves are more locally generated the approaches must be different. By comparison of direct measurement and calculated waves MOUTZOURIS has determined that the CERC (Shore Protection Manual) over-estimates fetch limited waves by 30-40%. The variability in waves is also much greater when fetch-limited, but a hyperbolic sine wave appears to be a suitable approximation (PIANK) with a variable exponent dependent upon the fetch length.

5.5 Bottom Profile Changes

A number of models exist to predict the change in bed profile with cross-shore transport. SZMYTHIEWICZ has evaluated these. He finds the Dally-Dean model suitable in the surf zone during storm events (with limited tidal range). Work is on-going to determine the best models for 'continuous' use.

6.0 MEASUREMENT TECHNIQUES

6.1 Acoustic Doppler Current Profiles

The accurate measurement of currents in coastal and estuarine waters is critical to models for pollution and sediment diffusion and dispersion. This impacts upon water quality and effects the stability of estuarine and coastal environments.

The ADCP technique is becoming increasingly popular. Indeed, NRA have purchased an Acoustic Doppler system in the Water Quality Section of North-West region. This system enables "slices" of water to be measured from a moving vessel enabling wide coverage in a relatively short space of time. The paper presented (KOLB, M) found a 2000 m^3 error term in a tidal cycle. However, this small error was achieved through land-based position fixing. It was found that reliance on the vessel speed over the bed or vessel mounted measurement was unreliable if the bed was not solid. To enable separation of the vessel speed from the current depends upon accurate and continuous positioning. If this is achieved it is considered that ADCP yields high quality/high detail information.

6.2 Bed Shear Strength (Cohesive Sediment)

Mudflats and saltmarshes lock pollutants up for long periods within their sediments. They also act as buffers for flood defences by damping out energy (waves/tides). There is a critical level where

6.2 Continued

the shear forces exerted upon the bed exceed the shear strength of the sediments. This leads to erosion and subsequent problems with flood defences. In order to project under what conditions and at what rate mudflats (or marshes) will erode, it is critical to define the bed shear strength. Methods in the past have used torque to define the shear over a 5-10 cm depth. In order to determine the surface shear strength, two systems have developed in parallel (HOUWINK, E and BLACK, K). Both systems are mini-flumes which are placed directly on the bed at low tide. These have an oblong channel to circulate water, driven by an impellor. The water exerts increasing shear stress on the bed which eventually causes erosion. This force can be used to calculate the strength of the surface in situ of the surface.

6.3 Sand Surface Meter

Flood defence schemes today may involve the use of beach recharge (nourishment) material. In order to determine how a particular beach is acting it may be necessary to identify how the surface reacts over time. The net effect can be determined by low water surveys but this may mask significant changes under water during storm events. One possibility is to measure the surfaces continuously (in parallel with wave and current meters) to see how change takes place. This may be undertaken by means of a sand surface meter (STRAUBE, J). This equipment is opto-electronic measurement (light sensor cells) fixed at 4-1 cm intervals on a

6.3 Continued

staff. As the sand level fluctuates more or less cells are exposed and this can be data logged automatically. There may also be potential for such systems to act as a warning that beach levels have reached below critical levels under storm conditions.

7.0 MARINE BIOLOGY

7.1 Benthic Habitats

Benthic habitats are frequently used as indicators of water quality. Work in the Wadden Sea (DAMM, S) suggests a highly variable natural system. This variability causes problems for sampling to determine pollution impacts. The numbers and type of species fluctuates both daily and seasonally in response to temperature, hydrodynamics, pollution, salinity and other variables. In order to determine pollution impacts, all the variables need to be isolated and their individual impacts determined.

7.2 Size Spectra in Aquatic Communities

"There is a relationship between energy dissipation and the way systems function" (KAMENIR). This relationship can be described in terms of size. This is the primary criteria for energy usage. A large mass takes more energy to move (or be moved) than a small one. This relationship can be applied across live and inanimate matter and creates a size spectra. This spectra has few large elements and numerous small elements. The small elements account for much of the total energy usage and are vital in an overall spectrum. Each individual organism has its own niche within the spectra in terms of size and numbers. If one species increases in number, this must impinge on other species. This does not have to

7.2 Continued

be species based, suspended sediment may be increased through erosion and occupy the space of a particular organism and change the biological balance. These relationships may have implications for the food chain, eutrophication and water quality.

7.3 Mixing Fronts and Plankton

Where waters of different density mix (eg fresh and saline) currents are set up which may converge at the mixing front. This convergence draws organisms with it which accumulate in the mixing zone. This zone draws in plankton and phytoplankton in particular and can often be seen as a froth on the surface. This zone also accumulates sediment and pollution and may represent the most significant location for pollution entering the food chain. It may also cause the demise of native species who come into contact with high concentrations of non-native species in this zone.

8.0 CONCLUSIONS

The Kiel conference covered a broad range of topics and specialities. The conference succeeded in bringing together a multi-disciplinary group with one common interest, the Coastal Zone. If Coastal Management is to improve and grow in the future, it is vital that links are made across the disciplines to create integrated management of the coast. Improving understanding of other disciplines and other countries' work may also have direct benefit to the National Rivers Authority in its role as Guardians of the Water Environment.

A P P E N D I X A

ABSTRACTS AND AFFILIATIONS

General remarks

The abstract volume represents the state of registration for ICC as of Aug. 10, 1992. Subsequent changes (withdrawals or delayed enrollments) would not be considered before the volume was printed. The organizing committee regrets all cancellations that have arrived after printing deadline.

The following abstracts (papers and/or posters) have been corrected as far as possible for orthographic or typing errors by the organizing committee. This may have led to slight differences between the original manuscripts and the printed abstracts. Because of technical reasons we could not include any figures in the abstracts. Aside from these changes, the contents of the abstracts are up to the responsibility of the author(s).

Please show your sympathy for still existing mistakes. Please check your address in the appendix. If your address has changed or if you find any mistakes please inform the registration desk.

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- Isotope-biogeochemical investigations of Baltic sea marine deposits
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- Seehundaufzuchtstation- Touristenattraktion oder ein Beitrag zum Seehundschutz? Das Beispiel Friedrichskoog.
- no abstract received -

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- Coastline of the European Arctic - Mapping & Database
- no abstract received -

Abstracts

ACTUAL DYNAMICS IN THE ALTO MINHO COAST (NW PORTUGAL)

by

Alves, A.M.C.

The coastline of the Minho region, situated between the Minho River that serves as Portugal's Northern frontier with Galicia (Spain), is characterized by the presence of estuaries, beaches of gravel and straight, but sometimes extense sandy beaches interrupted with outcrops of paleozoic schists alternating with hercynian granitoids. These are surrounded by a long shore dune of weak expression and preferentially distributed at the Southern board of the rivers, frequently forming spits. The region is geomorphologically distinct from the rest of the Iberian Peninsula's Occidental coast; to the North this is dominated by the existence of the deep galician "rias", while South of the Douro River it is characterized by the presence of sandy beaches and lagoons of which the principal example is the incorrectly named "Ria of Aveiro".

The region's actual dynamics is, in general sense and like great part of the Portuguese Occidental coast, controlled by the atmospheric circulation associated with the Azores' Anticyclone, particularly in what refers to the winds that condition the waves along the coast from the Northwest with some sporadic times, although of great energy, from West and Southwest. The result is a current along the coast responsible for the sediments transportation from the North to the South. The presence of natural or manmade coastal structures, of which the Caminha islet, in the Minho River's mouth, and the North breakwater protecting the Viana do Castelo port are examples, provoke important modifications in the waves' motion, with the consequent effects on sedimentary dynamics. They can locally induce an inversion of the current's direction and thereby an inversion of littoral drift of which results the formation of spits and the silting up of the estuary's mouth.

The actual or recent evolution is manifestly transgressive, identifiable by the deficiency of sediment input in the littoral drift that condition an intense erosion of the Quaternary deposits and offshore dunes, and the loss of energy by the rivers manifested by the intense estuary silting up and eventually the entry of sediments from the littoral in the rivers' mouth.

**RELATIONSHIP BETWEEN THE PORT STRUCTURES AND COASTAL
DYNAMICS IN THE GULF OF GELA (SICILY - ITALY)**

by

Amore, C.; Giuffrida, E. & G. Randazzo

The results of surveys carried out in the Gulf of Gela are presented in this study. The Gulf is affected by the presence of an industrial port which, in the last 30 years, has undergone constant transformations and continual additions which have had immediate effects on the coastal dynamics.

The Gulf of Gela, which is 64 km long, goes from Capo Scalambri to the mouth of the River Salso and has a shallow, sandy coastline. The littoral drift, which has been seriously changed by the port operations, is the final link in a series of interventions which have also affected the underlying hydrographic basins. As an immediate consequence, the morphology of the coastal environment has been altered; there have been marked withdrawals, limited and punctual advancements, phyto- and zoobenthonic associations and a profound deterioration in the beaches in terms of their countryside and health situation.

**PRELIMINARY INVESTIGATIONS OF GRAVEL BEACH DEVELOPMENT IN
MEDITERRANEAN FRANCE: BAIE DES ANGES, FRENCH RIVIERA.**

by
Anthony, E.

The southeastern Mediterranean coast of France locally exhibits gravel beaches whose coarse clastic composition reflects the lithology of the supplying catchments. In the Baie des Anges coast of the French Riviera, these coarse deposits form two bay-beaches separated by the Var river mouth. The beaches retreat in places, reworking older sediments inland and threatening coastal infrastructure in an area of dense touristic development. Existing stratigraphic data suggest that the present gravel shoreline started as a series of Middle to Late Holocene landward-migrating proto-barriers and beaches fringing and overlying paludal-lagoonal areas and poorly consolidated cliff outcrops cut mainly into Pliocene puddingstones variably rich in coarse rounded clasts. While the immediate vicinity of the Var river mouth has prograded into a convex Gilbert-type delta by capturing most of the gravels brought down by this river, the rest of the shoreline on either side of this delta appears to have become organized into continuous barrier/beach systems from the initial discontinuous proto-configuration, the link-up having been favoured by channel mouth fill, paludal sedimentation and efficient longshore redistribution of fluvial and puddingstone gravels. The shoreline simultaneously migrated inland, reworking the Pre-Holocene deposits landward and transgressing over paludal areas. Both the formation of a continuous gravel shoreline and its landward migration may have been favoured by a still slowly rising sea level as late as 2000 B.P.. Landward retreat has been apparently very moderate because of a predominantly low wave-energy regime punctuated by fetch-limited low-frequency storm events, a micro-tidal range and sustained, though probably moderate, sediment inputs. In spite of longshore variations in retreat related to sediment inputs or residual sediment drift, backbarrier or backbeach morphology, incident wave energy and clast size, overall landward shoreline translation on either side of the convex Var delta has been such as to maintain a coherent, essentially concave, plan-view shoreline configuration, no doubt through longshore redistribution of sediments within "closed" bay-beaches characterized by variable drift. A Late Holocene conjunction of a stable or slightly recessive sea level and the hydrodynamic climate and sediment conditions mentioned earlier may have even led to a cessation of shoreline retreat in historic times. However, the details of sea level history in the study area still need to be better elucidated. Local departures from the afore-mentioned shoreline configuration have occurred in areas where the net long-term sediment budget situation has favoured at least stabilization or, conversely, higher retreat rates vis-à-vis the rest of the shoreline. It would seem that man-induced modifications of the sediment dynamics of these beaches in the past century have been a factor responsible for the resumption or local exacerbation of retreat.

Key words: Gravel beaches and barriers; stratigraphy; retreat; sediment dynamics; Baie des Anges, French Riviera, Mediterranean Sea.

A STATISTICAL PREDICATION OF CROSS-SHORE SEDIMENT TRANSPORT

by

Anwar, M.N.; Khafagy, A.A. & A.M. Fanos

The phenomenon of onshore and offshore movement of sediment has been a challenging subject of investigation for scientists and engineers. Although longshore sediment transport equations have been well established, on the other hand there is no single model for cross-shore sediment transport that receives the general acceptance of the scientific community. This is mainly due to the difficulty in measuring and the complexity of the mechanics of this phenomenon.

In the present work, the Eigenfunction approach is adopted in order to analyze the temporal and spatial scales of the onshore and offshore sediment transport and consequently the corresponding variability in beach profiles. The Empirical Orthogonal Eigenfunction method is used as a linear statistical predictor to represent the large amount of beach profiles data by a limited spatial and temporal Empirical Orthogonal Eigenfunction, $\Phi_i(x)$ and $\Psi_i(t)$ respectively. The depth at an offshore location y and time t is to be described as

$$h(y,t) = \sum_i \Psi_i(t) \Phi_i(y) (\lambda_i, n_t, n_y)^i$$

Where n_t and n_y are the number of temporal and spatial points respectively, and λ the eigenvalue associated with the n th eigenfunction.

The various geomorphological features of the beach, such as the bar-berm generation and displacement along the beach profile, are related to these eigenfunctions associated with the first two longest eigenvalues respectively. Quantitative prediction of cross-shore movement of sand, q , is obtained by integrating; with respect to the offshore variable y , the continuity equation

$$\delta h / \delta t + \delta q / \delta y = 0$$

along the profile between two consecutive locations. Results representing the predicted amount of cross shore movement of sand and variation in beach profiles at the Rosetta promontory, Egypt, are given.

**POST-MINING REHABILITATION OF COASTAL SAND DUNES IN ZULULAND,
SOUTH AFRICA**

by

Avis, A.M.; Lubke, R.A. & J.B Moll

In the process of dredge mining, employed since 1977 on the Zululand coast, heavy minerals are extracted from the dunes after the complete removal of the existing vegetation. The tailings are then reshaped to approximate their original contours, topsoiled and revegetated with a cover crop, together with indigenous seeds of long-lived (woody) species. The existence of stands of different ages over a recorded period provides an opportunity to study changes in species composition and vegetation dynamics. Five random 10 x 10 m quadrats were sampled in stands of age 4 to 12 years, and cover data were used for multivariate analysis using TWINSpan and DECORANA. Importance values of each species, and total and mean species richness was also calculated. Pre-mined and mined soil samples were analyzed for trace elements, organic matter and pH, and potential seed bank was determined. Within the rehabilitated areas, species richness showed a progressive increase with age of rehabilitated stands, with more woody species in the older stands and a slight decline in dominance of *Acacia karoo*. Classification by TWINSpan grouped older and younger stands into distinct groups and these were related to a chronological succession gradient, as shown by DECORANA ordination. The results from the rehabilitation sites, which show increasing plant species diversity with age, were compared with other studies showing a natural plant successional series. Some soil nutrients of rehabilitated areas compared favourably with the pre-mined topsoil, but percentage organic matter content was found to be higher in natural dune forests. There is a seed bank of viable seeds in the topsoil but these preliminary studies do not show any conclusive evidence of a build-up of forest species. However, they indicate a good chance of sustainability of the system. Evaluation of the success of the existing rehabilitated areas is based on five criteria for natural ecosystem functioning, namely; sustainability, productivity, invasibility, nutrient retention and biotic interaction. Increases in soil nutrients suggest that nutrient retention and the establishment of substantial soil flora and fauna are occurring, providing evidence for the sustainability of the soils. The relationship between the natural succession of vegetation in revegetated sites shows strong evidence of secondary succession to dune forest via an *Acacia karoo* woodland pathway. The community has a high productivity, and evidence from this and other studies of natural stands of *Acacia* suggest woody species will invade and replace the *Acacia* dominated woodland. Return of the faunal components to the ecosystem are still under study, and further work is required to elucidate the extent of biotic interactions occurring. From this study it appears that successional changes follow the facilitation pathway, and rehabilitation will eventually lead to the restoration of the dune forest.

EXPERIENCE FROM SHORE PROTECTION OF THE HEL PENINSULA

by
Basinski, T.

Hel Peninsula is a famous recreation area at the Polish coast. The 33-km long spit is strongly eroded by the sea and has in some parts the width of only 100 m; about 45% of the land area is under the ordinate + 2.5 m. This creates serious shore protection problems.

During the years 1948-70, 162 groynes have been constructed along the coastal section about 12 km long. During the construction of groynes and in the first few years after, an increase in beach width was observed. Then the tendency of further erosion was modified by the groynes in such a way that beach accumulation increased rapidly during mild wave conditions and was again followed by erosion during storms. It can be found that groynes slow down dune erosion but are not able to prevent it during severe storms and at high water levels.

The increasing sand deficit and proceeding dune erosion have forced us to look for other shore protection methods.

Beginning from 1980 different technologies of artificial nearshore and beach nourishment have been developed and tested. The most effective one has consisted in sand supply to the beach and dune area. The new beach profile caused a 100% wave energy dissipation and fully protected the dune from erosion. After the first year 43-46% of the beach fill stayed on place.

COASTAL EROSION ALONG THE BLACK SEA COAST OF TURKEY AND PROPOSED PROTECTIVE MEASURES

by
Bilgin, R.

The coast of the Black Sea is 4431 km in length, nearly 50 % of which is actively eroding. The worst effected region by wave erosion with human impact is in the north-east part of Turkey, total length about 500 km. Beach sediment available is estimated to be around 4-6 cubic meters/m/year and the erosion rate to be 2-3 m/year in this coastal region. Besides, various groins and fishery harbours recently constructed without proper designing and site selection cause serious damages on coastal sediment budget. One of the typical damages is sediment accumulation at a site of harbour (upcoast) and erosion at the other site (downcoast).

Within the past 30-40 years human impact has greatly accelerated erosion rates at many coastal sites because of the construction of passive concrete walls, the use of beach deposits as construction material for roads, cities and summer resorts. When the coastal highway extending from Samsun to Hopa was constructed during 1960's the highway was some hundred meters away from the sea and was not directly exposed to waves. During the years after construction severe erosion along the coastline occured and the coastal highway is now exposed to direct wave action which necessiates heavy maintenance cost each year. In 1986, The Turkish Highway Department put forward a research project in cooperation with the Hydraulic Laboratory of Karadeniz Technical University located at the region to protect the highway from sea waves. The extent and the conclusions reached in the project period from 1986 to 1988 are described in this paper.

As protective measures to be taken at seventy seven coastal sites severely eroded two main approaches were considered: passive measures (rubble-mound shore protective structures, T-groins, offshore breakwaters) and active measures effective in long run (artificial nourishment). Of these measures only the rubble-mound structures are presently under construction. The advantages and disadvantages of these measures for the sites are discussed.

THE RESUSPENSION OF COHESIVE INTERTIDAL MUDS: SOME NEW CONCEPTS AND IDEAS

by
Black, K.S.

The direct, in situ evaluation of the behaviour of cohesive marine and estuarine sediments under tidal flows has become of increasing relevance today, because it enables an inherently more accurate and realistic prescription of the sediment hydraulic properties. Laboratory flume studies, despite their usefulness, are unfortunately unable to recreate the natural environment and in situ properties of these sediments.

Experiments using purpose built, field-portable recirculating seawater flumes (which can be used directly on undisturbed sediments), have yielded new insights hitherto unavailable into the way in which flocculated intertidal muds respond to periods of increasing bed shear stress, similar to natural tidal boundary layer flows. Results presented from within the intertidal zones of the Bay of Fundy (Canada) and South Wales (U.K.) are compared to laboratory based experimentation and used to demonstrate many of the features associated with the erosional phases of these sediments.

The erosion of naturally deposited cohesive muds is a complex process which depends upon a large number and wide variety of factors. Patterns of erosion vary according to the magnitude of the bed shear stress; at low stresses ($< 0.1 \text{ Nm}^{-2}$), erosion is characterised by a gradual winnowing of weak sub-unit floccules or primary particles, but at higher stresses large aggregates or clasts are removed from the bed. Although sediment transport is primarily via suspension, some concomitant bedload transport is observed.

Erosion of sediments through time under periods of increasing bed stress is a combination of time-dependent linear and non-linear processes and may be classified in terms of the Type I/Type II patterns of Mehta and Partheniades (1982). Patterns of erosion are contingent upon the microstructural, textural and microbiological properties of the floc aggregates, which contribute to micro-scale gradients of cohesion within the surface 1-1.5 mm. Entrainment of muddy sediments by a tidal flow is thus a very interface phenomenon only.

Specific, manipulative field experiments demonstrate the emerging influence of biological processes on sediment resistance to erosion; forced removal of the biological and organic phases within the surficial floc aggregate network reduces the threshold condition by a single order of magnitude, and increases initial entrainment rates by between 50-150%.

Assessment of those primary variables governing the resistance to erosion of natural muddy sediments is complicated and the predictive capability of physical and biochemical sedimentary indices is confounded by the wide degree of natural property heterogeneity and significant degree of inter-property covariation. A qualitative general conceptual model only of sediment-water interface dynamics in turbid, macro- or mesotidal estuaries is therefore appropriate. However, this should provide a framework in which processes may be identified and will act as a guide to future experimentation and ultimately to process modelling in this field.

**BEACH DYNAMICS AND PROTECTION MEASURES ON BARRED
NEARSHORES: NORTH SEA (SYLT) AND SOUTH PACIFIC
(GOLD COAST, AUSTRALIA)**

by

**Boczar-Karakiewicz, B.; Jackson, L.A.; Kohlhase, S.; Strohmann, F. &
A. Naguszewski**

Presented work is based on wave and bathymetry data collected on two prototype beaches: on the island Sylt (North Sea) and in the Gold Coast area on the South Pacific (Australia). These data are used in a mathematical model of wave-bed interactions. Results are describing the formation and dynamics of the two barred nearshores responding to the incident wave regime. For both beach systems (Sylt - meztidal and Gold Coast - microtidal) the model predicts a dynamical cycle in bathymetric changes in the nearshore under varying wave conditions. Results show that the cycle of beach dynamics may be described in two different time scales. Pronounced offshore bars, characterizing the post-form state of the seabed are formed in a few days of extreme storm activity. A stable bed topography characterizing a dynamical equilibrium state is established during several months of moderate wave activity. The recurrence cycle of beach transformation has been estimated from observations. Model predictions compared with observations show for both beach systems a satisfactory agreement.

The objective of this work is to contribute to a better understanding of the dynamical behaviour of nearshore beach systems dominated by a strongly variable wave regime. Attention is focused on justification of offshore nourishment protection measures. Presented results suggest the locations, amount and timing of sand to be placed offshore to get the most cost-effective measure of protection and possible gain of volume of sediment on the visible beach.

**ENVIRONMENT AND DYNAMICS OF THE KALININGRAD COAST THE
BALTIC SEA**

by
Boldyrev, V.

Kaliningrad coastal zone includes the molar shores of Sambians peninsular and the adjacent Kursh and Visla spits (about half of the length of each).

Due to its protruding into the position and west storm predominance there is an irreversible drift from the jut to both 5 sides of almost all abrasion material. As a result there is an intensive erosion and recession of most shores, including the root of Kursh Spit. This process is inherited from the first phases of Holocene transgression.

In this process on the bottom large boulder fields were formed from the stone material washed off from glacial loams. That is why shoreline sand feeding goes at the expense of coastal erosion. Current recession rate is 0,3-1,5 m.

The before-war beach-protecting system has proved ineffective. Inwash of sand wave-extinguishing beaches has been recognized to be the most effective fundamental beach-protecting method today. An example of it is mass sand feeding coming from the Amber open-pit soil discharge (50 mil. m³ since 1958) on the West Coast of the region. As a result wide 30 km long sand beaches were formed with a swell-like coast-dune.

From 1987 to 1990 on the Northern Coast a 2 km long and up to 170 m wide sand beach was inwashed at the expense of cutting off the root abrasion coast in 1992 a 120 m wide sand beach will be inwashed in Svetlogorsk (Raushen).

On the damaging parts of the shoreline (Kursh Spit, Zelenogradsk) original wave-extinguishers built in 1984-1990 are very effective. In 1992 wave-extinguishers of a new type will be built in Svetlogorsk Bay.

Projects of building new large ports are being considered within the framework of the current geopolitical situation and local conditions.

BEACH NOURISHMENT BY DUMPING AT LIDO DI OSTIA (LATIUM - ITALY)

by

Caputo, C.; Ferrante, A.; La Monica, G.B. & F. Pugliese

The shore which underwent artificial nourishment is located on the left wing of the Tiber River delta, the evolution of which is well supported by various evidences as from Roman times. The nourished sector belongs to the shore in front of Lido di Ostia a town which, especially during summer, records a very high human pressure due to its prevailing tourist and bathing activity. This shore, like neighbouring ones, has been affected as from the Fifties by very severe erosion having caused a notable narrowing of beaches especially near the Tiber River mouth.

The defences built as from the Seventies concerned only the area to the north of the considered sector. For the one going from the Pontile della Vittoria to the Canale del Pescatori, about 3 km long, a project of artificial nourishment has been proposed and then carried out. This project provided for a spilling of sediment with granulometric characteristics consistent with those of the band belonging to the beach to be nourished. This sediment is held and protected by an artificial submerged bar whose end is also to pull down the energy of incident waves. The works started during May 1989 were brought to end during July 1990 and allowed the reconstruction of a large sandy strip.

The designed nourishment, the amount and sedimentological characteristics of the burrow material, the structure peculiarities of the artificial bar as well as the artificial response of the beach to some storms will be illustrated.

**A MODEL TO DESCRIBE THE SECULAR DEVELOPMENT OF
MORPHODYNAMIC DOMAINS ON A PARAGLACIAL COAST: CHEDABUCTO
BAY, GUYSBOROUGH COUNTY, NOVA SCOTIA**

by

Carter, R.W.G.; Hinton, A.; Orford, J.D. & S.C. Jennings

The north shore of Chedabucto Bay comprises a series of gravel and mixed sand/gravel beaches that are being driven up-bay under conditions of dominant fetch waves, extreme storms and sea-level rise. Movement is slow, but inexorable. As the shoreline evolves so the location of headlands dictates the development of a series of cells, with drift-aligned characteristics, evident in the pattern of morphosedimentary response. Each cell reveals structural and textural organisation. Ragged Head beach is a particularly good example of a cell reflecting variation in beach slope, crest height, beach width, sediment size, cusp form as indexes of longshore gradations in morphodynamic domain. Ragged Head Beach is now fed intermittently both from internal and external sources. The secular evolution of the Chedabucto Bay system also depends on the open and closing of lagoons, such as Long Pond, Carrs Pond and Collins Pond, especially where the lagoon infilling allows diversion of beachface sediment into re-entrants.

The paper will present a general model of shoreline development by wave processes.

**PROPOSALS AND PROGRAM FOR THE ORGANIZATION OF THE NATURAL
PARK ON THE COAST OF ARBUS (SARDINIA)****by****Castelli, P.; Di Gregorio, F. & C. Ferrara**

Sardinia's regional system of parks, reserves and natural monuments (Regional Law no. 31/89) includes the natural park of Monte Linas, the natural reserves of Capo Pecora, Piscinas/Monte Arcuentu, the San Giovanni Wetlands and the dunes of Pistis on the west-central coast. The recently (1991) presented pilot project for the Monte Linas Natural Park poses the problem of examining the proposal to place other natural treasures under the protection of the Park and involve local populations in the formulation of cultural programs and induced productive activities. The method starts from an evaluation of the natural and cultural worth of human and parimonial resources as well as the proposed uses of the Park. It proposes a way of establishing perimeters and importance of areas to be assigned to the Park administration; it goes on to deal with the internal zoning of areas of total protection, areas of general reserves, including parts of the territory which, although transformed, are the result of correct man/nature interaction, protected areas where traditional uses are allowed, or even encouraged by the presence of visitors, and zones of development destined mainly to social activities. The planning of access roads and paths to places of interest and the setting up of support facilities for park employees and services for visitors are discussed. Even a rough estimate of additional costs allows an evaluation of the feasibility of the proposal. The geo-environmental characters considered, which are decisive in defining levels and types of ecosystem protection, can be classified as: rocky coast landscapes, beach-outlet-dune systems, wooded hill and mountain or Mediterranean bush landscapes, agricultural or mining landscapes. The main kinds of protection proposed concern:

- protection of steep coastal scenery from buildings overlooking the sea;
- protection of dunes and beaches through proper planning of access roads;
- safeguarding and organizing the fruition of wetlands, rich in rare and interesting bird species;
- protection of geological monuments and the paleontological patrimony.

The method and solutions proposed appear to be the most effective answer to administrations and local populations pressing for the creation of settlements and job- and income-producing initiatives as well as favoring the conservation of environments and ecosystems which are fast being reduced in the Mediterranean area in the wake of increasing pressure of new settlements and tourist resorts along the coasts.

COASTAL AND NEAR-SHORE EROSION AT VEJRÖ, DENMARK: COMBINED EFFECTS OF A CHANGING WIND-CLIMATE AND NEAR-SHORE DREDGING

by

Christiansen, C.; Christoffersen, H. & M. Binderup

Shoreline -and cliff erosion on the island Vejrö, Denmark in the period 1954-1988 have been evaluated from aerial photos. During the period a net loss of 49563 m² was observed along the 3500 m long shoreline. Coastal retreat was specially significant on the eastern (up to 66 m) and the northern (up to 30 m) part of the island. Cliff erosion was up to 19 m on the northern part and insignificant on the southern part of the island. A total loss of 2.1 10⁶ m³ was observed along the cliffs. A partly submarine spit on the NW part of the island diminished both in length and width during the study period.

By comparisons of maps and new surveys a total gain of 2.1 10⁶ m³ was observed in the 20 km² near-shore area. However, there was a loss of 1.2 10⁶ m³ connected to the spit retreat. Approximately, half of this loss could be explained directly by dredging.

There has been a change in wind-climate during the study period with increasing frequency of strong winds both from the NW and the S. These two directions have the longest fetches. Sea level measurements show a rise in mean sea level of about 1 mm y⁻¹. More important, there is a stronger increase in both yearly max. and min. sea level.

Observed sediment data together with the use of the program REFRACT, which computes sediment mobility from wind and bathy-metrical data, allowed to infer changes in sediment transport.

It is concluded that the observed coastal and near-shore erosion is partly due to the wind climate. It is also partly due to the dredging operations. These operations have changed the bottom topography and thereby induced new wave refraction patterns and new paths for the sediment transport. Very steep slopes in the dredging hollows do not allow sediment to return to the littoral zone after periods of erosion.

**RECENT EVOLUTIONAL TREND OF THE SHORELINE IN THE RAVENNA
LITTORAL (ADRIATIC SEA-ITALY-)**

by

Ciabatti, M.; Giorgi, G. & F. Marabini

The poster shows the comparison among the different shorelines from the last century up to day along the Ravenna littoral in the Adriatic Sea.

The aim of this work is to point out the recent shoreline variations and the coastline regression connected with the bad weather conditions and the more and more massive utilization of the coastal zone for economic overuse.

**GEOMORPHOLOGICAL EVOLUTION OF THE CLIFFS IN THE CENTRAL
ADRIATIC SEA (ITALY)**

by

Cicco, L.; Elmi, C.; Fanucci, F. & O. Nesci

Western cliffs and headlands of the central Adriatic sea, corresponding to the external structures of Apennines, develop in about 40 km from Cattolica to Ancona. They show different morphological and evolutive features due to the structural and lithological conditions.

The cliffs of S. Bartolo (Pesaro) and M. Conero (Ancona) are active and the wave action causes a fast retreat, with a maximum rate of more than 0,7 m per year in the former. Such rapid recession activates different kinds of landslides on the slopes: in the S. Bartolo cliff, with jointed and thinly bedded sandstones and marly clays, rock slumps and rock slides prevail; rock fall or large rock block slides are more frequent on the calcareous cliff and headland of M. Conero.

The cliff of M. Ardizio, south-east of Pesaro, now inactive, is protected by a large sandy beach, fed by the nearby Metauro river. The slope processes are less evident.

The whole coast is bordered by a large wave-cut terrace, with some remnants, covered by thin, mainly sandy sediments or by recent slide materials.

COASTAL MANAGEMENT IN POLAND

by
Cieslak, A.

In Poland, during 1990 and the beginning of 1991, two basic options of coastal management were discussed. One - to give all responsibility for coastal management and protection to the local communities, and the other to make the State through the Maritime Offices responsible for coastal protection and management of a narrow coastal belt. The final result of the discussion was incorporated in the new Act of Parliament "On the Sea Areas of Poland and on Maritime Administration" which came in force on July 1-st 1991. The Act establishes a "coastal belt", and:

"The coastal belt comprises:

- 1) the technical belt - which is the zone of interaction of sea and land; it is an area set apart for maintaining the coast in appropriate state according to requirements of safety and environmental protection,
- 2) the protective belt - which covers the area in which human activity has direct influence on the state of the technical belt."

The act makes the maritime administration responsible for coastal protection and management of the technical belt, giving it also some influence over the neighbouring protective belt and also areas lying further inland.

The paper presents the former state of coastal management, the philosophy lying at the basis of the adopted solution, and some of its details, and also required directions of further research and legal work.

**SEDIMENTOLOGICAL AND GEOCHEMICAL CHARACTERISTICS OF THE
CARBONATIC BEACHES OF THE GULF OF OROSEI
(EAST-CENTRAL SARDINIA)**

by

Cristini, A.; Di Gregorio, F. & C. Ferrara

Results of research on the geo-environmental characteristics of beaches in the Gulf of Orosei in east-central Sardinia are illustrated. Moving from north to south, the geomorphological characteristics and sedimentological, minero-petrographic and geochemical parameters of sediments making up the single beaches are described in an attempt to discover possible correlations between sedimentological parameters and heavy metals read as tracers in different conditions of beach formation, both from mixed (granitic, metamorphic, carbonatic) and exclusively carbonatic petrographic provinces. Grain size distributions point to the unimodality of most of the sediments, with localized modes in determined grain-size intervals depending on the geomorphological and hydrodynamic characteristics at the sampling points. In the first five stations, from N to S, the mode is in the ambit of coarse sands, with fairly evident tails of gravel. In samples 6 to 11, where the carbonatic component is prevalent and feed comes mainly from detritis and overhanging cliffs, the mode shifts to the ambit of gravels, with some heavily polymodal samples. Samples 12 to 14 fall in the ambit of medium sands and gravel tails. Results emerging from the sedimentological analysis are compared to those obtained from the minero-petrographic and geochemical investigation. Analyses were carried out on samples as taken after making them soluble with turpentine. Using the fluorescence technique, each sample was analyzed for the principal elements (Al, Si, Ti, Mn, Fe) characterizing the sedimentation environments, while the metal concentrations (Cr, Co, Ni, Cu, Zn, Rb, Sr, Cd, Ba, Pb), which were investigated as possible tracers, were determined by means of spectrophotometry (ICP, AA). Results appear to confirm the possibility of integrating data from the geomorphological, sedimentological and minero-petrographic analyses with the geochemical analyses to obtain a better definition of beach and sedimentation environment characteristics.

GEO-ENVIRONMENTAL CHARACTERISTICS OF THE COASTAL DUNE OF THE GULF OF PISTIS (SE SARDINIA)

by

Cristini, S.; Castelli, P.; Di Gregorio, F. & C. Ferrara

Sardinia's western coast presents frequent, more or less extended, dune fields ranging in age from the Pleistocene to the Holocene. Recently, several of these have been stabilized through reforestation, while others have been left in their natural free state, or partially stabilized by spontaneous vegetation. The purpose of this research is to improve knowledge, and thus control, of these environments, which attract many tourists in the Mediterranean area. The dunes studied are located on the west-central coast of Sardinia, stretching inland about 1 km from the beach of Pistis. They cover Paleozoic metamorphic rocks, ancient terraced alluvial deposits, residual outliers of cross-bedded Würmian eolian sandstones and slope detritus. Through a detailed survey, the analysis of aerial photographs taken at different times and a series of sand samples taken along profiles orthogonal to the beach, the geomorphological, sedimentological and geochemical characteristics of the grain-size fractions, these take the overall form of parabolic tongues, with frequent accumulations of sand around obstacles, eolian ripple fields and eolized, pebbly pavements. Mineralogic analyses of the most significant interval under the optical microscope reveal a clear prevalence of quartz, followed by K feldspar, felds and lithoids, as well as traces of accessory minerals. Bioclastic and organic components are lacking. The ratio of quartz to the other components increases progressively from the coast towards the interior, also as the result of greater resistance to mechanical stresses during saltation. The granulometric denote a higher sorting of dune sand samples compared to those from the high beach, where a coarse fraction selected by deflation (pavement or lag) is present. Under morphoscopic analysis, all samples show a high degree of rounding that took place in the sea, probably during several working cycles. The various grains are opaque and pitted by being wind-borne. The increase in the number of tourists, especially in the last few years, and the lack of limitations on access to the area have caused the retreat of the vegetation, which was already discontinuous, and the widening of the apertures along the parabolic tongues. Vegetation is composed of the anemological successions of windy dune environments. The finding of shards and flint utensils indicates the presence of a prehistoric human settlement.

**RECENT DYNAMICS OF THE TYRRHENIAN BEACHES OF CALABRIA
(SOUTHERN ITALY)**

by

D'Alessandro L.; Davoli L.; Lupia Palmieri E. & Raffi R.

A study of recent dynamics of the Tyrrhenian beaches of Calabria showed that during the 1950-1978 period a severe erosional crisis affected the shores of Calabria, and about 3,300,000 sq.m of beaches were lost. During the 1978-1987 period, the shore seems to have reached a state of dynamic equilibrium, and in places there is even some progradation. The erosional crisis of some delta cusps still persists.

The main human factors which contributed to stopping the erosional trend and to achieving a state of dynamic equilibrium of the beaches are the defences, built particularly as from the end of seventies, and the end or reduction of mining from beaches and stream beds, officially ordered as from the eighties.

As for natural causes the study of the wind regime, carried out by comparing the data recorded in two periods (1954-1978 and 1978-1987) showed that during the second one winds were less frequent and intense.

All the beaches of the Golfo di Gioia and especially those at the Fiume Mesima and Petrace deltas were subject to different dynamics to those of the other beaches: the erosional crisis of the 1954-1978 period still persisted during the following decade. These dynamics are chiefly to be ascribed to the role played by the Gioia Canyon, located very close to the shoreline.

**DETERMINATION OF BENTHIC WADDEN SEA HABITATS BY
HYDRODYNAMICS**

by

Damm, S.; Kaiser, R. & D. Niemeyer

Benthic animals in the Wadden Sea are usually well adapted to the extreme short-term changes in their living conditions due to the tidal cycle. Nevertheless they are remarkably sensitive both to mid-term and spatial variations of hydrodynamical boundary conditions of their habitats. Subject of this paper will be to highlight these interactions.

Firstly the zonation of Wadden Sea habitats due to local flooding periods is demonstrated and secondly the one to the spatial variations of acting wave energy which is derived from the well established knowledge of the interdependence of local sediments and benthic habitats in Wadden Sea areas. Additionally mid-term fluctuation of boundaries of Wadden Sea habitats become evident by regarding the seasonal fluctuations of tidal water levels and respectively flooding durations.

Recently a pilot study on direct interactions of hydrodynamics and macro-zoobenthos has been started in the East Frisian Wadden Sea area close to the island of Norderney. The evaluations of samples taken in different intervals of some weeks or some days respectively indicate that some species are not significantly sensitive to the occurrence of raised tidal water levels due to set-up and the usually accompanying increase of wave energy whereas other species respond to these events with remarkable changes of their abundances. Though these first results gained up to now have still to be verified they allow already an insight in the interaction of Wadden Sea habitats and hydrodynamics which superimpose significantly as well seasonal variation as human impacts.

**VARIATIONS IN PRESENT DAY BEACH DYNAMICS ALONG THE
BELGIAN COAST**

by
De Moor, G.

The Belgian coast is a uniform, rectilinear, sandy, megatidal coast of 65 km length, showing a runnel and ridge morphology, backed by a dune ridge.

The EC CORINE-Coastal Erosion project produced a map of the actual morphodynamical state of the Belgian coast as part of the Community's coastline.

In order to guarantee the objectivity and comparability of the evaluation, to uniformize the meaning of the information, to allow the monitoring to adapt to sudden short term events such as storms, and to get numerical data as a prerequisite for regression analysis and causal research, a time series of volumetric measurements has been used for parametrization of the beach evolution and that of its morphological sections. Frequent, detailed and very flexible beach profilings have been used as basis for the acquisition of a phenomenological signal covering the period 1978-1991 in different stations representative for various morphodynamical beach types. Special attention has been given to the impact of the february 1990 storm effects.

The results confirm the existence of a long term spatial and temporal succession of mobile erosive and accretional coastal sections and of related variations in morphological storm effects.

STORM IMPACT ON THE MORPHOLOGY OF A TIDAL SANDBANK

by

De Putter, B.; De Wolf, P.; Houthuys, R. & J. Van Sielegem

The Flemish Banks (southern North Sea) are widely considered as mainly maintained (if not shaped) by tidally induced forces. The influence of wave-induced forces is relatively unknown. Especially in this field there is a sore need of reliable measurements.

In order to study the effects of a storm event on the morphology of the Middelkerke Bank, use was made of the hydrographic BEASAC hovercraft. This hydrographic craft was developed under the auspices of the Belgian Ministry of Public Works for performing fast and accurate bathymetric measurements, even in very shallow water.

After a preliminary analysis of the Middelkerke Bank morphology, two small test areas were selected for detailed bathymetric surveys. The first survey was carried out at the end of a long period of fair weather. A second survey took place on the first day that conditions allowed after several weeks of stormy weather.

Large-scale maps of both surveys were established, as well as graphical representations allowing a visual appreciation of the morphology. Digital terrain models support the numerical description of the surveyed areas.

The field conditions of the time period between the two surveys are characterized by hydrometeorological parameters calculated from both offshore and shore based measurements. The impact of the storm period on the sandbank's surface morphology is studied using depth difference maps and volume differences. In the paper, the results of this analysis are presented and interpreted.

MORPHOLOGICAL STRUCTURES IN GERMAN TIDAL FLAT AREAS

by
Diekmann, R.

The nearshore region of the German Bight is characterized by a large tidal flat of 7.500 km². These tidal flats are regions of extensive alluvial activity. Sedimentation and erosion are longterm acting and to a certain degree also normal process.

The surface of the tidal flats is very complex and dissected by numerous small to large watercourses, creating a typical shape pattern. Within this pattern there exist several special, repeatedly occuring sandbodies, called morphological structures. Most of the structures are situated in a special vertical range above and below MLW. Some of these structures are only common in flats of estuaries, such as the Weser estuary, others can be found in the entire tidal flat area. The shape and the location of these structures explain the general forces they originate from. Knowing these structures, the surface shape of the flats is like a mirror, showing the general hydrodynamic load and the sediment transport conditions.

Morphological structures are not necessarily stable. In general, there is a development towards a state of equilibrium, representative for special boundary conditions. The knowledge of the development of structures allows more accuracy when making predictions on morphological changes. Some of the structures are sensitive to changes of hydrodynamic boundary conditions. Their observation is therefore useful for an early recognition of morphological processes and reactions.

Because research on morphological structures in German tidal flats arises recently, no complete catalogue of these structures is available. However, approximately 15 macro - and mesoscale structures will be presented in connection with the adjacent flat areas by means of aerial photographs and bathymetric charts.

Due to geological influences the recognized morphological structures presumably differ to a certain degree from those found in similar coastal sections elsewhere.

ON THE DYNAMIC RELIEF-FORMING AND DEPOSITIONAL SEDIMENTARY ENVIRONMENTS IN THE SAND COASTS

by

Dolotov, Yu.S.

Based on the results of long-time and detailed stationary work carried out in the sand coasts of the Baltic and the Black seas, the characteristic peculiarities of the relief-change, of the sediment differentiation by size and on gravity, the specific dynamic conditions for forming the sedimentary strata textural features and the dynamic types of nearshore marine sediment are considered, during an individual storm cycle and in different seasons too. Evident dependence is determined between character and intensity of the relief-forming and the depositional sedimentary processes, on the one hand, and the wave-strength and the wave-approach to shore, the sediment supply pattern and budget in the nearshore area as a whole, on the other hand. Total results of the storm action greatly depend on the each wave-phase duration (wave-strength rise, wave-stabilization and wave-extinction phases characterizing by dissimilar character and intensity of the hydrodynamic factors action). Evident correlation exists between character of the relief- and the sediment composition-change, on the one hand, and the hydrodynamic regime peculiarities, on the other hand, in the Late-Autumn-Winter and the Spring-Summer seasons. In nearshore marine area it is proposed to distinguish three dynamic environments (or zones): of the wave-transformation (or "current zone"), of the wave intensive deformation and destruction (or "wave zone"), of the swash and backwash (or "swash zone"), based on the predominant hydrodynamic (dynamic) factor, type of the relief-forms and its range, the sediment grain size (and sorting) and the heavy mineral total content in sediment and its change range, characteristic type of the sediment strata lamination.

DESCRIBING THE COASTLINE OF EUROPE

by

Doody, J. P., Chairman, EUCC, Science Commission

INTRODUCTION Science Commission

The Science Commission of the European Union for the Coastal Conservation (EUCC) was established at the recent EUCC congress in Galway, Ireland in 1991. Its principle objective is to support the work of the Union by providing information and advice on the scientific aspects of coastal conservation. To this end it is concerned with three main activities:

- **DESCRIBING THE COASTLINE OF EUROPE**
- **SURVEY AND MONITORING**, habitats and species
- **RESEARCH**, management in the coastal zone.

This contribution will outline developments in the first of these.

"DESCRIBING THE COASTLINE OF EUROPE"

A considerable amount of information exists on coastal habitats, sites and species concentrations. Much of this is unpublished or only available in documents with restricted availability. As a first stage in the preparation of a comprehensive description of the coastline of Europe a review is being undertaken of the available data on habitats, sites and species concentrations. The recently completed inventory of sand dunes (Doody 1991) provides an illustration of the approach. On the basis of this an attempt will be made to provide a synthesis of information for habitats across Europe. This will be undertaken in two ways:

1. **HABITAT INVENTORIES.** These will provide an overview of the location and importance of the main coastal habitats in Europe. Following the example of the sand dune inventory a habitat specialist in each country would be responsible for providing information on:
 - a) Location and size of the total resource
 - b) Location and size of important sites
 - c) Identification of other nature conservation interest
 - d) Summary of impacts and management problems
 - e) Conservation requirements

An attempt will be made to encourage the production of inventories in the following habitats; sand and mud flats, sand dunes, saltmarshes, shingle structures and beaches, lagoons, coastal grazing marsh and sea cliffs.

2. COUNTRY DISCRIPTIONS: In order to set the individual habitat data in context within a country, it is appropriate to describe individual country coastlines. To this end a coastal specialist will be identified who would be responsible for providing data on:

- a) Length and type of coastal formations
- b) Distribution of habitat and species concentrations
- c) Protected sites (for nature conservation)
- d) Coastal status (built up; protected by sea bank, dike etc; natural coast, eroding, accreting)
- e) Conservation problems.

It is intended that these will be published as a series by the EUCC over a period of 5 years. They will be aimed at a wide audience including the interested general public, as well as the site managers and politicians.

The UK COASTAL REVIEW UNIT. The UK Joint Nature Conservation Committee is developing a Coastal Review unit for the UK, following on from the "Estuaries Review" (Davidson et al. 1991). This will include a data storage and retrieval system for information on coastal habitats and sites and on the impact of man on them. The work will be more detailed than that outlined above and may provide a useful way forward. The approach has already been supported by the 1992 "Odessa Protocol on international cooperation on migratory flyway research and conservation" which recommended that "full use is made of existing relevant information .. gathered by simple techniques .. on site inventories of wader habitats .. and analysis of human activities."

This abstract is intended to provide preliminary information on the approach. More details will be given at the conference. However, in the meantime, if anyone is interested in collaborating with this project, perhaps they would contact the Chairman of the Science Commission.

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**SEDIMENT VARIABILITY - AN IMPORTANT ELEMENT IN THE EVOLUTION
OF MUD-FLATS**

by

Eitner, V. & G. Ragutzki

Sedimentary distributions and properties should not be considered as static because of the complex interaction of hydrodynamics, morphology, biology and sediments. There are many dynamic conditions which produce spatial and temporal variation of sediment distribution. In reality, these changes often reflect natural deviations of a dynamic equilibrium.

Sediment samples taken monthly from 100 m² areas in the Niedersächsisches Wattenmeer, reveal the problems related to temporal and spatial variability.

Sediment samples taken with 6 cm cylinders, were used to examine short-term sediment redistribution. Spatial variability was determined from the differences between five samples taken from each area. A mean of these data was used to analyse temporal variability.

Samples cored to a depth of 12 cm, display the characteristics of long-term changes, because sediment redistribution is predominantly restricted to the upper millimeters/centimeters.

In the past, the aspect of spatial variability was often neglected in sedimentary mapping, and hence the result was a static view of the sediment distribution.

The present analysis shows a more complex picture of sediment dynamics. This variability is an essential component of the development of the mud-flats. The sediment analysis and therefore the scale of the survey will depend on the required approach to coastal and ecosystem protection.

DRIFT RATES ON ACCRETED AND ERODED BEACHES BY FLUORESCENT SAND, NILE DELTA COAST

by

El-Fishawi, N. & A. Badr

Fluorescent sand grains were used to predict the sediment motion quantitatively and qualitatively. This approach was necessitated by the release and sampling methods utilized. The present study was performed at Burullus area to investigate the sediment movement on natural beaches, near man-made structures and through the silted part of the Burullus outlet. The eastern side of the Burullus area subjects to severe erosion where the sea has advanced more than 200 m since 1935. On the other hand, accretion a general phenomenon on the western side due to construction of a jetty of about 180 m long.

The estimated velocity for sand grains in motion ranges between 1.59 m/min and 2.38 m/min. Such low velocities indicate that the bulk of the sand load travels at much slower rates along the coast. West of Burullus outlet, the drift rate was estimated to be 0.92 to 1.20 million cubic meters per year where continued accretion was created at the up-drift side of the jetty. At the eastern side and where the waves attack the foot of the coastal dunes, high drift rate was occurred which estimated to be 2.10 million cubic meters per year. The amount of offshore drift which estimated 1.20 million cubic meters per year is probably responsible for severe erosion on the coastal dune area.

A significant portion of the sediments in motion which estimated 0.37-million cubic meters is directed from the eastern tip of the outlet to the west and resulting siltation of the outlet and creating difficulties to the navigation.

BEACH-FILL PERFORMANCE AT TERRACINA (LATTUM-ITALY)

by

Evangelista, S.; La Monica, G.B. & B. Landini

The shore at the town of Terracina (Southern Latium) is located in the eastern side of a gently arc-shaped sandy coast West-East trending. The southerly seas acting along this coast produce a prevailing eastward longshore drift.

Because of the marina at the West boundary of the shore (ended in 1970) and of the protective structures built downstream, erosional processes began and became greatly severe in a short time along the eastern side.

In order to stop or at least to reduce the shoreline retreat, an experimental beach-fill with protective submerged groins was designed. The project took from 1980 to 1983 to be completed.

Some quarried carbonate gravel - heterogeneous in size - was spread along the beach and at the shoreface (-2/-3 m). While some sandy sediment - dredged from a marina and a river inlet - was spilt at places at a depth of -3/-4 m.

This intervention produced at the beginning a beach widening and a slight aggradation of the shoreface and the fill's efficacy persisted for about two years. Starting from 1985 a vice-versa evolution of the littoral took place.

In this work the morphological and sedimentological variations following the beach-fill, as well as the vertical and horizontal distribution of the spilt gravel in the backshore, are pointed out. Hypotheses about causes that might have produced the present beach dynamics will be expounded.

DUNE EROSION AND SHORELINE RETREAT BETWEEN AVEIRO AND CAPE MONDEGO (PORTUGAL). PREDICTION OF FUTURE EVOLUTION

by

Ferreira, O. & J. Alveirinho Dias

The coastal zone between Aveiro and Cape Mondego (Portugal) is constituted by an open sandy shore with 50 km length, which is bordered by dunes. In the northern part, landward of dunes, exists a channel of the Aveiro lagoon, the major morphological feature in this zone.

Aerial photographs from different dates (1947, 1958, 1980 and 1990) were analyzed with the aim of determine the evolutionary trend of shoreline retreat in the study area. From this analysis it was concluded that those rates have been growing exponentially in the last decades, except in the littoral zone immediately northward of Cape Mondego where the shoreline configuration remains more or less stable. Maximum shoreline retreat rates reached 8m/year in the last decade.

A larger part of the dune string was eroded in more than one half of its width and in some small places, downdrift of groins, dunes do not exist any more.

Using the computed shoreline retreat rates and the expected behavior as a tool for determine shoreline evolution and dune erosion it is possible to reach some important predictions:

- a) The occurrence of overwashes will be generalized and frequent in the next years. In case of overwashes small inundations of the lower lands are expected.
- b) It will be possible to have the complete destruction of dunes in large areas (several kilometers long), in a near future.
- c) If the verified increase in the shoreline retreat rates will continue in the next 20 years, it will be possible to have the establishment of a new inlet for the Aveiro lagoon, placed 2 km southward of Praia da Vagueira.

AN APPROACH FOR THE REHABILITATION OF COASTAL WETLANDS AND ESTUARINE AREAS IN NORTHERN SPAIN

by

Frances, E.; Rivas, V. & A. Cendrero

During the last two centuries a large part of intertidal and wetland zones in the north coast of Spain have been subject to reclamation through enclosures, draining and filling, with the consequent environmental degradation and loss in biological productivity. Recent initiatives have been launched to reverse this trend and plans are being prepared for the rehabilitation of some of those degraded areas.

This work presents three examples of rehabilitation plan designed using a method based on the identification, mapping and assessment of integrated homogeneous units. Both intertidal and permanently emerged zones were mapped and a series of units with similar characteristics with respect to landforms, materials, processes, biological assemblages and human features were represented. These integrated units were the basis for description, diagnosis and definition of management actions.

A series of environmental indicators, reflecting the potential for conservation and recovery of the units, as well as the technical feasibility of restoration actions, were defined and used to obtain a classification of such units according to their capability for rehabilitation. These indicators were also used to establish the most advisable kind of action in each unit, in order to restore the area. The final product obtained was a map showing the recommended types of use and the rehabilitation actions to be undertaken.

HISTORIC EVOLUTION OF THREE COASTAL LAGOONS IN THE COAST OF PORTUGAL

by

Freitas, M.; Jones, F. & C. Andrade

The Obidos, Albufeira and Sto André lagoons are small coastal lagoons (estuarine lagoons) located on the Portuguese West coast.

At present, these lagoons are isolated from the ocean by sandy barriers and connexion with open sea waters is made by means of artificial opening of temporary inlets.

The evolution during historical times was made using written documents, maps and aerial photographs, which allowed the estimation of areal and volume change. Physiographical changes and average sedimentation rates are suggested and seem to be quite variable because of local constraints.

The study of the morphological evolution of the backbarrier area, showed that major changes are related with different location of the artificial opening in the last few years. These changes led to sediment redistributions and morphological reorganization of the backbarrier and marginal intertidal flat area.

Although the natural filling of these coastal lagoons may be explained by natural processes, recent anthropogenic action has considerably its intensity.

SPATIAL AND TEMPORAL CHANGES AT ALEXANDRIA BEACHES, EGYPT

by

Frihy, O.E.; Nasr, S.M.; Dewidar, Kh. & M. El. Raey

Long-term variations in beach width of Alexandria Governorate have been analyzed using two sets of aerial photos taken in 1955 and 1983. The analysis reveals that a major part of the beaches has been subjected to coastal erosion except few ones. The estimated average erosion long-term rate is approximately 0.20 m/y.

EL Maamoura beach, located east of Alexandria, is selected to evaluate seasonal variations. The study is based on an analysis of repeated beach profiles over one year period of 1989/1990. The profile analyses include average shoreline position, beach volume changes and beach sediment characteristics. Sand volume losses are found to be 450 m³/m/y for the entire beach length (1.2 km). Average beach width is less than 30m in winter while it reaches about 40 m in non winter condition. The annual average shoreline fluctuation in landward and seaward directions along the beach is about 15 meters. Winter beach profiles are characterized by narrow beach width with steep slopes and few sand bars at 1 to 2m below MSL, while non winter beach profiles have wide beach widths with gentle slope and frequent sand bars at 1 to 2m below MSL. The local pattern of erosion versus accretion is reflected in the sediment texture of the beach sand.

Annual sand transport by wind is determined by placing a series of wind blown sand traps on the beach of EL Maamoura. It is estimated that about 37.7 m³ of sand are trapped by wind action during study period. Subtracting this amount of sand from the net sand loss (450 m³/m/y) yields 412.3 m³/m/y of eroded sand caused by the action of currents and waves.

ARTIFICIAL BEACH NOURISHMENT ON THE MEDITERRANEAN NILE-DELTA COAST

by
Frihy, O.E.

Several artificial beach nourishment projects were completed during the last four years on the Nile Delta coast. A beach monitoring program was initiated between 1987 and 1991 at four beaches at Alexandria waterfront on the western margin of the Nile Delta and at Baltim beach at the central coast of the Delta to evaluate the response of these beaches to coastal processes. These beaches considered as the primary summer resort of Egypt on the Mediterranean. Analysis of sand compatibility indicated that the inland desert sources of medium and coarse sand are suitable for beach nourishment. Repeated beach profile survey above and below mean sea level was conducted before and after nourishment. The annual loss rate of sand from the fill was greatest immediately after the placement ranging from 10 to 20% by volume. The calculated sand losses with time in the project areas are quite variable. Alexandria projects show sand losses ranging between 10% to 60% in 4 year period, while these losses are extremely greater being around 70% during one year period at Baltim beach.

Most of Alexandria coasts are rocky and have very little or no beach. The shoreline is generally undulated forming small embayments and pocket beaches. The long-term rate of erosion at Alexandria is fairly small at the order of 20 cm/year. Profile analysis indicates that the small rocky limestone islets submerged in the nearshore zone in front of Alexandria beaches serve as wave energy dissipator in the lower parts of the active profiles, affecting the predominant sediment transport pattern to the east. This creates shoreline accretion or erosion at the sides of the beach. The central portions are usually either stable or show little erosional and/or accretional changes. Baltim beach is located on a very active shoreline consists of sandy arcuate beach, which has experienced a net long-term retreat of about 4m/year. The profile analysis of Baltim beach reveals sediment transport following the predominant direction toward the east.

Chemical and biological characteristics of different water masses in the German Bight.

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Abstract: Especially in shallow sea areas with rather complicated hydrographic structures like the German Bight, actual distributions of plankton organisms are supposed to be very heterogeneous, because the patterns result from the physical processes to a large extend. This article shows that nevertheless the German Bight's pelagic system can be subdivided into at least 3 distinct natural regions, being distinguished on the basis of physical, chemical, and biological variables. Data interpretation makes use of the cluster analysis.

COASTAL EROSION IN THE EASTERN BLACK SEA COAST OF TURKEY A CRITICAL REVIEW

by

Gökçe, K.T.; Dakoglu, A.; Koç, S. & M. Gürhan

Along its 500 km coastline Eastern Black Sea is increasingly faced with erosion problems both due to natural causes (wave action) and due to human interventions (marine engineering works, sand mining activities, river basin management). The progressive erosion of the Black Sea coastline causes extensive damage to properties and creates social and economic hardships for the inhabitants at these places.

The economic activity along this zone is fairly high; Strong tradition of coastal fishery led to the construction of numerous coastal works. There are about 4 commercial and 20 fishing harbors along the coast.

The major rivers and hundreds of smaller ones discharge huge amounts of material to the sea creating littoral drift from west to east. Harbors block the littoral drift resulting in progressive accretion at the west side of breakwaters, silting the entrance of the harbors, thus causing navigation difficulties. Sand by-pass operations at the various harbors are desirable. State highway runs parallel and very close to the shoreline which was constructed in 1960's, partially by filling the sea. Highway experiences vital damage due to storm waves and as a general measure for the protection of these vital areas permanent seawall systems have been selected. However in not too distant future it can be expected that the erosion will spread along the coasts adjacent to the protected areas and steepening of the coastal profile will occur especially in front of protected areas, which in the long term will endanger the stability of coastal works.

The present problems are thus primarily caused by man through the construction of the highway, several harbors and removal of sand for construction purposes. The coast erosion effect of these works was in most cases predicted, but apparently had to be materialised before being taken seriously. The influence of man is today so large that natural erosion trends are masked. There is however much evidence for the view that coast in the region were in dynamic equilibrium prior to the man made works.

The essence of the problem is man caused imbalance and the solutions to problems of these nature require interagency co-operation. Therefore national and local priorities have to be prepared jointly with the administrations concerned leading to short term actions and long term planning for the coast. Essential is the integral overall management of the coast.

DYNAMICS OF THE EIDER CHANNELS

by

Gönnert, G.

The project "Dynamics of the Eider Channels" analyses the influences and consequences of coastal protective buildings (dikes, barrings, dams) on the morphodynamics of the Eider channels. Endangering of protective buildings by intensified meandering of creeks and effects on navigation (for example the silting up of navigable water) will receive priority in the considerations.

The project is aimed at an evaluation of the channels' reactions to manmade interferences into the contours of the channels and a prognosis of a future endangering of the protective buildings.

The Eider is located in the north-west of Schleswig-Holstein, south of Eiderstedt and north of Büsum. With a length of 190 km it ranges from Flensburg in the north to Neumünster in the south and to the Kieler Förde in the east.

A lot of protective buildings have been built up along the Eider. Especially interesting is the barring of the Eider (1967 - 1973) and the tidegate, which is in operation since 1979.

The morphodynamics of both, the Eider and the estuary of the Eider, have been heavily unbalanced by these buildings. For example the channels in the estuary of the Eider were heavily meandering and sharply changed their course. Because of this the northern channel moved towards the dike with an increasing speed (max. 1 meter / tide 1979). The dynamical morphology of this movement is to be analysed in pursuance with the following steps:

1. Balancing of the volume and evaluation of a dynamic equilibrium based on the MORAN-function (MORAN = Morphologische Analysen Nordseeküste).
2. Evaluation and drawing the form of the channels with the parameters location, depth and cross-cut.
3. Processing and interpretation of relevant hydrological parameters: maximal tide, tidal range, water-level, tidal stream.

The results of these steps will be linked up to gain morphological parameters which can be adopted for the present movement. This is aimed to develop a method to detect potential dangers to the dikes.

MORPHOLOGICAL EVENTS IN THE PORTUGUESE NW COASTAL ZONE DURING HOLOCENE

by
Granja, H.M.

The coastal zone of NW Portugal is understood as the sector comprised between the Minho river (boundary with Spain) and the "Serra da Boa Viagem" which ends in front of the sea at "Cabo Mondego".

For forecasting the future evolution of the coastal zone, the history of the events that have characterized its morphology during the past thousands or hundreds of years (Holocene) has a significant weight. It will be the subject of this paper.

Having as support aerial photo interpretation and vibracoring, a lithostratigraphic succession, composed of detrital sedimentary units was established.

In some units samples of shell, peats, diatomites and fragments of trees were collected, thus allowing, by means of radiocarbon dating, to define a parallel chronostratigraphic succession. One of the units designated by the folk name "tijuca" (mainly composed of fine and silty sands, plastic when wet), with peat, diatoms and shells of gasteropoda and lamellibranchia of brackish environment, shows the presence of holocene lagoonal system (420 ± 100 - 3250 ± 100 years BP), which, south of Espinho town is still preserved through the Esmoriz lagoon and Aveiro lagoon, and north of that town only exists a residual form (Apúlia lagoon, Esposende).

Other events are revealed by the existence of paleosoils of podzol type, with truncated profiles and whose A₁ horizon will have an age comprised between 950 ± 80 and 3160 ± 90 years BP.

Under the podzol there are sandy units with sedimentary structures that suggest the existence of a paleo intertidal bar, intercalated with greenish beds, the uppermost with coal fragments whose attributed age is of 5500 ± 160 and 6830 ± 60 years BP, by radiocarbon dating.

North of Espinho (Fão, Esposende) a medieval necropolis recovered by dune sands, without podzol, is attributed to the Little Ice Age (meaning 400-150 years BP).

The deformation of the podzol, the discontinuance and truncated profiles and the breaking of the greenish bed and sedimentary injections in the upper sandy beds of Formation with "tijuca" of Agucadoura (Póvoa de Varzim) led us to suppose that an important significance should be given to the recent tectonic deformation when one tries to forecast the future evolution of the coastal zone.

**MAP OF THE LENGTH AND CHARACTER OF SHORES BY MUNICIPALITY IN
SW FINLAND. GEOGRAPHICAL INFORMATION SYSTEM (GIS)
APPLICATIONS FOR COASTAL STUDIES**

by

Granö, O. & M. Roto

The use of computer assisted methods in analyzing regional characteristics of the Finnish coastal belt has resulted in new source data about the configuration and areal pattern of the coastal environment. The data were collected by means of cartographic measurements.

The "Shores in SW Finland" map shows the length of different types of shore in relation to surface area. In a coastal environment shores are factors of crucial importance. Variations in shore characteristics reflect regional variations in the coast.

The length of the shore depends on the scale and exactitude of the map and on the method used to measure the length of the shoreline. In this study the length of the shoreline was measured from the 1:20 000 Basis Map of Finland by squares of 5 x 5 km². The Basic Map was chosen because it is the largest-scale available map showing the whole of the Finnish coastal belt. At the same time this scale provides the best basis for collecting data concerning man's functional environment. A 5 x 5 km² square was chosen as the basic unit since it corresponds to the visual landscape in archipelago conditions and is well adapted to illustrating regional variations.

Measurements were made using a digitiser connected to a computer. The coordinates of the shoreline were digitised for use with the measuring program, which calculated the length of the line. Coordinates were drawn for the program when the cursor had progressed an average of 2 mm on the map. The measurements were rounded to an exactitude of 0.1 km and stored on DOS floppy disks. The total length of the Finnish seashore was 39 139 km of which 31 % are in SW Finland.

The shore types were classified according to the deposits of the shore. Five categories were used: rock; till; gravel and sand; silt; clay and marsh; artificial. Characteristic features of the coast of SW Finland are: the large size of the whole coastal belt (nearly 10 000 km²), the great length of the shoreline (12 173 km), the great frequency of islands (22 483), the fragmented nature of sea and land areas, great density of shores and islands and the parallel zonation of the coastal environment: Rocky shores dominate in the outer parts of the archipelago, till shores in the intermediate parts and silt and clay shores along the margin of the mainland.

**ENVIRONMENTAL DEVELOPMENT AMONG THE TENMILE CREEK
COASTAL DUNES IN OREGON, USA**

by
Heikkinen, O.

Spectacular coastal dunes are found along the Pacific coast from southern Washington through Oregon to northern California. The development of these dunes is favoured by certain climatic and geomorphological factors, the most important being the powerful westerly winds which hit the open coast line.

Old wave-cut platforms caused by eustatic sea level fluctuations serve as a base for the coastal dunes. Reddish, badly eroded "Pleistocene dunes" can be found well above the present sea level and usually further inland than the recent "Holocene dunes". The upper part of a "Pleistocene dune" at Tenmile Creek, the main area studied here, gave a thermoluminescence date of 18300 \pm 1500 B.P. (R-863204), and the "Holocene dune" sand, only half a meter above that, 1060 \pm 100 B.P. (R-863203).

Large, oblique dunes, and in places parabolic dunes as well are migrating in the direction of the strongest winds, burying and suffocating trees and other vegetation in the moist depressions and exposing snags and stumps of older trees in their wake. Radiocarbon dates are presented for six samples collected from the remnants of such overrun trees to aid the interpretation of past aeolian processes.

Dune processes and the plant cover have changed drastically since the mid-19th century, when the white settlers started to introduce exotic plant species, to exploit extensive dune areas for grazing and cultivation and to establish their first settlements, with roads and small-scale industries. European beach-grass (*Ammophila arenaria*) virtually revolutionized hydrological, vegetational and aeolian conditions on the coastal strip, since it has been primarily responsible for the formation of a massive foredune which raised the ground-water level in the dune areas and blocked the supply of sand from the littoral zone, so that the wind began to create a deflation plain inland from the foredune. This plain is widening and becoming forested all the time. The trees establishing themselves on the moist deflation plain and in the interdune swales have been dated dendrochronologically in order to assess the rate of environmental changes.

Generally speaking, the white man first destroyed the vegetation and accelerated aeolian processes, and then from the early 20th century on, he also stabilized the open sand surfaces, partly using introduced plants. Nowadays conservationists are worried about the survival of the native plant species and communities, while the business world is afraid that the shrinking of the open sand fields will make the dune areas less attractive. Some action has been taken to save both the original natural environment and the recreational opportunities, and other measures are planned.

DYNAMIC PRESERVATION OF THE COASTLINE OF THE NETHERLANDS HOW DOES IT WORK OUT?

by
Hillen, R.

In 1990, the Netherlands Parliament has decided on a new national coastal defence policy. The choice for "dynamic preservation" of the coastline is essentially a choice for enduring safety against flooding and for sustainable preservation of the functions and values in the dunes. The choice for "preservation" also implies that the coastline will be preserved at its 1990 position at least.

Since 1990, the concept of "dynamic preservation" has been worked out in more detail. The 1990-coastline, the reference line (often referred to as the "basal coastline") has now been defined. Moreover, new ideas on innovative nourishment techniques have been and are being developed and efforts are underway to ensure the dynamic charm and quality of the dune coast, thus acknowledging the "dynamic" aspect of the policy choice.

To realize the policy, a set of instruments is available, including an institutional framework, a yearly budget for sand nourishments, and a coastal monitoring and research scheme.

The new coastal defence policy is not just a State affair, it is merely a collaborative effort of national, regional and local authorities in which each party assumes its own role. After slightly more than one year's experience, it appears that we can really make the policy work.

**DISTRIBUTION OF EPIGAEIC ARTHROPODS IN COASTAL HABITATS OF THE
BALTIC SEA IN SCHLESWIG-HOLSTEIN**

by
Hoerschelmann, C.

In three natural reserves along the Baltic coast of Schleswig-Holstein activity-densities of epigaeic arthropods (Araneae, Coleoptera: Carabidae) were obtained by pitfall-catches in 1988/89. The influence of factors determining the distribution of species in coastal habitats of the Baltic Sea was determined by means of a canonical correspondence analysis (CCA). Distributions and abundances of 146 species of spiders and 60 species of carabide beetles in the adjacent habitats "dune", "dry-meadow", "reed", and "salt-meadow" showed distinct correspondence to gradients of moisture, salinity, vegetation-density and frequency of flooding. Distribution of species in the three sampling sites along the Baltic coast of Schleswig-Holstein correspond to a gradient of climate. The atlantic climate of the north-western part of the coast is characterized by higher residues and comparatively moderate winters compared to the continental climate of the eastern part of the coast. This climate gradient showed high covariance to distribution of xerophilious species of the sandy habitats "dune" and "dry-meadow" along the Baltic coast of Schleswig-Holstein, whereas hydrophilious species in the moist habitats "reed" and "salt-meadow" showed little response to climatic differences.

HOLOCENE COASTLINE SHIFTS AT THE MEDITERRANEAN COAST OF ANDALUCIA (SE SPAIN)

by
Hoffmann, G.

In a joint program with the German Archeological Institute Madrid, the Geological Institutes of Kiel and Bremen University investigated the stratigraphy of Holocene sediments in the valleys of the Mediterranean coast of Andalucia. The aim of this interdisciplinary cooperation is the investigation of human settlements and the reconstruction of the environment in distinct periods. In regard to the reconstruction of landscape, the changes in coastlines during Holocene are of particular interest.

For the investigation of the Holocene stratigraphy a hand auger of the Eijelkamp Company (Netherlands) was used. With the auger bits of 10 cm diameter a maximal depths of 19.5 m was reached. The Holocene sediments were dated by radio-carbon method and by ceramic fragments, found in the drilled sediment.

In nearly all of the investigated valleys marine and brakish sediments were found below flood plain. The dated sediments prove that there still have been several bays of the Mediterranean Sea on this coast between Gibraltar in the West and Almeria in the East until medieval times (15th century). After this period, when the Catholic Kings expelled the Moors (Reconquista Period) also from the southern part of the Iberian Peninsula, an enormous increase in the accumulation rate was caused by deforestation and by the introduction of a badly adapted agriculture. The sediments of the 16th and 17th century have a thickness of 15 to 20 meters. During this time the valleys were filled up with the eroded soils of the hinterland.

The dominant factor for this evolution of landscape was man, supported by a wetter and cooler climate at the end of the Middle Ages ("Little Glaciation") and by the unstable equilibrium of the forests in the Mediterranean subtropics.

SALT MARSHES AND SEA LEVEL RISE

by
Houwing, E.J.

Sea level rise causes marsh erosion through an increase in tidal flooding and an increase in wave energy. It has been observed that in the last ten years parts of the salt marshes along the coast of the Friesland and Groninger Wadden Sea Coast have been eroded due to a recent rise of the high water levels. These salt marshes can be found in the salt marsh works. The salt marsh works consist of three artificial sedimentation fields. The sedimentation fields measure 400 x 400 m each and stretch from the seawall towards the tidal flats. The inner sections of the works are made up of the salt marshes. The middle sections are the pioneer zone which is the area of interest because the survival of the marshes depends mostly on the accretionary balances in this zone. The outer sections are closed to the tidal flats and have nearly any effect in the salt marsh works. Erosion in the pioneer zone eventually will lead to an erosion of the marshes from the seaward edge.

The sediment bed in the pioneer zone consists of mud and fine sand and can be classified as a cohesive bed. Erosion of a cohesive bed or deposition of cohesive material will be confined to a nearbed layer and will be hard to measure in situ. The erosion process of cohesive beds depends on the shear stress acting on the bed by wave and current motions, and the shear strength of the bed. At first the erosion and deposition processes will be described by parameterizing them. By this, the non-linearity of wave and current interactions in the nearbed layer and the complexity of the bed shear strength can be simplified. For the bed shear strength the yield-stress will be used which describes the shear stress at the initiation of movement of the bed. The shear stress itself will be used for describing the stress induced by a combination of wave action and current speed.

Sea level rise will affect the processes of erosion and deposition of cohesive material. With an intensive field campaign it is tried to find the major mechanism which control these (parameterized) processes. In the pioneer zone of the salt marsh works the waveheight, water depth, current velocity, orbital velocity, suspended sediment concentrations (on an optical and mechanical way), the windspeed and the wind velocity, the yield-stress of the bed and the level changes of the bed will be measured from each slack water towards the next slack water. The measuring technique mostly will be self registering. Only the mechanical sampling of the suspended sediment concentration, the sampling of the yield-stress and the measuring of the level changes of the bed will be performed by man-power. The location of the self registering units will be chosen on ground of fetch length and sediment composition of the bed in the pioneer zone. The result will be a long record of various parameters measured under various conditions. Analysis of this record will lead to the understanding of the major mechanisms which control erosion and deposition of cohesive material.

This understanding will lead to a better understanding of management techniques. Finally, in knowing the major mechanisms the erosion and deposition of cohesive material can be examined on a more detailed scale.

**BARRIER BREACHING IN MICROTIDAL ENVIRONMENTS:
THE TRABUCADOR BAR CASE (EBRO DELTA)**

by

Jiménez, J.A.; Sánchez-Arcilla, A. & M.A. Garcia

The Trabucador Bar is a 6 km narrow coastal stretch that joins the main body of the Ebro Delta with the southern spit of the Delta. The Bar has an averaged width of 150 m and the highest top level 1.5 m above the mean sea level.

During a "normal year" this Bar is subjected to a longshore transport gradient directed towards the south that origins a slight erosion in the southern part of the Bar. This gradient dominates the long-term evolution of the Bar, but other mechanisms can alter its typical evolution.

In this way, during the "normal year" several flood episodes can be detected under the pass of low atmospheric pressure systems. Under these conditions, a relative little amount of sediment is transported from the beachface towards the Bay. This sediment can come back to the beach during "Mestral conditions" (winds from the NW).

But, when the surge coexists with heavy wave storm the process is quite different. Then the Bar is completely flooded and waves can reach the beach and break over it. In October of 1990 a heavy wave storm was present in the spanish mediterranean coast, characterized by waves arriving from the east with a $H_s=4.5$ m and a surge of approximately 60-70 cm.

The storm action over opened a 800 m long breach in the Bar. An estimated amount of 70,000 m³ of sediment was removed, with the main part of it was transported towards the inner bay and deposited in a shallow platform behind the Bar.

After the pass of the wave storm, the breach was still submerged because the sea level was surged during several days. Under these conditions, the "constructed waves" that transport the sediment from the submerged profile to the beach crossed the breach. The waves broke over it and reformed as bores, transporting the sediment towards the bay and removing it from the outer coast.

In that moment the Bar was acting as a sediment sink and was altering the "normal evolution" of the coast. To stop this process an artificial dune was designed and constructed to close the breach. The performance of the dune was good and it allowed the reconstruction of the beach. Nowadays, the Bar is still closed although several storms have attacked it, but the actual width of the Bar in this zone is less than before.

ESTIMATION OF SEDIMENT BUDGET AND LONGSHORE TRANSPORT RATES FROM COASTAL RESPONSE. APPLICATION IN THE EBRO DELTA

by

Jiménez, J.A.; Garcia, V.; Valdemoro, H.; Garcia, M.A. & A. Sánchez-Arcilla

The sediment budget for a coastal stretch can be evaluated using different methods:

(i) comparison of beach profiles, (ii) evolution trend obtained from shoreline displacements and (iii) calculating transport rates from wave data. If we are evaluating the behaviour of a coastal stretch, theoretically all of them have to give the same results, but problems inherent to each method make the results slightly different (in the best case).

These methods have been applied in the Ebro Delta using data obtained from 04/88 till to 03/91.

For all calculations a closure depth of approximately 7 m has been assumed. This depth has been chosen like the limit for significant changes during a "normal year" from beach profiles comparisons and empirical formulations using wave data.

A general erosive behaviour is detected. Some important erosive zones have been identified and quantified: (i) one near to the mouth area where a divergent transport scheme has been identified (part of the sediment is transported towards the south and part northwards) and (ii) the Trabucador Bar, a 6 km coastal stretch that could be identified like a barrier island, both of them in the southern hemidelta and (iii) the Marquesa Beach in the northern hemidelta.

The total loss of sediment in the southern hemidelta has been evaluated in 380,000 m³/y while the erosion in the northern hemidelta is about 120,000 m³/y. Some differences in the calculated volumes are observed, but the three methods give a similar qualitative behaviour. From these volume changes and making some assumptions a sediment transport scheme has been proposed. The main assumptions are: (i) the most of the changes can be associated to an unbalance in the longshore transport and (ii) a divergent point in the southern hemidelta is present, where we can assume that the longshore transport is nule. With these assumptions and the quantities before calculated, the sediment transport scheme for a "normal year" has been proposed and is shown in figure 1 for the southern hemidelta. Transport rates obtained from shoreline displacements and transport calculations using Bijker's formula are coherent and give similar results.

COASTAL ARCHAEOGEOMORPHOLOGICAL RESEARCHES IN WESTERN CHALKIDIKI, GREECE

by

Kabouroglou, E.; Papangelos, I. & S. Kabouroglou

In the context of the archaeogeomorphological researches we carry out during the last years in coastal areas with archaeological interest of the Hellenic region, such researches at the Western Chalkidiki, from Epanomi to the north till Paliouri to the south edge of Kassandra peninsula, are included.

The aim of this researches is the application of several, mainly geomorphological, methods to the study of the reasons that formed the coastal landscape of Western Chalkidiki, as well as the interpretation between the natural environment and the human habitation during the historic and prehistoric times.

The field work included coastal archaeogeomorphological mapping for the researched area of:

- a) The appearances of ancient ruins at the coastal and submarine area, their correlation with the sentiments and their importance to the geomorphological evolution of the coastal environment.
- b) The coastlines, recent or fossil mainly in the form of beach-rocks.
- c) The alternation of the relative sea level at the area during the last 5000 years.
- d) The alternation of the coastal environment at the area from the Late Neolithic period till today.

Also, core drilling research was carried out at several areas, aiming to the sampling of Holocenic deposits in order to estimate the vertical time sequence of the stratum.

The laboratory research included samples analyses, mainly from beachrocks, by the scanning electron microscope (SEM), electron probe X-ray microanalyzer (EPMA) and X-ray diffraction (XRD) methods for the check and the identification of the fossil coastlines.

All over the length of the researched area no older coastline in a higher level of the present was found. Generally it was proved that the land in that area transgresses during the last 5000 years under the influence of eustatic factors mainly (the influence of tectonism is indirect) with result the increase of the marine area.

All the samples, independent from area, location and depth of sampling are characterized by the steady presence of Mg and the uniform distribution of the calcite cement. The steady presence of Mg-calcite was estimated at $\approx 15\text{mol \% MgCO}_3$ in solid solution.

INTERDISCIPLINARY INVESTIGATION OF AQUATIC COMMUNITIES USING SIZE SPECTRA

by
Kamenir, Y.G.

The **OBJECT** is modelling of integral natural aquatic communities.

The **MEANS** is Size Spectra set (SSS) for biochemical parameters (DNA, RNA, ATP, photopigments, proteins; energy dissipation) describing biological processes of prime importance. SSS allow to get a compact and graphic description of the community or living matter of ecosystem in question as a multidimensional probability distribution or a "set-object" (Vernadsky, 1980; Chislenko, 1981) like it is usual in thermodynamics or statistical taxonomy.

Every entity of living matter is classified then as an autotroph/heterotroph (photopigments), living/dead (ATP), of organic/neorganic origin (DNA, proteins), its coordinates are given in a specially designed metric coordinate space, the nuclei of the distribution are marked out. This helps us to change from taxonomic or "trophic levels" scheme of the community decomposition to an operational approach adapted well for application of automatic tools of adaptive acquisition and processing information in real-time regime.

Use of quantitative formalized parameters (i.e. body mass of an organism or non-living particle, plasma volume) simplifies use of mathematical methods, i.a. allometric equations. There are important allometries allowing estimations of time and space scales of objects and processes. Maximum sizes of organisms of the community are of importance. They can be compared with another estimate calculated from the water area to produce a quantitative measure of the community succession/degradation (i.a. under anthropogenic impact).

The ratio "surface:volume" (SV) of biota can be used as a quantitative formal parameter for information integration when describing the littoral communities characterized with importance of large plants with highly elaborated morpha. The ratio of epiphytes and basiphytes surfaces can be used as an eutrophication criterion.

CONCLUSION. Formalized quantitative schemes of integral natural communities and abiotic parameters of the environment allow to obtain and to process information in reasonable time, to organize cooperation of scientists, managers and technical personnel of different specialities.

INVESTIGATIONS TO OPTIMIZE THE COASTAL PROTECTION ON SYLT

by

Kamp, W.-D.

For centuries the whole length of the west coast of Sylt got increasingly affected by the open North Sea, by sea motion and tidal forces. Sea motion and tides continuously erode and move away material from the sandy shore and fore shore areas, dunes and cliffs are affected during heavy storm surges, that to a steadily progressing recession of the nearly 38 km long west coast and causes a shifting of the coastal profile to the east beginning in a water depth NN-10 m until the dunes and cliffs erosion line.

In 1985 the ALW Husum has worked out a specialist project "Coast Protection of Sylt" in order to obtain a general concept. In this specialist project it turned out that a stockpile of sand as artificial dune in conjunction with sand nourishments is the best solution to protect the exposed west coast. Presently investigations have been carried out to optimize this specialist project by supplementary constructional measures.

The research program includes,

- gathering of field data of the wave climate, current, morphological alteration and sediment distribution
- development of numerical models in order to simulate the patterns of tidal and wave currents as well as the estimation of sediment transport processes.

The main part of the research program consists in investigation of constructional measures. Under consideration of supporting conditions that may be defined concepts are presently worked out.

CLIMATICAL CONDITIONS AND TOURISM THROUGH THE TURKISH AEGEAN COASTAL ZONE

by

Kocman, Asaf

Natural beauty, cultural and historical richness and convenient climatic conditions are main resources that constitute touristic potentials of the environment. Among these, climate provides continuity as a natural power and inexhaustible resource of tourism. In the last years, we see density at tourism activities, especially in our country's coastal area, with an increasing demand. The research on the Aegean coastal area on the climatic conditions, especially for their effects on human health and tourism, will increase the usage for recreational purpose at this coastal zone.

As it is known, by the way of time tourism facilities depend on certain periods of the year, especially periods of summer. According to our fixation, possibility of getting profit from climate along the Aegean coastal zone increases beginning from the gulf of Edremit to the south. For example, if 22-25°C can be regarded as water temperature for sea cure, the cure period is on an average 114 days in Ayvalik (between May 28-September 18), in Izmir 136 days (May 27-October 9) and in Bodrum 143 days (June 27-November 16). On the other hand, weather temperatures and also relative humidity and wind characteristics present convenient possibilities in point of recreation and sea tourism. According to threshold valency (17-25°C) that makes man to feel himself better at the Aegean coastal area, in where tourism is active such as Edremit, Dikili, Izmir, Kusadasi, Bodrum and Marmaris, this period changes between the least 114 days (Edremit) and the most 160 days (Kusadasi). Again in the mentioned places, the renewal of the air and the sea water, which are important for the human health, continually is being provided naturally by slight winds and coastal breezes and 35-70 % relative humidity provides comfortable environment. As a result, the climate of the Aegean coastal area has the best positive conditions from the point of recreation and tourism facilities.

**MEASUREMENT OF TIDAL WATER TRANSPORT USING A VESSEL-MOUNTED
1.2 MHz ACOUSTIC DOPPLER CURRENT PROFILER (ADCP)**

by
Kolb, M.

The riverine water discharge and the tidal transport in estuaries between any two points on the track of a moving boat may be calculated on-board from ADCP measurements using extrapolations for the top and bottom layers outside the profiling region. Principally, the ADCP's bottom tracking faculty provides the ship's absolute velocity in shallow water and thus a self-supported evaluation of the absolute water velocity is possible. However, in practice, the bottom tracking may be falsified by the bottom conditions, i.e. by suspended matter moving over soft ground. In this case, the evaluation must be supported by navigation instruments. This paper will deal with the experiences and results obtained during four extensive campaigns in the Elbe estuary and during preliminary measurements in the Lister Tief to the north of Sylt. Finally, the results are compared to calculations using a simple tidal prism model.

ANCIENT COASTLINES OF WESTERN SAKHALIN ISLAND

by

Korotky, A.M.; Razjigaeva, N.G. & T.A. Grebennikova

Geomorphological levels, well pronounced along the western coast of the Sakhalin Islands, have heights 2-3; 4-6; 8-10; 12-15; 25-30; 30-40; 50-60; 60-80; 80-120 m. The genesis of terraces has been discussed by many writers. Biostratigraphy and lithological-facial analysis of the terraces shows a marine origin of these levels.

The 100-120 m terrace were correlated with Early Pleistocene terrace of the Japan Islands. Its deposits were formed under intensive hydrodynamic condition. Lower layers of 60-80 m terrace are correlated with warm climatic phase of beginning of Middle Pleistocene. Pollen complex of upper layer indicates intensive cooling. The sections of 35-40 m terrace are represented by marine deposits, recovered by alluvial lagoon deposits. Well roundness of pebbles and large variety of petrographic composition indicate the existence of intensive longshore drift. The age of this terrace is accepted as the Middle Quaternary one and coincides with one of more intensive warming episodes during this epoch.

Sections of 20-30 m terrace are subdivided into some units: eolian inshore, lake-swamp and lagoon marine deposits. Marine units are characterised by the moderate - warm pollen complex and continental deposits were formed under cold and humidic climate. The age of deposits is in agreement with the second half of Middle Pleistocene. The terrace of 12-15 m is of the accumulative type. Its deposits formed in intensive hydrodynamic environments. Pollen and diatoms complexes allow us to correlate the age of accumulation of marine deposits of the terrace to end of last epoch of Middle Pleistocene - beginning of Riss-Wurm. Deposits of 8-10 m terrace were formed during Riss-Wurm. Holocene development of coast is fixed by series of low marine terrace 5-6 m (Atlantic), 3-4m (Subboreal), 2-3 m (Subatlantic).

The upper complex of the terrace (Q_{1-2} ?) form under an intensive tectonic rise of the area to 120 m above modern sea level. The low complex of terrace (Q_{1-4}) corresponds to sea - level oscillation of the World Ocean.

LATE PLEISTOCENE-HOLOCENE DEVELOPMENT OF VIETNAM ISLAND COASTS

by

**Korotky, A.M.; Razjigaeva, N.G.; Ganzey, L.A.; Volkov, V.G. &
T.A. Grebennikova**

Relief and deposits of Vietnam shelf islands (Tkhanlam, Koto, Dongkho, Fongwong, Re, Che, Tyam, Kondao, Fukuok, Tkhotu, Tkhom) were studied. The islands have continental origin. In Late Pleistocene-Holocene these areas were the islands during transgressions, when continent was submerged. And the islands were connected with continent during regressions. Formation of the islands resulted to intensive cutting of the slopes and destruction of mature hypergenic complexes, having been formed during continental phases of the development with stable tectonic regime. Relicts of planation surfaces and weathering crusts with complete profile were remained only within flat watersheds. Slope deposits consist of removed material from mature weathering crusts. Lower parts of slopes are represented by Sangamon abrasion-denudation cliffs, covering immature slope deposits. Abrasion, abrasion-denudation, abrasion-inlet, abrasion-ingression coasts are widespread on the islands. Accumulative and marsh coasts observe within inlets.

Coastal relief and deposits indicate the marks of Sangamon transgression and some Middle-Late Holocene little-amplitude transgressions and regressions. Transgressions were fixed in 10 and 2.5-3 m marine terraces, elevated benches and elevated coral reefs. Intensive abrasion processes were occurred during maximal high stand of the sea level. Large amount of detrital material carried out coastal zone; shallow lagoons and barrier forms were formed. In this time coral reefs were widespread within the coastal zone of the southern islands. Exclusively terrigenous sedimentation occurs in Bakbo (Beibo) Gulf islands.

Erosion and eolian processes have been more active during regressions. Large eolian dunes were formed within coastal zone. Mostly intensive phase of eolian accumulation coincided with Atlantic-Subboreal boundary. Ferricrete horizons were formed in lagoon and marsh deposits in oxidizing environment. During Late Holocene carbonate sedimentation began to decrease.

BEACH CUSP GRANULOMETRY: A STUDY OF BEACH CUSP SEDIMENT GRAIN-SIZE STATISTICS

by

Kristensen, P.J.; Ghionis, G. & C. Christiansen

Previous works on beach cusp sediment have shown no systematic variations in grain size parameters. This is probably due to the great variability of the sediments in which beach cusps can develop, but can also be caused by the methods used in estimations of the parameters. Therefore, three series of samples from beach cusps of different spacing and grain-size from the Gulf of Kyparissia, Greece have been examined by the use of three grain size statistics:

- 1) 20 samples collected on successive active cusp horn and cusp embayments ($\lambda_c = 10.9$ m.),
- 2) 18 samples in a shorenormal transect over a relict megacusp ($\lambda_c = 30$ m.), and
- 3) 14 samples collected in a grid over an active beach cusp ($\lambda_c = 12.6$ m.).

Grain-size statistics for the first and second series were derived from sieving technique (1/2 Φ -interval) and Folk & Ward and moment parameters were computed. The third series was analysed using settling-tube technique. In addition all series were fitted the hyperbolic distribution.

Based on sieving results a simple grain size spectra map showed systematic longshore variations between cusp horn and embayments. Such variations were also observed with the hyperbolic parameters for size, sorting and symmetry. There were substantial differences between Folk & Ward and moment parameters, specially the shape parameters (skewness and kurtosis). The parameters of central tendency from the two latter methods showed systematic variations, whereas the values of sorting did not show any distinct trends.

The spatial distribution of beach cusp sediment settling velocity indicated the presence of underwater deltaes seaward of the embayments.

It is suggested, that interpretations of beach cusp sediment datasets could benefit from using the settling-tube technique combined with the hyperbolic distribution.

DESCRIPTION OF CHANGES IN A POCKET BEACH USING EMPIRICAL EIGENFUNCTIONS

by

Kypraios, N.G. & C.I. Moutzouris

Introduction

Changes in grain size distribution and beach profile geometry on a coastal zone occur both spatially and temporally. Wind-generated waves and the transfer of incident wave energy to other modes of fluid motion are the main sources which drive beach changes.

In previous papers (Moutzouris and Kypraios, 1987; Kypraios, 1988) measurements and results about cross-shore and longshore sediment size distributions on a Greek pocket beach were presented. In the present paper the variability of the same pocket beach is assessed using the Principal Component Analysis (P.C.A.). The resulting primary modes of variability provide an insight in the process-response under examination.

Measurements and Results

Measurements included systematic sediment sampling, bathymetric surveys, water level measurements along twelve pre-defined transect lines. The collected data provide a detailed record of profile evolution with sediment size distribution.

The grain-size distribution in the cross-shore direction is related to coastal forms both reflecting the different wave energy impact in the successive sub-zones of the nearshore zone (Moutzouris and Kypraios, 1987).

The longshore variation in sediment size is related to the direction of wave approach. Shoreline migration was also found to agree with the longshore movement of finer grains (Kypraios, 1988).

The variation of the field data mentioned above is described with a relatively small number of functions and their time dependence coefficient using the statistical method of the Principal Component Analysis. Aim of this Technique is to separate the temporal and spatial dependence of the data. Coastal features analysed are:

- shoreline/breaker zone/offshore segment position
- swash zone/breaker zone/pre-breaker zone mean grain-size diameter
- swash zone/breaker zone/pre-breaker zone bed slope

The graphical presentation of the eigenvector loadings and the corresponding temporal scores for the first two eigenfunctions are presented in fig.1 for the shoreline position and in fig.2 for the swash-zone mean grain-size diameter.

The analysis indicates that most of the variation in nearshore topography and sedimentology occur in two principal modes which account for more than the 70% of the total variance of the data. The first mode represents variance caused by the wave incidence, whereas the second mode variance caused by mean sea-level variations.

The spatial patterns of the first eigenvectors in fig.1 and 2 assumes the observations concerning the beach shape variations. Under the evidence of the longshore wave-induced currents a landwards migration in the southern (northern) part of the beach is accompanied by a seawards migration in the northern (southern) part.

**CHANNEL MAINTENANCE BY FLUIDISATION
A FIRST EXPERIMENT IN FRANCE**

by
Larcher, M.

At the EUROCOAST meeting in MARSEILLES (France) (July 9-13, 1990) a paper for a new channel maintenance technique was submitted by an American geologist and entrepreneur named James H. Parks.

This paper was entitled "NEW TECHNOLOGIES FOR BEACH ACCRETION AND BOAT CHANNEL MAINTENANCE WITHOUT ENVIRONMENTALLY-DAMAGING DREDGING". The summary of this presentation was that instead of dredging a channel, a longer lasting deep water effect would be obtained by fluidizing the bottom of the desired channel by pumping water regularly at ebb tide through a permanent perforated pipe. Fluidization then would put the sand in suspension to be washed or pumped away e.g. to a near-by eroded beach.

This experiment was carried out for the first time in France by LITTORAL ET PATRIMOINE S.A.

The topic of our presentation will be to summarize the results of this endeavour, as well as to inform the community of the new accretion device developed by the inventors LARCHER & DIAS, under the trademark "STABILITO" ("STABI"-lisateur de "LITTO"-ral). The "STABILITO" is a mobil beach speed-bump slowing down high velocity currents and thereby permitting sedimentation and beach growth.

The basic approach of LITTORAL ET PATRIMOINE S.A. is to reduce the technical conflict of interest between ports- and coastlines by using coastal techniques to help harbors manage their deep-water problems.

Illustratively, opening port channels without "improvements" such as piers and jetties protects the coastline while meeting the harbors deep-water requirements.

COASTAL ANCHORING

by

Larsen, O.F.

Low and gently sloped reef structures cause a minimum of confrontation with waves, ice, wreckage, etc., and a minimum scour problem along the structure. With an appropriate layout it will be partly covered with drift material. The construction and maintenance costs therefore are minimum. The types of structure for instance may be seabed material wrapped in geotextile or, in favorable cases, rubble-mound.

2. In which way should the available means be combined and applied ?

The strategy may be to reduce the wave energy all along the coast section to be protected or, preferably, over shorter, spaced sections. In the latter case consequently salients or tomboloes here will develop and form headlands in a stabilized beach with no or only little littoral drift past the headlands.

The reduction of the wave energy in the lee of each reef structure can be obtained by

- 2.1. breaking (or damping) the waves
- 2.2. deflecting the waves in longshore direction, by refraction/diffraction
- 2.3. reflecting the waves in seaward or longshore direction
- 2.4. combining at least two of these effects.

In cases 2.1. and 2.2 a prerequisite is initial formation of a submerged or emerged shoal induced by the reef structure. Thereafter the break or deflection of the waves is caused by the shoal. Now the task therefore is to determine such layout of the reef structure that will cause the initial formation of an appropriate shoal. Effective wave breaking during storm conditions and high water level requires that the shoal beforehand has emerged. In such case planning of the layout of the structure may be aimed at a reduction of the steepness of the incoming waves and/or of the coast profile.

It is known that flat waves build up an emerged beach berm, and that a barrier island may develop in shallow water, if the coast profile is "too flat" as compared with the normal profile. Determination of the optimal layout based on one or more of the above effects 2.1. - 2.4. could include examination of the following examples:

SHORT AND LONG TERM VARIATIONS IN SEDIMENT ACCUMULATION RATES IN A SEMI-ENCLOSED BAY AT THE FRONTAL ZONE BETWEEN THE NORTH SEA AND THE BALTIC SEA

by

Lund-Hansen, L.C.; Floderus, S.; Pejrup, M.; Valeur, J. & A. Jensen

Sediments traps have been placed in eight different depths: 0.3; 0.5; 0.75; 1.0; 2.0; 4.0; 8.0; and 10.0 m above bottom. The sediment trap system was deployed for 1.5 year (February, 90 - May 91). The traps were emptied with intervals in the range of 2 - 3 weeks. Another system placed 1.5 m above the bottom automatically measured the sediment accumulation rate in intervals of days ($\text{g/m}^2 \text{ day}$). This system was deployed for 3/4 year (November, 90 - May 91). Both systems were placed at the same position in Aarhus Bay at a water depth of 16 m. The bay has mean water depth of 14 m and contains a volume of $5 * 10 \text{ km}^3$. The hydrography of the bay is dominated by periods of high salinity water (32-34 ‰) from the North Sea and low salinity water (15-20 ‰) due to outflow from the Baltic Sea. The results showed, both on day and 2-3 weekly interval, that in periods dominated by water from the Baltic Sea, low sediment accumulations rates were found, whereas in periods dominated by water from the North Sea, high sediment accumulation rates were found. The study also shows, that sediment is affected by resuspension. Effects of resuspension are even recognized in the sediment traps placed 8-10 above the bottom. Resuspension is mainly due to surface gravity waves set up by wind.

INFLUENCE OF THE WAVE-INDUCED PORE WATER PRESSURE ON THE SEABED STABILITY

by

Magda, W. & W. Richwien

The instability of a sandy seabed due to surface wave action is an aspect of major importance with respect to the safety of some on-shore and off-shore structures, e.g.: rubble mound breakwaters, vertical monolithic breakwaters, submarine tanks, oil platforms, submarine pipelines, which are built straight on the ocean floor which usually contains sandy deposits on top. Unstable sea bottom sediments itself can cause unexpected changes in a bathymetry that can be further related to erosion and sediment transport problems.

If large amplitude storm waves exist on the surface of the sea, a change in the wave-induced hydrodynamic pressure occurs on the ocean floor (bottom pressure) and, as a consequence, within the soil matrix (pore water pressure) which may be of sufficient magnitude to result in the initiation of relatively deep slides in water depths of tens of metres. Oscillations of the wave-induced pore water pressure within the seabed are responsible not only for the effective normal stresses in the soil but also for the effective shear stress. This fact has always to be taken into account and implemented into the calculation procedure evaluating the risk of failure mechanism.

Assuming circular shear surface, a wide analysis has been made where the safety factor of the seabed against sliding is checked with respect to different factors, namely:

- pore water pressure profile,
- loading characteristics,
- bottom slope angle,
- size of sliding body,
- stratification of the subsoil.

The loading characteristics, bottom slope angle, and size of sliding body formulate a geometry of the problem. Evaluation of the wave-induced pore water profile is based on the analytical solution derived for a finite seabed layer thickness from the general solution presented by Madsen (1978). Pore pressure distribution is, among others, a function of several soil parameters. The influence of variations of some leading parameters, i.e.: soil permeability, soil and fluid compressibility, incorporated into the analysis, is also investigated and discussed.

A situation of a uniform seabed is compared with a two-layered soil system which is considered as a special case of the subsoil stratification. Here, the solution for the pore water pressure field is obtained by numerical approximation using the finite element method.

CONTROL OF SAND SPECIMEN DENSITY BY SAND POURING TECHNIQUE

by
Magda, W.

Laboratory tests where soil is one of considered medium, need special techniques of soil preparation. A type of chosen technique depends on a character of soil, soil parameters to be modelled and a scale of tests. In most cases an uniform state of soil is required. Performing a representative series of tests it is also necessary to assure repeatable soil conditions for all tests. Therefore, reconstitution of soil specimens is estimated to be the best way in achieving test results which are going to be representative for a certain group of tests. In case of clay preparation the procedure seems to be easier when comparing with sand. Uniform and repeatable clay specimens can be obtained simply by cutting it out from a natural consolidated material. Having a cohesionless material like sand, it is impossible to follow this idea and each sand test specimen has to be prepared individually from the material in its loose state.

Uniformity of a sand sample requires not only a well-graded soil but also the sand sample preparation has to create the same density within the entire sand sample. This condition can be fulfilled when applying a proper technique. A need to form a uniform sand specimen induce necessity of continuous control of sand grain package factors during the whole process of preparation. Reconstitution by pouring is reported as the most promising technique for obtaining uniform sand samples under laboratory conditions.

Repeatability on an initial soil sample state can assure that results of measurements from a certain test series belong to one and the same group and can be used in averaging of results. On another hand, uniformity of sand sample is very helpful for data interpretation and comparison with theoretical approaches which in most cases were possible to derive only under the assumption that the physical parameters involved are constant and representative for the entire soil specimen.

Project A 13 (SFB-205 "Küsteningenieurwesen") is actually involved in theoretical description and experimental investigation of the pore water pressure generation due to cyclic loading exerted on a saturated and unsaturated porous sandy seabed. Smallscale laboratory tests required very careful sand specimen preparation with respect to both uniformity and desired degree of density, before each test run. The main series of tests in a sand column, 80 cm in high and 20 cm in diameter, had to be preceded by preliminary sand pouring tests to establish controlled values of densities.

The author describes the sand pouring technique used in the test model preparation. The achieved sand model densities are discussed with respect to the main controlling parameters, i.e. height of pouring and pouring intensity.

**THE IMPACT OF MAN ON THE SHORELINE OF THE WESTERN
COSTA DEL SOL, SOUTHERN SPAIN**

by

Malvarez, G.; Bueno, E.F. & R. Carter

Over the last 30-40 years development of the Spanish coast has had a major impact on the shoreline. Many of the natural shoreline features, ranging from cliffs to sand dunes and salinas have been destroyed, while others have been seriously damaged. In particular, the sediment budget of the coast has been disrupted. Transport of coarse bedload down steep river valleys has decreased due both to damming and abstraction of water for domestic use and irrigation. Many former coastal streams are now dry valleys. In addition sand and gravel extraction from river beds for building and construction work. The hydrological problems have been exacerbated by recent drought. The net result of these processes has been the onset of erosion, especially near river mouths and along the flanks of deltas. The beaches have also suffered; sediment is removed for both construction and glass-house agriculture, and the widespread building of sea walls and groynes in the 1960s and 1970s (mostly to improve access) has encouraged beach erosion, to the point where structures at Estepona and Marbella have been removed. Finally, the development of marinas has added to the problem of sediment loss, as finer sediment is directed offshore into deeper water along the edges of marina jetties. One response to these pressures has been to embark upon extensive beach nourishment projects.

ECOLOGICAL PLANNING IN THE COASTAL ZONE

by

Marcos, C.; Pérez-Ruzafa, A. & L. Ramírez

The land capability to support a variety of uses, interactions between activities and the impact on each other and on the environment must be taken into account to approach to the littoral in a global and integrated way.

The multivariant integration of concepts like maximum land capability for each activity, minimum environmental impact and maximum compatibility and minimum competition between uses constitutes a conceptual framework for regional planning in general.

In this scheme we have paid particular attention to ecological planning, by which we mean the evaluation of land capability to support different activities.

The suggested methodology is based on the realization and application of tables for each proposed use. The limitations imposed by the factors considered determine the different classes of capability, from the most favourable to the least.

We have worked mainly on biologically based uses as agriculture and aquaculture, and the suitability and effectiveness of the tables have been tested on a practical case in the Mar Menor area in the SE of Spain.

**ENERGY EVALUATION ON SAND BEACHES AS A TOOL FOR
LITTORAL MANAGEMENT**

by

Martinez, J.; Melián, E.; Reyes, F.; Rua-Figueroa, C.; del Toro, C. & A. Santana

The aim of this paper is to estimate the energy that falls into a beach, sampling impressions in the sedimentary deposition. A simple and economic methodology is developed that may be of interest for the design of sea structures and the optimization of beaches.

The research is carried out with data from beaches of the littoral in Gran Canaria island (Spain).

Since we overlook a sandy beach as a system that tends to a balance among:

- Energy from the incident swell,
- Slope of the strand, and
- Size of the aggregates

We want to correlate some granular parameters of intertidal deposition with wave energy of the breaking zone expressed in conventional physical units.

To achieve this:

- 1) We contrast the analysis of time distributions of the directional energy taken from the sea climate in the area and the values of the granular parameters rendered by the energy impressions.
- 2) We establish a correspondence function.

MORPHOLOGICAL TYPES OF ROCKY COAST ON SOUTHEASTERN APULIA, ITALY

by

Mastronuzzi, G.; Palmentola, G. & P. Sansò

Along the southeastern Apulian coast, between Torre dell'Orso village and Otranto town, weak layered calcarenites outcrop, gently dipping seaward and affected by a nearly vertical joint system. The coastline is exposed to the northern winds, locally the most frequent and strongest ones. There, three types of rocky coast are recognizable: the first is represented by a gently sloping coast; the second by a cliff with the sea-floor deeper than maximum wave breaking depth; the third by a cliff with even sloping sea-floor above maximum wave breaking depth. Each of these types can be further subdivided according to the presence of accessory forms (i.e., wave-cut platforms; notches; and so on).

In general, the evolution of sloping type coast is influenced by lithoclasts: indeed, following the direction of the latter, the sea generally models narrow bays.

The cliff coast with sea-floor deeper than maximum wave breaking depth, is affected by a decidedly slow retreat owing to rockslides and, subordinately, to diffuse erosion of hitting wave.

The cliffs with sea-floor above maximum wave breaking-depth, rapidly retreat by means rockslides caused by undercutting. This type of coast outlines a strongly indented shoreline with bays, arches, stacks and so on, according to the strike and density of lithoclasts as well as to rock resistance. Some morphological aspects, together with archaeological data, allow us to estimate this coastal type has been during the last 2100 years up to 2.8 m/100 years.

**STRUCTURE OF THE INVERTEBRATE FAUNA IN SALTMARSHES OF THE
WADDEN SEA COAST IN SCHLESWIG-HOLSTEIN INFLUENCED BY
SHEEP GRAZING**

by

Meyer, H.; Reinke, H.D. & I. Tulowitzki

The influence of different sheep grazing intensities on the invertebrate fauna at two sites in saltmarshes of the German Wadden Sea Coast situated near Meldorf and Bredstedt are investigated (since 1989). Each site is managed with five grazing intensities of 0.0, 0.5, 1.0, 1.5 and 3.4 sheep equivalents. On each site the fauna is registered by a transect of 5 trapping points corresponding to different inundation levels above the Mean-High-Tide-level. Main aspects of these investigations according to grazing effects are density of species and specimen, phenology, exchange processes, long term changes of species composition, population dynamics, biocoenotic zonations and food webs.

Many species showed distinct reactions due to grazing effects especially in comparison between ungrazed and intensively (3,4 sheep equivalents) grazed areas.

Effects of grazing on microclimate result in higher ranges of variation of temperature and moisture especially on soil surface. This microclimatic changes cause e.g. a reduction of hygrophilous Collembola and an increasing growth rate of Cicadina (*Psammotettix putoni*). Effects of grazing on structure and composition of vegetation result in changes of food resources.

Decreasing food resources for phytophagous insects caused by increasing grazing intensities are due to the extinction of the flower horizon (*Aster tripolium*) and to the reduction of host plants being sensitive towards grazing (*Aster*, *Plantago*) respectively.

Increasing food resources due to grazing effects result in higher population densities of some invertebrates. This is caused by both the supporting of the proliferation of grass shoots e.g. of *Puccinellia maritima* (*Psammotettix putoni* - *Cicadina*) and by the increase of soil algae respectively (f.e. *Ochthebius auriculatus* - *Hydrophilidae*, *Assimineia grayana* - *Gastropoda*). Effects of trampling by sheep leads to the destruction of habitat structures. This causes e.g. the extinction of larger soil caverns inhabited by *Orchestia gammarellus* (*Amphipoda*).

SLOPE OF THE EQUILIBRIUM RANGE IN THE FREQUENCY SPECTRA OF WIND-GENERATED WAVES IN GREEK SEAS

by

Moutzouris, C.I.

Introduction

Numerous studies have been conducted around the world, which have led to general conclusions concerning various of the energy spectra of wind-generated water waves. An important subject of research is the law of decay at the high-frequency end of the spectrum. In most cases the studies were based on data from measurements in open seas, where swell often dominates and wave propagation is unobstructed.

In the present paper the law of decay at the high-frequency end of the spectrum is examined with data from measurements from Greek seas, which have some very specific features. Waves are generated locally, wave propagation is obstructed by the presence of islands, and tides are almost negligible. The distance over which winds blow is often small so that the build-up of waves is limited by the fetch (fetch-limited wave generation). In many cases, wave heights are also limited by short storms (duration-limited wave generation). At a few locations, fully-developed seas may sometimes result from long storms blowing over considerable distances. In these cases, wave heights and periods are both dependent upon the velocity only. The above features are expected to influence spectral properties. Therefore, it seemed appropriate to investigate the wave spectra in Greek seas on the basis of measurements and to compare the results with those from the ocean.

Slope of the equilibrium range

The energy spectrum at the high-frequency end may be written as

$$S(f) = Af^{-n} \quad ; \quad f_p < f$$

where $S(f)$ is the energy density, f is the frequency and f_p is the frequency of the spectrum peak. A is a dimensional constant. The slope n at high frequencies indicates the law of decay of the spectrum. Phillips, 1958, applied dimensional considerations and proposed that the slope of the equilibrium range in the high-frequency region of a wind-wave frequency spectrum is -5. Neumann (1953), Derbyshire (1955) and Roll and Fischer (1956) had previously proposed -6, -7 and -5, respectively. Phillips based his considerations on a dynamical saturation between energy input and dissipation processes. Measurements seemed to justify the -5 slope. Both the Pierson-Moskowitz and the JONSWAP spectra were proposed with an f^{-5} dependence at high frequencies. Recent observations show evidence that the spectrum is proportional to f^{-4} rather than the widely used f^{-5} . Mitsuyasu et al., 1980, proposed more recently $n=-4$. Toba's spectrum contains an f^{-4} decay. Phillips, 1985, re-examined the process of energy input from wind wave breaking and wave-wave interactions

and concluded that the frequency spectrum is proportional to $g u^* f^{-4}$, where u^* is the wind friction velocity. Re-examination of the JONSWAP data by Battjes et al., 1987, showed that the spectrum is proportional to f^{-4} . The analysis of a large number of data records in the Great Lakes made by Liu, 1988, did not serve to clarify the uncertainty between $n=-4$ and $n=-5$ for the frequency exponent. The author had indications that the slope is not unique, but tends to vary with wave momentum. For sufficiently well-developed wind waves, the exponent appears to cluster between -3 and -4. For practical applications, the f^4 equilibrium range is perhaps an effective approximation, according to the same author.

Measurements - Results

Measurements were made with Datawell waveriders of the accelerometer type moored at three different locations in Greek seas. Standard analysis of the measurements led to the moments m_i of the spectra, from which significant wave heights H_i , average zero upcrossing period T_i , energy spectra $S(f)$ etc. were computed.

The results from the study show that in numerous cases n does not remain constant in the high frequency region. n changes considerably, as f increases from the peak frequency f_p to a higher frequency f_i (i.e. in the domain $f_p < f < f_i$). f_i was always smaller than $2f_p$, and in most cases smaller than $1.6f_p$. The slope n showed constant values in the frequency domain between f_p and, say, $2.5f_p$. The values of f_i found in the most representative spectra are shown in Fig.1.

Concerning the constant values of the slope in the frequency domain (f_p , f_i) found in our spectra, most values of n were found to lie between -3 and -6. In a few extreme cases, n showed values as high as -11.

The frequencies of occurrence of the various slopes found in the spectra are also shown in Fig.1. The range of observed values of n is large when all spectra were retained. When the spectra with the higher significant waves were considered, the range of values of n decreased significantly. In the extreme case, when only the spectra with the highest significant waves were retained, the corresponding values of n ranged from -3 to -6. This result seems to be rather important. It shows that although the law of decay of the spectra at high frequencies still remains uncertain, the slope of decay of the more developed spectra tends to cluster between -3 and -6, which is a range wider than in the ocean.

In the paper a further analysis of the results is presented and comparisons are made with data from the ocean.

COASTAL PROCESSES ALONG ROSETTA PROMONTORY OF THE NILE DELTA, EGYPT.

by

Nafaa, M.G.; Fanos, A.M. & A.A. Khafagy

Rosetta promontory is located on the western side of the Nile delta coast about 60 km east of Alexandria. This promontory was prograded into the Mediterranean, by about 3,5 km during the nineteenth century due to the large quantities of sediments brought by Rosetta branch during flood periods.

This trend was reversed at the beginning of the 20th century and the rate of erosion has accelerated since 1964 due to the absence of the sediments which were trapped in the upstream of the High Aswan Dam.

The dynamic processes and environmental parameters affecting the coastal changes of Rosetta promontory have been monitored for the last 20 years. A concentrated program for field data collection started in 1982 comprising; survey of about 50 profiles covering the area, directional wave measurements, current measurements and collection of surface bottom samples. These data were used in planning and designing protective works executed during the period from 1986 to the beginning of 1991.

The aim of this paper is:

1. to give a brief description of the data collected and the results of analysis;
2. to illustrate the factors used in the design of the protective works, and
3. to monitor the response of the shoreline due to execution of the protective works.

**BEACH AND NEARSHORE FEATURES ALONG THE DISSIPATIVE COASTLINE
OF THE NILE DELTA**

by

Nafaa, M.G. & O.E. Frihy

Rhythmic beach and nearshore features along the Nile Delta coast have been investigated from aerial photographs, beach profiles and field observations. Beach cusps and underwater sand bars of parallel and crescentic types, typical of tideless sea, were delineated. Aerial photographic analysis and field observations showed that many beaches west of Abu Quir headland, contained long crescentic bar system. In contrast, parallel longshore bars exist along the delta extending from east of Abu Quir to Port Said.

The parallel bar system along the Nile Delta is generated by the dominated eastward longshore current associated with littoral drift in the same direction. The crescentic bars west of Abu Quir headland at Alexandria are associated with rip currents and almost negligible littoral drift. Application of surf-scaling parameter (ϵ) indicates fully dissipative state of the Nile Delta coast and moderate dissipation west of Abu Quir. The surf-scaling analysis and the configuration of the beaches suggested that the study area can be generally divided into two morphodynamic zones: The delta coast has a gentle slope varying from 1:50 to 1:100, smooth wide beach face mainly composed of quartz sand of neolithic origin and characterized by parallel bars. The beach sand is fine to medium sand, mainly derived from the Nile River. The second zone is located west of the Delta, along Alexandria waterfront and the beaches further west. This zone is characterized by steep slope nearshore bottom of 1:30, with pocket and embayment shoreline made of biogenic sand with rocky shoals except for the western part which is straight, medium to coarse oolitic carbonate sand beach dominated by crescentic bars. The oolitic grains are derived from the adjacent Pleistocene limestone ridges parallel to the western coast of Alexandria.

DINOFLAGELLATE CYSTS: FACTORS FOR RECURRENT NUISANCE ALGAL BLOOMS IN THE COASTAL ZONE

by
Nehring, S.

Two possible effects of nuisance phytoplankton blooms are of economic relevance in the coastal zone: aesthetic problems of water quality and the danger of mussel poisoning. The most frequent producers of such events are dinoflagellates.

Many of the estuarine and neritic dinoflagellate species responsible for nuisance blooms include a dormant cyst stage in their life cycles. The formation of this resting cyst is the result of a sexual process (zygote formation). In contrast to the vegetative cells, cysts have a negative buoyancy and accumulate on the sea bottom. These resistant cells have various potential functions in the life cycle of dinoflagellates:

- over-wintering stage acting as "seed" population
- survival mechanism during environmental stress
- means for species dispersal (e.g. in ballast water)
- means for genetic recombination through sexuality
- source of toxicity
- determination of bloom development

Facing the important role of resting stage formation, there is an increasing need to study the distribution, abundance and general physiological aspects of dinoflagellate cysts.

This poster provides an introduction to modern dinoflagellate cyst studies.

MORPHODYNAMICS OF INTER-TIDAL AREAS - THE WADDEN SEA

by

Noorbergen, H.H.S.

Inter-tidal areas are constantly subject to morphological changes. The spatial distribution of tidal channels and tidal flats can strongly vary in several years. Until now geomorphological changes of an area like the Dutch Wadden Sea are measured by depth-soundings from vessels. A complete depth-sounding for the Dutch Wadden Sea requires a surveying period of about five years. The derived depth-sounding maps are therefore not a presentation of one moment but the compiled result of soundings during a five-year period.

The project presented here concerns the use of Landsat MSS satellite images in order to determine the geomorphology of the Dutch Wadden Sea at one certain moment. By using more satellite images of different acquisition dates, geomorphological changes can be detected.

By 1991 Landsat MSS imageries from the whole world is available for two decades. The present build up database of 20 years remote sensing provides a useful potential for multitemporal research.

In this study three mosaics of Landsat MSS images were composed, all taken at the same low water levels but of different acquisition years, namely 1975, 1980 and 1987. After geometric coregistration it was possible to detect morphological changes between these years. Several image processing methods were used like spatial gradient filtering and three-color composition of the three different years.

The remote sensing analysis can be considered operational in the sense that

- well defined basic image processing routines suffice to obtain the information.
- the project satisfies immediate information needs of a large area, leading to direct application in hydrological studies and engineering work.

FLUIDIZATION AND BEACHFACE DEWATERING: RECENT PROGRESS AND CASE HISTORIES

by
Parks, J.

Fluidization is a process for maintaining navigability of marina and small harbor entrances and of sand bypassing from a permanent buried system of perforated pipes and pumps.

Beachface dewatering is the opposite process, of pumping water out of a shore-parallel buried drain pipe, to enhance beach accretion and stability.

Recent improvements in means for burying pipes in saturated non-cohesive sands have made both of these new technology methods economically attractive with advantageous cost-benefit ratios.

Fluidization works by pumping excess water into the sediment producing a fluid mixture of sand and water that can be pumped for appreciable distances, leaving a channel behind. Beachface dewatering works by removing water from the tidally-elevated vadose saturated zone beneath the beach swash zone, allowing part of each wave runup to soak into the beach, reducing the volume and velocity of backwash and leaving additional sand on the active beachface.

The greater part of beach erosion occurs during the relatively few days per year of significant storm activity. "Standard" beachface dewatering as at Sailfish Point near Stuart, Florida offers some protection against storm erosion by providing a wider base beach. However, the temporarily elevated sea level (storm surges) allow storm waves to attack at the foot of the dunes (if present). Storm surges create a temporary "perched" water table on the upper beach because the permeability of beach sands cannot handle the large volume of water during storm wave runup. Recent improvements place a secondary drainpipe well above normal ground water level at the dune foot. This is connected to drain by gravity to the normal pump system, and pumping water out of the upper inland drainpipe during elevated storm surges acts to slow down and retard storm beach erosion.

Case histories of recent examples of each process, in the United States will be discussed, including analysis of the problem, design of the system, installation, operation, and monitoring as well as results obtained and both capital and operating costs. Several additional projects in the planning stages will also be discussed.

**AN ASSESSMENT OF THE EXISTING GLOBAL SEA LEVEL DATA AND
IMPLICATIONS FOR SEA LEVEL TREND ESTIMATES**

by

Plag, H.-P. & Gröger, M.

The increasing release of CO₂ and various other Greenhouse gases into the atmosphere is expected to lead to a global warming. Among the possible impacts of such climatic changes on environmental conditions a predicted rise in global sea level is considered to be of high importance. Thus, quite a number of recent studies have focussed on detecting the "global sea level rise" or even an acceleration of this trend. However, the results are not conclusive, though most of these studies have been based on a single global data set of coastal tide gauge data provided by the Permanent Service for Mean Sea Level (PSMSL).

A detailed discussion of a thoroughly revised subset reveals that the PSMSL data set suffers from three severe limitations: (1) the geographical distribution of reliable tide gauge stations is rather uneven with pronounced concentrations in some areas of the northern hemisphere (Europe, North America, Japan), and much fewer stations on the southern hemisphere where particularly few stations are located in Africa and in Antarctica; (2) the number of stations recording simultaneously at any time is far less than the total number of stations with the maximum available data from the interval between 1958 and 1988; (3) the number of long records is extremely small and almost all of them originate from a few regions of the northern-hemisphere.

The sensitivity of the trend median on these temporal and spatial limitations is discussed by restricting the data set in both the spatial and temporal distribution. It is shown that the data base is insufficient for determining a global sea level rise.

Nevertheless, the data is providing valuable information concerning regional trends in sea level. Namely, regionally coherent patterns have been detected indicating trend variations in certain regions, this being an information which might even be more important for impact studies than the expressed by a single number denoting a globally averaged trend.

**SHORELINE CHANGE SIMULATION AND EQUILIBRIUM
SHORE-ARC ANALYSIS OF EMBAYED MUDDY COAST**

by
Qiu Jianli

In this paper one-line theory for simulating shoreline changes and equilibrium shore-arc theory are initially applied to the shoreline form and dynamic studies of embayed muddy coasts. The applications are based upon some characteristics of the coasts in the study area. A suspended load transport rate replaced the equation of the littoral sand transport rate on a sandy beach and is uniformly used both in the simulation of shoreline changes and the analysis of shore-arc. Assuming the suspended load that makes a net contribution to the shoreline dynamic states for a long time is carried into bay from the left and right sides by longshore currents, which are caused by the waves along two main wave directions, and taking a profile thickness that is far larger than the experiential value in a sandy coast model, the shoreline dynamic states of Yeyashan area, Zhoushan-Island, are simulated. Then the equilibrium shore-arc expressions of this shore section and Beilun area are deduced. The theoretical shoreline forms are coincident with actual shoreline configurations. The conclusion on the shore dynamics is also identical with those from other studies. It showed the effectiveness of the theoretical methods presented and provided quantitatively geomorphological data for exploitation on these shorelines.

THE STABILITY OF SANDY SEABEDS UNDER WAVES

by

Richwien, W. & W. Magda

The state of soils is determined by stresses and density, the latter with respect to well defined steady state conditions which are unique values for any given types of soil. Steady state is defined as stress level and density for which the soil deforms with constant volume and constant strain rate. Thus stress increments to reach steady state at given density can be used as state parameter to characterise the soil behaviour.

Wave loads are cyclic changes of effective stress and shear stress in the soil skeleton, they normally produce a densification and simultaneously a reduction of stress state as a consequence of pore pressure generation. This behaviour ends up in a loss of stability of the soil, under critical conditions up to a totally liquefaction.

The paper gives a practical approach for the evaluation of stability of sandy seabeds under waves.

DETERMINATION OF THE EVOLUTIONARY CONDITION OF COASTAL CLIFFS ON THE BASIS OF GEOLOGICAL AND GEOMORPHOLOGICAL PARAMETERS

by

Rivas, V. & A. Cendrero

A method is described for the characterisation of cliffs in terms of erosive rates, based on the correlation between observed erosion and erosional micromorphology, on the one hand, and a series of geomorphological parameters (bedrock, structure, height of the cliff, slope, orientation, gradient of the adjacent coastal platform) using regression and principal component analyses.

These analyses, applied to the north coast of Spain, show that 4 types of cliffs can be distinguished in terms of erosion, corresponding to rates of:

< 1 mm/year; , mm/year; mm-cm/year; dm-m/year. The factors that appear most important for determining erosion in the cliffs of this region are bedrock and the gradient of the adjacent platform, with the following regression equation:

Erosion grade = $1.62 + 0.164 \text{ bedrock} - 0.079 \text{ platform gradient}$.

Correlation coefficient: 0.6151

The principal component analysis shows that 100% of the observed variance can be explained by three axes: First axis, from variables height and slope; second axis, material variables (bedrock, structure, erosive condition); third axis, process variables (orientation, gradient of the platform).

Although the method used needs refining, it offers good possibilities for the prediction of erosive rates, on the basis of parameters which are easy to determine.

Finally, observations carried out in this region, indicate that there has been an intensification of erosion rates in recent years, which does not seem to be related either with an increase in storm frequency or intensity or with human intervention.

**MORPHO-CLIMATIC EVOLUTION OF THE AVEIRO REGION LITTORAL
(NW OF PORTUGAL) DURING TERTIARY AND QUATERNARY**

by

Rocha, F. & C. Gomes

During the last years we have been engaged in studying the sub-surface geology of the Ria de Aveiro region. The area under study represents about 55 km², corresponds essentially to the estuary of the river Vouga and it is still an active sedimentary basin. It belongs to the northernmost part of the Lusitanian basin. At present the Ria de Aveiro corresponds to a barrier lagoon that communicates with the Atlantic Ocean by an artificial channel. All the information on the sub-surface geology yielded so far is based on mineralogical and sedimentological studies carried out in the cuttings derived from more than twenty boreholes used for water prospection and production.

Clay minerals and the accompanying non-clay minerals were utilized for lithostratigraphical discrimination and for paleosurfaces definition. In particular, clay minerals assemblages reflect paleogeographic and paleoclimatic conditions of formation and deposit. As a matter of fact, in the case of the Ria de Aveiro region, their nature and crystallochemical features allowed the zonation of Tertiary and Quaternary sediments as well as the definition of deposit environment conditioning. Mineralogical and sedimentological data did show a sharp transition between late Cretaceous sediments (Argilas de Aveiro formation) and the post-Cretaceous sediments.

It is considered that late Cretaceous sediments were deposited in a littoral, probably estuarine environment with low hydrodynamics. The sediments of the lower unit (Paleogene) of the post-Cretaceous sediments appear to be mainly derived from a perimarine sedimentation, with confined lagoonal character; its pre-evaporitic and evaporitic facies point out towards a dry and hot semi-arid climate. However, there are variations in the mineral assemblage, point towards alternating less and more saline environments. Anyway, the saline character is gradually reduced towards the top of the unit. The lithological and mineralogical composition of the sediments of the second unit (Neogene) of the post-Cretaceous point towards a littoral environment of shallow waters with alternating episodes characterized by higher salt water or fresh water influence. The sediments of the two upper units (attributed to Plio-Pleistocene and Holocene) are mainly land-derived and deposited in swamp and estuarine brackish waters, particularly the top unit. In places, the environment has been and still is anoxic, since the sediments are noticeably rich in organic matter and contain sulfides.

**SPECTRAL AND STATISTICAL CHARACTERISTICS OF WIND GENERATED
WAVES DURING A STORM IN THE COASTAL ZONE OF
CANARY ISLANDS (SPAIN)**

by

Rodriguez, D.R.

This paper describes the evolution of the sea severity, recorder by a Waverider buoy placed at a depth of 40 meters, during an storm which occurred in the Littoral zone of Canary Islands on 4th May 1988. In this period the value of significant wave height was 4 meters, with a maximum height of 7 meters. Obviously, this Storm is not so big, but it was selected because is not of common occurrence in Canary Islands where the storms appear usually during wintertime. Thereby, it is possible to compare the typical features of the regular storms (occurring in winter) with this singular event.

The development of the sea state is studied taking into account the variation of the Spectral Density of wind generated waves, which is computed by traditional Spectral Analysis methods (Blackman-Tukey and FFT) and by Maximum Entropy Method (MEM). This spectra are fitted to the JONSWAP (Hasselmann, et. al, 1973) and Wallops (Huang, et. al, 1981) models. The goodness of fit is contrasted by means of the deviation index, defined by Liu, P. (1983).

Furthermore, the behaviour of spectral and statistical parameters, such as zero upcrossing wave heights and periods, spectral moments and several shape parameters, is analyzed.

The variations between the same parameters obtained by the different methods of spectral computation are discussed.

**COASTAL MODIFICATIONS ON THE SOUTHERN USSR LARGE LAKES
DURING THE LAST CENTURIES: A NATURAL MODEL OF COASTAL
RESPONSE TO THE GLOBAL SEA LEVEL RISE**

by
Selivanov, A.O.

The problem of global sea level rise attracts primary attention of scholars around the globe. Recent inundation and coastal modification processes will aggravate if an acceleration of sea level rise occurs in the next decades. Enclosed lakes in the Southern USSR (The Caspian Sea, the Aral Sea, the Issyk-Kul lake) experienced fast climatically-induced water level fluctuations during the last centuries (up to several meters in one century). So they can serve as excellent natural models for coastal response to changes in water levels. Observations on the Caspian Sea show that nearshore slope values are of primary importance for the evolutionary pattern of accumulative coasts. Several types of coastal response to water level changes are distinguished. Sandy shores with moderate nearshore slope (approx. 0.005) exert accumulative coastal bar formation even after the alteration from water level fall to its rise in the mid 70s. Distinct erosion according to the Bruun Rule is observed only where nearshore is steeper than 0.01.

Both theoretical data and direct paleogeomorphological observations lead to the specific conclusion: successive periods of fluctuating level changes (e.g. rises before and after falls) can result in different coastal modifications due to morphological and sedimentary processes and a coastal zone self-regulation.

**CONTROLS ON BARRIER ARCHITECTURE IN A COLD-CLIMATE
PARAGLACIAL ENVIRONMENT: ST. GEORGE'S BAY AND THE
STRAIGHT COAST, NEWFOUNDLAND**

by

Shaw, J. & D. L. Forbes

On the sediment-deficient coast of Newfoundland, constructional coastal landforms develop only in proximity to Quaternary glacial deposits. The various barrier types which occur can be explained in terms of (1) the character of source sediments; (2) the pattern of sea-level change; and (3) the local physiographic setting. This is illustrated by two examples.

In St. George's Bay, southwest Newfoundland, sea level has been rising from an early Holocene lowstand of -25 m. The drift-aligned Flat Island spit developed in its present position after 2000 radiocarbon years BP. Dates on basal freshwater and salt-marsh deposits on the barrier range to a maximum of 1350 radiocarbon years BP. The barrier has a very large sediment supply from 40 km of eroding glacial bluffs. It has prograded into a deep (to -90m) coastal basin, forming a subaqueous sandy platform which underlies subaerial gravel beach ridges.

On the northeast coast of the island, the Holocene lowstand may have been at -15 m, and by just after 4 ka BP sea level was at its present position. The Man Point barrier foreland faces a wide, shallow, inner shelf and probably formed just after 4 ka BP. It is composed of prograded dune ridges and is mantled by salt-marsh and freshwater peats up to 3 m thick and dating to a maximum of 3150 +/- 90 radiocarbon years BP. The only source sediments at the coast are scattered, thin deposits of glacial sand and gravel. Offshore, the shallow, low-gradient inner shelf has a thin, discontinuous veneer of highly mobile gravel and sand between bedrock ridges.

The contrasts in barrier architecture result from differences in the three factors noted above. The Flat Island barrier formed with moderate rates of sea-level rise and an effectively unlimited sediment supply. The subaerial is therefore relatively young, with the earliest beach ridges now submerged. Furthermore, the barrier continues to grow, despite continuing submergence. Finally, because of proximity to a deep receiving basin, construction of a thick, subaqueous sandy platform was a prerequisite for development of the subaerial barrier. The volumetric ratio of the subaerial barrier to submerged component is less than 10 percent, with the subaerial barrier being predominantly gravel, the subaqueous platform predominantly sand.

At Man Point, however, the barrier formed with almost stationary sea level and is relatively

old. It has no observable sediment source. It was probably derived from an unknown offshore glacial source, which was conserved and moved onshore during the early -mid Holocene transgression. The barrier formed, it is believed, from the disintegration of a precursor barrier system located in an embayment which was submerged during the final several of sea-level rise. It has no sediment supply today, and with continuing submergence, is eroding rapidly. The long-term adjustment of the coastline continues as sandy sediment moves in the littoral zone into new sediment sinks. Here the subaerial barrier is predominantly sandy, and stores more sediment than the adjacent shoreface.

These are but two examples from a continuum of barrier types on the coast of Newfoundland. As a rule, differences in architectural style elsewhere on the island can similarly be interpreted in terms of interplay between sea-level trends, sediment supply, and physical setting.

INFLUENCE OF RUSHY WETLAND ON THE STABILITY OF COASTAL ECOSYSTEMS IN MONREPOS GARDEN (FINLAND GULF, VIBORG)

by
Shilin, M.

At present, the coastal ecotones of the Monrepos Garden (founded in the north-eastern part of the Gulf of Finland in 1759) accumulate sedimental material. Water quality in the Rosental Bay and Ludvigstein canal fail to meet sanitary and fish-farm needs. The stabilizing role is due to the presence of rushy wetland (*Phragmites communis* + *Scirpus lacustris* + *Typha angustifolia*), which pump away the pollutants (N,P,K) both from water and bottom, building up the coast line and being a refuge for the water foul as well. The pumped N,P,K are included in the body proteins of macrophytes and they don't return back to the water of the bay especially if the rushy wetland has been mown. In June-July N,P,K concentrate in leaves, in August-September - in leaves and rhizomes, and in October mostly in rhizomes. The organic matter (including oil products and other organic pollutants) storing efficiency in different years ranges from 7 to 14 %, the level being near to that of a maize field. The preservation of the rushy wetland and the water level control as well as the planting of the new rushy areas are necessary.

**PERSISTANT MARINE DEBRIS ALONG THE GLAMORGAN HERITAGE COAST,
UK: A MANAGEMENT PROBLEM**

by

Simmons, S.L. & A.T. Williams

The Glamorgan Heritage Coast is located in an high energy wave environment in South Wales. Eight beaches -Gileston, Colhuw, Tresilian, Nash, Temple Bay, Dunraven, Ogmere by Sea, and Merthyr Mawr were investigated for persistant marine debris. Debris was collected in three 5 m wide transects down each beach from high to low tide locations in summer and winter. At Tresilian, debris was collected from the entire beach in one summer and two winter periods. Debris composition was similar at the above sites and compared favorably with results found by other investigators. Plastics made up approximately 75% and 25% of the total debris by number and weight respectively; paper 6% and 54%, and metals were fairly consistant in number and weight. Apart from metal containers which were found in greater quantities on sand beaches, beach substrate (pebble or sand) was shown to have little influence on abundance and composition of debris. This is in contrast to findings of other workers. Negligible seasonal variation in debris was found disproving views that beach debris is the result of visitor discards: Seventeen days after all debris had been cleared from Tresilian beach, it was found that the debris was replaced by an even bigger volume. This suggests that beach clearance is not a sound long term management option as it does not tackle the debris source.

INTEGRATED PLANNING AS A NEW PARADIGM OF A COASTAL ZONE MANAGEMENT

by

Šimunović, I.

Coastal zones are specific geographical areas, in fact a meeting point of the two different natural phenomena: land and sea. The ecological experience of the coastal zones indicates that these zones are not independent areas unaffected by external influences. On the contrary, the experience has revealed that the populated areas are subject to the causal effect of natural and artificial elements within the immediate or more distant environment (?), and these influences may have serious effects on the surrounding.

The author uses this fact as a basis for developing the definition of contemporary coastal zone development as an integral concept including the development of nature, man, and technology. The coherence of the development idea in coastal zones has a further significance, as in these zones interference occurs continental and maritime life, which are two quite different forms of life and nature. That man-generated relation and not nature-generated can be both profitable and damaging. Both the profit and damage jointly require a somewhat different formulation of the development in coastal zones.

The integral-type planning is being used while searching for the solution to control the coastal zone development. That means there has been an attempt to find a corresponding planning type concerning the totality of that development and also of its parts, which runs counter to the concept of the development of overall composite structure. This means: time, space, and structure coherence.

In the summarized interpretation, the integral planning respects all the naturally-related life elements of an environment and is relevant for the development and maintenance of a particular environment. From the professional point of view, the discussion concerns the isomorphic sector treated in this case in accordance with the logic of the system applied. An important section of this paper is the part which deals with the interconnections relating to various territorial levels (?). The author has solved this linking by means of a multilevel matrix system. The solving of a coastal continuum and polycentrism, in fact the development of integral system from the environmental standpoint, is of utmost importance in developing the structure of the integral approach.

The author includes successful achievements and relation possibilities of the suggested system in the context of management of coastal zone development.

**VULNERABILITY OF THE COASTS OF GERMANY DUE TO SEA LEVEL RISE
AND CLIMATE CHANGE: ANALYSES AND RESEARCH DEMANDS**

by

Sterr, H. & Schellnhuber, H.-J.

Germany has coasts both with the North Sea and the Baltic Sea which differ greatly in morphologic appearance, hydrographic conditions and ecological as well as socio-economic structure. The low-lying North Sea coast to the west, with its adjacent waddens and islands is exposed to a considerable tidal range and frequent storm surges and is widely protected by hard structures (dikes, seawalls etc.). This coastal zone is therefore very vulnerable to (accelerated) sea level rise, which historically amounted to about 1,5 mm/y, and to a possible increase in storm surge magnitude and frequency in the German Bight. The high risk potential along this coast is associated with a general magnification of erosional processes, extension and shifts of tidal channels, loss of wadden and dune areas, dike failures and resulting inundation and, last but not least, setback of nearshore land use structures (tourism, settlements, agriculture etc.). Thus, for this coast detailed vulnerability assessments and coast-benefit analyses with regard to protection or adaption strategies are required which follow plausible sea level rise and climate change scenarios.

The Baltic Sea coast to the east displays a wide range of natural landforms and ecological characteristics varying from exposed cliffs, beach ridge plains and spits to enclosed coasts within sheltered embayments (Bodden) characterized by plant overgrowth (phragmites, salt marshes etc.). In the absence of extensive coastal protection works this coastal region is susceptible to increasing erosion rates along cliffs, beaches and dunes but also to flooding of low-lying sections and river mouths as a result of accelerated SLR and changing storm patterns. In addition to the high vulnerability of protecting spits, which when flooded or breached would render Bodden interiors to higher wave energies, increased warming trends here might have strong effects on salinity and sea ice cover. These factors in turn might have considerable effects on flora and fauna of the Bodden margins, thus changing a precious biological habitat. Currently large-scale research projects are prepared to estimate climate induced impacts and management options in both the North Sea and the Baltic coastal zones of Germany.

**SEDIMENTOLOGY OF A NORTH FRISIAN SALT MARSH:
TRACES OF STORM SURGES ON THE ISLAND OF SYLT**

by

Stieve, B. & J. Ehlers

Salt marshes originate from accumulation of tidal flats. Their generalized stratigraphy shows a near horizontal layering of seasonal deposits: more sandy in winter, more clayish in summer. Extreme flooding events leave even coarser traces, for example mollusca shells. The site treated momentarily is a long stretch of exposed salt marsh cliff on the east coast (landward side) of the north frisian island of Sylt. This contemporary cliff section stretches over 3 km, at the maximum just over 1 m high.

Evaluation of maps and aerial photography show that the east coast of Sylt in this area was dominated by accretion from the middle of the 19th century, in the past 100 years erosion dominated.

In order to date the cliff stratigraphy the content of $^{137/134}\text{Cs}$ was measured. The top 80 cm of the layered deposits represent some 60 years. Existing shell layers are correlated to known extreme storm surges of the recent past (evaluation of tide gauge records for this are).

Our field work is to be extrapolated downward into older salt marsh deposit. This means drilling further inland, as we have already reached the frontier to the old tidal flat at this site. Inland - as the maps indicate - is a longer history of mainland above mean sea level.

In order to confirm and also expand this method for defining storm surge layers and chronologizing them within a salt marsh accumulative history x-ray analysis and thin-section description of profiles are undertaken. Simultaneously extended laboratory investigations for the individual layers are planned.

The long-term goal of the project is to conclude on climate and sea-level changes through sedimentological interpretation of historical storm surges. This work is part of an international research project "Climate Change, Sea Level Rise and Associated Impacts in Europe", which forms part of the EPOCH programme of the European Community.

**A GIS-SUPPORTED SENSITIVITY ANALYSIS. IMPLEMENTATION OF
RESULTS FROM ECOSYSTEM RESEARCH**

by

Stock, M.; Boedeker, D.; Schauser, U.-H. & R. Schulz

As part of applied ecosystem research in the Schleswig-Holstein part of the Waddensea National Park an interdisciplinary approach has been taken to study the impact of touristic activities and natural succession on breeding birds on primary dunes.

The study area is situated at the only nearshore beach-barrier system off the mainland coast of Schleswig-Holstein. The natural beauty of the extensive system of primary dunes, natural saltmarshes, and beaches near Sankt-Peter-Böhl attracts millions of tourists every year. At the same time the area holds the most significant breeding population of Kentish plover (*Charadrius alexandrinus*) in Europe. Large parking and touristic facilities on the beach lead to conflicts between recreation and nature conservation.

In order to quantify the extent of human impact on the breeding success of Kentish plovers detailed investigations on population dynamics have been conducted since 1989. The ornithological data were incorporated into the existing Geographic Information System GIS-WEST. The combined data were used to analyse and document recreational impacts on coastal breeding birds.

The sensitivity analysis enables the authors to formulate certain objectives for the protection of the area. They can be used by the National Park authority to work out detailed management plans.

MIDDELKERKE BANK; SEDIMENTOLOGY AND HYDRODYNAMICS

by
Stolk, A.

In the southern North Sea some groups of linear sand banks occur. The southernmost group is situated off the Belgian coast and is called the "Flemish Banks".

The Flemish Banks exist of a subgroup of coast parallel banks, up to 8 km offshore, and a subgroup of banks, which are orientated with an angle of 25 degrees in respect to the coastline, up to 25 km offshore.

The Middelkerke Bank belongs to the last group. The bank has a length of 12 km, a width of 1,5 km and a height varying from 15 meter in the southwest to 8 meter in the northeast. The cross section of the bank is strongly asymmetric with a steep side to the northwest (slope: 3%) and a more gentle side to the southeast (1%). Sand waves are found on the gentle slope and on the top of the bank.

The depth of the top of the bank is at its shallowest part 4 m below MLLWS. The tidal range is 4 m. Maximum tidal currents are about 1 m/s.

The behaviour of a linear sand bank can be described as a morphodynamic system. In such a system the hydraulic processes and the morphology interact with each other on different time scales.

The investigations of the Department of Physical Geography are pointed on the sedimentary processes. For this purpose the water movement close to the bed and the sedimentary structures in the upper sediment layers are studied.

To investigate the hydrodynamics that lead to the maintenance of the bank under the present current and wave conditions, two measuring tripods were placed on the slopes of the bank. The measurements of the flow velocities and directions, combined with the measurements of the suspended load and records of the elevation of the water surface gives insight in the hydrodynamic processes near the bed.

To study the sedimentary structures a total of 108 boxcores and 61 vibrocores were taken along 12 cross sections over the bank.

The sedimentary structures in the boxcores show a rather regular pattern. The samples from the slopes and from the top of the bank mostly consist of yellow brown sand with abundant shell fragments. These shell fragments accentuate the sedimentary structures. Often a cross bedding structure is found, due to migrating megaripples. Bioturbation is almost absent. In the upper 20-30 cm of the boxes hardly any reduced sand occurs.

In the channels besides the bank more living shell fishes and more bioturbation occur than on the slopes and on the top of the bank. On a depth of more than 6 cm under the bed surface the sediment is mostly reduced. In some samples a clay layer with a thickness of a few centimeters occurs.

The above mentioned features point out that the channels are much less dynamic area than the slopes and the top of the bank.

The vibrocores present a complex picture of the upper 3 - 5 meter of the bank. Sediments of all grainsizes are found on different depths, varying from clay to cobbles with a diameter of 10 cm. The vibrocores also contain thick shell layers. This is an indication that the linear sand banks are built up by a complex mechanism.

In the presentation the hydrodynamic and sedimentary processes and the resulting sedimentary structures will be discussed.

MEASUREMENTS OF MORPHOLOGICAL CHANGES BY MEANS OF A SAND-SURFACE-METER

by
Straube, J.

Measurements of waves and wave induced currents have been taken at the Baltic Sea Coast near Schönberg/Holstein since 1990. Additional records of erosion and sedimentation at selected locations within the underwater profile by means of an opto-electronic sand-surface-meter were initiated in Summer 1991.

The measuring device consists of a rectangular steel rod with 61 optical sensors emitting infrared light, sensor control, battery supply and memory board in watertight housing. No additional cable is required. Once the system is started it can operate e.g. with a one hour sampling interval up to 42 days. Measurements were taken at different locations at Schönberger Strand/Kalifornien with up to three sand-surface-meters at a time.

At the end of June, 1991, a storm event with maximum significant wave-heights up to 1.5 m and morphological changes of approximately 40 cm within two days was recorded. The data of the sand-surface-meter showed that along with the occurrence of the maximum wave-heights at the beginning of the storm an erosion of 15 cm was measured. With decreasing wave-heights following the storm peak, erosion stopped and sedimentation with a rate of 40 cm over 36 hours followed. One reason for these morphological changes was certainly the fact that the decrease in velocity, especially with respect to maximum velocity, was not as strong as the wave-height decay over the storm duration. Despite of that it is not quite clear whether a large-size erosion/sedimentation was observed or if it was the migration of a longshore bar system. This will be subject to further investigations in the near future.

COMPARISON OF MEASURED AND CALCULATED NEARSHORE BOTTOM PROFILES

by

Szmytkiewicz, M.

The evaluation of usefulness of modified Dally and Deans's model, Kriebel and Dean's model and Bailard's model to the prediction of bottom profile short-time changes due to cross-shore sediment transport is given in the present paper. Each of the chosen models represents a certain concept of description of sediment movement in the sea. Dally and Deans's model belongs to a group of models assuming sediment transport mainly in suspension. Kriebel and Dean's model represents a group of models of global character, in which the asymmetry of oscillatory motion largely affects sediment transport rate.

The choice of a standard (for engineering purpose) model calculating on- and offshore sediment transport and cross-shore profile changes has been the aim of the present paper.

The estimation of usefulness of the chosen models has been obtained on the basis of field measurements taken in Coastal Laboratory in Shkorpilovtsi (Bulgaria) at the Black Sea. The installed apparatus provided very precise frequent measurements of depth changes under storm conditions, also in the surf zone. The accuracy of registered depths was about 0.01-0.02m. Storm period of 70.5 hours was chosen from ten days of measurements to verify the numerical solutions.

The verification yields that the modified Dally and Dean's model has supplied depth changes closest to measured ones in successive phases of a storm. The particularly accurate description of depth's variability has been obtained for the surf zone. While the numerically modelled storm was developing, the beach berm was being built in the close vicinity of the shore and the depth increased in the surf zone as it was observed in nature.

Presently conducted long-term surveys of depth variability in a coastal zone of the South Baltic (Lubiatowo) are to answer the question whether Dally and Dean's model with the proposed modifications is appropriate to the prediction of short-term depth changes in multi-bar coastal zone.

DETAILED HOLOCENE SEA LEVEL CURVE

by

Tanner, W.F.

The low-energy beach ridge systems near Fredrikshavn and Jerup, in extreme northern Denmark, have now yielded a history of sea level change, over the past 8,000 years, with data points at 51-year intervals. Still older beach ridges permit continuation of that history back in time approximately 3,000 more years (to the beginning of the Holocene), but that work is not complete yet.

The data set to date includes granulometric measurements (first six grain-size moments plus other parameters) for 154 samples, collected from a similar number of low-energy beach ridges in a continuous sequence from oldest (western edge) to the modern beach (eastern edge). It has been shown previously that the Kurtosis and the Sixth Moment Measure, given as moving averages, reflect accurately small sea level changes (such as 1-3 m), and are rarely indicators of storm-vs-fair weather conditions; this applies to low-to-moderate energy beach ridges only and is not appropriate for the high-energy ridges on the northwest coast of the peninsula.

The sampling method precludes collecting from storm deposits, and the statistical treatment removes any traces that might remain. The rapid rate of despositional progradation, relative to isostatic rebound, provides that uplift had no important role in shaping the grain size distribution.

Valuable information was obtained also from beach ridge altitudes (which indeed do indicate rebound), map positions, and ages.

The resulting sea level curve shows clearly the amount, direction and timing of sea level changes associated with the Little Ice Age. It also matches, back to about 3,500 B.P., sea level curves obtained in the U.S.A. from smaller beach ridge systems (no uplift) having shorter histories.

The mid-Holocene high sea level, about 6,800-4,900 B.P., and the subsequent low (perhaps -2 m), about 4,500-3,000 B.P., are obvious. Several rises and falls in the interval 3,000-1,100 B.P. can be seen. Lab work is not yet complete on samples older than 8,000 B.P., but it is already clear that there were sea level fluctuations in early Holocene time.

A study of oversize and undersize oxbow lakes, on river floodplains in south-central and southwestern American states, shows that at times of highest Holocene sea level, rainfall and runoff in that area were twice as great as today, and that at times of lowest Holocene sea level, they were only about half as much as now.

**PLANNING AND DESIGN FOR THE LEISURE CRAFT WITHIN A
TRADITIONAL FISHING HARBOUR**

by

Teixeira, A.T. & T. Gamito

The debate over the advantages and the disadvantages of the presence of leisure and fishing boats within the same harbour has been going on for some time. It seems that two requirements should be met before the planning and design work proceeds towards a successful planning solution. The harbour must be large enough to accomodate the two fleets keeping them apart in separate mooring basins. There must be enough grounds surrounding that basin in order to create all the facilities for the leisure craft and for the fishing fleets. In common the two fleets will have the same sheltered place on a particular coast location.

The authors present in this paper the planning and design of a new mooring basin and of the port facilities that will be created inland within a traditional fishing harbour in the north of Portugal. Within this harbour it is planned to create two hundred and sixty berths for the leisure crafts ranging from 8 m to 18 m in length. Draft will range from 1.8 m to 3.0 m.

The grounds surrounding the leisure craft area constitute a feature that is at least equal in importance to the water area containing the pontoons for berthing of the boats. Special attention was paid to the location of the buildings for the following activities: administration, bathhouses and boat storage sheds. In addition to the buildings, space was allocated for the access roads, walkways and parking areas for boats and automobiles. An open service yard, open dry storage for boats, fuelling facilities and boat handling equipment was also considered in the design.

COASTAL WOODLANDS, FORESTRY AND NATURE CONSERVATION

by

Tekke, R.M.H.**Introduction**

Dry coastal environments in Europe include an enormous variety of natural habitats, many of which are specific for the coastal zone. Therefore more than 35 coastal habitat types have now been classified as important within the European Communities and included in the EC Habitat Directive which was approved last December.

-The natural quality of several of these habitats has been altered significantly by afforestation. The creation of pine, fir, eucalyptus and acacia plantations have been used for sand stabilizing and wood production purposes. Most of these species are exotic to the areas where they have been planted.

The extensive wood plantations have not only resulted in a complete change of the natural habitats but also in a dramatic decrease of mobile and dynamic coastal dune systems.

Afforestation is the main reason for coastal dune habitats decline in Europe. In general this decline was not compensated by the newly established forest plantations which are mostly poor in species. Besides wood plantations have changed the hydrological systems with various consequences for the ecosystems of wet dune valleys and lakes and for the seepage volumes into related areas.

Coastal woodlands and forestry

A European Community policy concerning afforestation is currently developing. This policy may result in further development of wood plantations in threatened coastal habitats. Therefore the European Union for Coastal Conservation (EUCC) has started a programme "Coastal vegetations and forestry" in June 1991, jointly with Eurosite and in close cooperation with universities in the Netherlands, Italy and Spain. This programme is aiming at the conservation and restoration of the natural values of threatened dry coastal habitats. In January 1992 a first project "Coastal woodlands and forestry" started within this programme.

The main aims of this project are:

- Surveying the various coastal woodland habitats in Europe including their endangered flora and fauna.
- Promoting the conservation of natural coastal woodlands in Europe especially with respect to afforestation programmes.

The project is now in its pilot phase. In the first half of 1992 the project mainly focused on woodlands and afforestations on coastal sand dunes along the Atlantic coasts of Europe. During this half year a first attempt was made to gather all the necessary information and to develop a good methodology. The first results of the inventory and methodology were discussed by experts during a workshop in Wissant (France) in June 1992. On the basis of these discussions the methodology was improved and extra information was and is still being gathered.

In the paper presented here attention will be paid to the methodology, first results of the project and if possible, the consequences of these results for future afforestation projects. Further an overview will be given of the continuation of the project with a request to all those present to submit their ideas and suggestions.

Mr. Tekke is working at the General Secretariat of the **European Union for Coastal Conservation** in Leiden (address: P.O. Box 11059, 2301 EB Leiden) and coordinates the "Coastal Woodlands and Forestry" project.

The **European Union for Coastal Conservation (EUCC)** is an international organization which aims to promote nature conservation and wise use of European coastal environments. The Union consists of a network of many hundreds of scientific experts, managers, government bodies and nature conservation organizations who interact to provide a cohesive approach to the protection and management of European coastal systems.

GIS FOR SHORELINE MANAGEMENT

by

Townend, I.H. & D. Leggett

A geographic information system (GIS) is being used as a central tool for shoreline management on the east coast of England from the Humber to the Thames. Initially the GIS was adopted as essentially an analysis tool; to map relevant variables and analyse the interrelationships between variables, as a means of producing interpretative maps. The adoption of a strategic approach to the planning of sea defences led to a change in focus for the application of the GIS. In addition to performing the requisite analysis, it was recognized that it could play a significant role in management activities.

The application of GIS was therefore further developed as an integrated management tool, with uses which include: retrieval of information; provision of summary data; classification into management zones; and predictive modelling. In order for the system to be kept up to date, the GIS was positioned in an overall management framework, with an extensive monitoring programme and periodic reappraisals of the management strategy.

A key part of development procedure was the design of the data model. This specifies the way the data is structured within the GIS. In addition a range of tools were developed to extend the analytical capability, provide improved access to complex data sets and to enhance facilities for on-going management of the system. The various design considerations will be reviewed in the paper, together with a summary of operational experience to-date.

ENVIRONMENTAL ASPECTS OF MINING CLASTIC MATERIAL FROM THE SEA BOTTOM

by
Ušcinowicz, S.

Investigations carried out during the years 1988, 1989 on the Slupsk Bank gave first data on the scale of marine environment changes caused by gravel mining. Within a 1 x 1 km test field, detailed observations and oceanographic, sedimentologic and biologic measurements were made.

Sedimentological investigations included:

- determination of the content and variability of suspension in water,
- determination of concentration and grain size of mineral suspensions in water flowing from the dredger and falling onto the sea bottom,
- repeated observations of sedimentary structures around datum point markers installed in the sea bottom,
- repeated measurements of bottom elevation changes at the datum points,
- repeated observations and measurements of troughs left by the mining operations.

Measurements of suspension concentrations in sea water, made during mining and 1 hour after stopping operations, showed that the material falls very quickly to sea bottom and does not propagate further than 50 m to both sides of the dredger's course (sea state 1, surface current 17 cm/s, 130 deg.; bottom current 6 cm/s, 310 deg.).

The thickness of the layer of sand settling on the bottom of the mined troughs was 0.5 to 1.0 cm (ca. 7500 to 15000 g/m²). In traps placed at a distance of 50 m from the dredger's course, settlement of 1.29 to 1221.52 g/m² was recorded. At distances exceeding 50 m the amount of suspended material falling to the bottom decreased very quickly.

The initial depth of troughs left after the mining was 0.2 to 0.7 m. After 2.5 months the depth of partly filled up troughs was 0.1 to 0.15 m. Traces of the troughs were visible also after 9 months and their depth was 0.04 to 0.12 m.

Observations of bench marks driven into the troughs and analysis of grain size distribution of sediments indicate that the troughs have been filled up partly by material sliding down from trough edges and partly by fine sand migrating along the bottom surface.

WATiS-WADDEN SEA INFORMATION SYSTEM

by

**Van Bernem, K.-H.; Krasemann, H.L.; Lisken, A.; Müller, A.; Patzig, S. &
R. Riethmüller**

For the German Wadden Sea a sensible management concept has to be developed. Substantial and accurate knowledge about this ecosystem shall be achieved by several research projects. The Wadden Sea Information System WATiS is designed as an efficient and flexible tool to facilitate the information exchange among various research groups and administrative agencies.

In this paper we discuss several aspects which had to be considered for the development of such a system.

The demand for a "project-oriented" information system is clarified. This results for WATiS in a flexible structure, open for many future developments on the research and monitoring field.

The technical concept is outlined. The main tools are a relational database for data storage and geographical information systems (GIS) for the handling of thematic maps. Much concern has been put on the close connection between the locally distributed GIS and the coordinating central database, to guarantee an automatic data exchange and a consistent data set within the WATiS.

To combine data from different research groups all data have to be well documented and the data structure has to be designed in close cooperation among the research groups and the staff of the information system.

**THEMATIC MAPPING AND SENSITIVITY STUDY OF MUD FLAT AREAS IN
THE GERMAN WADDEN SEA**

by

**Van Bernem, K.H.; Müller, A.; Grotjahn, M.; Knüpling, J.; Neugebohrn, L.;
Ramm, G.; Sach, G. & S. Suchrow**

A metodologically uniform inventory of the entire German Wadden Sea was completed in 1992. It is based on quantitative and descriptive data and includes a documentation of temporary aspects. Making use of the synchronously prepared WATiS data processing system, a basis has been established for the development of a spatially and temporally differentiated vulnerability study of the tidal flats to help formulate methods to combat oil pollution. It also makes information available for the needs of the national park authorities and to serve scientific purposes.

After completion of a feasibility study from 1983 through 1986, the entire eu- and supralittoral area of the German Wadden Sea was charted under the direction of the GKSS Research Centre Geesthacht through the years 1987-1992. The work was financed in concert by the following institutions: Umweltbundesamt Berlin, Nationalparkverwaltung Niedersächsisches Wattenmeer, Landesamt für den Nationalpark Schleswig-Holsteinisches Wattenmeer, Sonderstelle der Küstenländer "Ölunfälle See/Küste" and the GKSS Research Centre Geesthacht.

The following independent categories were established for the cartographic survey:

Saltmarsh, sediment, benthos (macro-, meio-, and microphyto-) and juvenile fish populations. Data for the categories avifauna and mammalia were prepared from literature studies at the "Inselstation der Vogelwarte Helgoland" as part of a special program.

Samples on the content of heavy metals and chlorinated hydrocarbons in tidal flat sediments at selected stations have been compiled since 1989 to be analysed in a separate study also directed by the GKSS.

SIMULATION OF MORPHODYNAMICS OF TIDAL INLETS IN THE WADDEN SEA

by

Van Overeem, J.; Steijn, R.C. & G.K.F.M. Van Banning

The Wadden Sea is an international inner sea separated from the North Sea by means of a number of barrier islands, which belong to Denmark, Germany and The Netherlands. The Wadden Sea is internationally acknowledged as wetland, such as defined in the framework of the Ramsar Convention. The Wadden Sea, as a wetland, is an important nursery area for juvenile fish and feeding area for birds.

For a sound management of this coastal system, it is of utmost importance to have a thorough understanding of the functions of The Wadden Sea and their interrelations. Management decision related to issues such as coastal protection of the islands, sand mining, closure of inner seas or channels, exploration and exploitation shall only be taken after a sound analysis of the policy to be followed, taking into account the effect of the human interference on the system and its functions.

In this type of policy analysis, the knowledge concerning the morphodynamic behaviour of the system is an important input. In particular, the morphodynamic behaviour of the tidal inlets to the Wadden Sea is complicated and therefore difficult to predict. This is because of the complex interaction of a number of relevant processes, which play a role both at the outer and inner delta and in the inlet itself. Changes of the hydraulic and morphologic characteristics of the Wadden Sea, caused by natural changes and/or human interference will have clear effects on the behaviour of the inlet and consequently on the adjacent coastlines and inner and outer delta's.

The morphology-shaping forces are tide, wind and wave action, coriolis forces and last but not least relative sea level rise.

A number of tools are available to analyse the governing processes, which usually take place at different time and length scales, and to predict the morphodynamic behaviour.

Recently DELFT HYDRAULICS has been involved in a number of projects related to tidal inlets to the Wadden Sea, such as the "Eyerlandse Gat" between the Dutch Islands of Texel and Vlieland, the "Friesche Zeegat" between the Dutch Islands of Ameland and Schiermonnikoog and the Wichter Ee and Accumer Ee, between the German Islands of Norderney, Baltrum and Langeoog. From these projects, it showed that the numerical modelling system for coastal morphology is a powerful tool in the analysis of the morphodynamics of these complicated systems.

In the paper, the methodology which has been applied for the prediction of the morphodynamic behaviour of these inlets, using numerical modelling systems, will be described. Moreover a number of results will be highlighted and discussed.

**MATHEMATICAL SIMULATION OF POLLUTANT DISPERSION THROUGH
CELLULAR AUTOMATA IN COASTAL AREAS**

by

Villagarcia, M.G. & J.M. Pacheco

As an alternative to partial differential equations and due to its non-linearity, a technique based in cellular automata is presented. It allows a discretization of the pollutant dispersion dividing its concentration into the ranges marked by law.

A TURBO PASCAL program is used to run the automaton, being able to reproduce advection, diffusion and decay. Finite differences techniques are used to pass from an advection-diffusion-transport equation to the model in the computer.

Some numerical tests are carried out for different sources of pollutants, being accurate or random, and for different tides.

If the model follows the general behaviour of plumes in pollutants, it could be used for prediction since an automaton captures the idea of selforganization within a system and therefore coastal management technicians could benefit of this tool to well manage the ever-changing coastal areas affected by settlement of tourism and industries.

TIDAL ZONE OF SPITSBERGEN AND FRANZ JOSEF LAND

by

Węslawski, J.M. & M. Zajączkowski

Zone between high and low water marks have been studied at over 300 stations at Spitsbergen and 25 stations at Franz Josef Land archipelago in 1988 - 1991.

The aim of the study was to compare "warm" and "cold" coasts at high latitudes, defining their importance for the coastal waters. Spitsbergen's western coast being under strong influence of Atlantic water current shows a high diversity and richness of tidal biota. Biomass may reach over 4000 KJ per m². The number of species inhabiting the tidal zone counts about 100 for macrofauna with densities exceeding 10 000 indiv.per m². At "cold" coast of Franz Josef Land, at the same latitude the sharp impoverishment of faunal diversity is observed. The presence of multiyear ice at the shore creates biota for the cryolittoral community represented by two - three species with high densities. Succession of faunal communities following the evolution of the Arctic coast is presented from glaciers cliffs to moraine lagoons.

BEACH AESTHETIC VALUES: THE SOUTH WEST PENINSULA, UK

by

Williams, A.T.; Leatherman, S.P. & S.L. Simmons

An innovative check list was designed to rate beaches on their aesthetic characters. Physical, biological and human usage parameters were selected and a five point scoring scale devised so that assessment was objective. Summation of the scores for each subheading mentioned above and the obtaining of a grand total, enabled percentage values to be given for any investigated beach. One hundred and eight two such beaches were analysed for the South West Peninsula, UK. The highest rating value obtained was 86%, the lowest 55.6%. The median value was 73.2%. Ratings tended to follow the pattern set out by European Blue Flag beaches but there were several discrepancies. Differences were found between beaches located on the north and south shorelines of the Peninsula.

DUNE EROSION AND COASTAL ZONE ECONOMICS

by

Wind, H.G. & E.B. Peerbolte

Introduction

Coastal zone managers often have to select appropriate measures to protect an eroding stretch of beach. In this selection process a number of steps can be envisaged. Using a systems approach (Miser and Quade, 1985) first alternative measures are defined, effectiveness of each of the measures is investigated, costs are estimated and procedure fore instance based upon multi criteria analyses is used to obtain the "best" measure. Although this systems approach seems to be rather straight forward, application to the coastal zone leads to a number of interesting complications. In this paper two complications will be delt with. These complications will be highlighted using a cost benefit approach.

Theoretical framework

In a cost benefit analysis the cost of protective measures is compared with the benefits due to the protection of goods. The cost of protective measures will be based on the well known approach of fixed cost, marginal cost and a growth factor of capital. An interesting element appears in the estimate of the benefits due to the protection of goods from dune erosion. Say that a building with a value A is located at a distance y from the dunefront and that during an extreme event the dune front recedes over a distance x . A key element in the calculation of the benefits of protecting this building is the probability of exceedance function of the erosion of the dunefront $\Pr(x > y)$. The benefits can be obtained from the product of the actual value $A(t)$ and the propablity of failure $\Pr(x > y)$. Although a wide range of literature is available on dune erosion, the empirical information on (the site specific) distribution $\Pr(x > y)$ is rather scare. Furthermore most of the information is not available in a form which is suitabel for application in a cost benefit analysis. In the paper a proposal for $\Pr(x > y)$ will be presented based upon available literature and dune erosion data.

Sensitivety Analysis

In a cost benefit analysis a number of parameters are included such as the growth factor of capital, the dune erosion during extreme conditions, the ling term coast line erosion, initial and marginal costs etc.. Obviously each of these parameters contains a degree of uncertainty. A sensitivety analysis of the cost benefit analysis will be presented, highlighting the relative uncertainty of the various assumptions in the selection of appropriate measures for coastal zone protection.

Verification

The approach has been verified for a beach replenishment near a holiday resort in the Netherlands.

**ASSESSMENT OF HYDROBIOLOGICAL CHATACTERISTICS FOR KÖYCEGİZ
LAGOON SYSTEM IN VIEW OF USE AND PROTECTION**

by
Yerli, S.V.

Köycegiz Lagoon System in the south-western part of Turkey is of tectonic origin. The Lagoon's geography, climate, hydrography, main features of flora and fauna and its use are outlined. The data were obtained on dates from March 1986 to March 1988 from the monthly field survey and laboratory analyzes. The observed main characteristics of the System is discussed in this paper in view of use and protection.

**EROSION-ACCRETION SYSTEM OF SOUTH BALTIC COAST DURING THE
LAST 100 YEARS****by****Zawadzka-Kahlau, E.**

Cartometric measurements were made on 1:25000 topographic maps from the period 1875 - 1978 and on 1:5000 and 1:2500 plans from period 1960 - 1983 which covered 430 km of the Polish coastal zone.

Analysis of direction and rate of changes showed that there exists an erosion-accretion system of the sea coast. Stretches of coast with erosion or accretion of various length class are a part of higher level structures of the erosion-accretion system, i.e. of "bi-structures", lithodynamic units, morphodynamic regions and erosion-accretion subsystems.

The main characteristic of the erosion-accretion system is the alternating position of elements with erosion or accretion trend in all distinguished levels of the structure. This principle was confirmed for all analysed periods.

During the last years, an increase in the rate and range of coastal erosion in relation to the 100-year trend was observed.

Results of the cartometric measurements have been verified on a 50 km long stretch of dune coast, on which stationary measurements have been made during the years 1960 - 1978.

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