



Welcome Message

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Chair, LOICZ SSC

It is with great pleasure that I welcome you to the Inaugural Open Science Meeting to usher LOICZ's second decade as a global change program. Building on its strengths in examining material fluxes from catchments to coast, LOICZ now embarks on a broadly expanded research framework focusing on the interactions between humans, ecosystems and material fluxes as drivers of coastal change. For three days, we hope to engage you and a community of about 270 coastal scientists and managers representing XX countries in an exciting dialogue about these interactions, their trajectories of change, including ways to approach sustainable coastal scenarios.

Through the morning keynote addresses and the concurrent paper presentations following, you will get an overview of the themes covered by the LOICZ Science plan. In the afternoon, you can participate in workshop sessions to develop research proposals and action plans targeting knowledge products. At the end of the conference, you will have forged initial linkages or renewed ties with colleagues to pursue LOICZ related activities.

Beyond the Open Science Meeting, I strongly encourage you to become an active link in the LOICZ network if you are not one already. The success of LOICZ as a platform for global change research greatly depends on the individual and collective strength of its community members like you to see the program through to fruition.

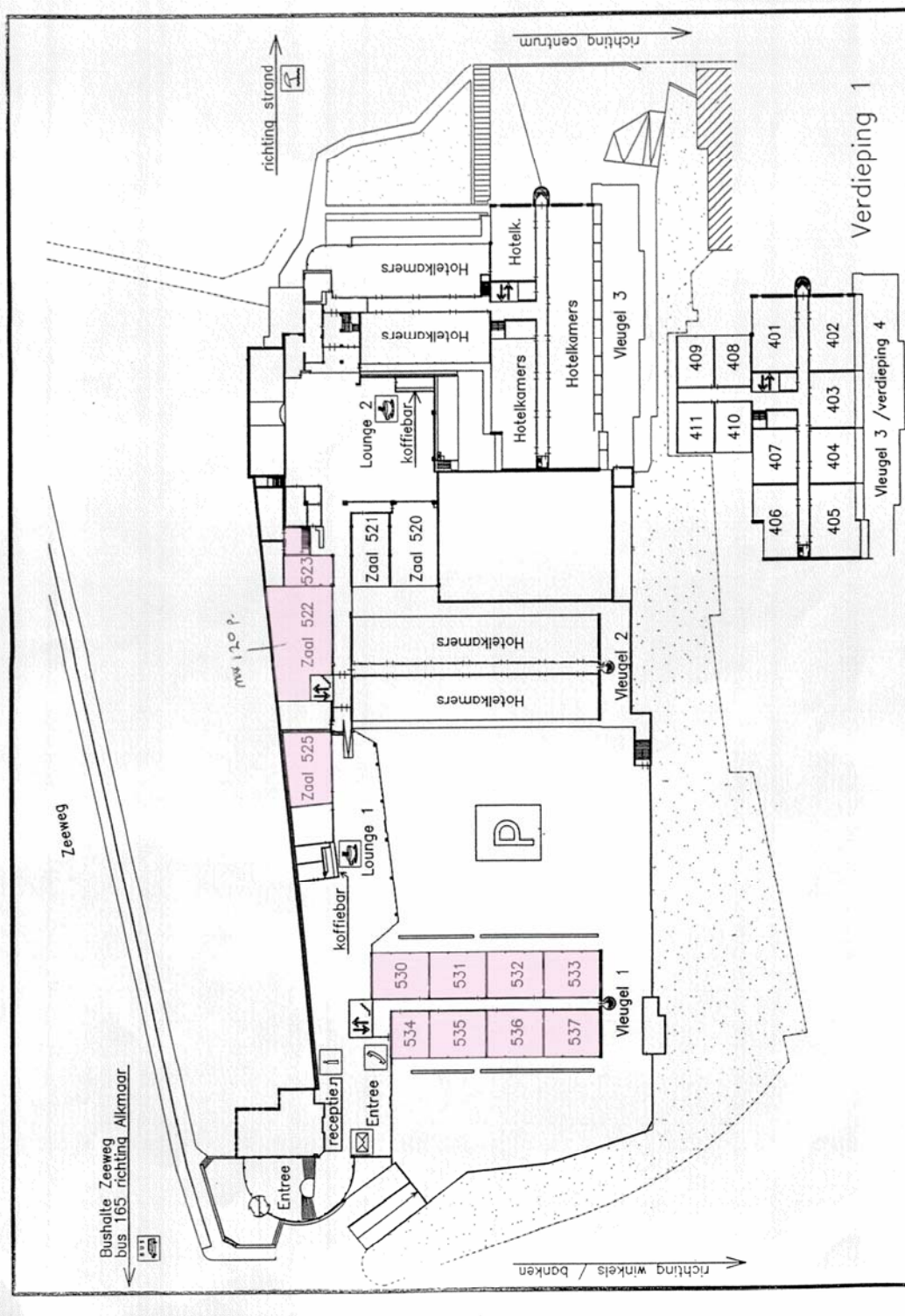
On behalf of the Scientific Steering Committee, the International Project Office and our Regional Nodes, *laat me welkom u aan Egmond aan Zee!*

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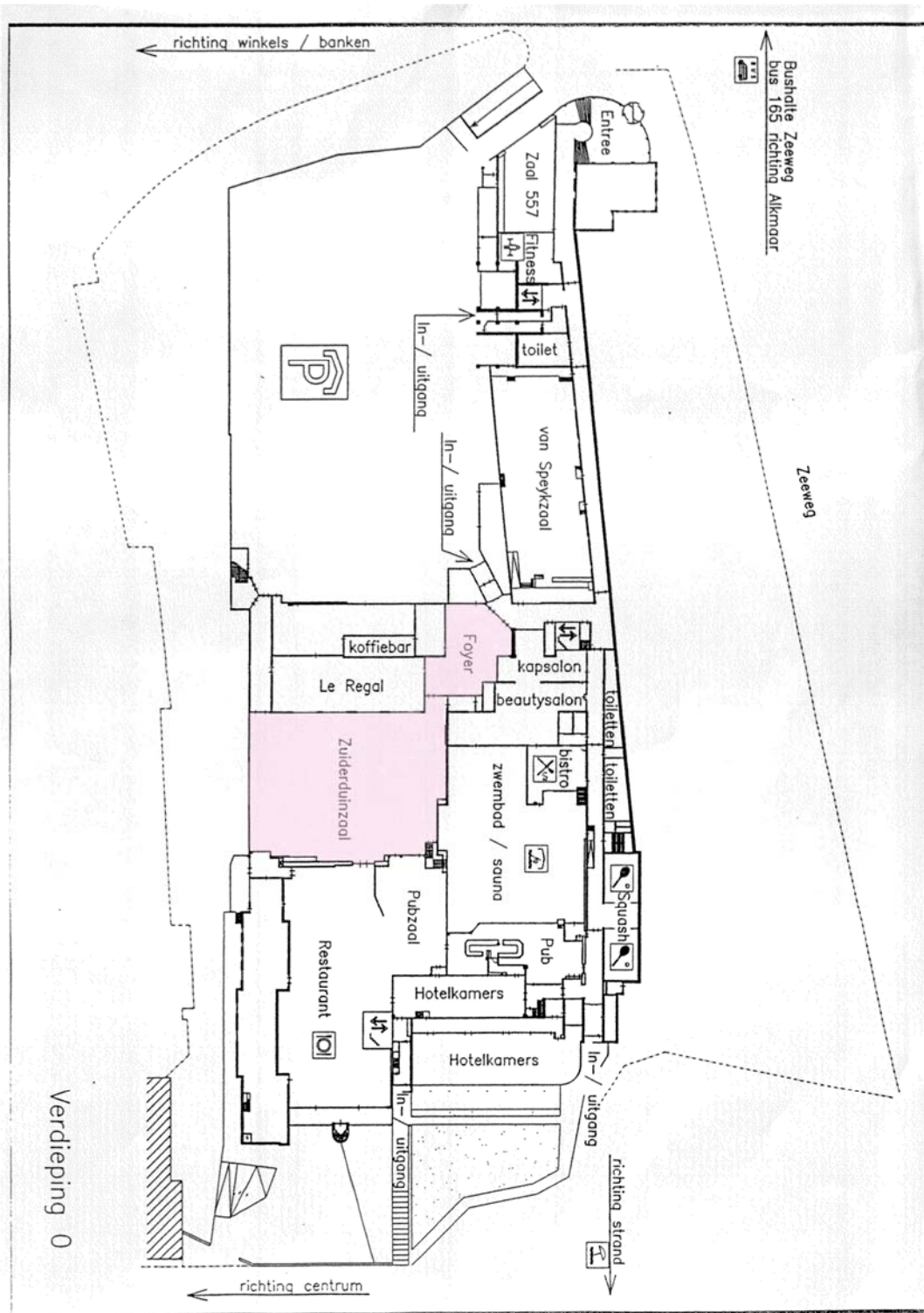
MEETING VENUE FLOOR PLANS

Main Level: LOICZ meeting rooms are shaded in the plan below:



The Main Level is where you will find the Meeting Secretariat desk (523) and the Sessions and workshop rooms (522, 525, 530 – 537). Specific room allocation for Sessions and Workshops will be announced each day and published on the Meeting notice board adjacent to Room 523. Drinks (coffee, tea etc) are available in the meeting rooms as well as at “refreshment stations” located around the meeting venue.

Lower Level: Rooms used by the LOICZ meeting are shaded in the plan below:



The Plenary presentations will be given in the *Zuiderduinzaal*, and Posters will be on display in the *Foyer* and is where the Ice Breaker evening will be held on Monday 27 June. The meeting dinner on Tuesday 28 June will be held in the *Van Speykzaal*. Breakfast and Lunch each day will be held in the *Restaurant*.

SUMMARY PROGRAMME AND SCHEDULE

The LOICZ Inaugural Open Science Meeting (IOSM) has 4 components:

1. *Plenary Presentations* with invited speakers will exemplify the broad domain of research themes that are encompassed within the LOICZ Science Plan and Implementation Strategy (SPIS) and address some of the science challenges that face the next 10 years of LOICZ activity.
2. *Contributed Sessions* will provide opportunity for some 140 speakers to present the principal outcomes of recent research findings. Morning sessions linked to the research themes identified in the LOICZ SPIS will be given context by an invited *keynote speaker* who will kick-off each session as well as act as a co-convenor. In the afternoon continuation sessions will present papers that cross the theme structure of the LOICZ SPIS.
3. *Workshops* provide an opportunity for groups to discuss specific areas of research and interest to LOICZ, and identify the gaps in knowledge, the future challenges and identify the contribution that future activity directions that should be taken up by LOICZ. Each workshop will prepare a short report of their deliberations to report back to the whole meeting in Plenary to close each day.
4. *Poster presentations* are an important feature in the LOICZ IOSM and complement the oral presentations. An ice breaker session on Monday 27 June in the *Foyer* will provide all participants opportunity to view the posters. The poster will be available to view throughout the meeting.

Meeting Overview

The tables below provide an overview of each day of the meeting:

TIME	Monday 27 June	Tuesday 28 June	Wednesday 29 June
08.30 – 09.00	Welcome and Opening Address: LOICZ – past present & future		
09.00 – 09.45	Plenary 1: Human Dimensions and Global Environmental Change	Plenary 2: Managing Canada's oceans and coasts: <i>A framework and an emerging plan</i>	Making the connection between healthy waterways and healthy catchments
09.45-10.30	Plenary 2: Coastal ecology in a changing world: can we provide the answers we promised?	Plenary 3: Interaction between eutrophication and suspended matter dynamics of a shallow coastal sea	Ecosystem-based knowledge for coastal governance
10.30 – 11.00	Morning coffee/tea		
11.00 – 12.40	Parallel Sessions		
	Session 1: Climate change and the coastal zone	Session 7: Geohazards, ground water and risk	Session 13: Coastal Assessments
	Session 2: Land-Ocean interactions on vulnerable coastal ecosystems (lagoons)	Session 8: Ecosystems, land and sea use (Deltas)	Session 14: Urbanisation
	Session 3: Sediment flux to the coastal zone: climate change, anthropogenic influences and future trends	Session 9: Coastal waters ecohydrology: from the mountains to the coast	Session 15: Nutrient flux to the coastal zone: trends and implications
	Session 4: Biogeochemical budgets	Session 10: Application of Remote sensing for Coastal Area management	Session 16: Shelf processes and the Earth System (Joint session with IMBER/SOLAS)
	Session 5: Human coastal communities	Session 11: Integrated assessment of coastal change and management: Socio-economic modelling and future scenarios	Session 17: Coastal ecosystem governance
	Session 6: Science, society and management of coastal zones	Session 12: Highlights of Dutch Coastal Zone Research	Session 18: Coastal typologies and datasets
12.45 – 14.00	Lunch		
14.00 – 17.45	Workshops & Continuation Sessions		
	Session 19: Climate change and ecological resources	Session 20: Nutrients, sediments and budgets	Session 21: Managing the coastal zone
	Workshop 1: Risk and vulnerability of Coastal Systems due to Climate Change	Workshop 5: Issues in scale of bridging the natural and social sciences	Workshop 9: Coastal Assessments
	Workshop 2: Integrated Coastal Zone Management and LOICZ – Current status	Workshop 6: Conceptual synthesis of global coastal environments	Workshop 10: Gauging Progress In Coastal Governance
	Workshop 3: Coastal Biogeochemical and Ecological models	Workshop 7: Integrating Socio-economic variables in mapping and modelling material deliveries from catchment to coast	Workshop 11: From river to coast: Collaboration between GWSP and LOICZ
	Workshop 4: Raising awareness and ownership of coastal management initiatives	Workshop 8: Marine Protected Areas – a management tool for ICZM?	Workshop 12: Implementation, Integration, and Participation: Strategies for LOICZ II
Evening	Poster Session & Ice breaker	Meeting Dinner	

Daily meeting schedule

The tables below provide the detailed schedule for each day. Descriptions of each Session and Workshop can be found starting on Page 16.

Monday 27 June

Day 1. Plenary presentations		
Time	Name	Abstract title
09.00 – 09.45	Young, B (Australia) & Göbel, B (Germany)	Human dimensions and global environmental change.
09.45 – 10.30	Herman, P (Netherlands)	Coastal ecology in a changing world: can we provide the answers we promised?

Day 1, Session 1: Climate change and the coastal zone.		
Convenor: Felino Lansigan		Co-convenor: Richard Klein
Time	Name	Abstract title
11.00 – 11.30	Klein, R (Germany)	Keynote: A New Assessment of Coastal Vulnerability to Climate Change
11.30 – 11.45	Boot, G (Netherlands)	Coastal erosion and sea level rise at the global scale; An assessment of impacts and adaptation
11.45 – 12.00	Dingerson, L (USA)	Predicting future shoreline condition based on land-use change and increased risk associated with climate change
12.00 – 12.15	Moya, B (Cuba)	Hicacos peninsula, a coastal territory, with urban and no urban space face to future changes
12.15 – 12.30	Thomalla, F (Sweden)	Understanding human vulnerability to coastal hazards and adapting to uncertain futures
12.30 – 12.45	Rupp-Armstrong, S (UK)	The future of managed realignment in Northern Europe – a comparative study of southern North sea coastal areas

Day 1, Session 2: Land-ocean interactions on vulnerable coastal ecosystems (lagoons).		
Convenor: Alice Newton		Co-convenor: Nick Murray
Time	Name	Abstract title
11.00 – 11.30	Murray, N (Italy)	Keynote: A European point of view. The Water Framework Directive: Integrating Coastal Systems and River Basins.
11.30 – 11.45	Mariscal-Romero, J (Mexico)	Environmental problematic in Bahia de navida lagoons: Reflections to implementation of a CZIM plan
11.45 – 12.00	Razinkovas, A (Italy)	Estuarine continuum in a temperate lagoon: spatial and temporal patterns
12.00 – 12.15	Arulanathan, K (Sri Lanka)	Impacts of freshwater discharge regulation on a shallow tropical lagoon-Puttalum Lagoon, Sri Lanka
12.15 – 12.30	Hung, JJ (Taiwan)	Biogeochemical Responses to the Removal of Marine Aquaculture Structures from the Eutrophic Lagoon (Tapong Bay) in Taiwan
12.30 – 12.45	Franco, A (Portugal)	A model for sustainable management of penaeid shrimp fishery - application to Maputo Bay, Mozambique

Day 1, Session 3: Sediment flux to the coastal zone: climate change, anthropogenic influences and future trends		
Convenor: Juan Restrepo		Co-convenor: John Milliman
Time	Name	Abstract title
11.00 – 11.30	Milliman, J (USA)	Keynote: Temporal change in global precipitation and river discharge. Are we seeing long-term change or simply natural oscillations?
11.30 – 11.45	Mil-Homens, M (Portugal)	A sequential method approach for sediment quality assessment
11.45 – 12.00	Sharma, K (Nepal)	Impacts of Human activities on region-wise budget and oceanward flux of sediment in South Asia
12.00 – 12.15	Knoppers, B (Brazil)	The Sao Francisco river basin and coastal zone, East Brazil: Physical and ecological alterations induced by dam construction
12.15 – 12.30	Kitheka, J (Kenya)	Coastal impact of damming and water abstraction in the Tana and Athi river basins of Kenya
12.30 – 12.45	Salomons, W (Netherlands)	Soil-Catchment-Coast Continuum: Legacy of the past

Day 1, Session 4: Biogeochemical budgets		
Convenor: Dennis Swaney		Co-convenor: Gianmarco Giordani
Time	Name	Abstract title
11.00 – 11.30	Giordani, G (Italy)	Keynote: LaguNet, the Italian lagoon observational network: Evaluation of fluxes and derived ecosystem functions in the transition zones along the Italian Coast
11.30 – 11.45	Solidoro, C (Italy)	Applicability of LOICZ derived indexes in complex ecosystem. A multibox analysis for the lagoon of Venice
11.45 – 12.00	Friedrich, J (Germany)	Towards nutrient budget scenarios for the north-western Black Sea shelf
12.00 – 12.15	Prego, R (Spain)	Land-ocean exchanges and budgeting in a river-estuary-ria-shelf system
12.15 – 12.30	Dürr, H (France)	Estimating natural silica fluxes to the coastal zone using a global segmentation
12.30 – 12.45	Morozova, O (Russia)	Nutrient budgets in the arctic coastal systems

Day 1, Session 5: Human coastal communities		
Convenor: Bernhard Glaeser		Co-convenor: Patricia Gallagher
Time	Name	Abstract title
11.00 – 11.30	Gallagher, P (Canada)	Keynote: Why don't we learn?
11.30 – 11.45	Campos, M (Philippines)	Fish for the future: An assessment of fishery conservation policies in the Philippines
11.45 – 12.00	Couto, E (Brazil)	Perception of environmental stress by fisherman communities of mangroves of Pernambuco, Northern Brazil
12.00 – 12.15	Sarwar, G (Sweden)	Coastal fisheries of Bangladesh: how to adapt with sea level rise
12.15 – 12.30	Woodrow, M (Canada)	Vulnerability and adaptation in coastal communities: a case study in adaptation on Change Islands, Newfoundland following closure of the cod fishery in 1992
12.30 – 12.45	Nguyen Thi, Tram (Vietnam)	Local communities within the Honmun Marine Protected Area must be relevant

Day 1, Session 6: Science, society and management of coastal zones: Educational aspects		
Convenor: Wilhelm Windhorst		Co-convenor: Don Alcock
Time	Name	Abstract title
11.00 – 11.30	Alcock, D (Australia)	Keynote: Seven habits of successful science communication programs
11.30 – 11.45	Ogodo, O (Kenya)	Media and environmental protection
11.45 – 12.00	Ballinger, R (UK)	Developing capacity building for local planners
12.00 – 12.15	Rigg, C (USA)	Common sense and common ground in marine and terrestrial resource management
12.15 – 12.30	Chaudhari, K (India)	Capacity building for coastal system sustainability by managing land-ocean interactions through stakeholders involvement: Indian perspectives
12.30 – 12.45	Krain, E (Germany)	SPICE, an Indonesian-German research initiative within the frame of land and ocean interactions

Day 1, Session 19: Climate change and ecological resources		
Convenor: Ticky Forbes		
Time	Name	Abstract title
14.00 – 14.15	Labane, L (Tunisia)	First assessment of the Tunisian coastline vulnerability to sea level rise
14.15 – 14.30	Khattabi, A (Morocco)	Fishing and aquaculture in the socioeconomic context of a coastal Mediterranean lagoon
14.30 – 14.45	Rahman, A (Bangladesh)	Challenges to sustainable development of Bangladesh Coastal Zone: An interplay of local, national, regional and global anthropogenic interventions
14.45 – 15.00	Del Toro, J (Mexico)	A regional approach for coastal sustainability, ICZM in the western central region of Mexico: building the coastal agenda
15.00 – 15.15	Le Tra, T (Belgium)	Marine Biodiversity protection under pressure of population growth. A case study of Nha Trang - Vietnam
15.15 – 15.30	McFadden, L (UK)	A new model of wetland loss and sea-level rise
16.00 – 16.15	Shumilin, E (Mexico)	Evaluation of anthropogenic impact on coastal marine sediments of heavy metals transported by water streams affected by mining in North-Western Mexico: Semi-deseretic Santa Rosalia, Baja California Sur and Tropical Marabasco River-the Barra de Navidad Lagoon, Colima
16.15 – 16.30	Krishnamoorthy, R (India)	Anthropogenic influences on freshwater resources versus Land Use and Cover Change (LUCC) in Southeast India coastal river basins-study based multi-data remote sensing data analysis and GIS application
16.30 – 16.45	Yamamuro, M (Japan)	Changes in the use of ecosystem due to the loss of eelgrass bed in estuarine lagoon, Lake Nakaumi, Japan
16.45 – 17.00	Guenette, S (Canada)	Insights from ecosystem modelling: the decline of Stellar sea lion in the Gulf of Alaska

Day 1, Workshop 1: Risk and vulnerability of Coastal Systems due to Climate Change	
Convenor: Felino Lansigan	Co-convenor: Frank Thomalla
Keynote: Hinkel, J (Germany) - Methodological issues in coastal vulnerability assessment	

Day 1, Workshop 2: Integrated Coastal Zone Management and LOICZ – Current status	
Convenor: Peter Burbridge	Co-convenor: Ben Malayang III
Keynote: Harvey, N (Australia) - Global Change Implications for Asia-Pacific Coastal Management	

Day 1, Workshop 3: Coastal Biogeochemical and Ecological models	
Convenor: John Parslow	Co-convenor: Jack Middelburg

Day 1, Workshop 4: Raising awareness and ownership of coastal management initiatives**Convenor, Jeremy Hills****Co-convenor: Don Alcock**

Keynote: Radford, T (UK) - TBA

Tuesday 28 June**Day 2. Plenary presentations**

Time	Name	Abstract title
09.00 – 09.45	Harrison, P (Canada)	Managing Canada's oceans and coasts: <i>A framework and an emerging plan</i>
09.45 – 10.30	van Beusekom, J (Germany)	Interaction between eutrophication and suspended matter dynamics of a shallow coastal sea

Day 2, Session 7: Geohazards, ground water and risk.**Convenor: Nalin Wikramanayake****Co-convenor: Evgeny Kontar**

Time	Name	Abstract title
11.00 – 11.30	Kontar, E (Russia)	Keynote: The Southeast Asia Tsunami Disaster Aftermath: Development of New Approaches to Coastal Zone Hazard Observation and Warning Systems
11.30 – 11.45	Rapaglia, J (USA)	Measurements of submarine groundwater discharge and associated contaminants into the Venice lagoon, Italy
11.45 – 12.00	Demetriades, N (South Africa)	The Mkomazi estuary: Human effects, freshwater and an oligotrophic coast in south-east Africa
12.00 – 12.15	Gomez-Gesteira, M (Spain)	Human induced bloom generated by Mino River intrusion in a Galician Ria Baixa (NW Iberian Peninsula)
12.15 – 12.30	Narayanan, K (India)	Climate change and vulnerability: evidence from Indian coastal waters
12.30 – 12.45	McLean, R (Australia)	Vulnerability of coastal systems: comparative analyses of three atoll island states: Tuvalu, Kiribati and the Maldives

Day 2, Session 8: Ecosystems, land and sea use (Deltas).**Convenor: Yoshiki Saito****Co-convenor: James Syvitski**

Time	Name	Abstract title
11.00 – 11.30	Syvitski, J (USA)	Keynote: The Impact of Humans on the Flux of Terrestrial Sediment to the Coastal Ocean on a Global basis: Long-term Averages and Seasonal Variability
11.30 – 11.45	Ohimain, E (Nigeria)	Anthropogenic activities contributing to coastal changes in the Niger delta
11.45 – 12.00	Anagnostou, C (Greece)	Management of deltaic systems-The need to trace new ways of thinking Case study: Deltaic systems of the Hellenic peninsula
12.00 – 12.15	Rabouille, C (France)	The fate of the Rhone river delivery to the coastal ocean: the need of benthic observatories within RiOMar
12.15 – 12.30	Radakovitch, O (France)	Heavy metal inputs from rivers and their deposits at the scale of a continental shelf: the Gulf of Lions
12.30 – 12.45	Cheong, S (USA/Korea)	The river basin and coast as single system

Day 2, Session 9: Coastal waters ecohydrology: from the mountains to the coast		
Convenor: Laura David		Co-convenor: Eric Wolanski
Time	Name	Abstract title
11.00 – 11.30	Wolanski, E (Australia)	Keynote: Estuarine and Coastal Zone Ecohydrology
11.30 – 11.45	Stevens, V (South Africa)	The threat and cascade method of estuarine health assessment- a logical sequence from impact to biological degradation via system physics and chemistry
11.45 – 12.00	Loeser, N (Germany)	River-basin - coast interactions: The Oder (Odra) case study
12.00 – 12.15	Schernewski, G (Germany)	Implementation of the European water framework directive in the Baltic region: a river-basin - coastal sea approach
12.15 – 12.30	Mwaipopo, R (Tanzania)	People, society and natural resource management: Understanding the implications of societal dynamics on the coastal environment
12.30 – 12.45	Monteiro, P, (South Africa)	Optimizing development needs at the River Basin-Coastal Ecosystem Scale: the Catchment2Coast Case Study in the Incomati-Maputo Bay System

Day 2, Session 10: Application of remote sensing for coastal area management		
Convenor: Goetz Floser/Weigen Huang		Co-convenor: Paul DiGiacomo
Time	Name	Abstract title
11.00 – 11.30	DiGiacomo, P (USA)	Keynote: TBA
11.30 – 11.45	Vander Woude, A (USA)	Chlorophyll and sea surface temperature time scales for global oceans and nearshore retentive embayments off California
11.45 – 12.00	Ferrari, S (Italy)	Applications of remote sensing in the study of tidal environment ecogeomorphology
12.00 – 12.15	Salisbury, J (USA)	Contrasting inherent optical properties and inferred carbon metabolism between five north-eastern (USA) estuary-plume systems
12.15 – 12.30	Nunneri, C (Germany)	Managing on-site activities for achieving off-site environmental effects
12.30 – 12.45	Szlafsztein, C (Brazil)	Vulnerability assessment to coastal natural hazards in Amazon Region (Brazil) using GIS

Day 2, Session 11: Integrated assessment of coastal change and management: socio-economic modelling and future scenarios		
Convenor: Kerry Turner		Co-convenor: Robert Nicholls
Time	Name	Abstract title
11.00 – 11.30	Nicholls, R (UK)	Keynote: An Integrated Assessment of Erosion and Flooding in North-East Norfolk, England
11.30 – 11.45	Prasad, M (India)	Status of quality of coastal environment in India - a review
11.45 – 12.00	Alder, J (Canada)	Value Trade-Offs of US Marine Habitats
12.00 – 12.15	Garcia, A (Cuba)	Cuban experience on ICZM: In search of the best mechanisms for the coordination and decision making processes in coastal management in Cuba
12.15 – 12.30	Trombino, G (Italy)	A multi-step scenario analysis for assessing possible strategies aimed to reduce the eutrophication in the north Adriatic coastal zone
12.30 – 12.45	Zessner, M (Austria)	Limits of cost-efficiency based nutrient management for river basins

Day 2, Session 12: Highlights of Dutch coastal zone research		
Convenor: Hans de Boois		Co-convenor: Carlo Heip
Time	Name	Abstract title
11.00 – 11.30	Heip, C (Netherlands)	Keynote: History and Ecology of the Western Scheldt Estuary
11.30 – 11.45	Hoekstra, P (Netherlands)	Sediment transport, tidal flats, sand waves, shoreline bars
11.45 – 12.00	Sinninghe Damste, J (Netherlands)	Carbon, N, P etc. under human influence
12.00 – 12.15	Olsen, J (Netherlands)	Ecosystems, food chains and invasive species
12.15 – 12.30	Lindeboom, H (Netherlands)	Resources and risks: mining, fisheries, flood risks
12.30 – 12.45	Dieperink (Netherlands)	Governance and knowledge management

Day 2, Session 20: Nutrients, sediments and budgets		
Convenor: M Snoussi		
Time	Name	Abstract title
14.00 – 14.15	Nitishinsky, M (Russia)	Carbon and nutrient fluxes in the arctic shelf
14.15 – 14.30	De Carlo (Honolulu)	Combined use of a coral reef instrumental platform (CRIMP) and synoptic water column sampling to characterize temporally and spatially the biogeochemical response of Kaneohe Bay, Hawaii to storm runoff input
14.30 – 14.45	Dedieu, K (France)	Coupling of carbon, oxygen and nitrogen cycles in sediments from a Mediterranean lagoon
14.45 – 15.00	Harcourt Baldwin, J-L (South Africa)	3D-numerical modelling of the hydrodynamics in a tidally energetic tropical embayment
15.00 – 15.15	Ruggieri, N (Italy)	Water and Nutrients Budget in a Semi-enclosed area of the coastal Ligurian Sea: the Port of Genoa
15.15 – 15.30	Kavalkli, Z (Greece)	An integrated coastal zone management approach based on scenario development and LOICZ budget analysis: application to a coastal ecosystem in the Aegean, Eastern Mediterranean
16.00 – 16.15	Bendell-Young, L (Canada)	Towards a sustainable shellfish industry; understanding the importance of upland sources of nitrogen to the geochemical cycling of nitrogen within the foreshore.
16.15 – 16.30	Radjawane, I.M (Indonesia)	On the study of simulated nutrient budget in Lampung Bay, Indonesia: Using coupled hydrodynamic-ecosystem model
16.30 – 16.45	Vinzon, S (Brazil)	Fine Sediment Retention in Estuaries in Amazon Estuary
16.45 – 17.00	Klaasen, W (Netherlands)	High CO ₂ fluxes from the air into a tidal flat area

Day 2, Workshop 5: Issues in scale of bridging the natural and social sciences	
Convenor: Alison Gilbert	Co-convenor: Jan Vermaatt

Day 2, Workshop 6: Conceptual synthesis of global coastal environments	
Convenor: Bill Dennison	Co-convenor: Don Alcock

Day 2, Workshop 7: Integrating Socio-economic variables in mapping and modelling material deliveries from catchment to coast

Convenor: Liana McManus

Co-convenor: Deborah Balk

Case study report: Krause, G (Germany) - Social-ecological system analysis for ICM support: A Mangrove Ecosystem in North Brazil

Day 2, Workshop 8: Marine Protected Areas – a management tool for ICZM?

Convenor: Jackie Alder

Co-convenor: Ron Johnstone

Wednesday 29 June

Day 3. Plenary presentations

Time	Name	Abstract title
09.00 – 09.45	Bunn, S (Australia)	Making the connection between healthy waterways and healthy catchments
09.45 – 10.30	Olsen, S (USA)	Ecosystem-based knowledge for coastal governance

Day 3, Session 13: Coastal assessments.

Convenor: Laurence Mee

Co-convenor: Veerle van der Weerd

Time	Name	Abstract title
11.00 – 11.30	van der Weerd, V (Netherlands)	Keynote: TBA
11.30 – 11.45	Kannen, A (Germany)	Changing human demands in marine areas: Implications for governance and use of integrated assessment concepts
11.45 – 12.00	Rullkoetter, J (Germany)	Interdisciplinary assessment of fundamental driving forces and transformation processes in a tidal basin, southern North Sea
12.00 – 12.15	Fernandez-Ramos, V (Uruguay)	GIS techniques for coastal habitats conservation in the Rio de la Plata
12.15 – 12.30	Pirrone, N (Italy)	Assessment of chemical pollution in the Mediterranean: A preliminary driver-pressure analysis
12.30 – 12.45	Taljaard, S (South Africa)	A proposed framework for managing (land-based) marine pollution sources in the BCLME region

Day 3, Session 14: Urbanisation.

Convenor: Michel Meybeck

Co-convenor: Frauke Kraas

Time	Name	Abstract title
11.00 – 11.30	Krass, F (Germany)	Keynote: TBA
11.30 – 11.45	Acma, B (Turkey)	Promoting sustainable human settlements and eco-city planning approach: Southeastern Anatolia Region and Southeastern Anatolia Project (GAP) in Turkey as a case study
11.45 – 12.00	Sharaf El Din, S (Egypt)	Impact of the extension of Alexandria coastal road on the transformation of material of the nearshore marine environment
12.00 – 12.15	Xu, X (China)	Land use conflicts and coordination in fast urbanized coastal zones
12.15 – 12.30	Perissinotto, R (South Africa)	Effects of sewage water disposal on the bio-physical dynamics of a South African temporarily open/closed estuary
12.30 – 12.45	Zanchettin, D (Italy)	New perspectives for the future of Venice

Day 3, Session 15: Nutrient flux to the coastal zone: trends and implications		
Convenor: Nancy Rabalais		Co-convenor: Sybil Seitzinger
Time	Name	Abstract title
11.00 – 11.30	Seitzinger, S (USA)	Keynote: TBA
11.30 – 11.45	Liu, S (China)	The effects of Changjiang transport on nutrient dynamics in the Yellow and East China Seas in summer
11.45 – 12.00	Laane, R (Netherlands)	Anthropogenic influences of enhanced nitrogen and phosphorus concentrations in the Rhine Catchment and the Dutch Coastal zone
12.00 – 12.15	Lampert, C (Austria)	Integrated assessment of the nutrient management in the Danube Basin
12.15 – 12.30	Staneva, J (Germany)	Response of the Northwestern Black Sea shelf ecosystem to nutrient load and climate change
12.30 – 12.45	Jennings, M (South Africa)	Anthropogenic influence on estuarine derived nutrient dispersal in the nearshore off two permanently open South African estuaries with contrasting freshwater inflow

Day 3, Session 16: Shelf processes and the Earth System (joint session with IMBER & SOLAS)		
Convenor: Helmuth Thomas Middleburg		Co-convenor: Dileep Kumar/Jack
Time	Name	Abstract title
11.00 – 11.30	Kumar, D (India) & Middleburg, J (Netherlands)	Keynote: Shelf processes: LOICZ-SOLAS-IMBER interactions
11.30 – 11.45	Liu, K (China)	The fates of terrigenous organic carbon and absorbed atmospheric CO ₂ in the East China Sea
11.45 – 12.00	Boski, T (Portugal)	Varying sea levels – a possible clue for varying atmospheric CO ₂ levels?
12.00 – 12.15	Ramesh, R (India)	Tsunami impact on water and trace gas flux in South India
12.15 – 12.30	Madron, X (France)	Natural and anthropogenic forcings on particulate matter budgets in coastal zone: Role of the re-suspension by storms and trawling
12.30 – 12.45	Da Cunha, C (Germany)	Regional impact of rivers on continental shelf biogeochemistry

Day 3, Session 17: Coastal ecosystem governance		
Convenor: Stephen Olsen		Co-convenor: Alejandro Robles
Time	Name	Abstract title
11.00 – 11.30	Robles, A (USA)	Keynote: TBA
11.30 – 11.45	Belfiore S (Italy)	Measuring the Progress and Outcomes of Integrated Coastal Management Initiatives: Toward a Common Framework
11.45 – 12.00	Gault, J (Ireland)	From science to policy: Experiences of the COREPOINT project
12.00 – 12.15	Rafiqul-Islam, M (Bangladesh)	Institutionalization of ICZM at national level: Bangladesh experience
12.15 – 12.30	Osthorst, W (Germany)	ICZM as instrument of regional governance - between spatial planning and extended participation
12.30 – 12.45	Pickaver, A (Netherlands)	An indicator set to measure the progress in the implementation of integrated coastal zone management in Europe

Day 3, Session 18: Coastal typologies and datasets		
Convenor: Dennis Swaney		Co-convenor: Bob Buddemeier
Time	Name	Abstract title
11.00 – 11.30	Buddemeier, B (USA)	Keynote: Typology: Tools for Integration and Analysis
11.30 – 11.45	Vafeidis, A (Greece)	Data requirements for global-scale coastal vulnerability analysis and the DINAS-COAST database
11.45 – 12.00	Colijn, F (Germany)	FerryBox - an observational system for the assessment of the coastal and shelf sea ecosystem
12.00 – 12.15	Jaganthan, R (India)	GIS based vulnerability mapping and coastal zone management: A case of part of Tamil Nadu coast, India
12.15 – 12.30	Hinkel, J (Germany)	The development of the DIVA tool for assessing coastal vulnerability
12.30 – 12.45	Maxwell, B (USA)	Web-based tools for typology development and data mining

Day 3, Session 21: Managing the coastal zone		
Convenor: Eva Roth		
Time	Name	Abstract title
14.00 – 14.15	Vodden, K (Canada)	Watershed-coastal interactions: building and supporting institutions for positive change
14.15 – 14.30	Dinelli, E (Italy)	Sediment-biota interactions in a polluted coastal lagoon (Piailassa Baiona, northern Italy): integrated geochemical and biological investigations
14.30 – 14.45	Burkhard, B (Germany)	Use of a virtual centre of competence as a management, information and education tool in coastal zones
14.45 – 15.00	Gee, K (Germany)	National ICZM strategies in Germany: challenges to the spatial planning approach
15.00 – 15.15	Ostrovskaya, E (Russia)	Ecological zoning of the Northern Caspian
15.15 – 15.30	Arizpe, O (Mexico)	Land-ocean use planning of a coastal oasis in the Gulf of California
16.00 – 16.15	Fontalvo-Herazo (Germany)	Method for the design of a participative indicator system as a tool for integrated coastal local management, Braganca peninsula-North Brazil
16.15 – 16.30	Lengyel, P (Romania)	Electronic networking on Black Sea conservation issues in Romania
16.30 – 16.45	Lechuga-Deveze, C.H (Mexico)	Using LOICZ biogeochemical modelling to achieve federal environmental regulations for shrimp aquaculture on the Sinaloa coast of Mexico
16.45 – 17.00	Pongthanapanich, T (Denmark)	An optimal corrective tax for Thai Shrimp Farming

Day 3: Workshop 9: Coastal Assessments
Convenor: Laurence Mee Co-convenor: Martin Adriaanse

Day 3, Workshop 10: Gauging Progress In Coastal Governance
Convenor: Stephen Olsen Co-convenor: Peter Burbridge

Day 3, Workshop 11: From river to coast: Collaboration between GWSP and LOICZ
Convenor: Joe Alcamo & Michel Meybeck Co-convenor: Nancy Rabalais & Eric Craswell

Day 3, Workshop 12: Implementation, Integration, and Participation: Strategies for LOICZ II**Convenor: Bob Buddemeier****Co-convenor: Bruce Maxwell**

Keynote: Dürr, H (France) - Towards a classification of coastal ribbon lithology using a new global database

Poster presentations

Poster author and titles	
Al-Rousan, S (Jordan)	Invasion of anthropogenic CO ₂ recorded in stable isotopes of planktonic foraminifera from the northern Gulf of Aqaba, Red Sea
Araki, R (Brazil)	Precipitation events associated with landslides in the tropics-Guaruja City, and example of Brazil
Aulinger, A.	Deposition of polycyclic aromatic hydrocarbons emitted from ship engines into the North Sea
Bock, S	Internet tools for coastal issues: A project database
Brewer, DT	Impacts of gold mine waste disposal on the sustainability of deep water fish in a pristine tropical oceanic system
Brogueira, M.J.	Environmental variables shaping phytoplankton structure in Tagus estuary
Buddemeier, R (USA)	Examples and achievements of typological applications
Craswell, E	The Global Water System Project
Darracq, A	Advective travel time variability in stream networks
De Souza (Brazil)	Biogeochemistry of N,P and Si fluxes to the East Brazil coastal zone. A tropical reservoir functioning or multiple impact scenario
Dennis, DM	How does gold mine waste disposal affect shallow coral reef fishes and habitats at Lihir Is, Papua New Guinea?
Ekau, W	IOI - OceanLearn; The Training and Education Programme of the International Ocean Institute
Fry, G	TBA
Glaser, M.	"The Social" in ecosystem research: pitfalls and potentials
Gonzalez-Mirelis, G (Spain)	Land meets ocean: the compilation of a GIS database for linking nutrient loading data with catchment area information
Hilton, M.	The redistribution of Coastal Dune Plants-A Global Issue
Huthnance, J (UK)	Process contributions to shelf-ocean exchange
Jayawardena, U (Sri Lanka)	Effects of the Tsunami to the human society due to the negligent of the Coastal Zone of Sri Lanka
Jedrzejczak, M (Poland)	Bridging biodiversity and tourism towards sustainable development of sandy beaches
Jinadasa, S (Sri Lanka)	Geo-morphological influences to protect the hazard ness of tsunami waves at coastal belt of Yala, Sri Lanka
Llorenz, J.L.P.	The use of phytoplankton and macrophytobenthos as potential quality elements in coastal waters of Ageciras Bay and surrounding areas
Mensah, A (Ghana)	The influence of land use activities on nutrient and sediment loading into upland catchment streams of Ghana
Mhammdi, N (Morocco)	'Natural' and 'Anthropogenic' vulnerability of the coastal zones of Morocco-A preliminary integrated analysis
Milton, D	Heavy metal uptake by coral reef fish at Lihir Is, Papua New Guinea: relative importance of gold mine wastes and natural sources of heavy metals

Poster author and titles	
Monteiro, P.	The biogeochemical linkage that governs the dependency of mangrove new production fluxes and food web responses to river boundary characteristics: Catchment2Coast Programme study in Maputo Bay, Mozambique
Newton, A (Portugal)	The LOICZ Erasmus Mundus joint master in water and coastal management
Nogueira, M (Portugal)	Estuarine processes involving organic carbon at different tide conditions
Nguyen Thi, K.A (Vietnam)	The situation of coastal fishery resources in Vietnam and some proposed solutions
Nunes, L (Brazil)	Environmental problems in the coast of Southeastern Brazil: determinants and impacts
Perillo, G (Argentina)	Shallow ponds as sediment and nutrient retainers, Buenos Aires Province, Argentina
Rabalais, N (USA)	Eutrophication adjacent to the Mississippi river plume
Rebelo, L.P.	Troia peninsula evolution: Foredunes as an accretion/erosion indicator
Rachold, V.	Arctic Coastal Processes
Schernewski, G	Critical Evaluation of an Internet-Platform for Regional Coastal Management
Shaghude, Y. (Tanzania)	The present and anticipated river basin and coastal impacts of water abstraction along the Rufiji river catchment, Tanzania
Souza, M (Brazil)	Anthropogenic Changes, Nutrient Biogeochemistry and Net Ecosystem Metabolism of the Estuary of Cachoeira River, Brazil
Spagnoli, F	Organic matter cycling in sediments of gulf of Manfredonia, Southern Adriatic Sea
Thomas, H (Canada)	Enhanced open ocean storage of CO ₂ from shelf sea pumping
Viaroli, P	Identification of monitoring criteria for transitional waters
Vorlauf, M	Internet tools for coastal issues: Awareness rising and education
Weragala, N.	Definition of a Tsunami safe boundary for Sri Lanka: A case study in the coastal zone of Galle, Matara and Hambantota districts

SESSION AND WORKSHOP DESCRIPTIONS

Session 1. Climate Change and the Coastal Zone

Convenor: **Felino Lansigan**

Co-Convenor: **Richard Klein**

Coastal zones are vulnerable to climate change and variability and related processes such as sea level rise, typhoons or cyclones, wind circulation, etc. Assessment of the impacts of climate change on the coastal systems may include the evaluation of both the biophysical and socio-economic processes which can be used to identify and formulate a suite of appropriate and cost-effective strategies to cope up with the associated risks. On the other hand, assessment of the vulnerability of the coastal system due to climate change may focus on how such driver of change or the causal mechanism affect the response and capacity of the ecological and social elements in the watershed-river-coast continuum. Such assessment studies may employ a variety or combination of approaches and methods such as (1) modelling and simulation at different scales, (2) scenario analysis, (3) development and use of vulnerability indicators which may be compared across regions and at different scales, (4) assessing vulnerability in the context of sustainability of coastal system, and (5) analysis of risks of socio-economic groups, etc. Regardless of differences in approaches and methods employed, however, assessments of impacts as well as vulnerability studies on climate change and coastal zones contribute to better understanding of the ecological and socio-economic elements. These body of integrated scientific information may be synthesized, and must feed into a platform or framework for science-based policy formulation and knowledge-based resources management strategies for sustainable coastal zone development.

Session 2. Land-Ocean interactions on vulnerable coastal ecosystems (lagoons)

Convenor: **Alice Newton**

Co-Convenor: **Nick Murray**

Coastal environments occupy one of the most dynamic interfaces on Earth and support some of the most diverse and productive habitats. The existence of many coastal ecosystems is dependent on the land-sea connection or arises directly from it (e.g., lagoons, deltas and estuaries). Coastal environments, settlements, and infrastructure are exposed to land-sourced and marine hazards such as storms (including tropical cyclones), associated waves and storm surges, tsunamis, river flooding, shoreline erosion, and influx of biohazards such as algal blooms and pollutants. The changes occurring in the functioning of the global system have implications for human well being. Basic goods and services provided by coastal systems, such as sufficiency and quality of food and water as well as an environment conducive to human health are all vulnerable to change. All of these factors need to be recognized in assessing human induced changes to the coastal system and the concomitant hazards posed to communities and ecosystems.

Session 3. Sediment flux to the coastal zone: climate change, anthropogenic influences and future trends

Convenor: **Juan Restrepo**

Co-Convenor: **John Milliman**

In estuaries and coastal zones, which serve as major sinks for sediments and are the major sites of nutrient-sediment biogeochemical processes, the alteration of the natural river sediment supply can cause considerable changes in the metabolism of the coastal zone and/or coastal zone morphology. Land use and climate change in river

catchments during the past century have altered basin hydrology and sediment load, which in turn have produced ecological responses in the upstream and coastal areas of societal significance. The interplay between human induced activities and natural factors along the river catchment /coast continuum has to be understood in assessing the magnitude and variations of sediment flux to the global coastal zone, and the implications of these discharges and changes on human uses and coastal functioning and services.

Session 4. **Biogeochemical Budgets**

Convenor: **Dennis Swaney**

Co-Convenor: **Gianmarco Giordani**

Under LOICZ I, considerable progress has been made in compiling nutrient budgets (N, P and occasionally Si) of the world's estuaries, bays, and even seas. This work continues, following a well-established LOICZ methodology, and some results on global patterns which are derived from this work have been published. This session welcomes presentations of budgets of coastal ecosystems and related topics including presentations on:

- ◆ nutrient budgets which follow current LOICZ conventions
- ◆ budget constructed using alternative approaches (especially where comparisons to the LOICZ approach can be made)
- ◆ budgets of materials other than dissolved N and P (e.g. sediment, other nutrients, etc)
- ◆ techniques for assessing particular aspects of nutrient budgets (e.g. specific nutrient fluxes)
- ◆ techniques for addressing analytical issues of nutrient budget calculations (e.g. uncertainty analysis)
- ◆ governance and policy implications in relation to nutrient budgets
- ◆ regional or global syntheses of budget-based information, etc.

Session 5. **Human Coastal Communities**

Convenor: **Bernhard Glaeser**

Co-Convenor: **Patricia Gallagher**

Human coastal communities compete for space and resources. This competition may result in conflicts. Conflicts are driven and shaped by economic interests, cultural values, perceptions of coastal images (how one might expect, believe or wish a coast ought to appear), and by visions of coastal futures.

Conflict resolution requires good governance, which implies, first and foremost, participation, transparency, legitimacy, accountability, and recognition of scales. Governance across scales means national ICZM strategies, regional specifications, and local implementation as well as linking different coastal communities and human demands.

Mediation, round tables, and dialogues between different coastal communities and stakeholders are one approach to conflict resolution and an important step towards stimulating, implementing and guaranteeing sustainable coastal development. This paper session features different coastal communities acting at different scales, and their interactions, conflicts, values, and visions. The focus will include, *inter alia*, fishing, off-shore wind farming, mariculture communities, and island populations.

Session 6: **Science, society and management of coastal zones**

Convenor: **Wilhelm Windhorst** Co-Convenor: **Don Alcock**

Are we ready to bridge the gaps between stakeholders? How do we increase local knowledge, community action and stakeholder participation for integrated coastal zone management? Success will depend on developing the skills and capacity of the people involved. The goal of this cross cutting session is to present innovative training and education concepts, methods and programs which will increase our ability to deal with pressing coastal issues. The session will cover formal education, stakeholder training and community education initiatives.

Workshop 1. **Vulnerability of Coastal Ecosystems and Communities to Climate Change**

Convenor: **Felino Lansigan** Co-Convenor: **Frank Thomalla**

In recent years an increasing amount of scientific research has contributed to improving our general understanding of global climate change and the potential impacts of such change on the world's coasts. However, there are still considerable gaps in our knowledge with respect to how multiple biogeophysical and anthropogenic processes interact to create risk, and how the vulnerability of coastal communities to climate change is shaped by these interlinked processes. In order to improve our understanding of such relationships, integrated assessments of human and ecosystem vulnerability need to be undertaken at different spatial (continental, regional and sub-regional) and temporal scales. Thus, following the session on *Climate Change and Vulnerability of the Coastal Zone*, a workshop will be convened to define the priority research agenda and workplan for the LOICZ II Theme 1 to address the issues of risk, vulnerability and adaptation to climate change in coupled human and ecological coastal systems. The workshop session will involve panel and open discussions on combining or integrating the analytical approaches of both the natural and social sciences in analyzing and assessing the effects and impacts of changes in the coastal zones on humans and ecosystems. The discussion will focus on the following issues: (1) the development and improvement of scientific methodologies for risk and vulnerability assessments, including indicators, scale of analyses, metrics of measurements; (2) the determination of thresholds and how to cope with uncertainties; (3) the identification of science gaps on risk and vulnerability of coastal systems and how to address them; (4) the identification of adaptive capacities and the development of coping strategies; and (5) how to strengthen scientific networks, research links and collaboration in the context of LOICZ SPIS.

Workshop 2. **The Potential Contribution by LOICZ to Integrated Coastal Management**

Convenor: **Peter Burbridge** Co-Convenor: **Ben Malayang III**

Integrated Coastal Management (ICM) represents the current phase in development planning where the interactions between land and sea are recognised as having a major influence on how coastal systems respond to human activities. ICM also recognises the influence of policies, investment strategies and development plans governing human activities have on the ability of coastal systems to sustain human development needs and aspirations.

The five new Research Themes are intended to promote better integration among scientific disciplines and our partnership with the International Human Dimensions programme will help to engage the social science more effectively with our strong natural science foundations. The theme on Sustainable Use of Coastal Regions and

Natural Systems forms one mechanism for better integration of the results and findings of individual LOICZ initiatives. To be fully effective this and other themes must consider the community of ICM policy makers, planners, managers and people who live and work in coastal regions as essential users of the products of LOICZ science.

LOICZ science has great potential to have a positive influence on policies, strategies and more local management plans for coastal regions. For this to happen the LOICZ community must develop a culture that strives for greater integration of the results of past research, that develops more integrated science in the new research themes and most important- seeks to communicate the results of past and on-going research more effectively with potential users from the field of governance and management. This is a major challenge we must address at this Open Science Meeting.

Workshop 3. Coastal Biogeochemical and Ecological Models

Convenor: **John Parslow**

Co-Convenor: **Jack Middelburg**

LOICZ 1 adopted a diagnostic approach to coastal biogeochemical modelling, developing a formal and consistent framework for quantifying and analyzing the fluxes and transformations of biogeochemical tracers in coastal systems. LOICZ II will also use prognostic coastal models to predict the responses of coastal biogeochemical (and ecological) systems to changing local and global pressures. There have been major advances in coastal modelling in the last decade, arising from advances in coastal observing systems, process understanding and computing power. This workshop will review the state-of-the-art in both diagnostic and prognostic coastal models, and identify promising approaches for further development and application. The workshop is intended to set the scene for a stand-alone workshop dedicated to this topic to be held later in 2005.

Workshop 4. Raising awareness and ownership of coastal management initiatives

Convenor: **Jeremy Hills**

Co-convenor: **Don Alcock**

Capacity building and stakeholder communication programs are often an “after-thought” of ICZM initiatives. However, involvement of administrations, the public and key stakeholder groups is a vital to the success and sustainability of ICZM initiatives. Like good science, stakeholder involvement and interactive communication takes time, effort and resources. A strategic overview is needed to engage key audiences and to use a mix of tools and techniques that are appropriate to relevant groups which deliver the required consensus or capacity outcomes. This workshop will evaluate case studies to show some approaches in action. An on-line Toolbox for capacity and consensus building will be demonstrated which assists managers in selecting appropriate tools and techniques for use within an overall strategy. By the end of the workshop the delegates should have a good understanding of the diversity of available tools for capacity and consensus building and be able to link them to enabling conditions for success and sustainability in ICZM initiatives.

Session 7. Geohazards, ground water and risk

Convenor: **Nalin Wikramanayake** Co-Convenor: **Evgeny Kontar**

Shelf zones and coastal zones are becoming major areas of industrial and technological development because of the growing human population in coastal

regions and because of their store of natural resources such as fish, oil and gas. Therefore, understanding the risks of natural and human-made hazards in these areas assists to safeguard the populations in these regions and to strengthen the scientific and technological basis of a number of industries including oil and gas production and maritime transport. This session will focus on evaluation of risks of saltwater intrusion, contaminated submarine groundwater discharge and their influence on coastal oceanographic processes, submarine earthquakes, landslides, tsunamis, to produce a cohesive understanding of geo-risks and human-made hazards in coastal, shelf, and continental slope areas.

Session 8. **Ecosystems, land and sea use (Deltas)**

Convenor: **Yoshiki Saito**

Co-Convenor: **James Syvitski**

Sediment-carrying rivers drop a significant portion of their load at their mouths, allowing nutrient-rich deltaic flood plains to form. These agriculturally productive regions are home to the competing factors of urbanization, food production and often become the intersection between terrestrial and seagoing transportation. Deltas support the world's largest wetland areas. Deltaic coasts are sensitive to the strong but competing influences of sea level fluctuations, accommodation space and sediment supply. Humans now strongly influence upstream sediment supply, and either directly or indirectly sea level change, resulting in coastal erosion. Conversion of natural wetlands (e.g. mangrove swamps) to agricultural land also influences the reach of storm surges, and separately the retention of sediment. Stop banks (levees) further decrease the nutrient supply to the delta plains. Deltaic coasts have been more vulnerable and need sustainability under human pressure.

Session 9. **Coastal waters ecohydrology: from the mountains to the coast**

Convenor: **Laura David**

Co-Convenor: **Eric Wolanski**

Point and non-point source pollution throughout the river catchment, erosion, basin-wide land clearing, urbanisation, industrialisation, and other unsustainable human activities induce and perpetuate habitat loss, negative impacts on estuarine and coastal marine resources, and the loss of the ecological services that they provided. Of particular concern is the increasing number and capacity of dams in the watersheds, as well as, the growth of mega-harbours and mega-cities at the coast. Ecohydrology is an emerging problem-solving approach that involves addressing the whole catchment (including hydrological processes and biotic dynamics) as a single entity in order to be able to understand the science (and hopefully promote sustainable management) of estuaries and the coastal zones. The temporal and spatial dimensions in such an approach spans a time frame from paleohydrological conditions to future global change scenarios and an understanding of the dynamic role of biota from cellular to basin scales.

Session 10. **Application of Remote Sensing for Coastal Area management**

Convenor: **Götz Flöser & Weigen Huang** Co-Convenor: **Paul DiGiacomo**

The coastal zone is a unique area where five major earth systems, the atmosphere, geosphere, hydrosphere, biosphere, and, in high latitude, the cryosphere overlap and are integrated. It has a special role from economic and environmental points of view. The need to understand the interactions linking land-ocean processes to climate in the coastal zone has become a matter of the most serious concern during the last two

decades. Remote sensing is one of the important approaches to this concern. It has been used to monitor the coastal zone change and to study the interaction between land and ocean.

Session 11. **Integrated assessment of coastal change and management: Socio-economic modelling and future scenarios**

Convenor: **Kerry Turner** Co-Convenor: **Robert Nicholls**

This session focuses on the need for interdisciplinary approaches to the analysis of long term coastal change and its consequences for society. Speakers will concentrate on the use of scenario-based analysis, following the lead taken by groups such as IPCC. Such approaches first require the combining of natural science modelling outcomes (forcing parameters) and socio-economic driving pressures to provide predictions of the impacts on the environment and economy of the catchment/coast; the subsequent need is then for an analysis of the welfare consequences of the change process over the long run. Both developed and developing country contexts will be reviewed.

Session 12. **Dutch LOICZ**

Convenor: **Hans de Boois** Co-Convenor: **Carlo Heip**

In this session an overview will be presented of current Dutch research on coastal systems. Key aspects are the holistic nature of coastal systems on the one hand and the disciplinary character of research on the other. A multidisciplinary approach is a prerequisite to address the themes which are formulated for LOICZ-II, but the basic science is disciplinary.

Workshop 5. **Issues of scale in bridging the natural and social sciences**

Convenor: **Alison Gilbert** Co-Convenor: **Jan Vermaat**

Natural and social sciences, and disciplines within these broad categories, tend to have different perspectives on scale as well as different methods in dealing with environmental issues which span scales. The aims of this workshop are:

1. to examine our capability to deal with multiple scales when analysing coastal zone process, function and governance;
2. to identify incompatibilities between/among disciplines; and
3. to identify potential means of bridging them.

The workshop will not only be relevant for LOICZ, but it will also contribute LOICZ expertise to a current activity within IHDP's IDGEC project.

Workshop 6. **Conceptual synthesis of global coastal environments**

Convenor: **Bill Dennison** Co-Convenor: **Don Alcock**

The aim of this half day workshop is to develop conceptual diagrams for the major coastal regions of the world. Regions will be large scale (eg NE Atlantic, Gulf of Mexico, Mediterranean, Caribbean Islands, West Africa, tropical Australia etc) and will capture key environmental processes, key environmental threats and key required management initiatives for each region. Diagrams will initially be drawn by hand and then converted to electronic format using the IAN symbol libraries in Adobe Illustrator (<http://www.ian.umces.edu/conceptualdiagrams.php>).

The workshop will run approximately as follows:

- ◆ 45 mins: introduction to conceptual diagrams and aims
- ◆ 1 hr 30 mins: working in predetermined regional groups, draw regional conceptual diagrams
- ◆ 45 mins: review conceptual diagrams from regions and plan continued effort

Workshop 7. Integrating socio-economic variables in mapping and modelling material deliveries from catchment to coast

Convenor: **Liana Talaue-Mcmanus** Co-Convenor: **Deborah Balk**

This workshop will explore current approaches and methods in integrating spatially explicit socioeconomic variables in mapping and modelling deliveries of materials (sediments, nutrients, water) from the catchment to the coast. It will identify a list of mappable socioeconomic indicators that correlate with changes in land use, population, hydrology and coastal uses within various scenarios of economic development, at national and regional scales. In addition, the session/workshop will pinpoint existing datasets at regional and global scales that can be used to develop these indicators.

Workshop 8. Marine Protected Areas – a management tool for ICZM?

Convenor: **Jackie Alder** Co-convenor: **Ron Johnstone**

Marine protected areas (MPAs) are an increasingly popular management tool with multiple ecological and social goals. They are a societally constructed management intervention requiring increased understanding as such. Specifically, there is a need to apply rigorous integrated social and natural science to increase our understanding of the human dimensions of MPAs and to improve their design, implementation, and monitoring. Conflict, diffusion of innovations, and social movements in support of MPAs are important phenomena warranting immediate attention.

Session 13. Coastal assessments

Convenor: **Laurence Mee** Co-convenor: **Veerle van der Weerd**

Modern approaches to marine and coastal management such as Ecosystem Based Management (EBM) and Adaptive Management are heavily reliant on our ability to assess the changing state of the environment, the pressures and socio economic drivers that produce state changes, the social and economic impacts of change and the governance structures, stakeholder attitudes and financial scope to respond to undesirable change. The concept of environmental assessment has moved from a static snapshot of pollution or biological community structure, to a more comprehensive and dynamic systems approach. Techniques for doing this are relatively new however and it is a good time to share current knowledge and practice through the experience of practitioners in this area. The session will benefit from a diverse group of specialists working in local, national and transboundary contexts, including several major international programmes.

Session 14. **Urbanisation**

Convenor: **Michel Meybeck**

Co-Convenor: **Frauke Kraas**

Urbanization has been one of the key drivers of Global Change over the last 50 years. In the coastal zone it generally combines (i) the development of megacities, (ii) the industrialization, (iii) the construction of facilities for navigation, (iv) the artificialization of the coastline, particularly as a result of mass tourism. These pressures have induced specific environmental issues as the direct release of liquid solid and atmospheric wastes to the coast, with and without adequate treatment, the profound modification of the aquatic habitat and shoreline through harbour construction, channelization of estuaries and deltas, wetland filling. The natural filter functions of the coast are therefore very much altered by urbanization, particularly in deltas and river flood plain regions. In addition to these direct impacts groundwater overpumping in deltaic aquifers and subsequent land subsidence and salt wedge intrusion is commonly observed. Land-use change around megacities (e.g. for suburban development, for fuel wood consumption) can also lead to dramatic changes in water, sediment and nutrients transfers from land to the coast through rivers.

In addition to these issues, most coastal megacities are built up in lowlands sensitive to sea level rise. The management of coastal urban area should consider these multiple conflicting uses together with an Earth System approach at the local to regional scale. Even if appropriate Human responses from coastal stakeholders are taken to alleviate environmental pressures, coastal managers are faced with long-term inherited issues as pollution hot spots in sediments, fate of contaminated dredged material, severe deteriorations of coastal habitats and food chains etc.

The session should privileged the analysis of multiple urban pressures and their ecological and economic impacts on the coastal resources as well as the modification of coastal filters, the development of indicators of changes that can be used to scale, map and assess the evolution of these issues, and the best governance to manage these questions.

Session 15. **Nutrient flux to the coastal zone: trends and implications**

Convenor: **Nancy Rabalais**

Co-Convenor: **Sybil Seitzinger**

Accelerated nutrient flux from water- and airsheds is becoming a major, global environmental problem in estuarine and coastal waters linked to landscapes with population growth and their activities, a focusing of the populace in coastal regions and agriculture expansion. Humans have altered cycles of nitrogen and phosphorus over large regions and increased the mobility and availability of these nutrients to coastal ecosystems. It is likely that coastal nutrient over-enrichment will continue to expand globally given the trajectories of future nutrient loads both in developed and developing countries. Changes in nutrient flux cannot be de-coupled from changes in hydrology, sediment loads, and climate. Understanding these complex interactions is imperative in efforts to target, by time and type, nutrient loads to coastal systems.

Session 16. **Shelf processes and Earth system**

Convenor: **Helmuth Thomas**

Co-Convenor: **Dileep Kumar & Jack Middelburg**

This session will be jointly convened by LOICZ, IMBER and SOLAS. The session intends to identify joint interests and to initialise joint implementation strategies for

coastal zone research, this including the land and atmospheric communities in order to address this issue as comprehensive as possible.

Session 17. **Coastal Ecosystem Governance**

Convenor: **Stephen Olsen**

Co-Convenor: **Alejandro Robles**

Governance is the process by which human societies negotiate the purposes, the rules and the procedures by which they regulate their activities and distribute power, access to resources and wealth. All governance systems are driven by the values that reflect what a society believes to be important. Governance systems are also shaped by the ecosystems in which a society lives as well as by their relationships with other societies with which they interact. Together these combine to form perceptions of how the world works and how an individual or group fits within their context. When considering the issues posed by the governance of a coastal ecosystem a first step is to understand how the associated population perceives the past trajectory of change and articulates goals for a desirable future. The analysis of governance systems is directed at understanding how the planning and decision making process relates to expressions of ecosystem change at a range of interconnected spatial and temporal scales.

Session 18. **Coastal typologies and datasets**

Convenor: **Dennis Swaney**

Co-Convenor: **Bob Buddemeier**

The LOICZ environmental dataset, a global dataset of environmental variables at ½ degree resolution, was developed during LOICZ I to form a basis for categorizing coastal and marine environments at global and regional scales. LOICZview, a sophisticated, online interactive software tool for statistically classifying such data, was developed in tandem assist environmental scientists in developing such typologies. During the last 10 years, with the rise of GIS software and increasing availability of satellite imagery, we have seen an explosive growth in global and regional environmental data developed for many purposes. This session welcomes presentations on new datasets, typologies, and analytical tools developed either independently or with LOICZ, including presentations on:

- ◆ Global and regional datasets relevant to the coastal zone
- ◆ New typological analyses of the coastal zone
- ◆ Addressing scaling questions (i.e. upscaling and downscaling beyond the resolution of the data)
- ◆ Technical (data analysis) issues related to developing typologies
- ◆ Governance and policy implications of coastal classifications

Workshop 9 **Coastal assessments**

Convenor: **Laurence Mee**

Co-Convenor: **Martin Adriaanse**

Modern approaches to marine and coastal management such as Ecosystem Based Management (EBM) and Adaptive Management are heavily reliant on our ability to assess the changing state of the environment, the pressures and socio economic drivers that produce state changes, the social and economic impacts of change and the governance structures, stakeholder attitudes and financial scope to respond to undesirable change. The concept of environmental assessment has moved from a static snapshot of pollution or biological community structure, to a more comprehensive and dynamic systems approach. Techniques for doing this are

relatively new however and it is a good time to share current knowledge and practice through the experience of practitioners in this area. The session will benefit from a diverse group of specialists working in local, national and transboundary contexts, including several major international programmes.

Workshop 10. Gauging Progress In Coastal Governance

Convenor: **Stephen Olsen** Co-Convenor: **Peter Burbridge**

Long-term and effective coastal governance is the major factor limiting progress towards the goal of more sustainable forms of coastal development. Science informs the processes of governance, but rarely drives them. Adequate funding is also essential but much that is allocated to improved coastal ecosystem planning and decision making is squandered. This session explores the concepts and tools for developing governance baselines and monitoring progress towards unambiguous goals that define desired societal and environmental conditions in a manner that encourages learning and adaptation. It will explore the interaction between the natural and social sciences and the processes by which coastal governance evolves and responds to new knowledge. Conclusions will be drawn on best and worst practices and recommendation will be made.

Workshop 11. From river to coast: Collaboration between GWSP and LOICZ

Convenors: **Joe Alcamo/Michel Meybeck** Co-convenors: **Nancy Rabalais/Eric Craswell**

This workshop is by invitation only and is an opportunity for the Global Water Systems Project and LOICZ to discuss areas of mutual interest and collaboration for their future research activity.

Workshop 12. Implementation, Integration, and Participation: Strategies for LOICZ II

Convenor: **Bob Buddemeier** Co-Convenor: **Bruce Maxwell**

The workshop will consider how to preserve, expand on, and augment the successful techniques of LOICZ I in addressing the topics of LOICZ II, building on the preceding sessions and workshops to develop specific recommendations. Productive experience with database development and typology applications in LOICZ I will provide a basis for addressing communication, information infrastructure, and shared resources as critical elements in building both community and capacity while addressing the scientific goals. Implementation strategies will need to address the increased diversity and sophistication of both scientific goals and available technology. In addition to action recommendations, desirable workshop products include initial formulation of proposals for infrastructure support, and identification of issues to address in a possible follow-up workshop on typology and data/information resource needs.

ABSTRACTS

Abstracts are listed in alphabetical order.

Oral Presentations

Promoting Sustainable Human Settlements and Eco-City Planning Approach: Southeastern Anatolia Region and Southeastern Anatolia; Project(GAP) in Turkey as a Case Study

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In the recent years, there have been many opportunities flourishing through the development of Turkey. One of these is unvalued rich agricultural and hydro-sources in the Southeastern Anatolia Region. The Southeastern Anatolia Project (GAP), one of the most important projects to develop the remarkable natural resources of the world, is considered as a chance to make use of rich water and agricultural resources of the Southeastern Anatolia Region.

In the recent years, the concept of promoting sustainable human settlements and eco-city planning approach have been included into the GAP Project. And by applying these concepts in real projects caused remarkable results through development of the region.

The aim of this study is analyze the concepts of promoting sustainable human settlements and eco-city planning approach in the GAP Project that has been still processed.

In the first section, the region of Southeastern Anatolia and the GAP Project will be introduced briefly. In the second section, the stages of GAP Project and the project existing will be analyzed. In the third section, the projects and sub-projects used for promoting sustainable human settlements will be introduced.

In the last and fourth section, a series of policies and strategies will be applied providing for an optimal process of settlements which is and harmony with the eco-system.

Seven habits of successful science communication programs

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Scientists and scientific organisations continually wrestle with the notion of communication. Indeed, the concept is so multi-faceted it is often difficult to understand and manage. Should science communication be just about information dissemination, public relations and peer reviewed publishing, or should it extend to political lobbying and social marketing? How responsible are individual scientists for applying their results, developing public policy or changing social behaviour?

Unfortunately, the science communication job is often botched at both ends of the spectrum – and as a result, our politicians have thundered off in full cry after other priorities. Many scientists shy away from the challenging role of public advocacy and public opinion. Good science communication, education and public awareness activities are also often hampered by inadequate funding, limited integration in other policies, conflicting interests, lack of skills, lack of understanding of complex social processes, and the treatment of stakeholders as ‘targets’. Other constraints include poor communication planning, short-term funding cycles, inadequate training, few incentives, poor marketing skills, and little understanding about social science. But the penalties for not effectively engaging with society about the importance of science and technology in addressing coastal problems have extracted a high price.

In our so-called information economy, science organisations will succeed not just in their ability to acquire, manipulate and use knowledge. It is not sufficient to simply tell people or publish what is happening so that they can correct what they do. The changes required of people will not come about by knowledge, or even by rational individual choice. Scientists need to think differently about using communication, education and public awareness rather than just making scientific information available to the public.

While we all endorse the importance of good communication, we don’t always put theory into practice. For example, experts tend to think that scientific facts are convincing in themselves. However, the exchange of scientific information does not necessarily motivate people who are not in these circles, and is insufficient to change attitudes or behaviours. Instead, scientific information has to be translated into concepts and messages that appeal to stakeholders, and are relevant to them, and connect with their emotions and personal beliefs.

Change will happen when scientists better communicate their vision, work and viewpoint to politicians, industry leaders, key stakeholders and the community. It will happen by using a mix of communication principles and strategies to increase political action. It will happen by using better public participation processes and social marketing to increase social commitment. It will happen by increasing their skills as communicators and by allocating more resources to innovative science communication programs.

The seven habits of successful science communication programs outlines practical ways for scientists to raise public awareness of coastal zone issues and communicate information more effectively. They also aim to encourage scientists make a greater social impact. The presentation will challenge member organisations and research leaders associated with LOICZ to adopt new communication strategies.

Topics include raising the profile of communication in your organisation, how managers seek and use information, the traps of information technologies, developing social research programs, building staff communication skills, developing communication plans, and evaluating impact.

Value Trade-Offs of US Marine Habitats

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Decisions for managing coastal environments requires policy makers to consider the economic value of the ecosystems and how those ecosystems are used by humans. In late 2004 a valuation study using direct and indirect valuation approaches assessed values of a range of marine habitats in the United States of America. Direct valuations were calculated for commercial and recreational fisheries focused on major habitats such as seamounts, coral reefs and estuaries. Indirect values such as bequest, future use and indirect were calculated for these same habitats using a willingness to pay questionnaire and a Discrete Choice Conjoint Experiment. Over 1100 US residents were polled on a number of coastal issues as well as their use of the coast and opinions on broad specific species, which were used as habitat proxies, and broad ocean management issues. The study identified the economic importance of major habitats as well as the willingness of residents to trade-off socio-economic benefits, future use and biodiversity to maintain or improve management of marine habitats in the United States.

Management of Deltaic Systems - The Need to Trace New Ways of Thinking Case Study: Deltaic Systems of the Hellenic Peninsula

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Greece has a coastline of a length of more than 18.000 km. This is an extremely long coastline in comparison with its land area (approx. 130.000 km²). The coastlines of Greece show a variety of coastal landforms. These coastal landforms have been developed and they are constantly changing under the influence of a range of morphogenetic factors. These include geology and geodynamics, geomorphology and some climatic factors, winds which regulate the wave regime, and rainfall, which

controls the sediment supply to the coasts. These processes resulted to the formation of a complicated geomorphology of the Hellenic peninsula, which shows a mountainous relief and a variety of drainage basins and drainage systems.

A significant portion of the coastlines are depositional coasts (~15 %), which are formed, where clastic sediments are supplied. These areas are mostly embayments of tectonical origin into which riverine sediments build deltaic systems and deltaic coastlines. The rivers deliver an abundant water and sediment yield to the coast. The size and shape of the Hellenic deltaic systems depend mainly on the rate of rivers sediment yield and on the effects of waves on the accumulating sediments. In the Hellenic area the tide fluctuations are relative small diminishing the role of tides in building delta types.

Using these two factors we can classify the Hellenic deltas in different types.

- By relative stark fluvial supply and low wave energy the branching digitate outline can be formed. A good example for this delta type is the Axios delta, in Thermaikos Gulf (NW Aegean Sea).
- When wave action is somewhat stronger the deltas develop smoother, cusped outlines. Acheloos delta, in western Greece, is formed by large quantities of sediments, which have been delivered to the river mouth. The progradation of the delta front is relatively rapid but no branching digitate outlines are formed. The wave action shapes the deposited material into cusped outlines, sorting the delivered material to form sand beaches and trailing spits.
- With stronger incident wave action, delta outlines become lobate. This is the delta type of Nestos river in the North Aegean Sea.
- When stronger open sea waves reach the coasts the delta blunts. The sediment delivered to the river mouth is quickly dispersed by the waves. Deltas are poorly developed on high wave energy coasts. This is the delta type of Pineios river flowing out in the NW Aegean Sea.

Deltaic systems are under pressures, facing complex development dilemmas. The deltas form fragile natural systems and they have for the mankind economical, social and cultural significance. A deeper understanding of the coastal morphodynamic processes is needed.

Mankind from the beginning of the organisation of its settling tends to make the necessary constructions along or near the coasts. Especially in the Mediterranean Sea the history of the civilization goes back more than 4.000 years.

The first coastal settlers utilized the deltas and generally the coasts without any significant modification, using the advantages of the particular locations.

Progressively and driven by the increasing population the pressures on the deltaic systems grew. Industrialization and the need to use big quantities of fresh water resulted in substantial anthropogenic modifications of the deltaic environment. These modifications were undertaken generally without regard for their impact on the natural environment.

The anthropogenic activities influencing the natural environment in the Hellenic deltaic systems can be grouped as following: agriculture, urbanization, aquaculture, industry, waste disposal. These pressures on the deltaic systems create various conflicts between different

user groups of the natural environment. There is a need to manage the deltaic systems. The management of these systems seeks to maintain or improve the state of the deltaic areas used by man. It includes the framing and the policing of any necessary regulations and decisions on the design and location of any anthropogenic activities needed to facilitate the use of the deltaic systems.

Trying to introduce some management principles in the different discussion and decision levels some important questions arise, which needs definition and analysis.

- In which degree do the activities at the deltaic systems and at the coasts generally facilitate the general development of Greece?
- What sort of development does nowadays Greece need?
- Can development in Greece be based on sustainability?
- How can the socio-economic structure of Greece, as part of the European community, respond to the international competitiveness?
- How can there be compatible sustainable development and competitiveness?
- Can sustainable development concrete be defined?
- How to manage coastal problems? Which are the management priorities for the Hellenic coastlines?

In order to formulate some principles for a better management of the deltaic systems, an assessment of the values, which are at stake, is needed. We postulate that social, cultural and ecological values gain priority. We put the economic values at the end of the priorities list.

In conclusion satisfactory management of the deltaic systems requires an understanding of the nature and dynamics of these systems, the various physical, chemical, biological and social interactions that take place on and around them, and the aims and perceptions of people, who come to use them.

Management of the deltaic systems must be based on another philosophy. We have to try to include all the information gained in a management system in which the central philosophy is the maintenance of the continuity of human benefits from the goods and services of the deltaic areas. We use the scientific information to suggest practical solutions in regional – local scales having always in mind the functioning of the system as a whole and its carrying capacity.

In any case the first priority should be the halting of the fragile deltaic systems in their natural state. We may keep these systems as natural value away from the maximalism of the economy development. We have to apply the principles of the sustainability of the environment independently of the political system dominated today.

Land-Ocean Use Planning of a Coastal Oasis in the Gulf of California

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From 2001 as a part of Gulf of California Regional Integrated Coastal Management approach, we have conducted many specific studies to terrestrial and ocean zoning in order to allocate environmental policies and specific uses in each zone. The Mulege estuary region is located at the southeastern part of the Baja California Peninsula. The coastal-oasis and adjacent areas with an extension of 550 km² are highly valued by local population as well as visitors from many countries, because it has been a pristine, scenic, and also a highly productive habitat in the Gulf of California. The former approximation with a scale of 1:25 000 were derived from ASTER imagery: False color composite for land use and digital elevation model for the micro-basins. The marine littoral zoning is an overlapping outcome from wave energy, depth and coastal geomorphology. The terrestrial zoning was derived overlapping micro-basins, terrestrial geomorphology and land use. The zoning outcomes were 31 terrestrial and 10 aquatic environmental units. For the evaluation processes of the environmental units, a weighting rating technique was used for three types of policies allocations: protection, conservation and development. The evaluation is based on a set of 30 environmental and 21 socioeconomic terrestrial indicators and 13 environmental and 16 socioeconomic marine littoral indicators. The results show that the 22% of the total area is recommended for the protection policy, 57% conservation and the 21% for the development or driven use policy. We developed and presented a planning process with management objectives to approach the conservation and sustainable development of this relevant coastal system.

Impacts of freshwater discharge regulation on a shallow tropical lagoon - Puttalam Lagoon, Sri Lanka.

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Puttalam Lagoon is a shallow vertically homogenous tropical lagoon with a spring tidal range of 60 cm. It receives an annual mean rainfall of 1200 mm, whereas the evaporation amounts to 1900 mm. The freshwater discharge into the lagoon is 5 m³ s⁻¹, however prior to the damming the upstream in 1980, the discharge amounted to 25 m³ s⁻¹. The southern mouth, which use to opens naturally during the Northeast Monsoon to drain the floodwater directly into the ocean, became permanently closed since early 90ies, while the northern mouth remained open as ever.

The annual mean salinity of the lagoon, prior and after the damming of the upstream is 27 and 37 psu respectively, thus the normal estuary turned into a perennial

hypersaline estuary after the damming. However, after the closer of the southern mouth, the salinity is below the oceanic during the Northeast Monsoon, otherwise it remain as a hypersaline estuary with a weak horizontal salinity gradient. In the inner end, the salinity increases far beyond the oceanic, some times to 55 or 60 because of evaporation whereas the rain periods may lower the salinities to between 20 and 30.

Stronger exchange is observed during periods of slack water and neap tide. The periods of weak or non-existent horizontal gradients are coincided with poor exchange. The salinity is in constant raise and the water exchange is poor even during the periods of stronger evaporation, possibly due to the convectional mixing, which may hinder inverse estuarine circulation from being established. The residence times of the lagoon during the wet and dry seasons are between 40 -100 days but even longer during the transition between normal to hypersaline estuary. Thus, the frequent shifts from normal to hypersaline condition bring down the long-term water exchange. Thus, the tropical shallow lagoons being more sensitive to human impact, the ad hoc regulation of freshwater input into the shallow tropical lagoon may result in large salinity variation and poor water exchange than in a normal estuary.

Building Integrated Coastal Management Capacity amongst Practitioners

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The development of Integrated Coastal Management (ICM) relies on ICM capacity-building of all those involved in the process. This not only includes those at the 'helm,' steering ICM development, but also the more disparate 'crew' of stakeholders, who, typically have a wide range of sectoral remits and responsibilities. This presentation focuses on recent experience in attempting to build ICM capacity within North West Europe, where Member States are developing national Integrated Coastal Zone Management (ICZM) strategies to conform to the recent EC Recommendation on ICZM. The relative merits and issues associated with the delivery and effectiveness of contrasting methods of ICM capacity-building are explored, including both formal and informal training approaches. In particular, the paper draws on the author's recent experience associated with the development and implementation of a formal short-course training course for local authority practitioners in North West Europe as part of the COREPOINT INTERREG project as well as the author's experience in government agency in-house ICM training and a number of other initiatives designed to foster increased awareness of the ICM process.

The paper focuses on the particular needs for and expectations of practitioners in ICM training. Given the diversity of interests, responsibilities, background and training of all those involved in the ICM process, there is no one simple 'one-size fits all' solution. Whatever the audience however, there is a need to consider not only what aspects of ICM are taught (the subject matter), but also how training / capacity-building is delivered. Although the style, method of delivery, format and setting of training courses are vital components of the design of ICM capacity-building programmes, it is the 'conceptual' and 'process' focus of ICM, particularly in Europe,

which presents the greatest challenge for ICM training when compared with training courses on 'simpler' and more tangible environmental management tools and techniques. The presentation concludes by providing recommendations related to both the subject matter of ICM training and methods of delivery.

Measuring the Progress and Outcomes of Integrated Coastal Management Initiatives: Toward a Common Framework

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With more than 700 ICM efforts initiated in over 140 countries, limited and often anecdotal information exists on their environmental, socioeconomic, and institutional impacts and it is necessary to improve approaches and methods to facilitate accountability and adaptive management. Few examples exist of development and application of indicators to support this process but preliminary results support the definition of common frameworks and suites of indicators of broad application. A framework tailored to the different stages and elements of the ICM policy cycle helps track the progress and institutionalization of ICM at different spatial scales. A set of indicators for the state of the coast, driving forces and pressures helps placing ICM efforts in context, while more specific outcomes and impacts indicators can guide the of measuring the results of ICM. Crucial in the determination of results is the availability of baseline information and time series on the state of the coast and the assessment of the contribution of ICM initiatives to change human behaviors and their impact on coastal conditions. While it is not always possible to specify targets and timetables for ICM initiatives, it is necessary to articulate their goals and objectives to monitor and evaluate progress and performance, review program logic and assumption, and adapt to changing conditions and progressive attainments. Major challenges remain for science and international programs such as LOICZ to help isolate the natural variability of coastal ecosystems from their response to human activities, balance development and economic priorities against environmental issues and long-term sustainability strategies, and understand social dynamics in the coastal zones. Targeted multidisciplinary research, participatory monitoring and evaluation, and exchange of information and experience among scientists, managers, and beneficiaries are required to support coastal managers to design and implement ICM programs and achieving ecosystem health, quality of life, and economic opportunities.

Towards a Sustainable Shellfish Industry; Understanding the Importance of Upland Sources of Nitrogen to the Geochemical Cycling of Nitrogen within the Foreshore.

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Bivalve productivity is dependent on primary productivity; hence an understanding of the factors that influence the cycling of nutrients such as nitrogen within the intertidal is important for the development of sustainable farming practices. Upland sources are known to contribute to nitrogen to the foreshore, but few studies have determined the importance of this role. Here we show that upland sources of nitrogen are a major contributor to amounts recovered from the foreshore and discuss our findings within the context of coastal zone management in general.

Interaction between Eutrophication and Suspended Matter Dynamics of a Shallow Coastal Sea

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On a global scale, coastal heterotrophy can be accounted for by the input of riverine organic matter. On a “local” scale, however, accumulation of organic matter from the off-shore coastal sea towards the land may drive local carbon and nutrient budgets. High bivalve biomass in the Wadden Sea – a shallow tidal sea largely protected from the North Sea by barrier islands - intrigued scientist about 60 years ago. Import of organic matter from the North Sea was proposed as the most probable explanation and this hypothesis has initiated some classical studies on suspended matter and organic matter dynamics in the Wadden Sea. Recent carbon budgets from the Wadden Sea support the heterotrophic character of the Wadden Sea which is in the order of $100 \text{ gC m}^{-2} \text{ y}^{-1}$. Carbon budgets would be the ultimate indicators of the eutrophication status of an area, but they are time consuming and not very accurate in documenting changes in time. Other indicators of the eutrophication status like the seasonal cycle of nutrients and phytoplankton biomass will be presented.

Organic and inorganic particles are intimately united in suspended matter. This is a common feature in both coastal seas and oceans. Evidence from the Northern Wadden Sea suggests that increased eutrophication enhances inorganic particle accumulation and suspended matter dynamics in the Wadden Sea. Apart from the possible role of eutrophication in the suspended matter dynamics, at least one additional factor should be considered: Due to global traffic and aquaculture three filter feeders have recently

spread in the Wadden Sea. Their new role in suspended matter, nutrient and phytoplankton dynamics is largely unknown.

The early studies on suspended matter dynamics in the Wadden Sea focussed on near-shore, more cohesive intertidal sediments as main suspended matter source and sink. Among the biological factors benthic diatoms and filter feeders were mentioned. Recent studies highlight the importance of the more ubiquitous permeable sands as filters and seasonal sources of suspended matter.

Coastal Erosion and Sea Level Rise at the Global Scale: An Assessment of Impacts and Adaptation

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It has been estimated that 70 % of the world's sandy beaches are already eroding. Whatever the cause, it is widely agreed that increasing sea levels will promote erosion and exacerbate this already adverse situation. The new Dynamic Interactive Vulnerability Assessment (DIVA) model, which was developed within the EU-funded DINAS-COAST project (www.dinas-coast.net) for the first time considers erosion due to sea-level rise at the global scale. Impacts and adaptation costs are estimated under different user-selected adaptation options based on varying amounts of beach nourishment. Erosion is a critical component in an integrated assessment of the values of the coast at risk given accelerated sea-level rise. This paper presents this analysis including the modules that underpin the analysis, and a range of results to illustrate the likely sensitivity of the world's coasts to erosion.

The erosion module calculates the net erosion due to sea-level rise of the active profile of sandy beaches to an annual depth of closure on the open wave-exposed coast. Calculations are performed based on 'homogeneous' coastline segments: >12,000 segments have been defined based on a series of segmentation rules. To capture shoreline response to erosion, a Bruun Rule Factor (*brf*) parameter (0 to 1) has been estimated for each segment from global data sets which characterises each coastal segment in terms of erosion potential: rocky coasts are 0, entirely sandy coasts are 1, and mixed rocky and sandy coasts have intermediate values.

First the module determines the direct effect of sea-level rise on beach erosion on the open coast. This is based on the Bruun Rule "rule of thumb": direct erosion is 100

times the rise in relative sea level is used. It then combines this direct loss with the sand loss due to any indirect erosion caused by about 200 large lagoons and estuaries that have been selected within DIVA. The indirect erosion uses the ASMITA model which links sand demand within estuaries and lagoons to a range of system characteristics, including sea-level rise. Collectively, the sum of direct and indirect erosion defines potential erosion, which is communicated to the Adaptation and Costing Algorithm. Depending on the user-selected response (no nourishment, cost-benefit determined nourishment, or full nourishment) the appropriate sand input to the next time step is determined. Under cost-benefit analysis this considers the value of tourism. Hence, the total (or net) land loss and nourishment cost is estimated.

Overall the model suggests that without adaptation, coastal retreat could be significant, with important impacts in terms of land loss and loss of resources such as tourism. An “optimum” response using cost-benefit analysis is estimated to significantly reduce losses. Results will be discussed across the SRES scenarios. Limitations and further developments will also be considered.

Varying Sea Levels – A Possible Clue for Varying Atmospheric CO₂ levels?

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It is generally accepted that the carbon storage within the principal earth surface reservoirs vary in a multitude of time scales. The shallow water continental margins belong to the most fertile areas in terms of organic carbon (OC) production and are also very effective carbon traps. However the rate of OC retention in these zones must be strongly affected by the sea-level, therefore it is to large extent controlled by glacial-interglacial cycles. In order to assess the changes of OC storage in the coastal areas, the OC content must be integrated with sediment accumulation rates on shelves, in lagoons and estuaries. We determined organic carbon content in several hundreds of samples taken from cored boreholes which crossed the entire infill sequences of Guadiana, Arade and Boina river estuaries, in Algarve (S.Portugal). These dated sedimentary sequences represent the time span from ca 13000 yr calBP to present and constitute one of the longest records from nonglaciaded terrains. The obtained data indicate that until ca 7000 yr calBP, i.e. during the period of fast sea level rise, organic carbon accumulated at an average rate of 240 gm²yr⁻¹. In the Middle and Upper Holocene, when the sea level rise was not exceeding 25cm/century the organic carbon accumulation rate dropped to an average value of 80 gm²yr⁻¹.

From the other hand, the analysis of gas bubble content from ice cores indicates that the atmospheric CO₂ concentration evolved during the last glacial/interglacial transition, from 180 ppmv minimum during the LGM to the 270 ppm preindustrial level. Identical variations accompanied the older Quaternary climatic oscillations and they remain still an unsolved question. Considering that from one hand the terrestrial particulate organic matter is an essential fertilizer of the ocean and that the sea level and hence the position of river mouths with respect to shelf break controls the

proportion between the part of this fertilizer which is buried in coastal traps and the part which is delivered to the open ocean from the other, it is postulated that enhanced burial of POM in the coastal areas during the period of fast postglacial sea level rise may be responsible for decrease of primary productivity in the open ocean and consequent transfer of 200 Gt of C to the atmosphere.

Typology: Tools for Integration and Analysis

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The first phase of LOICZ pioneered coastal zone applications of typology – classification of geographic and/or functional units so that measurements and conclusions in data-rich areas could be applied to similar but poorly characterized regions. Among the working products developed were web-accessible databases of both general coastal characteristics and biogeochemical budgets, and geospatial clustering, analysis, and visualization tools (originally Web-LOICZView, followed by DISCO).

The experience gained in LOICZ-I, the science and implementation plan developed for LOICZ-II, and external developments of data access, analytical tools and internet connectivity within the larger scientific community, have come together to point toward an expanded role for Typology in the future of LOICZ, as well as additional avenues for its implementation and application.

Past experience has provided us with a list of desirable improvements and developments in the existing tools: more user-friendly and flexible data manipulation options in both the database and the clustering and visualization tools; inclusion of additional budget, environmental, and human dimension parameters in the database; higher resolution data (especially oceanographic) where it is available, and – leading to the next points – more geographically defined datasets (drainage basins or coastal geomorphic or functional polygons, rather than gridded data).

GIS datasets, both for off-line use and for interactive mapping and modeling applications on-line, are becoming a standard for geospatial science, and need to be incorporated into the LOICZ toolbox. With this capability comes the need and opportunity to make use of remotely sensed images for both visualization and quantitative system characterization.

Time dependent data – both time series and ranges of seasonal and interannual variability – are needed to better characterize coastal zone fluxes, and especially to develop a basis for prediction of future changes in coastal systems based on history and projected changes in conditions and forcing functions. In order to make effective use of such data, tools for manipulating, comparing, and analyzing time series data need to be made accessible to the LOICZ community. In all of these considerations, there is the need to shift from unsupervised or parameter-based classifications to a

more rigorously designed supervised typology, identifying degrees of similarity to the systems judged to be best known or most important.

These needs and opportunities, however, occur in the context of a rapidly developing informatics environment, where databases of all sorts are increasingly accessible on-line, and where data portals and central access points are being developed across a wide range of disciplines. By aligning itself with larger community developments and by forming strategic alliances with programs and institutions with similar interests and complementary capabilities, LOICZ can achieve a major expansion of its access to relevant data and tools, while simultaneously making its products visible and useful to a wider audience.

In order to take advantage of such technological advantages with regard to both Typology and other aspects of LOICZ operations, it will necessary to make a significant commitment to both coordination of distributed resources and maintenance of a central informatics facility to serve as a project portal and showcase.

Making the connection between healthy waterways and healthy catchments

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River systems and their associated floodplains and wetlands are regarded as the most threatened ecosystems on the planet. In the developed world, most floodplains are intensively cultivated and are considered to be functionally extinct. In the developing world, the remaining natural flood plains are disappearing at an accelerating rate, primarily as a result of changing hydrology. Alteration of flow regimes is a serious and continuing threat to these systems and associated infrastructure is recognized as having major implications on sediment transport to coastal areas. Projected increases of human population are likely to lead to further degradation of riparian areas, intensification of the hydrological cycle and increase in the discharge of diffuse and point source pollutants. In turn, these catchment changes will undoubtedly place increasing pressure on the health of coastal ecosystems.

Southeast Queensland, Australia provides an excellent case study of the challenges for ecological sustainable management of rivers and coastal ecosystems in the face of such pressures. The region's waterways, including Moreton Bay, represent unique and complex ecosystems that have a high conservation value and support major recreational and commercial fisheries. The agricultural districts of the region also contribute significantly to the local and regional economy and, together with the growing urban areas, are heavily reliant on the availability of good quality water supplies. However, the human footprint of these activities has led to significant changes in catchment hydrology and sediment delivery, declining water quality and loss of aquatic biodiversity. Nutrients (particularly nitrogen) and fine sediments have

been identified as causes of significant environmental problems. Predicted population increases in the region are likely to further impact on the ecological and economic health of its waterways and catchments, and there are growing community expectations about reversing the trend of decline in water quality and ecosystem health.

In response to these concerns, government, industry and community stakeholders have worked in close cooperation to develop a whole-of-government, whole-of-community approach to understanding and managing the region's waterways. The Moreton Bay Waterways and Catchments Partnership, as it is now known, focuses on 15 major freshwater catchment areas (22,353 km²) and associated coastal waterways and incorporates 19 local governments. The key elements of the Partnership include: the implementation by a range of partners of management actions ranging from upgrades of sewage treatment plants, to improved planning regimes and rehabilitation of riparian vegetation; a multi-disciplinary science and research program that underpins the management action program and monitors its effectiveness; and the Healthy Waterways promotional and educational program that seeks to build on similar activities of partners and ensure that there is community awareness and support for action. This paper provides an overview of the experience gained through development of the Partnership and highlights some of the key factors we believe have contributed to its current success.

Use of a Virtual Centre of Competence as a Management, Information and Education Tool in Coastal Zones

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The complexity of coastal zone issues requires integrative approaches and participation if we tend to involve people concerned. Providing them with information and skills needed to find future oriented concepts is a major task of responsible scientists. Today's information society, accustomed to apply computers and telecommunications, holds opportunities supporting these aims. Within the joint research and development project *Zukunft Küste - Coastal Futures*, a virtual web-based platform has been established. The system enables project members, stakeholders and the interested public to inform and participate in discussions regarding coastal zone matters, to manage complex project activities and to implement educational objectives.

Due to the application of a Content Management System (CMS) (WebGenesis), the competence centre provides more options than a rather static web site. To arrange the varying user requirements, the system is organised in three levels: a) a public platform with general information about Integrated Coastal Zone Management (ICZM) and the project, b) an expert platform, including information, documents and discussion forums and c) a project management platform (with limited access authorisation) containing information for the project-partners, e.g. task/time schedules, reports and drafts of texts. The system was activated in January 2005 and will be upgraded

successively. In combination with a map server, GIS-based spatial data are visualised illustrating recent land- and sea-use patterns and scenario-based possible future situations. Linked with comprehensive data bases, an image of various developments in coastal zones can be depicted. The concept is prepared to represent stakeholder specific views, allowing to identify common and conflicting interests already in the forefront covering spatial conflicts based on GIS and expectable long term effects based on model evaluations.

The arrangement of a (successful) ICZM calls for advanced knowledge, stakeholder involvement and participation. Hence, beside established educational structures, innovative concepts are claimed. At this point, the virtual centre of competence can play a role by affording web-based teaching and learning modules related to coastal management. Multi-media based techniques and interactive elements will help to encourage learning progress and ensure participative training. By co-operation with appropriate partners, the virtual centre of competence is planned to remain after the project has expired.

The virtual centre of competence can be found at: <http://www.coastal-futures.org>

Fish for the Future: an Assessment of Fishery Conservation Policies in the Philippines

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Lamon Bay is one of the most important fishing grounds in the Philippines. In spite of this, most fishermen in the area live in poverty, and their plight is getting worse, not better. Fish catch is declining by 13.5 % a year, more than double the decline experienced elsewhere in the country. Current fisheries policies for the area have failed to improve the situation but no research has been done to find out why. Are the policies poorly designed? Or have they not been adequately enforced? This report attempts to fill this information gap about the reasons for policy failure. Drawing on data from secondary sources and an original survey, it uses a bioeconomic model to simulate the effects of changes in the enforcement levels of three current policies: ban on electric shiners, fish cage regulation, and regulation of both electric shiners and fish cages. Investments of the government on different levels of enforcement were assessed using benefit cost analysis. The report assesses the effects of enforcing current fisheries policies more stringently. It finds that a substantial investment (PHP 614,000 per year) would be required to ensure compliance with regulations and that the benefits of achieving high levels of compliance would exceed costs by only a tiny margin. The situation would be transformed into one in which large and perhaps increasing numbers of people would continue to fish, expending larger amounts of effort to comply with various gear restrictions but, in all likelihood, harvesting no fewer fish. Because the bay is already overfished, catch per unit effort and marginal productivity would decrease. Any additional fishing effort in the bay will result in a decrease in the average catch of all fishermen. Enforcement of current policies will not address the underlying problems of open access and the overfishing. A policy to deal with the problems of open access and overfishing is to set a limit on the total number of fish that can be caught and divide this quota among Lamon Bay's fishermen. Over time, the total allowable catch might be reduced. (The easiest way to make the initial reductions would be to revoke the permits of fishermen who contravene fishing regulations, e.g. regarding permissible catch size or seasons). To allow flexibility, the quotas

allocated to individual fishers might be tradeable. This system of individual tradeable quotas or permits has been very successful in New Zealand. The typical Lamon Bay fisherman lies below the poverty level, has almost no secondary source of income and finds his household members willing but unable to obtain work. Efforts to reduce overfishing in the bay should therefore be complemented with measures to promote alternative sustainable livelihoods.

This paper falls under the theme: Towards coastal system sustainability by managing land-ocean interactions. Different policy options are analysed using bioeconomic modelling.

Capacity Building for Coastal System Sustainability by Managing Land-Ocean Interactions through Stakeholders Involvement: Indian Perspectives.

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Coastal cities are getting bigger on virtually all continents. Of the world's 17 mega cities in 2001, those with over 10 million inhabitants, 14 are coastal. With the exception of sub-Saharan Africa and parts of parts of Central and South Asia, coastal populations are growing at a faster rate than those further inland: Close to 4 billion people - two-thirds of humanity - live within 400 km of a seacoast. Roughly 3.1 billion people - half of the world's population - lives within 200 km of a coast, occupying only 10 per cent of the earth's land surface. In Latin America, the most urbanized of the developing regions, three-quarters of the entire population - 382 million - live within 200 km of a seacoast. With three-quarters of the world population expected to reside in the coastal zone by 2025, human activities originating from this small land area will impose a disproportionate amount of pressures on the earth system.

Coastal zones play a vital role in earth system functioning providing a significant contribution to the life support systems of most societies. Human's activity modifying the hydrology and fluxes of material from river systems into the coastal zone has increased in both scale and rate of change during the last 200 years. The underlying processes that drive changes to coastal systems occur at a multiplicity of temporal and spatial scales. These changes have a major effect on coastal ecosystems significantly altering the availability of goods and services for human resource exploitation. Therefore, capacity building for coastal system sustainability by managing land-ocean interactions through stakeholder's involvement is necessary for coastal system sustainability in this region.

In India, 3 magacities, Mumbai, Kolkata and Chennai are coastal cities consisting more than 50 million urban and periurban population. Apart from this there are more than 50 coastal cities having population more than 100,000. Due to continuous rise in human settlements along coastal zones exert pressures on coastal systems and influence natural resources availability in the region.

To mitigate this NGOs, CBOs and societies are participating in the development of coastal zones and management of its resources for long term sustainability. Public

participation found an effective tool to avoid degrading sustainability of coastal goods. The Government has declared the integrated coastal zone management policy to ensure the sustainability and minimizing hazards to humans from coupled human and ecological system change along in coastal system.

An attempt has been made in this paper to develop the plan for coastal system management for agriculture, aquaculture and horticulture and other coastal goods, using innovative technologies from Indian experience .The paper also evaluates vulnerability of coastal systems and hazards to human societies in the coastal region. The paper also discusses the impacts of global changes for coastal ecosystems and sustainable development focusing on conflicting spatial, temporal, and organizational issues of coastal change, land and sea use, how these exert pressures on coastal systems and influence natural resources availability and natural systems for increasing productivity avoiding risk of degrading sustainability of coastal goods in Indian scenario.

The River Basin and Coast as a Single System

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This paper addresses ways to study catchment (river basin) - coast continuum as a single system. Few have examined catchment and coast as one system, and therefore, a robust theoretical framework is lacking. To contribute to theory building and conceptualize two systems as one, the first step is to uncover linkages that necessitate the coupling of river basin and coast. Foremost are the physical elements that create linkages between river basins and the coast through the movement of sediment, nutrients, and contaminants from the watershed to the coast. Human impact is the other element that ties river basins to the coast. Human activities in the river basin influence sediment movement, raise nutrient levels, and generate contaminants in the coastal zone. Furthermore, watershed or river basin policies affect coastal communities. The paper, thus, delineates both physical and human elements that bind the river basin and coastal zone, and establishes an analytical basis for coupled human and natural systems in the catchment-coast continuum. Lastly, in an effort to integrate the coupled river basin and coastal system *and* coupled human and natural systems, the paper draws insights from integrated assessment applied in the field of climate change.

FerryBox – An Observation System for the Assessment of the Coastal and Shelf Sea Ecosystem

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For the effective management of coastal and shelf sea ecosystems it is necessary to distinguish between anthropogenic effects from natural cycles and events. This requires that a sufficient data base exists. However, even in well studied areas such as the north west European shelf it is evident, that data are lacking in many areas, particularly in the winter months when research ships have difficulties due to storm events etc. Research cruises may allow extensive ranges of measurements to be made but the view is limited by the temporal coverage. Optical remote sensing from satellites potentially provides global coverage but is limited to a few determinants and often have problems such as cloud cover.

A new operational tool which uses ferryboats as carrier platform for automated monitoring equipment has been developed. Such systems can be operated very cost effective compared to automatic buoys and research vessels. Currently the systems are tested in an EU project in which nine ferry routes are used for testing the so called FerryBox systems in different European waters. The key aim in this project is to test the hypothesis that autonomous instrumentation on ships of opportunity are a cost effective way of collecting the environmental measurements that are vital for improving the information needed for better management of European seas.

The FerryBox system presented here has been installed on the ferry from Cuxhaven (DE) to Harwich (UK) covering the coastal zone of the German and Dutch coast and is in operation since November 2001 until now with a break of 9 months in 2003. The system consists of a fully automated flow-through system with sensors and automatic analysers for the measurement of oceanographic and chemical parameters, among which are nutrients and algal properties. It provides the possibility of automatic cleaning cycles in order to prevent bio-fouling and allows position-controlled (GPS) sampling of water samples for additional laboratory analysis. Data can be transferred to shore and the system can be remotely operated via mobile phone.

Results after three years of experience demonstrate the applicability of the FerryBox system for better understanding and assessing the ecosystem and the underlying biogeochemical processes in the coastal region of the Southern North Sea. Together with hydrodynamic transport models and by combination with remote sensing images the 'one-dimensional' view along a transect of the ferry even can be enlarged to a more spatial view along the coast. Special events like strong short-term algae blooms, which will be detected only occasionally by standard monitoring methods, can be studied in detail and related to variations in influencing factors such as temperature, wind and nutrient load. This information may be used for further development of ecosystem models. Examples of such events detected by the FerryBox system will be presented and it will be shown how these data can be used to develop a better knowledge and data base about the biogeochemical processes along the southern coast of the North Sea.

Perception of Environmental Stress by Fisherman Communities of Mangroves of Pernambuco, Northern Brazil

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This study was done in Pernambuco, north coast Brazil, in the estuaries of Catuama and Itapessoca rivers, with fishermen and traditional community pickers of the communities of Atapuz, Barra de Catuama and Tejucupapo. The objective of the work was to study the established relationships between fishermen and these community pickers and their understanding about environment, at ecological and social dimensions. Quantitative and qualitative methods were used, strategy used in Human Ecology, suitable to the complexity of the human relationships with environment. For socioeconomic characterization, structured questionnaires and informal interviews were applied.

The results demonstrated predominance of fishermen and pickers, depending exclusively on the fishing activity, with on average four economic dependents, low instruction level and linked to an association (Colony of Fishermen). Information about the knowledge of the fishermen and pickers of fish and benthic macrofauna, its relationships with the environment, intuitive classification and the environmental factors that interfere in the fishing activity were considered. A matrix of anthropogenic interference was built to characterize the environmental factors that interfere in the fishing production from the perception of fishermen and pickers. The more frequent environmental impacts were over fishing in the creeks, and the use of explosive and poison. The external factors related were increasing navigation, mangrove logging and dumping, and pesticides from sugar cane culture. These communities share the same environmental resources but present peculiar characteristics in their socio-economic structure, production and fishing techniques, and environmental perception. The fishermen and pickers revealed knowledge of ecosystem functioning and are able to discern the human pressures that cause environmental harm and prejudice their activities.

Regional Impact of Rivers on Continental Shelf Biogeochemistry

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Global approaches to coastal ocean biogeochemical processes are made difficult because of their very heterogeneous nature. Here we present a sensitivity study on the impact of riverine nutrient fluxes (P, Si, Fe) in the coastal ocean using a global ocean biogeochemistry model. We include scenarios simulating an increase in phosphorus fluxes due increased human population. We subdivide the global coastal ocean in biogeochemical provinces (Longhurst approach), and emphasize our discussion in coastal provinces affected by high river runoff. We observe that primary and export production are much enhanced in provinces combining high river inputs and coastal upwelling like the Gulfs of Guinea and Alaska, and the South-eastern Pacific. Our results suggest that increased nutrient availability leads to an increase of 3 to 7 % in primary production and 6 to 14% in export production in continental shelves. Increased efficiency in the biological pump leads to a decrease in sea-air CO₂ fluxes of 12 to 30 %. The highest regional increase is observed in the Bay of Bengal, where riverine nutrient flux enhances primary production from 10 to 24 % and export production from 17 to 42 %. Consequently, continental shelf oxygen-minimum areas increase from 3 to 19 %. Based on regional elemental budgets from observations and on model results, organic carbon inputs from rivers exceed export production in the North Brazilian Shelf (Amazon River) and in the Bay of Bengal (Ganges and Brahmaputra Rivers). Phosphorus is the most limiting nutrient in the coastal ocean whereas Fe has the highest impact in primary and export production, and consequently on sea-air CO₂ fluxes.

Our sensitivity study matches LOICZ II theme 4 – Biogeochemical cycles in coastal and shelf waters. Our modelling approach can be used as a tool to assess the nutrient and carbon exchange processes between the continental shelf and the open ocean, and how human-induced changes in riverine nutrient fluxes may impact the different biogeochemical provinces of the coastal ocean. Our scenarios considering increased phosphorus fluxes due to human influence could provide reasonable insight into future potential feedbacks on eutrophication in the coastal ocean.

Combined Use of a Coral Reef Instrumented Platform (CRIMP) and Synoptic Water Column Sampling to Characterize Temporally and Spatially the Biogeochemical Response of Kaneohe Bay, Hawaii to Storm Runoff Input

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Pulsed storm-runoff inputs have rapid and significant impacts on coastal water quality in the high islands of the Hawaiian Archipelago. This is especially true in semi-enclosed coastal embayments, where long residence times provide for extended reaction between land-derived material and receiving waters. Traditionally, coastal waters have been studied primarily using synoptic low-frequency sampling that provides “snapshots” of these highly dynamic environments. In contrast, a combination of spatially distributed synoptic sampling with continuous *in-situ* measurements yields data that capture the short-term variability in system response. We have deployed successfully a multi-instrument Coral Reef Instrumented Monitoring Platform (CRIMP) in Kaneohe Bay, Hawaii under calm and windy dry (background) conditions as well as during extreme rain events and their aftermath. The CRIMP measures a suite of physical and biogeochemical parameters at 10-minute intervals. Sediment traps on the CRIMP are serviced daily (during storms) to bi-weekly (storm aftermaths), at which times complementary measurements are also made of physical and biogeochemical parameters at a network of stations distributed throughout the bay. Our approach is particularly well suited to studying ecosystem response over extended periods following pulsed inputs and has allowed us to elucidate the relationships between physical, biological, and chemical processes in the bay, as well as the evolution of plankton community structure subsequent to phytoplankton blooms.

We will discuss the bay response to several high rainfall/runoff episodes during the 2003-2004 and 2004-2005 rainy seasons mainly in the context of Theme 4 of the conference but also address certain aspects of Themes 2 and 3. The rainstorms during these two winter seasons resulted in large runoff events that increased sediment and nutrient loading to bay waters. Nutrient enrichment experiments and water column DIN:DIP ratios of 2 to 4 during background conditions suggest baseline nitrogen limitation of primary productivity. Elevated DIN:DIP (25) in storm runoff changes significantly the proportion of dissolved nutrients available for biological uptake, temporarily relieving N-limitation and driving the system toward P-limitation. Biological responses include transient increases in Chl-a shortly after storms and longer-term changes in phyto- and zooplankton community structure. The response to one particularly large storm also included a sustained (3 months) increase in water column NH_3 concentrations (10-15 μM versus normal concentrations $\ll 1\mu\text{M}$), probably from remineralization of terrestrial organic matter deposited in bay sediments. Enhancements in primary productivity during storms also result in a drawdown of dissolved CO_2 , changing bay waters from a net source to neutral or a slight sink of atmospheric CO_2 . These storm-induced changes have important

consequences for bay ecosystems and for the management of fluvial nutrient inputs to the bay.

Coupling of Carbon, Oxygen and Nitrogen Cycles in Sediments from a Mediterranean Lagoon

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As a part of the French Coastal & Environmental Program MICROBENT, a study of biogeochemical processes at the sediment-water interface in eutrophicated environment was performed in the Thau Lagoon, France. Micro-electrode profiles were obtained *in situ* using an autonomous profiler and diffusive oxygen fluxes were calculated from these profiles. Laboratory incubations on sediment samples allowed the determination of nitrification and denitrification rates. This data set and a steady-state diagenetic model are used to determine the factors controlling the dynamics of carbon, nitrogen and oxygen and to investigate the spatial and seasonal coupling between these elements. Results highlights a spatial variation at the lagoon scale of nitrifying and denitrifying bacteria activities and a seasonal negative correlation between the sediment oxygen demand and nitrification-denitrification rates. Two main factors seem to drive the coupled oxygen-carbone nitrogen system : the oxic zone thickness which controls nitrification and the seasonal variation of sulfide which inhibits nitrification for the station inside the oyster park. The model outputs fairly represents the profiles of O₂, TOC and nitrification rates when a term corresponding to nitrification inhibition by hydrogen sulfide is added in the model equations. Ammonium profiles are correctly simulated only when the boundary conditions (C_{flux}, part of labile C_{org}) are changed suggesting a strong vertical decoupling of sediment characteristics not considered in the model or a different C/N ratio. The mineralization pathways shows a large contribution of anoxic mineralization compared to denitrification and oxic mineralization in both stations and all seasonal periods. The fine-scale distribution of O₂-demand processes reveals that more than 80 and 70% of oxygen is used to re-oxidize the by-products from anaerobic reactions, the rest being used to oxic mineralization.

A Regional Approach for Coastal Sustainability, ICZM in the Western Central Region of México: Building the Coastal Agenda.

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Needless to state the need for managing our coastal zone in an integrated manner; this project has to do more with creating a coastal agenda in a country where the coastal zone has been historically nonexistent or relegated in terms of policy and regulation. Planning for development from the federal scope has had a severe lack of practicality; it is common for large areas of the country as well as for a vast number of activities to not have either support from government programs nor presence as a regulatory body.

A milestone change is about to occur and for the first time in Mexico's history a truly regional approach to planning for development is in course; since the current presidential term 9 regions have been created and each one has its own regional planning body; this new approach comes in timely along recently international efforts such as the Gauteng Declaration, signed during the World Summit on Sustainable Development in Johannesburg; in it 23 Regional Governments from different parts of the world recognised themselves as a crucial sphere of government in terms of proximity and efficiency as well as being strategically located for the development of policy and the implementation of sustainable development in cooperation with other spheres of government as well as civil society.

From these 9 regions the most advanced, in terms of having started this process and already having its regional planning body, is the one related to Mexico's central western region (Region Centro Occidente RCO); in the RCO only 4 out of 9 states border the sea and has a low coastal population (less than 5% of RCO), there are only 2 major ports and 2 important tourism sites, fisheries is not a very relevant economical activity and aquaculture is important in only one of these 4 states.

But even when the numbers are low, yet the pressure is high when potential for development is the driving force; these 4 states have different priorities for their coastal areas and each one of them will address these on a sectoral "business as usual" manner, without any distinction for coastal ecosystems and dynamics. We believe that this poses a serious threat to our coastal zone and are promoting a series of actions towards creating a coastal agenda, so these issues can be addressed in an integrated manner tending to more sustainable practices and processes.

In order to build this Coastal Agenda for RCO we are drawing from international experiences such as the EU's Demonstration Programme on ICZM and we are proposing a project with the University of Guadalajara to deliver a stocktaking exercise for the RCO that will identify the main actors, laws and institutions influencing coastal zone management; along with capacity building on ICZM principles and objectives of the key areas in the state government agencies as well as universities, NGO's and cooperative societies (fisheries, aquaculture, tourism service providers, etc), coastal municipalities and local communities in the region.

The Mkomazi Estuary: Human Effects, Freshwater and an Oligotrophic Coast in South-East Africa

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The Mkomazi river on the Kwazulu-Natal coast of South Africa is an extremely important resource in a regional context having a catchment area of 4 400 km² and a virgin MAR of 1 070 million m³. The estuary is classified as a permanently open system, which results in added significance in a local context, as it is one of the few on the KZN coast which remain open to the sea all year. The magnitude and variability of the flows associated with the system result in a significant, but periodic, transmission of influences derived from catchment based processes to the local, oligotrophic coastal environment.

A paper mill on the estuary, which discharges wastes via a marine outfall, is the biggest single user of water from the river. No dams have been built on the river but temporary barrages are constructed to store water during exceptional low flow periods. Incompletely treated water from a local sewerage works is a source of contamination. The head area of the estuary is used as a source of building sand, a process which both removes and mobilizes sediments..

Annual surveys since 1998 have indicated an impoverished benthic fauna induced by frequent low salinities, especially during the wet summer months, and sediment instability associated with periodic high flow levels, arguably exacerbated by sand winning and the collapse of the temporary barrages. The nature of the estuary, which appears to be defined by the dominant physical processes, and the lack of significance as a nursery habitat for invertebrates is balanced by the apparent significance of the outflow of the river in the local coastal environment where a 17 year monitoring programme has shown a strong positive correlation between river flow and fish egg abundance. The results of this survey will be presented in relation to the measured anthropogenic influences on the estuary and coastal environment.

The size of this estuary and its catchment result in a greater land-ocean interaction than many of the systems along the Kwazulu Natal coast and enables this study to address at least two of the themes related to the current activities of LOICZ, specifically “Anthropogenic influences on river basins and coastal zone interactions” as well as “Vulnerability of coastal systems and hazards to human societies”

Sediment-biota interactions in a polluted coastal lagoon (Pialassa Baiona, northern Italy): integrated geochemical and biological investigations

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We present the results of an interdisciplinary study carried out in the Pialassa Baiona, an heavily polluted coastal lagoon along the northwestern Adriatic coast, Emilia-Romagna region (Italy). It is a critical zone, since it is close to a major harbour area and a large industrial centre and the area has long been impacted by industrial discharges. It is directly connected to the sea and receives freshwaters mainly from agricultural lands.

The aim is to provide an integrated evaluation of the degree of pollution in the area, analyzing the bulk chemical composition of different sediment compartments: suspended sediments, 0-5 cm and 5-10 cm layers derived from sediment cores. The evaluation of easily removable metal fraction after EDTA extraction (Cr, Cu, Ni, Pb, Zn) and the analyses of selected biomarkers in *Mytilus galloprovincialis* and *Chamelea gallina* in addition to the trace metal content in their tissues have been performed in order to evaluate the status of the environment and to investigate sediment-biota interactions. *M. galloprovincialis* lives in the water column and can integrate water column and suspended sediment pollution, while *C. gallina* lives within the sediments and mostly reflects this compartment. A battery of 6 biomarkers has been employed, some sensitive to a specific (metallothionein content, AChE activity), other sensitive to a generic (lysosome membrane stability, neutral lipid and lipofuscine accumulation, heat shock proteins) stress syndrome. The bivalves were exposed for 30 days in 5 sites within the lagoon, chosen for marked differences in the degree of pollution, which are related to the proximity of the pollution sources.

Metal concentrations are locally high, at least one order of magnitude higher compared to local background values, with Zn and Cu being the most concentrated elements in the pollutes sites. Tests on mobility identified Pb as the most easily mobilized among the studied elements. Good correlation between biomarker responses and the degree of environmental pollution, mostly related to anthropogenic perturbations, has been determined. This combined approach is particularly effective in the evaluations of the environmental status of a coastal areas subjected to various kind of pressures.

Predicting Future Shoreline Condition Based on Land Use Change and Increased Risk Associated with Climate Change

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Marshland and riparian buffer are facing an increased risk of degradation in the face of land use conversion and climate change. Change in land use can bring about changes in shoreline condition, and by examining these relationships, a more realistic model of future shoreline condition can be developed. The project was conducted in Guinea Neck, Virginia, an area characterized by very low relief, mixed land uses, and a sizable rural population. Historical imagery was used to build a prediction model to evaluate future land use conversion. Image sets spanning 65 years were digitized, classified for land use, and classified for proximity to features that would make development more appealing (water, roads, schools, etc.). The prediction of future land use was based on the historical rate and proportion of conversion from one land use to another. Sea level rise resulting from climate change was estimated for the low-lying study area and incorporated into the model. Correlations between land use and shoreline condition were then used to build a fuzzy logic framework to predict the impact of land use change on condition of the shoreline. The model is intended to aid coastal managers and decision-makers in assessing likely changes to coastal resources over time. This information can be used to encourage appropriate incentives and regulations to guide shoreline development and preservation. As part of the analyses, various management strategies will be examined to determine their effects on future shoreline condition.

Estimating Natural Silica Fluxes to the Coastal Zone Using a Global Segmentation

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Natural fluxes of dissolved silica (DSi) to the coastal zone have been established on the basis of a segmentation of the continental surfaces in 140 mega catchments linked to coastal segments. These segments are defined on combined criteria as natural geographic boundaries of continents/oceans/regional seas, coastal morphology, submarine relief, runoff distribution on coastal cells, and, if needed, coastal currents and tectonics (Meybeck et al. 2005 submitted). Political/administrative boundaries are not considered at this stage. Segments have a maximum homogeneity for land and ocean attributes. Median average depth of the segments is 150 km, median length a little over 2000 km. Only 13 of the drainage basins of the coastal segments exceed 1000 km in depth. The global silica budget is based on documented river DSi data on 57 % of the exorheic area (i.e. $\sim 115 \text{ M km}^2$) and 57 % of the total exorheic discharge

(i.e. $\sim 40000 \text{ km}^3 \text{ y}^{-1}$) for major world rivers with minimum human impacts, such as reservoirs, using databases like GemsGLORI (Meybeck and Ragu 1995) and PRISRI (Meybeck 2004). In total about 200 rivers are documented, with catchment areas varying between 10^5 and $6.4 \cdot 10^6 \text{ km}^2$. Total area and runoff of the coastal catchments connected to the coastal segments are established using global databases at 0.5×0.5 resolution (Vörösmarty et al. 2000 a,b; Fekete et al. 2002). The total flux from the individual catchment is the sum of documented river fluxes in each catchment plus extrapolated fluxes based on the estimated concentration (using climate and lithology similarities) and the water runoff from global models. Results show a global mean concentration of 9.3 mg l^{-1} , well within the range of literature values, and a global mean yield of $3.3 \text{ t DSi km}^{-2} \text{ yr}^{-1}$. 56 % of the silica flux to the coastal zone occur in 17,4 % of exorheic area where silica flux exceeds 2 times the world average. From one coastal catchment to the other DSi yields may vary over 2 orders of magnitude, illustrating the intrinsic heterogeneity of the global puzzle of mega catchments. About 1/3 of silica fluxes are not discharged directly to the world oceans but are actually reaching regional and marginal seas basins.

Towards a classification of coastal ribbon lithology using a new global data base

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Surface lithology of the global coastal ribbon, here defined at 50 km depth, is needed by various scientific communities, working on coastal erosion, water resources management, coastal ecology etc. Estimating global direct inputs of groundwater to the coastal zone needs knowledge of lithology (e.g. karst regions on the coasts, coastal alluvial aquifers). Lithology of the coastal ribbon has been estimated using a new digital map of the continental surfaces targeted to riverine material transfer (Dürr et al. 2005 submitted) identifying 15 lithological types. These types may be used to answer questions related to erosion, water chemistry, and aquifer porosity.

The data base will be proposed for the 'LOICZ cross-cutting activities addressing issues of the advancement of a coastal typology, data and modelling' at a 0.5×0.5 resolution and/or as coastline segments. The average coast lithology is then re-aggregated at the level of 140 mega coastal segments (Meybeck et al. 2005 submitted) and to their related runoff (Fekete et al. 2002).

GIS Techniques for Coastal Habitat Conservation in the Rio de la Plata

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The integration of Remote Sensing and Geographic Information System in coastal habitats analysis and biodiversity assessment is an emerging field. This study uses RS

and GIS to examine the relationship among focal species, biodiversity and water characteristics along de estuary of the Río de la Plata. Coastal zones are seat of multiple and sometimes incompatible human activities, interacting with the environment. A better understanding of these interactions is critical to sustainable development.

The Uruguayan coastal zone is the area of the country of greater concentration of population and different activities that cause a strong pressure deteriorating the natural resources. For more than ten years one has been looking for to make a scope where an integrated management of the coastal zone (GIZC) on the basis of a scientific criterion is developed, a plenty social participation and normative adapting.

One first requirement in GIZC process is to organize the significant information in a consistent way with the aim to reach a holistic vision of the coastal geographic spaces, characteristics and conflicts. The work involves the implementation of a GIS used so much as the main storage device of data bases as well as tool to develop models based in ecological sensitivity analysis.

The focus of this project is the application of this technology to the environmental protection and conservation of habitats and to the management of the coastal resources. The product will be a tool which can be used to identify environmental sensible coastal areas and main threats to habitats.

The methodological approach is base in the WWF (World Wildlife Fund) which allows finding a biological assessment. This is built on the distribution of species, communities and habitats in the ecoregion, ecological processes sustaining that biodiversity and current and future threats to its maintenance.

It was also considered some habitat information as substratum types, oceanographic environment and environmental threats like contamination, biological invasion, harmful algal blooms and habitat destruction.

Using GIS tool took to identifying and mapping diverse aquatic ecological systems, compiling data from different sources, adjustment of the information to enter it to the system, processing and georeferencing images, linking databases, storing and retrying information. Others steps included the manipulation of the information weighting it with biological criteria which involve analysing ecosystem structure and function.

Applying these criteria which considers high species richness of species assemblages, significance for population and/or ecosystems processes and relevance for charismatic and engineering species inducted to identify 8 priority areas to be protected.

Applications of Remote Sensing in the Study of Tidal Environment Ecogeomorphology

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Salt marshes and mudflats in tidal environments are characterized by complex spatial patterns of form, both in their geomorphological and ecological features. This contribution aims at retrieving accurate quantitative maps of salt marsh vegetation in the Venice Lagoon (Italy). In order to study and monitor the heterogeneous patterns of intertidal biotic and abiotic components, we collected remotely sensed observations and accurate ground truth data during several campaigns under the European Project TIDE (Tidal Inlets Dynamics and Environment, EVK3-CT-2001-00064).

Observation/classification schemes are proposed in terms of appropriate spatial and temporal resolutions, comparisons among airborne and satellite sensors with different spectral and spatial resolutions, ground ancillary observations, data pre-processing, classification schemes, and training and validation procedures. Applications include the use of 3 airborne hyperspectral sensors (RODIS, 1 acquisition; CASI, 2 acquisitions; MIVIS, 5 acquisitions) and 2 satellite multispectral sensors (Ikonos, 1 acquisition; QuickBird, 5 acquisitions). The merits of the classifications based on each sensor are discussed. The spatial structure of intertidal vegetation is then studied on the basis of the optimal classification schemes selected and physical factors influencing plant organization are discussed.

Method for the Design of a Participative Indicator System as a Tool for Integrated Coastal Local Management, Bragança Peninsula – North Brazil

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Guidelines developed during the last decades for the implementation of Integrated Coastal Management (ICM) programmes underline the relevance of indicator definition to monitor changes, trends and effectiveness of ICM efforts. Guidelines also highlight the importance of involving stakeholders in all ICM process at the earliest possible stage. This study proposes a method for the design of a participatory indicator system as a tool for coastal management at village level. Two main stakeholders are addressed: villagers and researchers.

The method includes three phases: 1) a participatory process consisting of an acting together approach where stakeholders have the opportunity to decide the orientation of the indicator system and define indicators for measuring changes and progress through time. 2) The design of a hierarchical structure based on the derivation of principles and criteria guided by stakeholders' priorities and its relation to the set of defined indicators. 3) A filtering process to improve the manageability of the indicator system by selecting of lower number of indicators. The resultant method is innovative because the hierarchical structure establishes a clear framework in which the aim of integrated coastal management is reflected through stakeholder determined principles and criteria.

This structure helps to visualize in which direction the region is facing changes and how those changes are related to the situation desired by the stakeholders. Moreover, its focus on local problems and desires leads to manageability and understandability of the indicator system by local villagers.

The coastal management indicator system constructed with the method above describe is intended as the first step in the development of a more comprehensive local monitoring tool for the assessment of marine and coastal sustainable development. For this reason, this study is related to the LOICZ conference theme "Towards coastal system sustainability by managing land-ocean interactions". The defined indicators should also give clues about marine and coastal vulnerability therefore the method could be linked with the theme "Vulnerability of coastal systems and hazards for human society". Moreover, the method is totally based on stakeholders' involvement and capacity building and therefore a cross-cutting theme.

A Model for Sustainable Management of Penaeid Shrimp Fishery – Application to Maputo Bay, Mozambique

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A mathematical model for sustainable management of a penaeid shrimp fishery is presented. The model was implemented for Maputo Bay, Mozambique, and integrates a bay-scale ecological simulation with a detailed description of penaeid shrimp population dynamics. The population model couples an individual growth model with a demographic model, in order to simulate the biomass and density of juvenile and adult size classes. The main physiological processes simulated at the individual level are ingestion, elimination, assimilation, respiration, maturation and spawning.

The bay-scale model includes water circulation and biogeochemical processes, and was implemented using an object-oriented paradigm. Maputo Bay has a significant shallow-water artisanal and semi-artisanal fishery, which annually captures about 600 tons of shrimp. Due to the socio-economic importance of the fishery to the local population, a socio-economic component was added to the model, allowing scenarios considering different catch periods, shrimp sizes and quotas to be simulated. The results obtained provide insight into population dynamics and distribution of *Penaeus*

indicus (H. Milne Edwards, 1833) in the bay, and on the effectiveness of different shrimp fishery management strategies.

Towards Nutrient Budget Scenarios for the North-Western Black Sea Shelf

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Integrating manifold existing and new data on sources and sinks of nutrients in coastal and shelf ecosystems into budget models can assist in developing ecological management scenarios that provide tools to coastal managers for decision support. Those budgets are even more helpful when different conditions of an ecosystem are considered, e.g. time spans that reflect certain states of an ecosystem.

The north western Black Sea shelf, for example, experienced severe changes in the ecosystem structure and functioning during the past decades; suffering from pollution, eutrophication and overfishing from the 1960's to the end of 1980's. After the collapse of the centrally planned economies in the beginning of the 1990's in eastern European countries, the ecosystem now starts to respond to the decrease in anthropogenic pressures.

We present here a simple nutrient budget for the north-western Black Sea shelf for the end-nineties, and a strategy towards more detailed budgets for the pre-eutrophication period (before 1960's), the eutrophication period (1960 to 1990) and the post-eutrophication period (1990 to recent).

The nutrient budget for the pre-eutrophication period is thought to reflect the sources and sinks during the pristine state of the ecosystem as baseline for management decisions. The budget for the eutrophic period should reflect sources, sinks and pathways during the time of ecosystem collapse and provide information on critical nutrient loads. It may also reflect the future if regulations on both sources and quantities of nutrient discharges fail to reduce them to pristine levels. The nutrient budget for the post-eutrophication period will also provide information on timescales until certain components of the system started to respond to decreasing external pressures.

The nutrient budget presented for the mid-nineties; the beginning of the post-eutrophication period, is based on field data of river input, atmospheric fluxes, benthic fluxes and sediment studies during the mid 1990's, and on modeling results of primary production, water column mineralization and transport of nutrients from a GHER 3D eddy-resolving coupled hydro-dynamical-biogeochemical model. According to the estimate about 65 % of the shelf primary production is remineralised

within the euphotic layer. 2 % of the material is transported off the shelf. 33% of the primary production reaches the sediment. Benthic nutrient recycling is a significant internal nutrient source for the pelagic system, sustaining high productivity by the release of phosphorus and nitrogen from the sediment in the same range as river inputs. The shelf sediments release about twice as much silicic acid than is discharged by the Danube. However, the shelf acts also as a sink for nutrients. After benthic decomposition 3% of the model primary production remains buried in the sediment. Model estimated atmospheric nutrient deposition seems to be of minor importance as it amounts to only 4-8% of the river inputs.

The International Study Group within the Black Sea Ecosystem Recovery Group, jointly with the Eutrophication Task Team of the EU FP6 project ELME (European Lifestyles and Marine Ecosystems), agreed to focus part of their work on detailed nutrient budgets for the different ecosystem states of the north western Black Sea shelf. The outcome of this work will provide valuable information for the International Commission for the Protection of the Danube River and Black Sea Commission in their joint efforts to control eutrophication through adaptive management.

Why don't we learn?

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This presentation will focus on the integration or non-integration of science into fisheries policy and management decisions and the implications for communities dependent on those fisheries. Two fishery case studies from Canada will be presented, the Northern cod in Newfoundland and Labrador and salmon selective fisheries in British Columbia, where science was not or was integrated into policy and management decisions, respectively. Another study will focus on the current conflict with respect to salmon aquaculture and the protection of wild salmon in British Columbia and related issues for coastal communities.

Cuban Experience on ICZM: In Search of the Best Mechanisms for the Coordination and Decision Making Processes in Coastal Zone Management in Cuba.

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Effective integrated coastal zone management (ICZM) requires that both, activities within the coastal zone itself and from outside the coastal zone are addressed. Cuba as an archipelago, does not possess any area where an action that takes place does not affect coastal resources. The identification of a sound and applicable local and regional mechanism for the ICZM has

been one of the main goals of the National Group for Coastal Zone Management. Created in January 2002, the Group is coordinated by the Ministry of Science, Technology and Environment and formed by national agencies and bodies, research institutes and project managers, among others, with jurisdiction over or expertise in issues related to the use and exploitation of the coastal zone. As a result of more than three years of work and through a very intense and participatory process, the Group has identified and assessed several mechanisms capable of giving appropriate responses to the challenges of ICZM. The National, Provincial and Municipal Councils of Hydrographic Basins are among the best organized mechanisms as is demonstrated by the outcomes of a GEF/PNUD Project involving five of the fourteen Provinces of Cuba. This paper will discuss the structure, functions and objectives and will analyze and propose an adequate agenda for some of these mechanisms, as well as the causes of coastal zone degradation due to local impacts, but also due to indirect ones as a result of the development of activities and processes in these ecosystems.

Addressing the Need for Coastal Research and Policy Integration - the Corepoint Project

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Concerns over coastal problems are common to numerous European countries. Following the completion of the Demonstration Programme on Integrated Coastal Zone Management (ICZM) a set of recommendations on a European Strategy was formulated. Subsequently, there have been varying levels of engagement with, but no true implementation of, this strategy across European Union Member States.

Funded under the INTERREG IIIB programme, the *Corepoint* Project consists of 12 Partners from Ireland, UK, France, Netherlands and Belgium. These Partners were deliberately drawn from both the coastal research and local authority communities in order to improve communication between the two sectors and pool their respective areas of expertise. These include environmental education and training, applied marine technology, spatial planning, coastal management, pollution, marine law, port and marine industry development, benthic ecology and socio-economics. This expertise is being harnessed to progress the development and implementation of ICZM solutions across the Northwest Europe region.

This presentation will discuss the unresolved key issues associated with implementing the outcomes of the Demonstration Programmes. It will outline how the *Corepoint* Project will seek to address these issues and demonstrate that solutions are dependant on successful integration of coastal research and policy. In addition, it will detail the activities perceived to be necessary to achieve the Project objectives and therefore the overall goal of the Project - to establish Northwest Europe as an internationally recognised region of excellence in coastal management.

National ICZM Strategies in Germany: Challenges to the Spatial Planning Approach

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Driven by a range of developments, German marine and coastal areas are facing profound change. Of particular importance is the rapid expansion of the offshore sector, which is characterised by the emergence of new permanent large-scale uses, the intensification of land-sea interactions and also new conflicts of use.

In Germany, these developments have served as a starting point for the development of a national ICZM strategy. The Federal Office for Building and Regional Planning and the Ministry of Transport, Building and Housing are currently developing suggestions for a national ICZM strategy from the point of view of spatial planning. The project aims at designing a framework suitable for the specific German context, with the establishment of a polyculture of use as its core concern.

A comprehensive stocktake was carried out of the coastal zone, comprising coastal and marine ecosystems as well as key institutions and the regulatory framework. Issues were then categorised into those requiring national input and those best dealt with at a regional level. This led to the proposal of a national strategy based on (1) a systems-oriented view of the coast, (2) the principle of compatible and incompatible resource uses, (3) the objective of establishing a system of sustainable multiple resource use, (4) the use of spatial planning as a key tool, and (5) a decision-making structure for the coast based on increased dialogue and transparency.

The project has made clear that marine spatial planning is likely to play a key role in delivering core management objectives of German ICZM. The main challenge lies in the facilitation of a continuous ICZM process, which needs to be sufficiently robust to deal with future economic, ecological and social changes on the coast and in society at large. This process must actively support the development and continued review of a vision for the coast. Another key challenge is the development of indicators capable of measuring integrated processes and the success of ICZM on a national and regional scale.

LaguNet, the Italian lagoon observational network: Evaluation of fluxes and derived ecosystem functions in the transition zones along the Italian Coast.

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LaguNet is a scientific observational network studying the fluxes of nutrients and other contaminants from lagoon catchments to the near coastal environment along the Italian coast. It was inaugurated in April 2002 in Venice from an idea developed during the workshop "Coastal and estuarine systems of the Mediterranean and Black Sea regions: carbon, nitrogen and phosphorous fluxes" organised in Athens (2-5th February 2001) by LOICZ with the support of UNEP and ELOISE. The main objectives of LaguNet are:

- i. to support and encourage co-operation of research groups studying lagoons, wetlands and salt marsh systems.
- ii. to promote an agreed common approach to the studies of biogeochemical processes, typology, indicators of health and quality that can provide support to management or policy applications in these transitional ecosystems.
- iii. to provide a forum for discussion and cooperation between researchers and administrators who are working in lagoons, wetlands and salt-marshes at sites along the Italian coast.
- iv. to evaluate the available information and present understanding of the biogeochemistry of carbon, nitrogen and phosphorous in transitional and coastal waters for the application of the LOICZ budgeting and typology approaches.
- v. to promote the institution of similar networks in the Mediterranean area and consider the feasibility of developing one or more projects either with Mediterranean EU partners as well as eventually from Eastern Europe and North Africa.

Presently LaguNet comprise 125 scientists, administrators and PhD students, 24 Italian sites are under investigation and the first results of budgeting are published in the LOICZ Report & Studies n° 28. Moreover groups are working on typology of transitional waters and benthic indicators of environmental quality. Details on these activities can be found in the web site www.dsa.unipr.it/lagunet.

Collaborations are developing with sister networks in France, Greece, Portugal and Spain, a first International Conference was organised in 2003 in Ferrara (Italy) and the second is scheduled for October 2005 in Klaipeda, (Lithuania, www.lagoons.corpi.ku.lt).

The first effort of LaguNet was to apply the LOICZ biogeochemical flux model to a number of sites located along the Italian coast. In Italy there exist numerous studies, including over the long-term, investigating coastal processes, in which the LOICZ methodology can be applied. Presently LOICZ budgeting was applied to 22 sites distributed around the whole of the Italian peninsular and islands. In total 94 flux estimations have been undertaken considering a wide range of systems and different time periods. This network of sites presents a very wide range of varying characteristics such as climate, surface area, water depth, primary producers, exploitation and management and a very high density of data. Interesting outputs exit from this exercise, in particular this approach allow to compare systems with different characteristics and their evolution can be described by a series of budgets calculated

in different years. Comparing LaguNet budgets to the global budgets of the LOICZ database, similar general trends can be identified.

Human Induced Bloom Generated by Miño River Plume Intrusion into a Galician Ria Baixa (NW Iberian Peninsula)

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An unusual intrusion of low salinity water was observed in the Ria of Pontevedra (NW Spain) on May 12-13 1998 coming from the Miño River (situated 40 km south from the Ria of Pontevedra). The abnormally high discharge is due to the sudden release of water from the dams that control the Miño river runoff. This discharge results in a strong along- axis salinity gradient, salinity decreases seaward, giving rise to a two- layered circulation pattern, with near bed water moving seaward and near surface water landward. In addition, a clear gradient of biogeochemical and biological variables was observed in the ria, with decreasing values towards the middle zone. The nutrient salts, the oxygen, the chlorophyll and the phytoplankton patterns suggest the existence of a bloom penetrating the ria embedded in a water mass fresher than the estuarine one. The high concentration of phytoplankton *Skeletonema costatum* observed as late as May also supports the idea that this bloom exhibits the features of the typical early spring bloom characteristic of the Rias Baixas linked to haline stratification caused by an important supply of continental water.

The antropogenic nature of the bloom can be interpreted in terms of the different patterns followed by the rivers in the area. The Miño River, located 40 km south from the estuary, is controlled by dams and the Lerez River, located inside the estuary, follows a natural pattern. Thus, the Lerez River discharge measured in April 1998 exceeds in 125% its historical values corresponding to that month while the Miño River only exceeds its historical values in 40% due to the presence of dams. At the beginning of May, the Lerez River discharge decreases and approaches its historical values, but a high fresh water pulse is released from the Miño River dams, exceeding its historical values in about 200% for 4 days. This results in an induced phytoplankton bloom at the adjacent shelf, which moves northward due to the prevalent SE winds. When reaching the neighbor Ria of Pontevedra, this nutrient rich water is pumped into the ria through surface layers due to the creation of a density gradient in the along axis direction (density decreases seaward). This induced bloom was firstly generated at the shelf as reflected by the appearance of NH_4^+ and the presence of a phytoplankton community with species characteristics of post- spring blooms. Nevertheless, the nutrient load is still high enough to fertilize the external and middle part of the estuary, resulting in an extra feeding source for mussel and clams, which are the main shellfish cultures in the area.

INSIGHTS FROM ECOSYSTEM MODELLING THE DECLINE OF STELLER SEA LION AND THE ECOSYSTEM OF THE GULF OF ALASKA

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Ecosystem models are useful to describe what we know about an ecosystem, and the impact of ocean productivity and fisheries. It also allows to evaluate data compatibility and generate hypotheses taking into account historical information. Such models are data driven and rely on data from stock assessment and other monitoring systems. We constructed ecosystem models using Ecopath with Ecosim software to evaluate scenarios that might explain the decline of Steller sea lions in the western Aleutians since the late 1970s. We also sought to compare our results with those from Southeast Alaska where sea lions have continually increased since the 1960s. Modelling results found that predicted trends in abundances of fish and sea lions were similar to those observed when environmental variations, fishing, competition and predation were taken into account.

3D-Numerical Modeling of the Hydrodynamics in a Tidally Energetic Tropical Embayment.

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The hydrodynamic processes of Maputo Bay, Mozambique (~25.9 S, 133 E), during seasonally varying fresh water inflow and wind conditions were studied under the Catchment2Coast project (www.catchment2coast.org) in order to understand the influence of the circulation on larval settling patterns and shrimp catches. Maputo Bay experiences a subtropical climate with summer rainfall and is heavily utilized for subsistence and commercial fishing. The hydrodynamic processes influence the biogeochemical cycling within the bay where anthropogenic changes in the catchment may result in changes in bay circulation leading to potential changes in the shrimp catches. Comprehensive field work surveys and three-dimensional numerical modeling were used to explore the sense and strength of the bay circulation and the influence of runoff and wind on the circulation of the bay. Field work results showed a pattern of a warm (20 C), salty (35) and vertically mixed water column. Changes to this occurred during the wet season, near the three river mouths, under heavy (>100m³s⁻¹) fresh water inflow conditions where the water column stratified and tidal straining was observed. The Delft3D-FLOW model successfully reproduced the seasonal and higher frequency variability observed within the bay and was used to

further explore the circulation under varying fresh water inflow and wind conditions. Surface drogues, released across the mouth and middle of the bay, under no wind and both wet ($>38\text{m}^3\text{s}^{-1}$) and dry ($<5\text{m}^3\text{s}^{-1}$) conditions were moved offshore in a north to northeasterly direction. Residual circulation patterns were similar for both dry and wet periods, indicating that the circulation is driven by the interaction of the tide and bathymetry rather than baroclinic effects. The bay was filled with a conservative tracer during these two periods and the bay flushing time explored. After 1 month, under both dry and wet conditions, the dye was up to 80% diluted in the mouth region, between 30-60% diluted in the central part of the bay and $<20\%$ diluted in the southern regions of the bay. Dilution of $>90\%$ took 4 months in the western region, between 5–6 months in the central and southwestern region and 11 months in the southeastern region. The effects of wind and fresh water inflow on hydrodynamic processes were further modeled and linked to shrimp larvae settling patterns.

Managing Canada's Oceans and Coasts: A *Framework and an Emerging Plan*

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The world's oceans and coasts are under significant stress not only from traditional uses, but also from the growing number of new and potentially conflicting activities which have emerged in recent years. While this is not news to those involved in LOICZ, it is only gradually that a number of key jurisdictions are beginning to grapple with the complex issue of Integrated Coastal and Ocean Management (ICOM).

The presentation will outline a *framework* for understanding this complexity. The first component is the challenge of the *scale of ICOM issues*, the need to adapt response mechanisms to these varying scales, and the requirement for consistency across the scales. The second component is the enduring environmental and ecosystem problem of "*common property*", particularly in fluid and migratory systems which characterize coastal and ocean areas.

The framework will then be used to outline recent ICOM activity in Canada. Having the world's longest coastline (at some 245,000 km), Canada faces significant issues at the very large world/national scale all the way through to local issues of major import – and this on three oceans (Atlantic, Arctic, Pacific).

The presentation will focus on recent developments at the federal (national) level. This will include a review of the Oceans Act (1997), the Oceans Strategy (2002), and the ratification by Canada of the United Nations Convention on the Law of the Sea (UNCLOS) in late 2003. More detailed comments will be provided on the preparation and implications of the Oceans Action Plan (OAP) (May 2005). This first phase focuses on four key pillars: International issues; Health of the Oceans (including a national strategy from Marine protected Areas (MPAs); Integrated Management; and Science and Technology. The presentation will then focus on next

steps, including the key issue of governance. It will conclude with comments on the unique challenges which Canada faces in the Arctic, including the current impact of global warming on coastal communities and the coastal and marine environments.

Global Change Implications for Asia-Pacific Coastal Management

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The Asia-Pacific Network for Global Change Research (APN), a 21-member intergovernmental network, recently commissioned a review of coastal research. The purpose of the review was to evaluate achievements of previous APN-funded coastal projects; to assess current issues for Asia-Pacific coasts; to identify future global-change research directions relevant for coastal management in the region; and to assist the APN in determining priority areas for future research support. The review assessed 20 APN-funded coastal research projects in the Asia-Pacific region of which 11 had coastal issues as their main focus.

Results of this review show that the majority of the projects assessed were successful in relation to the APN goal of 'supporting regional cooperation on global change research' in addition to a number of projects which achieved cooperation with other global change networks such as LOICZ (Land-Ocean Interactions in the Coastal Zone). Many projects were also successful in terms of the APN goals of 'capacity building' and 'scientific data exchange' but this could have been improved with better project design and linkages to longer term funding sources extending beyond the initial APN input. An important area for improvement of global-change coastal research in the region is to develop more effective science-policy interaction, which may require alternative strategies to be developed in the future. A number of APN-funded projects are identified in the review as examples of best practice. The review notes that important outputs have been achieved even once the APN funding for a particular project had ceased, for example, a Pacific-based workshop held in 1998 led to a number of coastal projects being developed over subsequent years. Similarly, project outputs such as refereed scientific publications often appear some time after project completion.

This paper presents results of the APN review in the context of coastal system sustainability and the need to use global change research in order to improve management of land-ocean interactions in the Asia-Pacific region. The paper identifies global change issues for the region, the most important of which is global warming and accelerated sea-level rise. The potential impacts from this are compounded by current issues; such as unsustainable use of coastal resources; coastal impacts from poor catchment management; population increase and urbanisation pressure; coastal resource and development pressure on rural coasts. Methods for tackling these issues such as integrated coastal management have few examples of best practice in the Asia-Pacific region. There is a need to recognize the diversity of coastal management practices in the region and to develop appropriate national and

local policies. Similarly there is a need for this to be accompanied by appropriate education putting less reliance on English-based material and western concepts. The paper concludes with a discussion of strong and weak sustainability options for coastal management in the context of global change research in the Asia-Pacific region.

History and Ecology of the Western Scheldt Estuary

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The Western Scheldt estuary drains the Scheldt River into the North Sea. The Scheldt drainage basin covers three countries France, Belgium and The Netherlands and one of the most highly industrialised and densely populated areas in Europe. It is one of the best studied estuarine systems in the world. Its history is well documented and reflects the interplay of political, religious and economic developments with the dominant physical processes, storms, sea level rise and the tidal energy from the North Sea over the last 2000 years.

Most of the changes in geomorphology of the estuary are directly or indirectly due to human activities. Direct changes were due to the exploitation of peat in Roman times, the construction of dykes and consequent land reclamation from the 12th century onwards and the dredging of the shipping channels in the 20th and 21st century. Human control of geomorphology was counterbalanced by a series of heavy storms and floods over the ages, the last one in 1953. Some floods were deliberate and used for military purposes, especially those against the Spanish occupation in the 1500's, that changed the landscape until the present day, and that against the Nazi occupation in the 40's of the last century, when only the interior of the island of Walcheren was flooded.

Changes in biodiversity and productivity are linked to eutrophication resulting from high population density and industrialisation already in the Middle Ages but increasingly until the sixties of the last century, and were imported from the river. Due to increased water purification, the filter function of the estuary has changed dramatically over the last forty years, with increased oxygen concentrations and a land inward migration of the nitrification and denitrification fronts. This has allowed the return of migratory fish species and harbour seals. The application of the EU Birds and Habitat directives will further strengthen the estuarine filter, for instance by maintaining the river's tidal creeks and inlets as hot spots in the transformation processes of nitrogen and silicon.

Methodological Issues in Coastal Vulnerability Assessment

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Coastal vulnerability is determined by many factors. Its assessment is an interdisciplinary analysis of the complex interactions between natural and social systems, requiring the integration of knowledge from various scientific disciplines. Different definitions and methodological approaches exist for vulnerability assessment. Due to the complexity of the issue, the short scientific history of this field and the diversity of systems and scales considered, it is evident that there cannot be a single recipe.

In spite of the lack of commonly agreed definitions or approaches, there is a great need to be able to assess and compare the vulnerability of regions, countries and sectors. In fact, comparability is key to the notion of vulnerability: policy-makers often ask which country, region or sector is most vulnerable. In addition, there is an opportunity to learn from and build on past assessments and methodologies, which has motivated the analysis of different definitions and approaches, as well as the development of overarching vulnerability frameworks (Ionescu et al., 2005, O'Brien et al., 2004, Brooks, 2003, Füssel and Klein, 2002).

For vulnerability assessments to be compared, they must share some common ground. Given the diversity of approaches and types of systems studied (natural and social), this common ground must be very general. The definition of vulnerability should therefore only include those elements that are absolutely necessary and it must be independent from a specific domain of application. Another prerequisite for the comparison of vulnerability assessments is methodological transparency. In the absence of a single approach that meets all requirements, the approach chosen or developed must be fully transparent, ensuring that others can understand the results and learn from the approach taken.

This paper illustrates these methodological considerations, using the example of the DIVA model for assessing coastal vulnerability on a global scale. The DIVA model has been developed within the EU-funded project DINAS-COAST. Starting with a general domain-independent mathematical definition of vulnerability taken from Ionescu et al. (2005), we show how this definition has been specialised to the needs of DINAS-COAST. The challenge lies in identifying and integrating the relevant natural and social science subsystem knowledge, which is complicated by the fact that this knowledge evolves over the course of the project as a result of the mutual learning process. Instead of working with one fixed definition of vulnerability, DINAS-COAST created and applied an iterative process of knowledge integration that allowed for refining and specialising the initial definition of coastal vulnerability during the assessment.

The Development of the DIVA Tool for Assessing Coastal Vulnerability

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This paper presents an interactive tool for the quantitative assessment of coastal vulnerability to sea-level rise and the methodology by which it was developed. This tool is called DIVA (Dynamic and Interactive Vulnerability Assessment) and is the final product of the EU project DINAS-COAST. DIVA comprises three components: a world-wide coastal database, an integrated model, and a graphical User interface (GUI). The route, to make the model itself available to the public, instead of only the results produced with it, was taken, because an interactive tool is a more powerful and comprehensive way of presenting complex multi-dimensional assessments than static data and papers.

The challenge in the development of such a tool lay in the integration of Natural and Social Science knowledge about the coastal sub-systems in form of data, dynamical models, and sub-questions to be addressed. Thereby, a trade-off between the scientific requirements of the project's participants and the end-user requirements had to be reached. First, a common data model was needed, which is powerful enough to represent the divers knowledge of all participants, but also simple enough for delivering a fast and comprehensible model to the end-user. To this end, a unique unit of spatial reference was introduced by splitting the world's coast-line into segments according to geomorphological and socio-economic criteria. Then, data from heterogeneous sources had to be collected and pre-processed into a consistent world-wide database. Simultaneously, the sub-models operating on this data needed to be coded as modules and configured into the integrated model. In order to make the data and the model accessible a GUI giving the user a lot of analytical power while not overstraining her with too much complexity was needed.

The integration process is a challenging organisational issue. The project's participants belonging to different scientific disciplines often use incompatible terminology and are distributed over various institutes. Frequent meetings are not possible; most of the tool development had to be coordinated via telephone calls and the Internet. Furthermore, the interactions between sub-systems are usually not fully understood at the start of the project; instead, such understanding is a major result of the project itself. These circumstances necessitated a flexible tool design, where new knowledge can be incorporated at any stage of the project, and an organisational structure which fosters communication and collaboration between the partners. To address these challenges, an iterative, web-based and semi-automated development process was introduced, which is based on the elaboration of a common formal language. DIVA was then produced by iterating the development process, refining the language, the data, the modules, and the GUI until a satisfactory result was achieved. The advantage of this approach is, that whilst at any stage of the project new knowledge can be incorporated, there is always a functioning tool available.

Biogeochemical Responses to the Removal of Marine Aquaculture Structures from the Eutrophic Lagoon (Tapong Bay) in Taiwan

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The Tapong Bay is one of major lagoons in southern Taiwan and is an ideal site to study the influence of environment change on the coastal ecosystem, as the surface structures (oyster racks and cage farming facilities) of marine aquaculture have been cleaned up during the study period. Therefore, this study aims to evaluate the influence of surface structure removals on biogeochemical processes and budgets of carbon and nutrients in the Tapong Bay. In doing so, dissolved and particulate phases of inorganic and organic carbon and nutrients were investigated bimonthly. The study lasted from August 1999 to August 2004 during which the surface structures were completely removed on January 2003.

Despite a small lagoon, the water residence time was not short as constrained by a narrow inlet between Tapong Bay and Taiwan Strait. Before the removal of surface structures from the Tapong Bay, the annual mean of water exchange time was about 10 days that was longer than that of the present condition (7 days). This suggests that the flushing condition of lagoon water has been improved after the surface structures were removed. The annual mean of each nutrient concentration was also lower at present situation than before condition, likely due to the enhanced water exchange rate and biological utilization. Consequently, water quality was improved after the removals of surface structures. Nevertheless, very high primary productivity was maintained and appeared to be constrained by solar radiation and turbidity rather than by abundant nutrients throughout the study period. The pattern of plankton community changed significantly after the removal of surface structure, largely resulted from the removals of oysters and most periphyton from the lagoon. The change of stoichiometric ratios among inorganic and organic nutrients (C/N, Si/N, N/P) may be derived from the shift of plankton community between two periods. The annual mean of $\Delta\text{POC}/\Delta\text{PN}$ was 8.1 that was larger than that of the previous condition (7.3), possibly resulting from the increase of inputs of organic detritus. Although the Tapong Bay remains an autotrophic system ($[\text{photosynthesis (p)} - \text{respiration (r)}] > 0$) after the removal of surface structures, the net ecosystem production (p-r) at present ($11.6 \text{ mol C m}^{-2} \text{ yr}^{-1}$) is twice as large as that ($5.6 \text{ mol C m}^{-2} \text{ yr}^{-1}$) of the before condition. After the removal of structures, the annual nitrogen fixation still exceeds the annual denitrification in the Tapong Bay with a magnitude of $5.35 \text{ mole N m}^{-2} \text{ yr}^{-1}$. The change of environmental conditions appears to influence carbon and nutrient biogeochemical processes and budgets significantly in a semi-enclosed ecosystem.

GIS based Vulnerability Mapping and Coastal Zone Management: a Case of a Part of Tamil Nadu Coast, India

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India has roughly 7,500 km of complex coastline with different problems and growing congested cities. Coastal Zone has complex human activity in the past and present, followed by high growth of urbanization and human interference. The present paper addresses the ecosystem change and its effect along northern Tamil Nadu coastal system, identification and mapping of vulnerable areas and vulnerable coastal community through GIS based mapping techniques. The purpose of this paper is to assess and explain spatial problems and suggest suitable spatial solutions for better coastal management. The assessment, comparison and mapping have been done using two-stage approach to land evaluation methodology and Land system based ecosystem approach.

Physical and socioeconomic surveys have been conducted to assess coastal resources of the study area. GIS mapping approach has therefore been used to study each unit of coastal area for better Coastal Zone Management. Geomorphologically the area has a wide coastal plain characterised by strandlines, lagoon, estuaries, creek, barred dunes, spits, beach terraces, mangroves, salt marsh etc. More than 40 per cent of rainfall is received from North East Monsoon period (October-December). During April- June the temperature goes up to 40°C and during winter the temperature falls up to 20°C. The annual rainfall is around 1200mm. The entire coast is affected by cyclones during North East Monsoon period. The present coastal zone consists of different ecosystems: beaches, agriculture, estuaries and important tourism centers. Since this area has many industries mixed with residential zones, pollution became a severe problem. Northern part of the area suffers erosion problem and there is a need to protect the coast from erosion. Levels Erosion, deposition, flooding, pollution, salt-water intrusion, coastal hazards and human activities have been identified and mapped with suitable spatial solutions.

Anthropogenic Influence on Estuarine Derived Nutrient Dispersal in the Nearshore off two Permanently open South African Estuaries with Contrasting Freshwater Inflow.

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Nutrient dynamics in two contrasting estuaries and in the adjacent nearshore waters along the south-east coast of southern Africa was investigated seasonally. The Great Fish estuary is a freshwater dominated, terrestrially driven system with an annual freshwater inflow of $250 - 650 \times 10^6 \text{ m}^3$ per year due to an inter-basin transfer of water from the Gariep Dam to the Great Fish River. In contrast, the Kariega estuary is a freshwater deprived, marine dominated system with a freshwater inflow estimated at $2.5 - 35 \times 10^6 \text{ m}^3$ per year. The reduced freshwater inflow can be attributed to regular impoundments along the Kariega River. Water samples were collected from surface and subsurface layers along the length of the estuaries as well as from a series of transects occupied in the nearshore environment. Samples were analysed for nitrate, nitrite, phosphate, ammonium and silicate concentrations. Temperature, salinity, depth and turbidity were recorded at each station. A LOICZ model was applied to both estuaries to assess nutrient cycles over the various seasons. In the Great Fish estuary nutrient concentrations were determined primarily by river flow rather than rainfall within the catchment. Outflow of nutrient-rich water into the adjacent nearshore environment was evident. In contrast, in the freshwater deprived Kariega estuary, the influence of the estuarine water on the nearshore environment was minimal reflecting the reduced freshwater inflow into the system.

Very little work has been done on the marine-estuarine links in southern Africa and in particular the fate of dissolved and suspended materials in the nearshore environment. Results from the study indicate that anthropogenic influences (impoundments and inter-basin transfers) significantly alter the estuarine and nearshore nutrient dynamics. Land-use patterns, principally agricultural practices in the Kariega catchment, may represent an important allochthonous source of nitrates and phosphates in the Kariega estuary. The biological consequences of the different nutrient cycles in the two contrasting estuaries are discussed.

Changing Human Demands in Marine Areas: Implications for governance and use of integrated assessment concepts

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The presentation looks at governance needs in the context of changes concerning human demands in marine areas. Using the German North Sea coast and large scale development plans for offshore wind farms as examples for changing use patterns, it will discuss implications for national ICZM strategies as policy tools and the related application of integrated assessment as strategic tool, emphasising interactions between stakeholders and communities acting at different scales, natural processes and socio-economic frameworks.

Driven by a range of developments, German marine and coastal areas are facing profound change. Of particular importance is the rapid expansion of the offshore wind energy sector, which is characterized by emergence of new permanent large-scale uses, intensification of land-sea-interactions and new conflicts. A comprehensive

inventory performed within the development of a national ICZM strategy (as requested from the EU from its Member States) has identified a complex net of administrative and institutional structures, significant trends and likely impacts on the coastal zone, from which transparency, information flow and communication emerge as core points for a national strategy. Particular attention is put in the presentation to the interaction between statutory and non-statutory instruments, which could stimulate management across scales, from local islands to transnational scales. A proposal for the implementation of a national ICZM strategy, based on a hierarchy of informal fora, linking existing institutions will be discussed.

At the same time, suggestions for national strategies must be grounded in a solid analysis of ecological, economic and social impacts of coastal and marine changes. This challenge is taken up by “Zukunft Küste–Coastal Futures”, a LOICZ regional project funded by the German research ministry (www.coastal-futures.org). This project and its 12 subprojects provide an integrative assessment frame, linking concepts and tools of ecosystem theory and social sciences into an ICZM toolbox. Based on scenarios which describe a wide range of societal priorities for future development at the North Sea coast, ecological and economic impacts, chances and risks associated with different development paths will be investigated at different spatial scales and provide the frame for governance models. The presentation will discuss the need for a multiple use concept aiming to achieve an “optimum mix” of several demands in the German North Sea area within the national ICZM strategy.

The approaches of the national ICZM strategy for Germany and the integrated assessment discussed in the presentation are explicitly linked to theme 5 (Towards coastal system sustainability by managing land-ocean interactions) in the LOICZ II science plan, but as much contribute to theme 2 (Implications of global change for coastal ecosystems and sustainable development). The focus is on governance across several scales in the context of societal priorities concerning the future development of coastal areas and the link between scientific concepts and policy making.

An Integrated Coastal Zone Management Approach based on Scenario Development and LOICZ Budget Analysis: Application to a Coastal ecosystem in the Aegean, Eastern Mediterranean

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Integrated coastal zone management must be based on efficient tools able to predict possible stresses and future changes. Socioeconomic trends and opportunities are often included in scenario analyses, whereas budget analysis methodologies are used as quantitative tools to assess ecosystem changes. In the present work, an integrated approach towards coastal zone management based on scenario development and LOICZ budget analysis is proposed. The methodology is tested in the coastal zone of the gulf of Gera, Island of Lesvos, Greece. The gulf is a semi enclosed shallow water body influenced by anthropogenic activities in the surrounding watershed. Agricultural activities, mainly the fertilization of olive trees, and urban growth result

to the input of a significant amount of nutrients in the sea and eutrophication crises are observed, especially during winter, after episodic rainfall events. Two possible scenarios were tested related to agriculture intensification and urban/tourism development. The changes in the land use and the number of inhabitants associated with each scenario were used as the forcing factors to a watershed model, estimating the daily water and pollutants discharges to the sea from point and non-point sources. These inputs were further used in the LOICZ budget analysis. The gulf was treated for the analysis as a single-box and single-layer system and two time periods were considered, the stratification period (May-October) and the mixing period (November-April). The water exchange between the gulf and the open sea was estimated by an existing hydrodynamic model calibrated against field data. Important parameters for the functioning of the ecosystem as the groundwater inputs, the water residence time, the role of the system as a source or sink of nutrients and organic matter were estimated by the LOICZ model. The first scenario of agriculture intensification, including the cultivation of horticultural plants, flowers, vineyards and the development of greenhouses, leads to an increase of fertiliser and pesticide application which end up to the gulf mainly through the river flow. This loading seems to significantly alter the nutrient and organic budget of the coastal system. The second scenario (urban and tourism development) includes the construction of the supporting infrastructure in the form of road network, hotels, restaurants and small industries. The discharges associated to these activities seem to change significantly the present condition of the ecosystem. Furthermore, important parameters as the net ecosystem metabolism and the trophic state of the ecosystem were also evaluated for the present condition of the coastal system and the two future scenarios. The application of integrated tools including both socioeconomic information and the consequences on the physical environment seems to be efficient and promising in the framework of integrated coastal zone management.

Fishing and Aquaculture in the Socio-Economic Context of a Coastal Mediterranean Lagoon – Evidence from the MedWetCoast project in Morocco -

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The lagoon of Nador is the largest one in the Mediterranean region. It is separated from the sea by a sand strip of more than 24 km length and communicates with the sea through an opening which was artificially built. Its hydrology depends on three main water sources: sea water which is by far the predominant, underground water, and surface water and urban sewage of the neighbouring cities.

This site is not only important as a wetland of great patrimonial value, but it is also significant for the production activities which are maintaining the livelihoods of a large local community. More than 400 small traditional fishing boats are operating in the lagoon and the largest company for fish and shellfish farming in the country is installed in it, producing more than three quarter of the national aquaculture production.

However, these two production activities are experiencing a decline of their productivities as a consequence of an increasing degradation of the water quality of the lagoon. This decline has begun slowly at the late eighties and has been accelerated since the beginning of the nineties leading to an irregularity of the fish production. This loss of productivity is attributed to the diminution of the fish stock which was negatively impacted by solid and liquid pollution.

In fact, the lagoon area is considered as one of the Moroccan coastal Mediterranean hot-spots as far as pollution is considered. Its population has drastically increased and as a consequence, the volume of the urban effluents has augmented. The industrial used water coming from the newly installed units is poured indirectly in the lagoon. The agriculture adopted in the zone makes an intensive use of various types of fertilizers, pesticides, fungicides and weed killers. Also, several channels which collect the rainwater running from the street of the neighbouring cities are connected directly to the lagoon bringing with the flux all the street sewage. The urban garbage of some neighbouring localities is thrown in ravines or in rivers which run during the rainy season into the lagoon.

Even though there is a water treatment unit in the area, the increase of the population has made the capacity of the treatment basins largely exceeded, especially during the summer period which knows an important surge of visitors. Prevalence of the organic matter and nutritive salts in the domestic, industrial or agricultural effluents combined with the insufficiency of the water treatment system are causing critical phases of eutrophication and contamination of the lagoon ecosystem.

This paper discusses the potential of fishing and aquaculture activities in the lagoon and how it is impacted by the unsustainable use of the natural ecosystem.

Coastal Impact of Damming and Water Abstraction in the Tana and Athi-Sabaki River Basin of Kenya

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This study was carried under the auspices of the AfriCaT Project, an initiative of the IGBP-LOICZ supported by the International System for Analysis Research and Training (START). The project focused on the coastal impacts of damming and water abstraction in the Tana and Athi-Sabaki River basins situated in Central and Eastern Kenya. The two river systems combined discharge is equivalent to about 90 % of the total flow to the Kenya sector of the Indian Ocean. The study found that while there has been an increase in sediment load of the Athi-Sabaki River since 1950's, the terrigenous sediment load in the Tana River has been declining as a result of construction of Seven Folk dams in the Upper Tana Basin. The increase in sediment load of Athi-Sabaki River was attributed to land use change characterized by increased land degradation. The coastal state changes at the Sabaki estuary and Malindi Bay that were attributed to the increased discharge of terrigenous sediment load included siltation and accretion, estuary morphological changes, changes in the river

discharge patterns, decreased water transparency and alteration and/or modification of critical habitats such as mangrove forest, seagrass beds and the coral reef complex.

The decrease in the supply of terrigenous sediments in the Tana Delta and Ungwana Bay coupled with modification of the flow patterns of the Tana River, has led to significant coastal state changes which include intensification of coastal erosion, saltwater intrusion, alteration and degradation of critical habitats such as mangrove forests and seagrass beds, decline in floodplain agriculture, changes in the volume of freshwater and nutrients supply, channel deepening and changes in water transparency.

The impacts of water abstraction on the flow patterns of the Athi-Sabaki and Tana rivers were difficult to establish with any degree of certainty due to lack of adequate data on abstraction rates for rural-urban water supply, agriculture and livestock watering purposes. However, preliminary data showed that the rates of abstraction are generally low but there is a high possibility of increased abstraction in the near future. Apart from impacts that could possibly be attributed to damming and water abstraction, climatic variability as characterized by increased frequency of drought and flood conditions seems to have much greater influence of the flow dynamics of the Tana and Athi-Sabaki River systems, and hence on the associated coastal systems. Land use change in the catchment areas of the two river systems as characterized by increased deforestation to open forest land for agriculture and settlement and the need to satisfy increased wood energy demands, were found to be responsible for increased land degradation and the associated generally high sediment loads of the two rivers. The study also discussed socio-economic impacts associated with the coastal state changes mentioned above.

High CO₂ Fluxes from the Air into a Tidal Flat Area

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High CO₂ fluxes are common in coastal areas due to high input of nutrients and organic matter. It is, however, less clear whether a specific coastal area is a source or a sink of CO₂, as both the uptake for photosynthesis and the release by decomposition of organic matter can be quite high. Measurements of CO₂ fluxes from various types of coastal areas are recommended to quantify the impact of coastal seas on the global carbon budget. Here we present preliminary results of air to sea CO₂ exchange measured at the edge of the Wadden Sea, a midlatitudinal tidal flat area between the North Sea and the Netherlands. The fluxes were measured using the eddy-correlation method at a height of 50 m from a tower at the edge of the Wadden Sea in the period May to July 2003. The observed fluxes show a clear daily cycle of daytime CO₂ uptake and nighttime release. To our surprise, the magnitude of the fluxes was very high and comparable with fluxes from grasslands. The flux footprint of these measurements corresponds with the width (5 km) of the Wadden Sea. Smaller scale measurements of pCO₂ in the air and the water of a creek were taken as a first step to determine the CO₂ exchange in specific parts of the complex Wadden Sea ecosystem. Although we had expected that decomposition would dominate in this muddy area, a day time uptake of CO₂ was found. These preliminary findings show the Wadden Sea as an autotrophic area that absorbs high quantities of CO₂ in this time of the year. It is recommended to extend the measurement period in order to determine the annual CO₂ budget.

A New Assessment of Coastal Vulnerability to Climate Change

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Global vulnerability assessments carried out in the early 1990s have been the key sources of quantitative information on the potential impacts of sea-level rise on regional and global scales. They played an important part in the preparation of the World Coast Conference 1993 and several reports of the Intergovernmental Panel on Climate Change. They have also been used extensively for further academic analyses, including integrated assessment modelling. However, with the widespread use of the existing global vulnerability assessments, their limitations have become increasingly apparent. These limitations include:

- The obsolescence of underlying data sources;
- The reliance on sea level as the only climate variable that determines coastal vulnerability;
- The static, one-scenario approach of instantaneously raising sea level on today's world;
- Arbitrary assumptions regarding socio-economic development and adaptation.

Whilst Nicholls (2002) tackled some of these problems, opportunities have arisen to combine data, scenarios and assessment models into a new integrated modelling activity. The project DINAS-COAST (Dynamic and Interactive Assessment of National, Regional and Global Vulnerability of Coastal Zones to Climate Change and Sea-Level Rise; <http://www.dinas-coast.net/>) has built on methods and expertise developed in a range of scientific-technological disciplines to develop an innovative, interdisciplinary methodology. DINAS-COAST has produced the first comprehensive integration of state-of-the-art scientific data, knowledge and models from climatology, coastal morphology and ecology, economics, geography and computer sciences. The result of this integration is a dynamic, interactive and flexible CD-ROM-based tool that will enable its users to produce quantitative information on a range of coastal vulnerability indicators, for user-selected climatic and socio-economic scenarios and adaptation policies, on national, regional and global scales, covering all coastal nations. This tool is called DIVA, which stands for Dynamic and Interactive Vulnerability Assessment. At its core is a simulation model that integrates knowledge of both natural and social sciences.

Other papers in the LOICZ II Inaugural Open Science Meeting will present the various components of DIVA in detail, such as the database, the modelling approach, individual modules, the graphical user interface and, of course, model results. This paper is intended to give an introduction to DINAS-COAST, summarising its rationale, its methodology and its results. In addition, CD-ROMs with DIVA will be distributed among all participants of the meeting.

The São Francisco River Basin and Coastal Zone, East Brazil: Physical and Ecological Alterations induced by Dam Constructions.

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The land-sea interface of the humid tropics, including of East and Northeast Brazil, harbors a number of medium sized river-estuaries, most of which are now being affected by some sort of anthropogenic influence in their river basins. Deforestation/erosion, domestic/ industrial pollution and engineering works (dam construction and irrigation networks), are among the major impacts. However, little is still known on the quantitative links between river basin impacts and alterations upon the estuarine-coastal realms for the majority of these systems. This study addresses the physical-biogeochemical, and some ecological and socio-economical alterations of the São Francisco estuary and coastal zone (Lat. 10° S & Long. 36°W), induced by the construction of a cascade of 07 large dams along its mid to lower river sectors. It represents a unique example of an estuary with a river basin ($A_B = 634000 \text{ km}^2$, $L = 2850 \text{ km}$) nearly entirely controlled (98 %) by hydro-electrical dams, implemented between 1977 and 1995. As most are set within the semi-arid portion of the basin, water loss from the reservoirs by evaporation and for irrigation has become considerable and water replenishment downstream of the dams near to negligible. River discharge (Q_r) to the estuary diminished by 30 % from 2850 to 2000 $\text{m}^3 \text{ s}^{-1}$ and, since the late Xingó dam of 1995 (located 180 km from the coast), it has been regulated to a constant flow, eliminating its earlier natural uni-modal seasonal pattern. The loss of the natural seasonal fertilization by seasonal inundation of the river's marginal lakes and plains has drastically diminished subsistence fisheries and agricultural practices along the lower river. Estuarine waters changed from turbid to transparent due to material retainance by dams and the nutrient mix is now extremely impoverishment with nitrogen against silicate, inducing oligotrophic conditions and the near to utter decline of fisheries yields of the estuarine-coastal waters. The estuarine mixing zone has become largely stagnant at and beyond the river mouth shoals, affecting the recruitent potential of living resources within the estuarine habitats, particulalry the mangroves. The system is naturally prone to coastal erosion due to the presence of a high wind and wave energy regime, but seems to being enhanced by the decline of supply of river sediments and a slight trend of sea level rise at about 0.3 cm yr^{-1} . Alternative socio-economic activities are now being developed, such as aquaculture in the reservoirs and in the river downstream and mangroves, the implementation of other agricultural crops, and also tourism in the entire area. These changes are set into perspective with other medium sized river-estuaries of the coast.

The Southeast Asia Tsunami Disaster Aftermath: Development of New Approaches to Coastal Zone Hazard Observation and Warning Systems

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On January 2005 the IUGG GeoRisk Commission issued a statement on the greatest earthquake and tsunami of the early 21st century and recommended that the countries around the Indian Ocean set up a Disaster Management Center and a warning system in order to monitor land, ocean and atmosphere in relation to all kinds of natural hazards, especially those related to coastal regions (<http://www.iugg-georisk.org>). Assessment of potential of geo-hazards and their risks to populated coastal areas is becoming an important domain of scientific research and mitigation management. Coastal zone, shelf and continental slope are quickly becoming new major areas of industrial technological development owing to growing population in coastal regions and vast natural resources such as fish, oil, and gas available in these areas. Understanding risks of natural and human-made coastal zone hazards contributes to strengthening the scientific and technological basis of a number of industries including oil/gas production and transport. Traditional ways to evaluate risks of earthquakes and tsunamis (e.g., through analyzing historic data) are often not comprehensive enough and may result in lower estimates of the actual risks of these hazards, while a combined approach developed recently at P.P.Shirshov Institute of Oceanology of the Russian Academy of Sciences provides more accurate evaluations, which may affect significantly human research and industrial activities in the coastal areas. We report here some new ideas, approaches and preliminary results in the development of tsunami warning systems based on a complex monitoring system using the deep-ocean cable installations and bottom observatories located in the vicinity of the oil and gas drilling platforms which are cable connected to data processing centers. Operation of such systems is to be combined with satellite survey as well as with scientific cruise investigations. Also we report here some results of the EU project which was designed to disseminate information to scientific and industrial communities on combined risks of submarine contaminated groundwater discharge, saltwater intrusion, coastal zone earthquakes, landslides, and tsunamis. This information can be introduced targeting potential risk groups, including local coastal zone authorities and the general public, to enhance general risk awareness.

SPICE, an Indonesian-German Research Initiative within the Frame of Land and Ocean Interactions

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Indonesia with its 17,500 islands is the largest archipelagic country in the world and only second to Canada in its length of coastline. Of its population of 240 million, 60% live within 60 km from the sea. The area is also a center of marine bio-diversity. However, the country's coastal areas have been severely stressed by river damming, deforestation, land use change, overfishing, destructive fishing methods, habitat destruction and land-based marine pollution. These problems are attributed to the country's intensive economic activities, a high population density along the coast, and poverty of large segments of the population. This makes Indonesia so important and challenging for research within the frame of land and ocean interactions.

In September 2003 a new Indonesian-German research initiative *Science for the Protection of Indonesian Coastal Marine Ecosystems (SPICE)* was launched to address major marine and coastal environmental issues in mainly four research areas on Java, Sumatra and Sulawesi, Indonesia. This program involves more than 10 Indonesian and German research institutions on each side. The first phase is planned up to 2006.

The program's current work spans over corals and mangroves biology and ecology, as well as biogeochemistry and climatology. Preparations are made to ensure that research findings flow into learning cycles as well as policy and decision-making processes in order to have a bearing on actions and behaviour of coastal stakeholders.

The program shall be expanded to incorporate research on coastal governance and management. The recent tsunami in the Indian Ocean and particularly severely impacting on Indonesia has brought an additional impetus to make the research work of SPICE more comprehensive.

It becomes evident that despite the already considerable build up of research work and networking SPICE needs to further establish contacts and linkages with players and organizations in marine and coastal sciences. In this respect a collaboration with LOICZ is seen as an excellent opportunity to increase the scope and meaningfulness of SPICE.

Social-Ecological System Analysis for ICM support: A Mangrove Ecosystem in North Brazil

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A main objective of our social-ecological system analysis was to find directions for the adaptive management of the very young socio-ecological system (SES) of a mangrove ecosystem in the region of Bragança, North Brazil (State of Pará). Main focus was placed on the interactions between geophysical processes and mangrove ecosystem dynamics with the social structure and socio-economic strategies of the local communities.

Beach profile sequences were assessed with stadia-rods, aerial photographs and satellite imagery over a four-year period. Patterns of land-use and mangrove structure were analysed via remote sensing and revealed the need for the use of weak pattern analysis of aerial photographs. Erosion was identified as a key element in the SES. It caused great damage to tourist infrastructure and brought about local micro-migration. This caused considerable asymmetries in the degree of satisfaction of the divergent interests of the principal stakeholders in the SES. The social structure in the research area was analysed by two census data gathering campaigns, by semi-structured interviews with key informants and in several local workshops.

The intentions and outcomes of management regulations in the mangrove areas of the North Brazilian coastal State of Pará were analysed with respect to their effects on social and economic structures and on coastal morphodynamic processes. The current interpretation of the Brazilian Federal constitution has resulted in an absolute non-use directive for mangrove ecosystems. Legal ownership of mangrove areas and permanent constructions in mangrove or beach areas is prohibited. This legislative framework does not consider the social and economic realities, which show ecosystem dependence of the majority of mangrove-adjacent residents.

This case study finds that the distribution of the “benefits of illegality” has further aggravated socio-economic inequalities and enforced undesirable ecological outcomes. Integrated coastal management (ICM) measures for the area should not only focus on the prevention of erosion and the preservation of the productivity of the mangrove ecosystem, but also on the interactive dynamics between the social and natural system. The application of a SES analysis reveals a strong negative co-evolutionary potential introduced by the fast immigration of ecologically illiterate agents. The paper concludes by identifying measures to reduce local actors’ ecological illiteracy in order to generate improved socio-economic and environmental outcomes.

Anthropogenic Influences on Freshwater Resources versus Land Use and Cover Change (LUCC) in Southeast India Coastal River Basins – Study based on Multidate Remote Sensing Data Analysis and GIS Applications

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The Indian coastal region presents an unique example of complex and more diverse land use and cover change (LUCC) processes all along the 7500 km length coastline including the islands. The coastal zone is characterized by high population concentration and the occurrence of “vulnerable ecosystem hot spots” and protected areas of rapid and intense anthropogenic changes lead to severe environmental degradation, which require immediate attention. This study is primarily aimed to understand the LUCC processes taking place in three important river basins i.e. Palar river basin in the north, Cauvery river basin in the middle and Tamiraparani river basin in the south of Tamil Nadu State located in Southeast India based on an integrated study using remote sensing and GIS technology tools along with data generated from laboratory analyses and field validations.

Multispectral data from IRS satellite series have been used to prepare thematic maps on Land Use and Land cover for different period for change-deduction studies, which includes the mapping areal spread of freshwater resources. Other relevant thematic maps on structural lineaments, geomorphological details of these three river basins have been prepared using remote sensing data. Laboratory analyses were carried out to study the water and soil quality from the samples collected during fieldwork. Integration of remote sensing data analysis output and laboratory data has been carried out using the Arc/View GIS to demarcate the areas undergoing changes in groundwater quality due to land conversion, over-exploitation of groundwater and industrialization.

The results of this study brought out that all these three river basins undergoing rapid land use and cover changes including the decrease in areal spread of many freshwater bodies. It was observed during field validations that land degradation has arisen due to various anthropogenic activities such as agriculture intensification, intensive and extensive brackish water aquaculture, saltpan activities, deforestation, drought and mining. Combination of these activities especially industrial discharges has contributed to the decline of both freshwater quality and quantity. A number of densely populated and rapidly growing industrial towns are located along these coastal river basins. Highly industrialized coastal belt attracts more population concentration, thereby aggravating the problem of depletion of water resources in the hinterland part of these river basins. Additionally, monsoon regime variations resulting in drought affects these river basins witnessed by agricultural crop failures in rain-fed areas favor migration tends and shift in land use practices. Analyses of water depth contour data indicate that the groundwater level is lowered in the areas nearer to industrial towns. The water quality parameters such as TDS, TH, pH, EC, chlorine are higher especially in the coastal areas. The groundwater quality has become highly saline in areas housing intensive aquaculture activities. All these three river basins

witnessed with the expansion of barren land areas during the last decade due to non-availability of water resources require sustainable water and land management plans that should be fitted within the framework of Integrated Coastal Zone Management (ICZM) plan involving all the stakeholders.

Shelf processes: LOICZ-SOLAS-IMBER interactions

M. Dileep Kumar and Jack Middelburg

Continental shelf processes are closely linked to the lives of the coastal population of the world. Human interference is causing concern on the health of coastal ecosystems whereas its adverse effects on coastal population and climate. For instance, increasing occurrence of hypoxic waters in coastal regions of the world has serious implications to ecology, biodiversity, climate and food resources. While the hypoxia in Gulf of Mexico are driven by agricultural waste discharges those along the west coast of India appear to have been mainly caused by the coupling of upwelling driven intense biological production and strong stratification resulting from freshwater discharge. Reduced oxygen supply through the air-sea interface leads to intense denitrification below the freshwater lens where very high nitrous oxide concentrations (upto to 533 nM) were found. In a recent study in Indian coastal waters dimethylsulphide concentrations upto 2.5 μM were found associated with prymnesiophyte blooms. Such an accumulation of exceptionally high levels of climatically important gases can lead to higher emissions to atmosphere that will influence the global radiation budget. Intense (harmful algal) blooms may also have adverse impact on coastal food resources. The new IGBP initiatives SOLAS and IMBER have already recognized the sensitivity of the coastal oceans and processes therein to Global Change or human interference, and appropriately included these studies in their Science Plans. While SOLAS-IMBER joint implementation strategies address scientific issues LOICZ II is expected to link the new understanding to human dimensions. Therefore, the present Session is being organized to plan the joint implementation strategies and to translate the IGBP science results for the societal benefits. In preparation for drawing such a plan five presentations have been identified in this Session with a focus on global issues of current concern and include: fate of carbon, fluxes in arctic shelf, impact of tsunami, impact of river discharges and forcings on particulate matter budgets over the shelf. We hope these presentations and the ensuing discussions will lay a foundation for developing LOICZ-SOLAS-IMBER joint implementation plan.

Anthropogenic Influences of Enhanced Nitrogen and Phosphorus Concentrations in the Rhine Catchment and the Dutch Coastal Zone

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Eutrophication of fresh, brackish and coastal waters has been recognized as an international problem in the European Water Framework Directive and by OSPAR. At the moment eutrophication can not be combated with generic solutions anymore, as done in the eighties and nineties. Tailor made solutions at an international catchment level will be necessary to reduce the input of nutrients further. To make these measures effective, the sources and fluxes of nutrients in the whole catchment and the relative contribution of the anthropogenic fraction must be known.

In this contribution the sources and fluxes of nutrients (N and P) will be presented for the whole Rhine catchment and the Dutch coastal zone. The results are based on field data and model results (MONERIS, ERSEM and CABARET) and collected during the EU-EUROCAT project.

Total and anthropogenic mass balances will be discussed in relation to the budgets from models. Special attention will be focused on the estuarine retention of fluvial Nitrogen and Phosphorus compounds in the Rhine catchment.

The impact of different reduction scenarios of the N and P input to the coastal zone on different marine ecological quality objectives will be shown and discussed.

First assessment of the Tunisian coastline vulnerability to sea level rise

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The Mediterranean region is not favoured by climate change, particularly the southern shores. Climate change projections indicate:

- a change in temperature greater than the global average warming,
- a little change in precipitation during, probably be more important in the South, particularly in the Eastern part,
- Furthermore, we expect an increase in the frequency of climate extreme events.

We expect a greater variability in the sea level rise between regions to other. This potential risk constitutes probably the mean threat related to the Tunisian coastline vulnerability to climate change.

The Tunisian coastline has a greater economic weight and a strategic role in the communication and the exchange with the outside world. In order to study its vulnerability to climate change and particularly to sea level rise, we can distinguish four regions:

- ✓ The north coastline: this being high cliffs and not highly affected by a sea level rise.
- ✓ The gulf of Tunis: characteristically low coastlines, hence a large socio-economic vulnerability to sea level rise,
- ✓ The gulf of Hammamet and the Sahel region: this being characterised by low coastlines with an important tourist infrastructure, hence a large socio-economic vulnerability associated to environmental vulnerability due to some infection coastal layers by seawater intrusion,
- ✓ The gulf of Gabes: characteristically low coastlines with important environmental threats due to the presence of archipelagos with a large biodiversity.

In regards to the lowest of their coastlines, some islands like Kerkena are particularly vulnerable to sea level rise. Taking a middle case scenario in relation to a sea level rise of 55 cm, 70 km² risks being lost, which represents (1/3) of the total area of the island.

In other respects, Ichkeul Lake is the most important wetland area in Tunisia. It is located in a coastal region with contact to the Mediterranean Sea. This lake is sensitive to a Mediterranean Sea level rise. With an assumption of (1 m) rises in the water level of Ichkeul lake we suspect an increase in water area to the detriment of the marshy terrain. This expansion of Ichkeul lake can conduct to the loss of 1160 ha of cultivated area.

The Tunisian coastline has a double vulnerability to climate change: a socio-economic vulnerability and an environmental vulnerability. This initial assessment of the Tunisian coastline vulnerability to Mediterranean sea level rise needs to not only completed but also extended to other threats.

Integrated Assessment of the Nutrient Management in the Danube Basin

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Mismanagement of nutrients in the Danube Basin has led to severe ecological problems including deterioration of groundwater, surface waters and the Western Black Sea. The results of the daNubs-project deliver a basis for a proper management of nutrients in the Danube Basin. Process understanding on the sources, pathways and sinks of nutrients in the Basin and on the Western Black Sea ecosystem directly

effected by nutrient discharges from the Danube River has been improved. Quantitative models on nutrient emissions, their transport along the rivers and their impact on the Western Black Sea have been applied and combined.

Results: Phosphorus loads transported by the Danube are 30 - 50 % lower as in the 1980s (dissolved P even to a higher extent). Nitrogen emissions considerably decreased as well. Decreased nutrient discharges from the Danube have led to a significant improvement of the western Black Sea ecosystem:

- reduced eutrophication, (reduced phytoplankton biomass, frequency of blooms and extension of high chlorophyll area.),
- increase in transparency and improvement of near bottom oxygen regime,
- regeneration of phytoplankton species (Diatoms) diversity,
- regeneration of phytobenthos,
- regeneration of macrozoobenthos (increase of species number and diversity).

Limiting factor for phytoplankton growth in the eutrophic areas of the N-W-BSsw is P. While in the Black Sea off shore waters mainly N limits primary productivity. Current low discharges of N and P to Black Sea are the result of (i) improved nutrient removal from waste water in D, A and CZ, (ii) reduced P discharges from detergents and (iii) the consequence of the economic crisis in central and eastern European countries (closure of large animal farms, decrease of mineral fertilizers application, closure of nutrient discharging industries (e.g., fertilizer industry). As the decrease is partly due to the economic breakdown in the former communistic countries economic development has to go along with proper waste water management and best agricultural practice.

Changes in the nutrient management are not reflected immediately in the quality of surface waters, therefore monitoring has to be enlarged to the sources of nutrients (fertilizer application, animal units, etc.). For any monitoring completeness and correctness of data sets are of highest priority.

Retention (storage) of P in and close to the river system as well as denitrification in groundwater and surface waters are heavily influenced by the local situation (hydrology, geology, morphology). High groundwater recharge and high river discharge goes along with low nutrient retention and losses during transport while the loads transported towards the Sea are comparatively high. Emission reduction in these regions effectively influences Danube, Danube Delta and Black Sea quality (eutrophication).

Results presented come from the project "Nutrient Management in the Danube Basin and its Impact on the Black Sea" (daNUbs) supported under contract EVK1-CT-2000-00051 by the Energy, Environment and Sustainable Development (EESD) Programme of the 5th EU FP. Details on the project can be found on the project homepage: <http://danubs.tuwien.ac.at/>.

Using LOICZ Biogeochemical Modelling to Achieve Federal Environmental Regulations for Shrimp Aquaculture on the Sinaloa Coast of México

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The Federal Environmental Protection Agency of Mexico required 340 shrimp farming companies, using 25,000 ha ponds, to comply with national environmental regulations to control degradation of the coastal ecosystem. Associated shrimp aquaculture farms asked CIBNOR, our research institute, to undertake the environmental studies in order to respond federal requirements, and define new policies and recommendations for better procedures in shrimp farming that meets federal guidelines for sustaining the coastal ecosystem.

Using GIS technology, an extensive database was created for analysing population, industrial, agricultural, soil, bathymetry, physico-chemical, and biological characteristics in 12 coastal lagoons along the Sinaloa coast for assessing human and natural influences on these water bodies. Environmental conditions in each lagoon was estimated by the use of LOICZ budgeting procedures, using existing data from universities, institutes, research centres, governmental monitoring agencies when available, and data obtained from the shrimp aquaculture farms. The budgeting procedures revealed that more than 80% of the nitrogen and phosphorus inputs to the coastal lagoons come from agriculture activity. Three of the twelve coastal lagoons lacked enough data to develop a complete budget. Seven coastal lagoons showed high heterotrophic behaviour, interpreted as a tendency to eutrophication. Only two coastal lagoons showed adequate environmental health making possible an increase of shrimp pond aquaculture. For the lagoons with heterotrophic conditions, there exist serious problems concerning shrimp diseases, declining production, and even closing of facilities.

An extended report was prepared and presented to the Federal Environmental Protection Agency of Mexico, giving several recommendations to initiate a program for recovery of the coastal lagoons and increasing harvesting success in the shrimp farms. Shrimp aquaculture farms accepted the Program, and several proposals were submitted to the Aquaculture Institute of Sinaloa to modify, among other projects, the hydraulic engineering of pooled shrimp ponds to minimize the use of water of poor quality. Federal, state and municipal governments have signed a document of support to the shrimp aquaculture associations to accomplish these goals.

Further monitoring of coastal lagoons and annual application of LOICZ budgeting procedures will be used to evaluate whether recovery of the lagoons is taking place.

Marine Biodiversity Protection under the Pressure of Population Growth - A Case Study of Nha Trang, Vietnam

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Nha Trang is a small coastal city in the central part of Vietnam. The city is well known as a tourist attraction for the natural beauty of its adjoining bay and of the richness of marine biodiversity found in the bay. Over the last 10 to 15 years, the city has experienced big economic growth and achieved considerable improvement in improving the material standard of living of its people. However, the rapid growth of population (including natural population growth, migration from neighbouring cities and tourists) and the development of different industries such as fishery, marine transportation, tourism, aquacultures have placed a great pressure on natural resources in general and on the coral reefs in Nha Trang Bay in particular. This unsustainable way of development, in a long run, would be a great threat for future welfare of local people.

Some coastal zone management projects have been carrying out in Nha Trang aiming at the protection of marine and terrestrial biodiversity. However, although the projects have obtained some optimistic results, a wide range of challenges is still there waiting for effective solutions. In many projects, the vital link between population growth and other aspects of development has not been clearly defined as one of the most important factors that cause biodiversity loss or degradation.

My master thesis tries to prove that there is an interrelation between the population growth in Nha Trang and marine biodiversity loss in the bay and that it is possible to limit the bay's biodiversity loss by applying a rational management model where population control is seriously taken into account. The main objective of this study is to construct such a model using Human Ecology approach - a holistic approach that employs the tools of different disciplines such as geography, demography, environmental science and political science etc...

Electronic Networking on Black Sea Conservation Issues in Romania

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The electronic networking on Black Sea conservation issues in Romania, was started in 2003 by UNESCO Pro Natura, in the framework of a project financed by the Black Sea Ecosystem Reconstruction Programme (RER/01/G33: BSERP/SGP/ROM4). The name of the project is: **“Black Sea Basin Environmental Issues On-line - Building an Informational Community of Romanian NGOs/ activists/ other stakeholders working in Black Sea basin based on interactive - user friendly - internet tools under ngo.ro web site.”**

The main idea is to establish an interactive community about Romanian waters (focused mainly on Black sea basin issues) based on a website. This improves co-operation of all stakeholders, strengthen visibility, communication and information sharing, also establishing partnerships of NGOs, which are members of Romanian Black Sea NGO Network, NGOs interested in Danube/ Danube Delta issues (including Danube Environmental Forum), StrawberryNet, Ministry of Waters and Environmental Protection – Biodiversity Conservation Directorate and other state institutions.

It the framework of the project, it was developed a customized application for web publishing, based on user-friendly on-line formularies and an automatic on-line database. It was created the domain <http://mareaneagra.ngo.ro> where was installed and configured the Linux Operating System, Apache web server, MySQL database engine and PHP4 software package.

It was elaborated the structure and layout of the website through 2 participatory workshops within the Romanian Black Sea NGO Network and other NGOs interested in Danube/ Danube Delta, wetlands and biodiversity issues (including Danube Environmental Forum). The web site was planned to be an "one stop site" regarding environmental issues of the Black Sea, and to be a "clearing house mechanism" in the sense of having many organizations/ institutions feeding up the mechanism with usefully information. It was organized a main workshop: **“Use of Internet Based Interactive Tools for Communication Improvement and Access to Environmental Information in the Black Sea and Danube Regions”** where the NGO representatives agreed to introduce their data in the proposed web portal, to facilitate communication and public awareness raising through this reliable and easily accessible information.

Sections of the website: 1. background information about Black Sea/ Danube/ Danube Delta; 2. legislation about waters including Black Sea/ Danube/ Danube Delta; 3. news; 4. campaigns; 5. initiatives; 6. NGOs and other institutions – directory; 7. an electronic Citizen Guide for solving environmental problems regarding waters; 8. educational lessons about the role of waters; 9. presentation of protected areas included in the area of Danube/ Danube Delta/ Black Sea; 10. the status of pollution and the main polluters in the area; 11. information about nutrients reduction measures (the needed normative tools) and the economic benefit resulted from remedial action; 12. major problems; 13. posters; 14. dialog of NGOs with authorities; 1115. photo gallery.

Some of the partners become responsible for different sections of the web site. For example the Romanian Environmental Journalists Associations (REJA) coordinates the news section. As a success of the web site, Alexandru Savulescu - president of REJA, transmitted from Kyoto with the occasion of World Water Forum, using our web site's mechanism.

Promotion of the website and media coverage of the project was realised through: Perspective - environmental magazine, Atitudini - NGO Magazine, National Romanian TV Chanel - in a TV program called "Web report" where are presented different web sites, www.ngo.ro inside the news section, on different mailing lists like

mediu_list and romania_eu_list, in Pro Natura rubric at Radio Romania Tineret. Also, promotional leaflets, brochures and posters were published and widely distributed.

By improving the information and communication between NGOs, state institutions and activists, about Black Sea basin issues (Danube, Danube Delta, Black Sea) based on an interactive website, the project produced public access to the environmental information and improved public participation in decision making, according to the Aarhus Convention adopted by Romania.

EMIGMA, a new tool to assess and to manage the status of the coastal zone.

Han Lindeboom and Erik Meesters (Alterra-Texel, The Netherlands).

The human pressures in the coastal zone continue to increase, together with a rising demand for a proper protection of the intrinsic nature values. At the same time, the development of the marine ecosystem is a very complex interplay between natural and human induced driving forces. How do we integrate the outcome of many scientific research projects and at the same time develop managerial advises which are soundly based on the actual developments of the marine realm.

At Alterra-Texel, we developed an new integration, management and modelling tool, called EMIGMA: Effect Modelling of Indicators, usage and Management. By combining the measured trends of different relevant indicators with trends in driving forces and managerial measures we gain insight into the correlation and possibly causation between these parameters. By adding detailed analyses of the intensity and actual effects of human usage we obtain a strong tool to analyse possible managerial measures to counteract undesired developments.

Apart from traditional uses as fisheries, shipping, oil and gas extraction and beach nourishment, and the impact of eutrophication and pollution, the development of large windmill parks and the call to establish Marine Protected Areas puts an increasing pressure on the Dutch coastal zone. EMIGMA is a useful tool to gain insight into the impacts of traditional and new uses. A long term data set of measured indicators and pressures is the backbone of EMIGMA, and in areas like the Dutch coastal zone enough different data series are available for a proper analyses.

In the presentation, we will demonstrate EMIGMA for several examples in the Dutch Wadden Sea and the North Sea and discuss the potential use of EMIGMA to gain more insight into Land Ocean Interactions in the Coastal Zone.

The Fates of Terrigenous Organic Carbon and Absorbed Atmospheric CO₂ in the East China Sea

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The East China Sea (ECS) shelf receives a huge riverine load of organic carbon (896 Gmol C a⁻¹) from some of the largest rivers of the world, including the Changjiang. Despite the tremendous riverine input of terrigenous organic carbon, the ECS absorbs a large flux of atmospheric CO₂ with a net input of 1246 Gmol C a⁻¹. Scientists are eager to find out what the fates are for the carbon input to the ECS and whether the capacity will change in the future as a consequence of the construction and operation of the Three-Gorges Dam in the middle reach of the Changjiang. We have established a new carbon budget for the ECS, which is based on a newly developed two-box model of the ECS shelf, which in turn draws results from a 3-D circulation model of the western North Pacific Ocean. According to the new budget, the fates of the carbon input follow three pathways of roughly equal importance; 34 % is buried in shelf sediments, 36 % is exported as DOC and POC and the rest (30 %) is exported as inorganic carbon. How long it takes for the exported carbon to be released back to the atmosphere from the open ocean is not clear, but the enhanced primary production and the significant undersaturation of CO₂ in the Kuroshio water downstream from the ECS shelf suggest that the retention time may not be very short. The export of the carbon is enhanced by the inter-shelf transport, which facilitates more effective export via the southern shelf, where the shelf is narrower and the flushing is stronger as compared to the northern shelf. The northern shelf and the southern shelf of the ECS shelf show contrasting characteristics due to the geometry and the circulation pattern. The Kuroshio Branch Current northeast of Taiwan (0.95 Sv) and the northward flow from the Taiwan Strait (1.1 Sv) make the water residence time in the southern shelf rather short (3-6 months). The northern shelf has wider shelf and less Kuroshio intrusion (0.4 Sv) so that the water residence time is longer (1.1-3.1 yr). In the future, more work is needed to trace the fates of the terrigenous organic matter, to better survey the air-sea CO₂ exchange and to simulate the carbon cycling in the ECS with a sophisticated 3-D coupled physical-biogeochemical model.

The Effects of Changjiang Transport on Nutrient Dynamics in the Yellow and East China Seas in Summer

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Riverine transport is the principal pathway of suspended and dissolved elements from land to the sea. Changes in riverine end-member nutrient concentrations and their ratios may affect coastal ecosystems. Field observations were carried out in September 2002 from Changjiang Estuary to the southern part of the central part of South Yellow Sea (section A), along the China coast areas southward (section B), and across the shelf until the Okinawa Trough (section PN). Anchor stations were occupied at Changjiang Estuary and coasts (E1, E4 and E5), mid-shelf (E2, E3 and E6) for over 25 hours, together with grid stations. Field observations in September in 2002 provide with extensive data sets of nutrient species spreading from Changjiang Estuary to the Yellow and East China Seas. This study focuses on the influence of Changjiang discharge on nutrient dynamics in the Yellow and East China Seas and the nutrient exchange fluxes between the sediment and the overlying water were discussed as well. Nutrients (NO_3^- , NO_2^- , NH_4^+ , PO_4^{3-} and SiO_3^{2-}) were analyzed using an autoanalyzer. Dissolved inorganic nitrogen (DIN) is the sum of NO_3^- , NO_2^- and NH_4^+ . The total dissolved nitrogen (TDN) and phosphorus (TDP) were measured using spectrophotometer method. The concentrations of dissolved organic nitrogen (DON) and dissolved organic phosphorus (DOP) are the difference between TDN and DIN, TDP and PO_4^{3-} , respectively.

Based on the results of several representative transects, it is known that transect PN is influenced by several processes, such as Changjiang runoff, the Taiwan Warm Current and the Kuroshio. The nitrogen compounds and silicate mainly come from the river input, while phosphate mainly comes from Kuroshio input, then river input. The nutrients distribution is highly stratified, increasing from surface to near-bottom waters. Phosphate is a limited factor in the coastal area while in the outer sea area both phosphate and dissolved inorganic nitrogen limit the growth of the phytoplankton. Yellow Sea Cold Water occupied the bottom of the east of transect A, while in the surface, the influence of the coastal current is more obvious. Transect B is controlled by the Changjiang runoff and Zhejiang Coastal Current. The concentrations of nutrient species show the influence of tide at anchor stations. Nutrient fluxes at sediment-water interface varied depending on the nutrient species, the sediment type, the redox conditions, the temperature etc. This will influence the nutrients structure in the East China Sea. Together with the result of the wet and dry atmospheric deposition, the contribution of each nutrient input process is evaluated.

River Basin - Coast Interactions: The Oder (Odra) Case Study

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Since the UNCED conference in Rio, 1992, it has widely been recognized that there are important linkages between the freshwater issues in the upstream river basins and the water issues in their adjoining coastal zones. Physical, environmental, as well as economical and social sectors play a role in these linkages.

In 2002 the UNEP outlined an initiative concerning the interactions of the Oder river basin and adjoining coast. M. Adriaanse, K. Furmanczyk, M. Landsberg-Uczciwek, S. Musielak, W. Okon and G. Schernewski were involved in the project draft. In 2003 the identified issues of the Oder region were outlined in a draft report and are updated within the framework of the research project “Integrated Coastal Zone Management in the Oder Estuary Region” (ICZM-Oder) funded by the Federal Ministry of Education and Research Germany (BMBF). Based on different methods, incl. media analysis, questionnaire, analysis of official and scientific documents as well as publications, the major interactions between the Oder river basin and the coastal area were elaborated. Several issues like tourism, infrastructure or traffic show interactions between coast and hinterland, but the Oder river itself forms the major link between basin and coastal zone. Directly related to the river and the basin-coast interface are the issues:

- Flood management, river regulation and navigation
- Environmental quality with focus on water quality
- Nature protection and preservation.

The Oder river, 854 km long and with a catchment area of 118,861 km², belongs to the most densely populated and industrialized areas of the Baltic region, and carries large pollution loads to the Baltic Sea. Mainly municipal and industrial discharges are important issues causing the pollution of water and eutrophication. But also the increasing shipping, expansion of harbours and marinas as well as river regulations (flood protection, barrages and polders) have an important effect on the river bed, flow rate and suspended load. Biological interactions exist for instance in the migration of fish and macrozoobenthos. The intrusion of alien flora and fauna species and the replacement of native communities are one of the most important ecological problems in the Baltic Sea as well as in the Oder estuary region.

The report serves as a basis for the communication and co-operation between river basin and coast and is an important working-document for the project ICZM-Oder. The report, the scientific issues as well as the project will be outlined and first results of a river basin-coast initiative will be presented. ICZM-Oder is a project under the LOICZ umbrella.

Natural and Anthropogenic Forcing on Particulate Matter Budgets in Coastal Zone: Role of the Resuspension by Storms and Trawling

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Significant quantities of organic and inorganic, dissolved and particulate matter are input to continental margins where intense hydrodynamic conditions control their dispersal. Recently, the community working on the carbon cycle took into account the specificity of continental margins, by adding a compartment interfacing the continent with the open ocean. The sedimentary sub-compartment on continental margins appears to be a vast reservoir of matter and nutrients, and is generally viewed as a carbon trap. However, resuspension of particulate and dissolved elements from the seabed into the water column might be important factors influencing biogeochemical budgets.

A study of the role of resuspension was conducted in the Gulf of Lion continental margin, NW Mediterranean. As a region of low tidal energy and of strong fishing activity, both impact by waves and by bottom trawling were considered. Newly acquired data showed that the impact of bottom trawls on the resuspension of the fine sediments per unit surface is comparable with that of the largest storms. Trawling-induced resuspension is complementary to that of the storms because the activity of the trawlers is concentrated on the outer shelf between 50 m and 200 m depth where the resuspension by waves and currents is negligible.

A first comparison of the respective impact of these natural and anthropogenic processes on the amount of sediment and particulate elements (POC, PON, PIC) resuspended and exported towards the adjacent basin was performed. For that purpose, realistic numerical simulations of resuspension and transport of particulate matter forced by currents and waves or by a fleet of bottom trawlers were developed and combined with a coastal hydrodynamic model. A simulation was conducted over a 16-month period to characterise the seasonal and interannual variability. The results indicated that though the amount of sediment resuspended was several orders of magnitude larger than the particulate discharge supplied by rivers to the gulf, the amount exported to the adjacent basin represented less than one-tenth of the river inputs. Besides, particulate matter resuspended by waves and currents exceeded those induced by trawling, but the quantities of exported particulate matter were comparable, owing to the fact that trawled regions are located on the outer shelf, closer to the continental slope.

By addressing both natural and anthropogenic effects on sediments and carbon cycle in shelf waters and their exchange with the ocean, this work contributes to theme 4 of LOICZ II.

Environmental Problematic in Bahía de Navidad Lagoons: Reflections to Implementation of a CZIM plan

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Natural resources, socio-economical conditions, environmental problematic, diversity and intensity of economic activities, impacts of tourism and urban development, on resources and landscape of lagoons of Bahía de Navidad are described and valuating based on scarce background of the area. In the area, land use, bottoms, beaches and flood plains are the environmental components more deteriorate and with highest pressures of use. 23 aquatic species with importance commercial to fisheries, moreover the extensive area of mangrove, were identified in the sites. Chocolate clam, blue crabs and rugosa pen shell are the more rentable species; eventually the last one is over-fishing at local extinction. The resources, goods, amenities and environmental services of the lagoon had not been integrally evaluated; they are the base of economical activities of Barra de Navidad people's, because there is a direct dependency in a significant proportion of the economically active population. The landscape, environmental services and amenities of the lagoon were determinate to be the base of preponderant economical activities in the community: essentially, tourism, commerce and tourist services. In spite of the area exists a strong private investment in touristy and urban infrastructure (marinas, golf course and grand tourism hotel), the urbanism, construction and waste waters of this developments had impacted hardly the common goods of the aquatic ecosystems and the benefits had not pouring on the population; because that is necessary to do, under more sustainability idea, an integrated coastal zone management plan. This strategic plan should have specific actions to stop deforestation of mangrove, pollution and siltation in deteriorated areas and try to diminishing the economics differences into the community.

Web-Based Tools for Typology Development and Data Mining

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The ability of modern sensor systems to generate data on a global scale far outpaces the ability of experts to analyze, characterize, and understand relationships within that data. Therefore, as we set out to analyze the anthropogenic impacts on global climate change we need tools to assist us in identifying relationships and extracting information from data. As part of the typology focus of LOICZ I and subsequent projects using similar approaches, we developed several web-based tools for data storage, management and analysis, including the Biogeoinformatics of Hexacorals and associated environmental database and the KGSMapper application at the University of Kansas and Web-LOICZView and DISCO at Swarthmore College. These tools have been used by researchers across a broad spectrum of scientific research, and continue to incorporate new data and capabilities. They are essential tools for the

mission of LOICZ II, and are already being used to relate scientific analysis to vulnerability assessments in the US NOAA Estuarine Eutrophication Project, and to derive the environmental characteristics of habitats (e.g., Cha et al., 2004, Distribution of sea anemones (Cnidaria, Actiniaria) in Korea analyzed by environmental clustering: *Hydrobiologia*, 530/531: 497-502) -- essential steps in identifying the potential impacts of climate change on habitats and their associated flora and fauna. The newest capability in DISCO is the ability to manage and analyze time-series data, looking for data relationships across both space and time. This presentation will highlight current and expected future capabilities and their application to tasks relevant to the LOICZ II mission.

This presentation will provide researchers a view of the web-based tools available to them for data analysis and exploration, and indicate possible directions for future development and applications. The focus will be on the cross-cutting themes of typology development and model-building.

A New Model of Wetland Loss and Sea-Level Rise

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Coastal zones are currently experiencing intense and sustained environmental pressures from a range of driving forces; ecologically-sensitive coastal wetlands are particularly prone to such pressures and impacts can have high human and environmental costs. In order to develop more effective management strategies to manage wetlands, behavioural responses to external forcing must be better understood. This paper introduces a new broad-scale Wetland Change Model, which examines the large-scale response of wetlands to a range of scenarios of sea-level rise under both unconstrained and constrained (by fixed defence line) response modes.

The Wetland Change Model is one impact module within the DIVA integrated assessment tool for coastal areas, developed within the EU-funded DINAS-COAST project (www.dinas-coast.net). Using an improved global database of coastal wetlands, the Model provides an assessment of regional to global patterns of wetland loss and transition across a range of wetland types i.e. coastal forest, mangrove, freshmarsh, saltmarsh and unvegetated intertidal areas. It seeks to capture the integrated response of wetlands to sea-level rise. Fundamental to this characterisation is a conceptual model that defines the key parameters that control wetland behaviour. A series of simple decision rules quantify wetland response to sea level rise, based on a combination of field observations with expert judgement. This paper discusses the key concepts raised in this process, which underpin the wetland loss model.

It is argued that wetland response to sea-level rise reflects two components: (1) a horizontal migration and (2) a vertical elevation change. These components are incorporated into the model through three primary driving parameters: (1) the ratio of relative sea-level to tidal range; (2) sediment supply; and (3) accommodation space. In unconstrained settings, combinations of these components define wetland vulnerability to sea level rise. Most existing models of wetland response to accelerated sea-level rise generally deal with the conversion of vegetated surfaces to open water, generating statistics on total loss of wetland area. The Wetland Change Model assesses both net wetland losses (due to conversion to open water) and transitions to other wetland types, through the conversion of vulnerability assessments into ecological sensitivity scores. In constrained settings, human interference removes accommodation space within the model by the landward margin placement of sea walls and dikes, reducing the migratory potential, and thus increasing the vulnerability, of the system in the face of sea-level rise. Conversely, artificial nourishment of wetland surfaces with sediment decreases the vulnerability of the system to sea-level forcing, reducing the rate of loss of the wetland. Hence, adaptation options selected elsewhere within the DIVA model influence wetland response.

Vulnerability of Coastal Systems: Comparative Analyses of Three Atoll Island States: Tuvalu, Kiribati and the Maldives.

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Summary. Based on any criteria atoll islands are the archetypal coastal system, comprising in close proximity reef-island-lagoon. They are small and relatively simple systems, that provide the only habitable space for human populations, their settlements and activities. Atoll environments are also ‘fragile’ and the islands highly vulnerable to a host of externally and locally generated impacts. Some impacts have resulted in the ultimate response to hazard: intra-state and inter-state resettlement and whole island abandonment. Such responses are not just historical artefacts but have occurred throughout the last decade and into 2005. Has island carrying capacity been exceeded? Can atoll systems and their populations be sustained throughout the 21st Century in the face of global change and local change pressures? Will more settlements and/or islands be abandoned? These issues are addressed with reference to three atoll states, which have subtle differences in their biophysical characteristics and climatic and oceanographic regimes, and more significant contrasts in their demographic and economic conditions, and particularly in their socio-cultural backgrounds: Polynesian, Micronesian and Maldivian.

Here we consider the major drivers of global change that affect all three atoll states—and coastal systems in general—and how they interact with a suite of more localised change factors. Three main global change drivers will be important in the future, and should be acknowledged in any integrated coastal/island management scheme. First, are the obvious physical processes, global warming and sea-level rise, together with major regional influences such as ENSO and the Asian Monsoon. Second, are the

externally driven socio-economic changes as evidenced by globalisation of economic activity and international trade (e.g., tourism, tuna fishery) which have a pervasive impact on atoll systems. And third, are global influences on the management of various 'natural' atoll environments (e.g., Marine Protected Areas). Local change factors are also important, including naturally dynamic coastal processes, extreme events such as hurricanes, space for settlements, access to living and non-living island, reef and lagoon resources, waste disposal, mining and coastal development and pollution.

Both global and local drivers comprise two components: physical and human. Most will show increases in the future eg sea-level rise, air and sea surface temperature, economic activity, population, urbanisation, water use etc. As a result of these trends, and their interaction, coastal 'condition' (or health) will decline and with it the local socio-economic condition, and perhaps island carrying capacity. In this scenario, vulnerability increases through time, and in extreme cases human presence becomes unsustainable. Alternative scenarios to redress this decline, to improve coastal conditions and sustainability, and to increase human resilience through appropriate adaptations are outlined. It is argued that the earlier these adaptive responses are recognised and put in place the better the biophysical and socio-economic outcomes, though there may still be local pressures for resettlement. The problem now is: what are appropriate adaptations?

A Sequential Method Approach for Sediment Quality Assessment

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Coastal zones as the transitional areas between land and sea are becoming increasingly important and vulnerable due to the increase of the human pressure in these environments. These are regions of focussed population growth and coastal urbanization, closely followed by the development of recreation and industrial areas. Their utilisation as waterways, together with risks for oil spills, the development of fishing activities, and increased industrial and domestic sewage discharges has threatened the sensitive ecosystems. Aggregate exploitation onshore and in estuarine areas also constitutes an extra factor affecting the environmental quality. The management of all distinct uses must be done carefully to balance between economic benefits and negative impacts on the health of these environments. Sustainable human use of coastal shelf areas and their natural resources requires close consideration of increasing development pressures, uncertainties over future pollution impacts and the scale and nature of climate change consequences on coastal shelf seas.

This methodological study proposes a sequential approach for assessment of heavy metals based on five commonly used evaluation procedures (comparison with geochemical thresholds, metal ratios using a reference element, the Gradient Method, estimation of a regional baseline and Enrichment Factor calculations). This approach was used to study twenty-nine surface samples from 3 areas of the Portuguese shelf,

recovered offshore from the mouths of the Ave, Douro, Lis and Mira rivers. Samples were collected with an Oktopus box core during the PALEO1 cruise (2002) aboard the RV POSEIDON. These were analysed using ICP-OES for selected major and trace elements (after total decomposition using a 3-step acid attack: Aqua Regia, HF, HClO₄, HCl). Organic carbon, carbonate content and grain size were also determined.

The 3 areas are characterised by different oceanographic and inland catchment characteristics (lithology, climate, industrial activities and human occupation). The different environmental settings produce distinct sediment compositions characterized by accumulating both natural and anthropogenic sediment components simultaneously. The comparison of the total contents by itself not allows to correctly evaluate the presence or absence of contamination. The variability of sediment geochemistry is complicated by the interaction of elements with sediment grain size, mineralogy and organic carbon contents. To compensate for these interactions, several granulometric and geochemical procedures for normalization have been developed. The results obtained individually by each technique complement each other and allow more detailed information related to sedimentary characteristics, from which the background influences and environmental risks are interpreted.

The greater effort put on the evaluation and integration of the results can be justified by the reduction of costs associated with a coherent selection of sub-samples or detailed analyses (e.g. sequential extractions, bioassays, toxicity tests) of a few representative samples rather than the entire lot.

Temporal change in global precipitation and river discharge. Are we seeing long-term change or simply natural oscillations?

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50- and 100-yr long-term trends in precipitation and river runoff indicate that the shorter interval reflects more climatic oscillations, primarily forced by oceanic signals such as the Pacific Decadal Oscillation, ENSO, and North Atlantic Oscillation, rather than any long-term change. From 1951 to 2000, for instance, precipitation (as indicated by data collated by the Climate Research Unit at East Anglia) decreased dramatically in much of Africa (extending into southern Europe), southern Asia and the Siberian Arctic, while increasing throughout most of Australia, southeastern South America and much of North America. River discharge differed somewhat from these trends, the result of human removal of water, primarily for irrigation purposes.

The 1901-2000 precipitation trends show a somewhat similar trend in that eastern Asia and the Arctic showed a slight increase, and African declines were more localized to the sub-Saharan regions. The 100-yr river discharge base, unfortunately, is much more difficult to access, but North American trends show a general increase in runoff, matching that seen by precipitation trends. The northern Mississippi and St. Lawrence watersheds are particularly noted for marked increases in runoff.

The general lack of long records makes it difficult at present to differentiate climatic oscillations for long-term net change. With discharge data for many countries becoming less accessible, it is not clear whether long-term changes will be easy to identify in the future.

Optimizing Development Needs at the River Basin - Coastal Ecosystem Scale: the Catchment2Coast Case Study in the Incomati – Maputo Bay System

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The Catchment2Coast programme is a FP5 (INCO) co-funded initiative aimed to provide an ecosystem scale understanding of the linkages that govern the economic dependency of tropical coastal resources on their associated river catchments (Monteiro and Mathews, 2003; Marchand, 2003). The limited success thus far in explaining this type of dependency is hypothesised to be the result of a lack of understanding on the critical scales that govern the most sensitive linkages and the correct level of system complexity. The programme has two main planned outcomes:

- Understanding the sensitivity of the value of ecosystem services to the remote and local forcing scales
- Understanding the nature of an explicit linkage across the biophysical – economics boundaries
- Combine these to support the assessment of development options that require the internalization of lagged ecological service costs into their cost benefit analysis

This system scale need was investigated through a combination of observational programmes and the use of high resolution models. The core hypothesis of this project is that the most important biophysical interactions between freshwater catchments and coastal ecosystem services that support economically important living resources occur at the sub-seasonal event scale (days - weeks). Unless these scales are resolved the assessment of the economic consequences / benefits of those interactions will not be adequate or robust.

The biophysical part of the project was guided by a number of additional ecosystem function hypotheses that guided the approach to understanding the issues of how

process scales govern ecosystem behaviour and the economic benefits derived by its services.

To achieve this, an explicit dynamical capability was developed and implemented in order to run a sensitivity analysis on the linkage scales. This programme integrates a number of numerical modules (coastal, river basin and ground water) with the required dynamical capability in order to implement a system approach to the functional dependence of coastal systems on river basin and ground water forcing. The approach focused on a single but economically important coastal living resource, the shrimp as an indicator of coastal ecosystem response. However, it is generic enough to deal, when required, with other recognized impacts such as mining effluents, pathogens, eutrophication, erosion and silting.

The programme also integrates biophysical and resource economics production models to translate the biophysical impacts into urban and rural livelihoods impacts. A number of scenarios are addressed that show what linkages govern the ecosystem function as well as how this could be used to inform policy options in the spheres of development and climate change. These scenarios will include a 20 year projections based on expected environmental pressures, demographic and development projections.

Nutrient Budgets in the Arctic Coastal Systems

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The aim of this study is to calculate nutrient budgets (phosphate, nitrate, nitrite and silicate) in the arctic coastal systems. The great Siberian rivers transport thousands tons of nutrients to the Arctic shelf. Study of transformation of these nutrients is very important. Nutrients are a mineral base for primary production in seawater. Silicate distribution indicates river influence in the Arctic estuaries. Nutrient budget studies allow us to characterize ecological metabolism of the marine systems and to show sensitivity of these systems to environmental changes.

The nutrient budgets in the gulfs were calculated for summer and winter seasons according to the LOICZ recommendations. Ice melting and new ice formation were considered to the calculation of nutrient fluxes. Nutrient fluxes from the coastal erosion were estimated through laboratory experiments for some gulfs of the Laptev Sea. The database from the US–Russian Electronic Hydrochemical Atlas of the Arctic Ocean was used to calculate nutrient budgets in the gulfs.

The arctic coastal systems have different hydrographic, and ice conditions. For example the greatest tides are in the White Sea however nutrient river flux is moderate. Coastal erosion is more important in the Laptev and East-Siberian seas. Polynyas influence biological production in the ice covered systems. Many Arctic gulfs have strong stratification of the water column, but some of them are homogenous. By means of this study we tried to estimate the influence of environmental conditions on nutrient budgets.

Nutrient budgeting studies and stoichiometric analysis indicate that many of the Arctic gulfs are net autotrophic and act as a net sink of dissolved inorganic phosphorus, nitrogen, and silicate while the bottom layers of the systems are net heterotrophic and serve as net sources of nutrients. It means that internal processes and water exchange with outer shelf are more significant than river run-off in the gulfs. Only exception is the Ob gulf that is heterotrophic overall. It was estimated influence of coastal erosion on nutrient budgets. Nutrient fluxes as a result of coastal erosion and river run-off are of the same order in small systems. Sea ice cover is a key factor controlling water and nutrient fluxes in the arctic coastal systems in winter.

Hicacos Peninsula, a Costal Territory, with Urban and Rural Space facing Future Changes.

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Varadero beach is located in the Hicacos Peninsula in the north coast of Matanzas province in Cuba, the biggest island in the Caribbean Sea. Varadero is one of the most important tourist places in Caribbean. It has around 20 km in length and around 1-2 km in width; its height is between 5 – 10 m above sea level.

The physical-geographic conditions in Varadero make it a vulnerable place to environmental change. Its geographic position, its exposure to sea-level rise, flood, drought, changes in temperatures, sunshine, winds, hydrology, its fragile ecosystems, the natural resilience, are aspects of its natural vulnerability to climate change.

Growing anthropogenic pressure process, i.e. urbanization and even more the increasing tourist exploitation adds new pressures and changes the vulnerability of this naturally sensitive space. The socio-ecological interplay of its human settlements, its economy and its ecosystems make Varadero a vulnerable place to global change drivers/pressures.

Analysis of climate change observations in Varadero provide a deeper insight in the variability of the climate over the last decade, assists in generating future climate scenarios, in the determination of changes in vulnerability and impacts on tourism, the main economic activity, thus the social and environmental impacts.

This work provides a physical, geographic and socio-economic diagnosis of change, future perspectives; it gives insight in the climate variability and future climate change scenarios. It focuses on the natural vulnerability, its evolution with increasing anthropogenic pressures, the potential impacts by climate change, and with this information develops adaptation measures aiming to assist future sustainable development in Varadero.

A European point of view. The Water Framework Directive: Integrating Coastal Systems and River Basins.

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Coastal zones play a key role in Earth System functioning providing a significant contribution to the life support systems of most societies. Goods and services derived from coastal systems depend strongly on multiple trans-boundary interactions with the land, atmosphere, open ocean and sea bottom. Human habitation, food production, growing tourism and transportation accelerate the exploitation of the coastal landscape and resources.

Changes in the hydrologic cycle coupled with changes in land and water management alter fluxes of materials transmitted from river catchments to the coastal zone having a major effect on coastal ecosystems.

In order to maintain a sustainable delivery of goods and services for humankind, science needs to better inform society, decision-makers and planners about:

- global changes that are part of natural cycles of change, such as climate, and those due to changes in the global economy/trade and policy.
- regional (trans-boundary and supra-national) changes as a result of regional and national drivers and pressures in the coastal zone.
- regional changes at the river catchment level which affect the downstream coastal zone and the near-shore marine environment.

In Europe a major effort is already being made in this direction through the implementation of the EU Water Framework Directive. The objective of this Directive is to make sure that all European surface waters (rivers, lakes, transitional/coastal) and ground water bodies are effectively protected, and where needs be remediation measures are to be taken, to ensure that water bodies attain good ecological status by 2115. Twenty-eight countries with a population of around 450 million people are collaborating towards this common goal.

Focusing on regional scales within this context, transitional waters and especially coastal lagoons are increasingly recognised as representing a highly diversified series of ecosystems reflecting the wide range of the European climate conditions. They also are often systems of important economic value to local communities, and as such are often strongly impacted by anthropogenic pressures. There is considerable scientific interest in understanding the ecological functioning of lagoons and the external pressures such as agriculture, industrial, tourism and aquaculture etc. The recent international conference on Southern European Coastal Lagoons: The influence of River-Basin coastal Zone Interactions, Ferrara, Italy, November 2003, and the present LOICZ II Inaugural Open Science Meeting and earlier ELOISE and LOICZ conferences have clearly highlighted some of the information gaps that still need addressing. Among these can be identified:

- What is the magnitude and speed of change on coastal systems that is being inflicted by change to biogeochemical cycles can the systems recover and are the result within “acceptable” limits?
- Assessment of how much and how fast can changes to the biogeochemical cycle be inflicted on a system and still allow it to return to an “acceptable situation”?
- Can we identify what makes systems sensitive/robust?
- Can we assess of the implications of habitat, ecosystem services and land loss on regional and global biogeochemical cycles?
- How close do these losses take the system to thresholds of significant change in regional biogeochemical functions, thus affecting these natural goods and services?
- Can we identify the potential role of different assemblages and habitats in sustaining the integrity of coastal systems and Earth processes?
- Can we delineate the balance between increasing and decreasing sediment loads to the coastal zone due to man and/or climate change, and its impact on coastal evolution especially on wetlands and estuaries?

What mechanisms can we develop and build upon to provide policy makers with soundly based, timely and focused scientific information needed to attempt to answer these questions? One major component is that of use of regional/national observational networks.

The development of regional/national (perhaps initially informal) networks would allow a more focused response to major policy and science needs such as the implementation of the EU Framework Water Directive or the assessment of the impact of coastal lagoon ecosystems to local, regional and global anthropogenic pressures, as well as providing information to LOICZ II and G-CTOS (FAO).

Using the southern European arc as a specific example, the development of a number of regional/national networks on coastal lagoon ecosystems has been a pragmatic way of focussing regional scientific and management interests at an effective scale, and allowing collaboration between different regional/national networks, local and regional Authorities to develop as mutual interests and concerns are identified.

That such networks can effectively be developed can be seen through the examples of the French (PNEC), Italian (LaguNet), Greek (EINet), Portuguese (PlaNet), and the newly founded Spanish network (RedMarisma) as well as the EU project DITTY. These networks are starting to make a significant scientific contribution in the understanding of many aspects of river basin-coastal lagoon functioning and are also, in some cases, developing as Early Warning System (LaguNet) for onset of rapid proliferation of Algal species of potential risk to aquaculture and human health.

The fact that local and regional authorities are also responsible for the monitoring (WFD and other national and EU Directives) of coastal-lagoon ecosystems involved in the networks has clearly helped making available long-term data and the testing of advanced predictive modelling approaches and information technology support systems (DITTY project) for coastal-lagoon management purposes.

On the basis of this experience it could be worth considering if such a system of regional networks could be extended covering the Southern European arc, the western and northern Atlantic coast and Baltic regions, and provide science products (as well as acting as an Early Warning System) to LOICZ II and C-GTOS from these highly sensitive ecosystems?

People, Society and Natural Resource Management: Understanding the Implications of Societal Dynamics on the Coastal Environment

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The role of humankind in the management of natural resources and coastal ecosystems cannot be overstated. Not only is its influence felt through the development of science and technology over time that has expanded people's capacity of taming nature, the choices and management options taken for the coastal area management have also had significant impact in that environment. Central among these are people's changing livelihood alternatives and its implication on the state of the coastal environment. Increasing limitations in pursuing traditional activities and increasing demand for land resources in order to survive, have also meant that most of what humanity designs for its survival can also be thwarted by humanity itself. The implication of these multiple processes on the coastal and marine environment can be deleterious.

While there has been considerable research on the linkages between natural processes and local people's livelihood systems and how they affect the environment in river basins and consequently the coastal and marine environment in the Western Indian Ocean (WIO) region, most research has not been able to balance community dynamics such as changes in people's livelihood systems, the relevance of local social organization and institutional related processes with knowledge creation on the surrounding environment. People's activities are often taken 'for granted' aspects in resource utilization, disassociating them from the contexts within which they evolve. Aspects such as ownership regimes, responsibilities and power, poverty and development intervention are all very important but not easily comprehensible. It is expected that a refined understanding of how these processes interact with and affect the environment will provide coastal zone management efforts a fresh outlook on methodologies for integrating human impacts on the environment.

Within this understanding, this paper examines and therefore makes an analysis of key land-based anthropogenic processes influencing changes in coastal ecosystems and therefore the livelihood statuses of coastal people themselves in the WIO region. It focuses on the communities living within the Rufiji basin in South-eastern Tanzania as a case study where agricultural production and intensified farming practices especially rice cultivation close to river banks and catchment areas has enhanced soil erosion. The Rufiji Delta, located about 150 km south of Dar es Salaam, contains the largest continuous block of mangrove forest in East Africa, comprising some 53,000 hectares. This delta also supports the most important fishery along Tanzania's coastline, accounting for about 80 % of all shrimp catches in the country. The Delta is

home to about 41,000 people, many of whom are small farmers and traditional fishers. Increasing demand for mangrove products in the area also seem to challenge efforts for conservation done by coastal management activities in the region.

Local Communities within the Honmun Marine Protected Area (HMMPA) must be relevant

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The fishery sector has recently joined Vietnam's spearhead industries, as it accounted for over 10 % of Gross Domestic Product in 2001, and its export turnover exceeded by US\$ 2 billions in 2002. Growing demand for domestic consumption and export, however, has come at the expense of the sustainability, that is, improper, even destructive marine exploitation. Accordingly, some species are vulnerable to alarming reduction, and marine habitats have been degraded. Therefore, the establishment of MPAs for the sake of sustainable maintenance of fishery resources has been put into the State's action plan.

Nha Trang Bay has gained widespread acceptance as an ideal biodiversity site in Vietnam. It is among the reasons that Honmun – Nha Trang Bay has been selected for the first comprehensive preservation of a representative example of international significance. In parallel, a cooperation model has been set up, and further, multiplied to other locations (15 MPAs are projected to be established).

In spite of its great potentials, the HMMPA is confronting a real challenge, that is, local communities can't immediately reap benefits from the project. This can be explained by the fact that many restricted exploitation areas have limited their livelihood activities. Meanwhile, some fishermen fail to shift their occupation due to small capital, limited access to preferential credit fund, low intellectual level...

In the face of this problem, it is logical if local communities can be closely engaged in the MPA management, as they themselves make the greatest adverse impacts on the fishery resources. It means their livelihood opportunities should be put high on priority. From the analysis based on primary and secondary data, we find that heightened awareness and newly created jobs that can generate alternative income, should be speedy solutions among those that minimize imminent threats to coastal fishery resources. For this reason, the article mainly focuses on the livelihood activities (e.g., aquaculture, eco-tourism...) in harmony with the strategic goal, that is, natural conservation. At the same time, the pilot HMMPA has been funded within only 4 years, while the operation costs for such a scheme are often unpredictably high, let alone the fact that marine conservation is usually a more finance-consuming program than inland one. Therefore, the article also discusses practical solutions to develop a sustainable financial mechanism for the MPA.

Despite not quite the same thing as a make-or-break factor, men's role in fishery development gives rise to a somewhat similar situation. It is simply because, among 3 major factors interacting for the change of coastal zone namely: land, ocean and people, the two formers, though dominated by the law of nature, are always affected

by human activities. All this together leads to an essential requirement for human development, e.g., special attention to local communities' interests. If this is to be materialized, local communities, for vital necessities, will play a pro-active part in the coastal management and development.

An Integrated Assessment of Erosion and Flooding in North-East Norfolk, England

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This paper reports an integrated assessment of erosion and flooding over the 21st Century for a 50-km length of coast in North-East Norfolk from Blakney Point to Winterton. It comprises large lengths of soft erodible cliffs, with large downdrift coastal lowlands at risk of flooding during storm surge events. The assessment considers 45 combinations of scenarios of sea-level rise, changing wave climate, and coastal management. This research has been funded under Theme 4 of the Tyndall Centre for Climate Change Research.

The assessment is based on integrating a number of distinct elements:

- A detailed long-term historic wave climate,
- The Soft Cliff and Platform Erosion model (SCAPE),

- Cliff-top retreat derived from SCAPE outputs,
- Inundation analysis of flooding,
- Socio-economic impact analysis (damages due to erosion and flooding).

SCAPE calculates coastal change at a series of shore profiles spaced, in this case, at 500 m intervals. Time series of wave and tide conditions are used to drive modules describing (1) nearshore wave transformation, (2) shore platform and cliff erosion, (3) bulk longshore sediment transport, (4) talus removal, (5) beach development, and (6) offshore beach sediment storage. SCAPE's strength lies in representation of critical interactions across a broad system. Long-term model stability is achieved by capturing negative feedback, particularly between beach volumes and erosion rates. Cliff-top position is derived offline using a probabilistic model.

For the flood analysis, the long-term shoreline evolution from SCAPE provides evidence of variability in beach levels over shorter time-scales. Together with estimates of beach scour, this information is used to estimate the probability of failure of the hard sea defences and subsequent dune erosion during extreme storms. An importance sample methodology is used to identify the failure modes that make the greatest contribution to flood risk. Inundation of the hinterland is then simulated with a simplified 2D hydrodynamic model.

The SCAPE validation was achieved through plan-shape comparison of model erosion rates against cliff-toe recession measured between 1885 and 2002 from historical Ordnance Survey maps. The flood model was validated against a 1938 flood event.

For future assessment, scenarios included relative sea-level rise up to 1.2 m (by 2100), and increasing offshore wave height and changes in wave direction. Management scenarios were based on increasingly 'natural' options, from 100% defended, through 80 % defended (as today), 40%, 20%, to no coastal defences. Summary results of all the SCAPE simulations are stored in a GIS to facilitate impact analysis.

Coastal retreat is found to be sensitive to sea-level rise, but due to longshore transport, in downdrift locations the growth of beaches is an important feedback which limits this response. Therefore, removing cliff defences will have benefits in terms of reducing flood risk, but these benefits have limits. Future developments of this integrated approach will be considered.

Carbon and Nutrient Fluxes in the Arctic Shelf

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The Arctic Shelf is unique in several aspects. Most of the waters exiting the Arctic Ocean have had their properties modified on the Shelf. River runoff brings significant amounts of particulate matter, nutrients, dissolved inorganic and organic carbon, metals and pollutants on to the shelves where some gets buried in the sediments while parts enter the deep central Arctic Ocean through incorporation into sea ice and the Trans Polar Drift.

The severe climatic conditions of these environments make the ecological systems vulnerable and the time of recovery if damaged can be extensive. Baseline knowledge of the hydrochemical structure of these seas is therefore valuable. This includes the cycle and fluxes of nutrients and carbon as well as its seasonal and annual variability.

High quality data was using in this work. The database includes temperature, salinity, oxygen, silicate, phosphate, nitrite, nitrate and dissolved inorganic carbon data obtained in international expeditions in the Arctic. For calculation of carbon and nutrient fluxes used LOICZ recommendation (<http://data.ecology.su.se/MNODE/Methods/TOC.HTM>).

Obtained fluxes of nutrient and carbon have permitted to estimate metabolism of systems in the Arctic Shelf.

Managing On-Site Activities for Achieving Off-Site Environmental Effects

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In the light of globalisation, an increasing number of agreements and legislative documents are issued in an international context; this is especially true for environmental protection targets (e.g. OSPAR nutrient targets for reducing eutrophication). Although this approach recognizes the transboundary nature of environmental problems, it sets a new challenge by presupposing cooperation at all 'lower' administrative levels, from the national to the local level. One of the main obstacles to this cooperation is the mismatch between the local region, where (on-site) actions need to be taken in order to achieve the set targets, and the (off-site)

international environment that benefits from those actions. For the actors locally responsible for the needed changes, the international environment may be a spatially remote and little known entity. Based on an unclear cause-effect relationship between their actions and the quality improvement of the international environment, local stakeholders may have scarce interest in reaching the targets. The challenge is then how to enhance cooperation across levels for achieving higher commitment by local actors.

Applied to the issue of reducing eutrophication within the North Sea, for which the OSPAR reduction targets (50% nutrient –nitrogen and phosphorous– reduction compared to the year 1985) are set, reduction measures and their ecological effects upon the North Sea are analysed. On-site measures are applied for nutrient emission reduction in two international and one national river catchments, namely the Rhine (Germany and The Netherlands), the Elbe (Czech Republic and Germany) and the Humber (UK)

Three reduction scenarios represent different levels of success in achieving the reduction targets set by OSPAR, a low-reduction scenario, a middle reduction scenario and a high-reduction scenario.

Regional and site-specific measures are recommendable to achieve comparable levels of nutrient reductions in different catchments. The costs of implementation of different on-site measures (chosen in dependence of the physical and economic characteristics of the river basins) are shown, together with the benefits associated to wetland creation.

An understandable representation of the ecological consequences of emission reductions upon the ecosystem (transparent cause-effect relationship) is the key-element for enhancing communication between decision-makers and local stakeholders.

Through modelling the ecosystem with ERSEM (European Regional Seas Ecosystem Model), selected ecological indicators (e.g. primary production) indicated that the same level of nutrient reduction can result in different indicator values in the studied areas. An aggregated indicator allows showing reductions of ecological risks in the North Sea associated with nutrient reductions in different catchments.

Given, on the one side, the costs of on-site measure implementation and, on the other side, the off-site effects upon the North Sea coastal ecosystems, the developed procedure allows an integrative evaluation of socio-economic endeavour and ecological outcome, which is comparable for different regions and constitutes the basis for a multi-scale dialogue between decision-makers and key-stakeholders.

Based on stakeholder perceptions –which should be carefully proofed through a stakeholder dialogue– the willingness to pay for increased environmental quality and to accept environmental risks, as well as the willingness to spatially re-distribute (monetary) benefits will be determinant for the achievement of the set goals.

Media and Environmental Protection

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Environmental degradation has been one of the major problems facing humankind. This stems from irresponsible wanton destruction of the environment and obviously coastal ecological systems have not been spared either. Over the years humankind has in their quest to tame the environment to meet their ever rising life demands not taken into consideration the damage they do to the environment. This has resulted in serious environmental degradation in coastal ecological systems. It is one of the most terrible degradations of our times posing serious threat to the future of mother earth. It is not only a humanitarian disaster but is also threatening to become another source of economic retardation and backwardness. Its heavy toll is felt in the developing nations most with the ones in sub-Saharan Africa being worst hit.

Every effort has to be made to combat environmental degradation. Science can lead to sustainable management of the environment including the coastal zones. In third world countries protection of the environment has been and will be a major issue looking at the accelerating depletion by human activities. It is through the media that some of the worst wanton destruction of the environment has been exposed publicly and a lesson can be learnt from this. In Kenya the fight against the degradation and sustainable environmental exploitation has been a key issue and the media have been present in tackling the issues. In Africa, in general, environmental destruction has been spreading fast. Society has reacted with less openness to the challenges posed by this, especially where high ranking individuals in the establishment are the culprits. Irresponsible exploitation of the environment must be broken down and its here where the media would be one of the most effective tools in the combat. Examples can be found in the *Standard* and Biosafety News which launched targeted campaigns to reverse this trend.

The media must continue to gather and disseminate accurate information on sustainable environmental use. It has a vital role to play and talking about the threat is extremely important if there has to be reduction in the destructions.

Anthropogenic Activities Contributing to Coastal Changes in the Niger Delta

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The Niger Delta is a wetland of over 76,000 sq km and has the largest mangrove forest in Africa (11,134 km²) and the fourth largest in the world. The region is rich in biological resources and provides important breeding grounds for fishes, feeding and nesting ground for migratory birds and wildlife. The delta also contains the second largest crude oil reserves in Africa. The ecosystem is characteristically low lying,

consisting of shallow meandering creeks that make access difficult for oil exploration and other marine related commerce. Dredging is done to overcome such challenges by creating navigable accesses to prolific oil locations. The concomitant dredged spoils are typically abandoned upon fringing wetland vegetation thus altering the topography and hydrology and causing extreme acidification in some cases, leading to vegetation and fish mortalities. The altered conditions often prevent the re-colonization of the sites by native species. The resultant spoil dumps initially remain bare for several years and later they become colonized by invasive species. Spoil abandonment has resulted in the creation of undulating heaps with canopy gaps in place of sheltered low lying intertidal mangroves. Because of the limited high grounds in the coastal area, the native fisher folks soon become attracted to the abandoned dredged spoils for the establishment of fishing camps and home gardens, many of which have blossomed into large communities that are now spatially located close to high pressured oil and gas installations. Subsequent maintenance of canals sometimes results in conflict between the dredged spoil residents and oil industry operators. Dredging activities fragments the ecosystem and opens them up for more extensive use. Other human activities within the coastal area include wood logging, sand mining and sand filling, many of which are carried out without any compensatory mitigation to achieve no net loss of wetlands. Solid wastes including non-biodegradable plastics and nylons that are freely released into the coastal area smothers wetland plants. Also, the exotic nypa palm introduced into the area in 1906 is fast replacing native *Rhizophora* mangroves especially in the eastern part of the delta. The combined effects of deforestation, plant invasion and alteration of topography and hydrology, which modifies the morphology and biodiversity increases the vulnerability of the coastal area to rising sea levels. The consequence of such anthropogenic modification has begun to emerge, which includes shifts in vegetation structure and diversity, land use and demographic changes. There are indications that the delta is increasingly becoming more vulnerable because of the observed erosion, flooding and to a lesser subsidence in recent times.

This paper is therefore aimed at drawing the attention of both local and international communities to the anthropogenic influences contributing to coastal changes in the Niger Delta, which affects the vulnerability and sustainability of the coastal ecosystem.

ICZM as Instrument of Regional Governance - Between Spatial Planning and Extended Participation.

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As result of the European initiatives in ICZM, an increased number of research and implementation projects is funded which (at least in Germany) in their majority are working on the integration of the relevant administrative agencies with their divided competencies and on the co-operation between state and civil society stakeholders. As always in such forms of co-operation the crucial problem is their relation to the legally established political and administrative decision-making routines - especially

with regard to legitimacy and liability.

From a theoretical perspective, these processes and problems could be regarded in the context of the governance-debate which is raising similar questions for the changing quality of national governments' ability to implement policies effectively, of changing relations between state and society and of the development of democratic decision-making in general.

The lesson to be drawn from the governance debate is that regional sustainability strategies and integrated politics cannot be achieved alone by the implementation of single instruments such as ICZM networks, which are intended to facilitate work in selected issue areas. Rather, the quality and the development of the complete arrangement of administrative and political decision-making procedures and their constitutional and legal regulation are decisive for the quality of participation and integration in ICZM.

With regard to a recent empirical investigation of co-operation and participation in German plan approval procedures it can be demonstrated that an extension of participation is urgently needed. On the other side the development of first drafts of new national strategies for the implementation of ICZM indicate a modernisation of the existing spatial planning systems (e.g. by extension of their regulation into the EEZ) without any fundamental change of the existing system of interest mediation.

It remains thus an open question

- a) if the concept of ICZM is a concept of only temporary importance to foster the modernisation of the established planning and spatial policy systems which finally proved to be effective and adaptive or
- b) if a restricted reform and extension of classical instruments is a traditionalist misunderstanding of the fundamental challenge the existing forms of democratic policy management are facing.
- c) This question is discussed in the light of a recent analysis of the performance of German approval procedures according to ICZM criteria.

Ecological zoning of the Northern Caspian

Dr E. Ostrovskaya, Dr S. Monakhov, Dr A. Kurapov

Northern Caspian is a part of the Caspian Sea and differs from the other part by lower salinity and large shallow water area. In fact it is the Volga River mouth area. There is an area of mixing river and marine waters, which is a geochemical barrier and plays an important role in processes of transport and sedimentation of organic and inorganic chemical compounds entering into the Caspian Sea with the Volga flow. The global importance for biodiversity of the Volga delta is widely acknowledged. The wetland habitat is considered to be the best conserved in Europe. Part of the Delta and Northern Caspian is the Astrakhan Biosphere Reserve and approximately half of the Delta has been designated a Ramsar Site (800,000 ha). In the region there are fifteen rare bird species listed in the Red Book of the Russian Federation. Relict plant species listed in the Red Book of the Russian Federation occur in this area together with at

least twenty endemic fish sub-species. Three globally significant bird migration routes run over the region, serving millions of waterfowl of many dozens of species. Northern Caspian is characterized by very high biological productivity. There are spawning grounds, migration routes and feeding areas of semi-migratory and migratory fishes including the most commercially valuable sturgeons.

The importance of the region is growing in the field of oil and gas exploration and extraction. At present, the region faces major environmental problems. These include threats to the area's unique biodiversity, declines in commercial fish stocks, marine pollution. In the near future anthropogenic pressure on the marine and coastal environment will increase considerably because of planned development of all kinds of human activities, including offshore oil and gas reserves exploitation that may bring essential damage to the ecosystem by large-scale pollution of the sea area and its productive grounds.

The ecological zoning of the area has been done with the purpose of marine environment protection at the oil and gas deposits exploitation. Several approaches have been used for this. Ten natural aquatic zones were revealed due to aquatic landscape zoning. They differ from each other by lithological features and structure of benthic assemblages. Zoning (four zones) was based on the monitoring data of fish distribution and fauna vulnerability to hydrocarbon pollution of the marine environment. Fourteen zones differing on contaminants migration processes were revealed using the data of marine environment pollution monitoring, which is conducted by oil companies within their frameworks of environmental security.

Results obtained are significant for protection and conservation of the Northern Caspian unique environment and sustainable development of all kinds of human activities in the region.

Effects of Sewage Water Disposal on the Bio-Physical Dynamics of a South African Temporarily Open/Closed Estuary

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South African temporarily open/closed estuaries (TOCEs) are normally mesotrophic to eutrophic systems that remain closed for large parts of the year during the dry season. They are important nursery areas for many estuarine and estuarine-dependent marine fish and crustacean species. Changes in the bio-physical dynamics of these estuaries may compromise their trophic function and the viability of these important

stocks. Very little empirical results are as yet available on the impact that recent anthropogenic activities may already be exerting on such systems.

The Mhlanga Estuary, on the KwaZulu-Natal north coast, was selected as a typical case study as it is currently experiencing the discharge of about 20 ML/day of treated sewage waters into its upper reaches. This has led to the hyper-eutrophication of its waters and a significant increase in its base-flow magnitudes, providing a capping flow of $0.23 \text{ m}^3 \text{ s}^{-1}$. A multidisciplinary investigation of the estuary was carried out during March 2002 - March 2003. Various physico-chemical and biological parameters were measured at three reaches of the estuary at monthly intervals. These included state of the mouth, water residence time, dissolved inorganic nitrogen (DIN), phosphorous (DIP) and oxygen (DO) concentrations, phytoplankton chlorophyll-a, zooplankton, macrofauna and fish abundances, composition and biomass.

Results show that the Mhlanga exhibits hypertrophic nutrient levels, with DIN and DIP values normally $> 100 \mu\text{M}$ and $> 25 \mu\text{M}$, respectively. Dense phytoplankton blooms (chlorophyll-a $> 100 \text{ mg m}^{-3}$) were observed on two occasions, in October 2002 and in February 2003. These were both attained after periods of uninterrupted mouth closure of 11 and 9 days respectively. The generally short residence time of these eutrophic waters within the Mhlanga restricted the time available for phytoplankton to take up enough nutrients to form more frequent blooms. Sixteen mouth-breaching events were recorded during the study period, with the estuary never experiencing closure of more than 15 consecutive days.

Effects of hyper-eutrophication are clearly detrimental to the health of the estuary and related economic activities. The increased frequency of breaching, induced by the capping flow of the sewage discharges, further compounds the problem. This is because frequent breaching does not allow the estuary to function properly as a temporarily open/closed system, with an extended closed phase capable of fulfilling its nursery role for the juveniles of estuarine-dependent marine fish and crustaceans. It is proposed that the treated sewage discharges from the treatment works be re-directed from the estuary into the ocean, or alternatively into a nearby permanently open estuary.

Assessment of Chemical Pollution in the Mediterranean: A Preliminary Driver-Pressure Analysis

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Mediterranean coastal zone pollution is largely originated from sources on land, mainly in the form of uncontrolled waste discharges from municipal and industrial sources. Several compounds producing pollution also reach the sea from river transport and from atmospheric deposition. The pollution reduction is strongly connected with the reduction of inputs into the coastal zone and therefore with the reduction of pressures exerted by land-based sources of pollution. Following the ongoing EU legislation and the scientific advances, an integrated approach must be

used when considering both the socio-economic activities generating pollution and the quality status of the water body. Hence, the interrelationship between the ecological and socio-economic studies and effective policy responses can be summarised under the Drivers-Pressures-State-Impacts-Response (DPSIR) framework as successfully experienced in recent EU projects

A further insight into the major patterns of chemical pollution in Mediterranean coastal waters (other than nutrients and oil spills) and a causal chain analysis is being carried out within the ELME Project (European Lifestyles and Marine Ecosystems). The assessment is performed through the definition of current chemical problems in the region which implies (i) the development of an inventory reporting the existing chemical products and their use in relation to major social and economic Drivers, (ii) an estimate of annual releases of chemicals from major point and diffuse sources into the marine environment, (iii) the determination of major transport pathways from the emission source to marine waters, and (iv) an evaluation of the present and projected future State of the marine waters. Having the above in mind, a scenarios analysis will examine the effectiveness of various options in achieving Water Quality Objectives.

In this preliminary phase of the project, the D-P analysis was done for the assessment of current chemical problems in the Mediterranean coastal zone environment, the inventory of existing chemical products in relation to the social and economic Drivers at the regional scale, and the current production and import volumes of chemical substances. The methodological approach involved the identification of main contaminant categories, the evaluation of data availability and check of their quality, the determination of main Drivers' categories that originate pollution and the definition of hot-spot and sensible areas. Main pollutant categories (metals and organics) were retrieved from scientific literature and reports, databases were developed and include data on emissions to air and water, chemicals concentration in water, sediments and biota samples.

An Optimal Corrective Tax for Thai Shrimp Farming

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If The of around 16.54 THB/kg for the Gulf but zero discharge tax for Andaman. Mangrove tax would be 14.31 and 17.41 THB/rai/year (6.25 rai = 1 ha) for the Gulf and Andaman, respectively. Lastly, abandoned farm tax would be 1.23-5.32 THB/rai/year depending on the culture site. A socially efficient level of production for the entire kingdom would be around 70% of private optimal production. The tax regime ensures a higher net gain from trade than at private optimum but it is ambiguous in terms of net social welfare. However, in the long run net welfare as well as net gain from trade from social optimal policy is obviously higher than from private optimal policy, in most generic cases.

This study also found that the numerical results are sensitive to biogeochemical-related parameters (e.g. nutrient assimilation, load concentration, carrying capacity)

which could cause varied interpretation of the results. On the other hand, the valuation data is likely to affect only the scale of the results.

Thai shrimp farming were taxed, how much should it be?" is the key research question of this paper. The dynamic-constraint optimization model is applied to the analysis. Accumulated nutrient load from farm discharges is incorporated as stock constraint. Environmental costs taken into account are: mangrove forgone benefit, abandoned farms (due to pond soil degradation) and cumulative nutrient build-up in coastal waters (that causes eutrophication). This aims to arrive at an optimal corrective tax (Pigouvian tax). The first two impacts are corrected as flow externalities while the last is corrected as stock externality. Social welfare effect and net gain from trade are also investigated.

The model shows a conventional outcome of increasing optimal tax path but decreasing optimal production path before it attains a steady state as a consequence of nutrient accumulated before threshold (critical level). In principle, this suggests some tax being imposed on stock externality that is equal to increasing shadow cost of nutrient stock even before damage occurs (i.e. before steady state). From empirical results, however, it turns out that the shadow costs for both coastal sites, i.e. the Gulf of Thailand and the Andaman Sea are very small (nearly zero) at the beginning of the paths for long time period. The results indicate that nutrient load has a negligible effect on Andaman while it is significant in case of the Gulf.

From base case scenario at shrimp price of 190 THB/kg (40 THB=1 USD), it shows total tax at steady state of 53.93 and 40.58 THB/kg for shrimp farming in ex-mangroves on the Gulf and Andaman, respectively. On the other hand, the tax for farming outside mangrove areas is 19.00 and 16.14 THB/kg, respectively.

This study suggests that the steady-state tax policy should be applied to shrimp farming on the Gulf and the initial-tax policy on Andaman. This would result in the tax being imposed on farm discharge

Status of Quality of Coastal Environment in India – A Review

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Coastal environment plays an imperative role in nation's economy by virtue of its resources, productive habitats and rich biodiversity. India has a coastline of 7516 km of which 5422 km accounts for main land and rest is small islands, which are scattered in the Bay of Bengal and the Arabian Sea. These are assuming greater importance in recent years due to increasing human population; urbanization and increased developmental activities which leads to increase the dumping of various pollutants to the coastal areas these are detrimental for the coastal biodiversity. At the same time, the natural hazards have proven to have major impact on the dynamics of the coastal environment. The recent tsunami has shown tremendous impact over the biogeochemical behavior of various dissolved and particulate material in the coastal ecosystems. Now, we are doing research on the changes in nutrient concentration and

dynamics after tsunami in the southeast Indian estuarine mangrove system (Pichavaram).

Nutrients dynamics and variability in any coastal ecosystem has a direct impact over the trophic status and ecological integrity. A wide ranges of biogeochemical processes taking place in these coastal environments due to mixing of fresh and saline water in the ecotone areas, which leads to intensify the biogeochemical processes with in the ecosystem itself that can change the chemical composition of the water and sediments. Because of strong unevenness in various physical and chemical variables and long residence time of water in the interface coastal systems provoke increased biogeochemical changes, which enables in a geochemical filter and a biological filter. This kind of nature has been observed in many coastal ecosystems of India (e.g., The Adayar & Ennore mangrove creek, the Pichavaram mangrove).

The major activities are responsible for coastal pollution in India is discharge and disposal of untreated domestic and industrial wastes, discharge of coolant waters, various dredging activities etc. Because of its natural geo- and biofilter nature, a significant amount of heavy and trace pollutants are trapped in the coastal environments. Atmospherically derived ^{210}Pb and ^{137}Cs radioactive isotopes were used to estimate the sediment accumulation rates, which give an idea about the retention capacity of the coastal sediments for toxic trace and trace pollutants. In general high rates of sedimentation observed in the coastal ecosystems not only reflect the capacity of the coastal regions as sinks for trace metals but also denote increased input of pollutants into the coastal environments in the recent past. Thus, this paper is aimed to address the impacts of various factors the dynamic coastal environment and this has direct and indirect impacts over the biodiversity and human settlements in and around the coastal environment.

Land-Ocean Exchanges and Budgeting in a River-Estuary-Ria-Shelf System (NW Iberian Peninsula)

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Rias are incised valleys where the estuarine zone can shift according to climatic changes (Evans and Prego, 2003). Thus, in the Western Galician Rias only the inner part can be considered as an estuary from both hydrographical and their resulting sedimentological considerations. This is the case of Ria Pontevedra, where systematic hydrodynamical, biogeochemical and biological research was carried out biweekly between October 1997-98.

From the ocean boundary, favorable atmospheric conditions in spring induced coastal upwelling up the continental shelf, which intensified in summer and was detected in the inner

ria. Thereafter, upwelling ceased and from November to March seawater transported by the poleward current was detected on the shelf and occasionally inside the ria.

From the continental boundary, the annual average contribution was 27 m³ s⁻¹ of freshwater, mainly by the Lerez River, and 2.4 mol s⁻¹ of DIN, with 79 % of nitrate from the river. By means of a steady state box model, the residence time of water (tr, days) in the estuarine ria zone was shown to depend simultaneously on the river discharge (Qr, m³ s⁻¹) and the seawater inflow (Qs, m³ s⁻¹) via the relationship: $tr = 1/(0.000696 \cdot Qs + 0.0125 \cdot Qr + 0.43)$. Moreover, a first-order implicit finite difference model revealed that tr in the inner and middle ria was 2±1 d and 6±2 d, respectively. Nevertheless, winds speed higher than 4 m s⁻¹ are able to dominate the current at surface layers, even against tidal effects.

From the benthic boundary, sediment incubation cores showed that large quantities of ammonium are effluxed to the water column (250 μmol NH₄⁺ m⁻² h⁻¹) with upwelling conditions. Net denitrification, determined by mass balance was estimated at two stations as 178 μmol N m⁻² h⁻¹ and 182 μmol N m⁻² h⁻¹. Denitrification was highest when upwelling relaxes and the flux of organic matter to the sediment increases. Regular inputs of offshore seawater ensured water renewal and re-oxygenation of bottom waters, thus preventing anoxia, particularly in the summer. Vertical fluxes of carbon estimated using sediment traps ranged from 530 to 1780 mgC·m⁻²·d⁻¹. A decrease in sedimentation was always observed from the inner to the outer ria, and from low to higher productivity periods. The daily export of carbon accounted for 75 % of primary production and between 18-66 % of phytoplankton biomass.

A non-stationary state mass balance of the type advocated by IGBP-LOICZ has been used to assess net ecosystem metabolism in the ria. Nutrient fluxes into the reservoir were strongly driven by the incoming oceanic flow throughout the year, which supplied 88 and 98 % of the total NO₃⁻ and PO₄³⁻ load, respectively. The mean annual net community production (NCP) predicted by the NO₃⁻ balance was 24.0 mg C m⁻² h⁻¹, and 35.8 mg C m⁻² h⁻¹ from the PO₄³⁻ budget. The Pontevedra Ria may be considered as net autotrophic, although the NO₃⁻ budget suggests alternation between autotrophy and heterotrophy over an annual cycle.

The Fate of the Rhone River Delivery to the Coastal Ocean: The Need of Benthic Observatories within RiOMar

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One of the aims of the RiOMar project (River-dominated Ocean Margins) is the understanding and quantification of the fate of river particles and dissolved substances delivered to the coastal ocean. In the context of the Rhone river, as in many river-shelf systems, the biogeochemical fate of the river discharge is largely influenced by hydrodynamics and by deposition, secondary transport and transformation in the sediments. Particulate organic carbon delivered to the coastal ocean promotes large

consumption of oxygen in the sediment close to the river mouth and dissolved nutrients contribute to larger marine productivity which further delivers organic carbon to the sea floor. In many river-dominated ocean margins (Mississippi, Yangtze) impacted by human activity, this enhanced organic carbon input to the sediments has promoted hypoxia in bottom waters, endangering shelf ecosystems. It is thus crucial to determine the fate of organic particles (transport versus local mineralisation) in order to understand the environmental impact of river inputs to shelf ecosystems.

In spring 2002, oxygen profiles were measured in the sediments of the continental shelf off the Rhone River mouth using an *in situ* microprofiler. They showed exceptionally high values of oxygen demand corresponding to intense mineralisation of organic matter. At the same time, an ADCP (Acoustic Doppler Current Profiler) was moored in a nearby station which measured current velocity profiles and wave characteristics. This *in situ* dataset highlights the major role of South-East swells in the erosion of prodeltaic sediments, their dispersion towards the South-Western continental shelf and their rapid mineralisation during the deposition stage. In order to understand the transformation associated with multiple resuspension events, it would be necessary to couple current meter measurements, turbidity and oxygen profiles in a smart benthic station, a task undertaken in the COBO programme (Towards Coastal Ocean Benthic Observatories), an EU-FP6 project.

Heavy Metal Inputs from Rivers and their Deposits at the Scale of a Continental Shelf: the Gulf of Lions.

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Heavy metals delivered to the coastal zone issued from three main inputs: rivers, direct urban wastes and atmospheric deposition. These inputs can be generally well constrained for a small area (bay, estuary...), but their study at the scale of a continental shelf requires more effort in order to combine a global approach with specific studies of each sources.

Fluxes of dissolved and particulate heavy metals delivered to the Gulf of Lions (Northwestern Mediterranean sea) by the main rivers (Rhône, Têt, Hérault) have been followed-up during three years to evaluate their respective significance as well as their time variations (Zone atelier ORME and PNEC programs). Obviously, the main driving parameters are the liquid and particles discharges, but annual variations are huge and directly related to floods events, during which 80 % of the annual flux can be transported. These events usual under Mediterranean climate must be absolutely taken into account, and this is particularly difficult at this scale where floods do not occurred at the same time for the various rivers. Relations between metal fluxes and liquid or particle fluxes have been now constrained for each river and should be used

for predictive models as well as for reconstruction of past fluxes. A precise estimation of such relation requires a sampling effort mainly concentrated during the few hours of any flood event.

These rivers inputs are lower than the present atmospheric deposition observed in the western Mediterranean sea, but the ratio atmospheric/river inputs directly depends on the surface influenced by the river and thus is difficult to define.

On the shelf, part of these metals is deposited on nearshore prodelta areas where they accumulate associated to fine-grain size with other chemical elements (organic carbon, radionuclides...), probably after flood events. These fine grain sediments are however mixed with coarse-grain, and normalizing metal concentration with a stable element (like Cs) is necessary to evidence metal accumulation. Such processes are observed for all the rivers, independently of their discharges. Surprisingly, these fine grains stands above the storm wave base, but part of them can be resuspended during storm but also by more usual bottom currents as we evidenced with resuspension experiments within laboratory. Part of these pollutants will thus be redistributed to areas with lower shear stress (middle shelf) or can be exported to the slope margin.

On the Study of Simulated Nutrient Budget in Lampung Bay, Indonesia Using a Coupled Hydrodynamic-Ecosystem Model

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The purpose of this research is to study the dynamic of an aquatic ecosystem in semi-enclosed Lampung Bay, Sumatera, Indonesia by using a numerical coupled hydrodynamic-ecosystem model. The model calculated the nutrient budget of chlorophyll-A, zooplankton, phosphate and nitrate. The distribution of each compartment of the ecosystem model was strongly effected by the current circulation. The dynamic of current circulation was generated by the tidal driven current. The simulated flow pattern of M2 residual current, the dominant tidal constituent in this bay, tends to flow into the western mouth of the bay from which part of them flow toward the head of the bay while the other parts flow out through the eastern mouth of the bay. The simulation also indicates the existence of an eddy with counterclockwise motion around the head of the bay. The simulated distribution pattern of each ecosystem compartment is in a good agreement with the field distribution results.

The distribution pattern of nitrate and phosphate is strongly related to the flow pattern of M2-residual current in the whole observation of the year. There is also shown an intensification of nitrate and phosphate concentrations in the bay head due to riverine inputs from Ratai River. Whereas the anticlockwise circulation in the basin region of the head bay and the smaller residual current in the head bay, therefore the

intensification of its concentrations will be distributed gradually to the outer part of the bay head. The calculated flushing time in Lampung Bay is 15 days, so it takes a half-month to distribute the material from riverine inputs.

The other sources of nutrients scattered along the eastern part of the bay's coastline (such as shrimp pond and rice field culture activities, Damar, 2003), the DIN concentrations will be distributed rapidly to the eastern part of the bay mouth. However, the influence of water masses coming from the Sunda Strait might occur. Related to the M2 residual current, there is a material transport (included DIN) which inflows to the Lampung Bay from Sunda Strait.

The primary production, secondary production (grazing), natural mortality of plankton and also decomposition by bacteria are less important to the budget and standing stock calculation in Lampung Bay ecosystem. The influence of rivers run off and ocean water from supply from Sunda Strait are more important than biochemical processes in the bay. The simulated rate of efficiency of heat flow from both the decomposition process and urine production by zooplankton to the primary production has missed of 30.48 %, while from the primary production to the secondary production (grazing) has added of 17.24 %.

Institutionalization of ICZM at National Level: Bangladesh Experience

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A total of 35.1 million people live in the coastal zone of Bangladesh (2001 census), of which 49 % are women. The extent of poverty is relatively high compared to the remaining part of Bangladesh: 52 % are absolute and 24 % extreme poor. The coastal population is projected to grow to about 41.8 million in 2015 and 57.9 million in 2050.

The coastal Bangladesh is known as a zone of multiple vulnerabilities. It is prone to severe natural disasters, such as cyclones, storm surges, and floods. In combination with other natural and man-made hazards, such as erosion, the high arsenic contents of ground water, water logging, water and soil salinity and various forms of pollution, these disasters have made coastal dwellers very vulnerable and slowed down social and economic developments.

During last decades, the Government of Bangladesh (GoB) has taken several attempts to facilitate coastal development such as the creation of the Off-Shore Island Development Board (1977-82), development of a coastal environment management plan (1987), special parliamentary standing committee on coastal area development (1988-90). In 1999, the GoB, issued a policy note on ICZM: Concepts & Issues.

Based on this GoB note, a Program Development Office for ICZM was established at the national level with the Ministry of Water Resources as the lead Ministry and the Water Resources Planning Organization (WARPO) as the lead agency. The PDO in-

house team is comprised of professionals from WARPO; experts from different Ministries/ agencies and a number of consultants, mainly national. Three **task forces** are created as main platforms for interaction and work coordination in the fields of: policy & strategy; livelihood; and knowledge management. **Focal points** at more than 30 relevant departments and organizations including universities and research institutes, involved in coastal zone management, maintain the operational contacts with the in-house team.

The ICZM process is steered by two high level committees. **Inter-Ministerial Steering Committee (SC)**, comprised of the secretaries of key ministries and chaired by the MoWR. The SC provides policy guidelines on issues related to the coastal areas. **Inter-Ministerial Technical Committee (TC)**, comprised of heads of all relevant departments and representatives from universities, NGOs, chamber of commerce and the civil society and chaired by the MoWR.

The PDO, through its platform, has been able to facilitate dialogue among many agencies and, so far, successfully concluded agreement on delineation of the coastal zone, a descriptive profile of the coastal zone and an indicative coastal land zoning. Dialogue on each of these issues continued for months together and an experience of ‘gradual understanding of each other’.

The PDO has also facilitated multi-level discussions on the formulation of a national policy on the coastal zone. The Government of Bangladesh has adopted and declared the ‘Coastal Zone Policy 2005’ in January this year. A Coastal Development Strategy (CDS) is being formulated in a similar manner. To support implementation of the CDS, a priority investment program is being formulated through developing a series of Concept Notes. Concept Notes are also the result of participatory formulation among, at least more than one agency.

The PDO, a temporary set-up is going to be transformed into the Program Co-ordination Unit (PCU-ICZM) with representations from >10 different GoB agencies.

Experience of this gradual transformation from concept to reality in institutionalization of the ICZM approach in Bangladesh will be discussed.

Challenges to Sustainable Development of Bangladesh Coastal Zone: An Interplay of Local, National, Regional and Global Anthropogenic Interventions

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Bangladesh Coastal Zone confronts a few of the major challenges at different levels of sustainable development decision making. Bangladesh coastal zone is the region of interplay the three major river systems, namely the Ganges, The Brahmaputra and the

Meghna. Through this small region one of the largest amounts of water emanating from the vast Himalayan Drainage Ecosystem.

Only 8% of the total area of this huge Himalayan drainage ecosystem covers the landmass of the whole of Bangladesh and only about 2% is in the Bangladesh coastal area. Further over 2.4 billion tons of sediments passes through this coastal zone, making it a most interactive and dynamic coastal area. The demographic pressures, economic and livelihood needs of the local communities forces the encroachment and rapid settlement on vulnerable and semi stable coastal landmass.

The national level planning encourages the growth of shrimp, which is the second largest export commodity of Bangladesh. Further the world largest mangrove forests- the Sunderbans, is also facing a series of serious management and anthropogenic threats. The nations need for food security have forced to modify the coastal ecology and land management with a large number of polders demonstrating new problems of water and sediment flow.

At the regional level constructions of infrastructure, dams and barrages across the Ganges particularly at Farakka have had severe effects on the mangrove system, increased salinity and shortage of water flow in lean period. This has become an area of regional contention, conflict and security challenge.

At the global level IPCC has established that anthropogenic interventions threatens Bangladesh, its adjoined coastal areas and several highly populated islands from the impacts of climate change such as sea level rise, increased natural disasters such as inundation and enhanced cyclones and water surges.

Bangladesh Centre for Advanced Studies has undertaken several studies on coastal communities, their perception of global and regional impacts and coastal resource use. The paper will integrate these studies to demonstrate how local, national, regional and global anthropogenic forces combine together to enhance the vulnerability of both the ecosystem and the human system in these coastal areas and how local communities respond.

This paper will build on and develop an integrated framework and identify the key elements and strategies for coastal zone management based on several relevant studies undertaken.

These include;

- (a) Findings of the recent (Dhaka, January 2005) major International Workshop or Community Level Adaptation to Climate Change.
- (b) A seven-component study on the Impact of Shrimp Farming on Poor Communities.
- (c) Vulnerability of Bangladesh to Climate Change and Sea Level Rise: Concepts and Tools for Calculating Risk in Integrated Coastal Zone Management.
- (d) River of Life: An evaluation of the Flood Action Plan and
- (e) Farakka Dams and other regional infrastructures and the Indo-Bangladesh Ganges Water Sharing Treaty.

This paper will further demonstrate the huge river basin system (Ganges-Brahmaputra-Meghna) and linkages to coastal zone particularly focusing on management of anthropogenic interventions and sustainable development issues.

Tsunami Impact on Water and Trace Gas Flux in South India

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The December 2004 Tsunami caused extensive damage in southern regions of India and Andaman and Nicobar Archipelago affecting a total of 2260 km of coastline. The primary objective of our study is to determine the spatial changes in surface water quality and to assess the landward intrusion of seawater in estuaries, both before and after-tsunami in the Adyar estuary (a polluted estuary in Chennai, India) and the Pichavaram mangrove (in the Cauvery delta region). Besides, we have also quantified the changes in trace gas composition from pre-tsunami to post-tsunami event and over a tidal cycle. The Adyar River and its estuary are a major source of CH₄ to the atmosphere and produces the highest ever rate of CH₄ in comparison to global estuaries and tropical wetlands. The flux rates determined from this site were as high as 42 to 60 mg m⁻² h⁻¹ comparable to emission characteristics from sewage-dominated systems before the tsunami event of December 2004, in sharp contrast to the Pichavaram mangroves, where fluxes were between 2 and 6 mg m⁻² h⁻¹.

The catastrophic tsunami event has breached the mouth of the permanently silted Adyar Estuary, which receives freshwater only during monsoon and constantly receives untreated sewage. Thus, the river and its estuary were dominant sources of CH₄ and N₂O for atleast a major portion before its confluence with the Bay of Bengal. After the 'event', seawater has penetrated to a distance of more than 3 km inland. This has caused tremendous variation in trace gas composition particularly CH₄, where we have observed a sharp decline near the estuary (pre-tsunami: 1226 nmol and post-tsunami: 9 nmol) because of its dilution with seawater. However, a 4-fold increase in CH₄ concentration downstream was observed because of the migration and concentration of sewage from the estuary had forced water movement to upstream regions (pre-tsunami: 2279 nmol to post-tsunami: 12367 nmol). There were also drastic changes in the tidal regime, which increased from nearly 0 to more than 1.5m after the event. We measured dissolved fluxes of CH₄ and N₂O during a 12-hour tidal regime after the 'event' and found significant variations in trace gas composition with high and low tides respectively.

This paper discusses new results from a recent major 'tsunami event' and the vulnerability of the coasts to such sudden changes. There has been a huge destruction of property and loss of lives because of this event and is a major coastal hazard of great magnitude in recent times. This study assumes special significance with relevance to both fluxes of essential nutrients; trace gases and also provides an opportunity to study the repercussions due to global climate change. Comparisons between pre-and post tsunami data has helped in the better understanding of characterizing the Tsunami for possible long-term solutions and preparedness. In addition, the role played by coastal vegetation in coastal (viz. mangrove) protection is emphasized.

The work carried out by us at the Institute for Ocean Management, Anna University is relevant to key areas of global change studies and LOICZ identified priority area of research. It directly address biogeochemical fluxes (i.e. nitrogen) between the coast and terrestrial systems and examines the vulnerability of both ecosystems and humans, before and after such natural hazards like tsunamis. There are clear implications regarding the impact of the coupled terrestrial-coastal ecosystem on climate and other aspects of global change, both natural and anthropogenic. Recent models have suggested that tropical coastal zones are major sources of CH₄ and N₂O but have large degrees of uncertainties associated with emission estimates. Our data and studies reinforce these model estimates, however, it is clear that more data are required to accurately constrain fluxes of trace gases, nutrients from tropical coastal zones. Thus, our research work on studying the impacts of tsunami has strong international relevance in the context of the LOICZ identified priority research themes. My participation in this conference would enable us share some of the new data from this 'event' and improve understanding on aspects of coastal hazards and its implications on global climate change.

Measurement of Submarine Groundwater Discharge and Associated Contaminants into the Venice Lagoon, Italy

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The first set of submarine groundwater discharge (SGD) measurements was made in the Venice Lagoon in order to complete the hydrological budget of the lagoon's drainage basin. The Venice Lagoon is a 550 km² shallow water body (average depth of 100 cm), which is connected to the Adriatic Sea by three inlets (Figure 1). It sits atop a series of nine unconsolidated or semi-consolidated aquifers with a total thickness of about 1000 meters. Though the surrounding land is of low relief, and therefore unlikely to support any substantial, water-table hydraulic gradient, free-flowing artesian wells are found. Two hundred SGD measurements were taken using benthic chambers vented to plastic bags in a pristine northern lagoon site (Isola la Cura) showing flow rates as high as 200 cm³ cm⁻² d⁻¹ with an average of 30 cm d⁻¹. While over 100 measurements were taken adjacent to a bulkheaded shoreline by the southern canal of the Porto Marghera industrial zone (Fusina site) which showed flow rates as high as 30 cm d⁻¹, averaging 6 cm d⁻¹. These rates were much greater than expected considering the characteristics of the study site. Integrated measurements of radium isotopes supported the data collected with the manual seepage devices. Flow rates of this magnitude, if representative of even a fraction of the lagoon floor, can easily account for a significant proportion of the overall freshwater balance of the Venice Lagoon, whose surface-water yield averages 35.5 m³/s. Groundwater flowing into the lagoon is driven by the circulation of porewater through marshes augmented

with groundwater driven across the sea floor from deeper artesian aquifers in the Isola la Cura site, whereas it is driven by the hydraulic gradient supported by the bulkheaded shoreline at Fusina.

In addition to being a significant source of terrestrial based water in the Lagoon, SGD may provide the major pathway for certain contaminants to enter the Lagoonal system as the concentrations of many compounds (e.g. nutrients) are often much higher in groundwater than in seawater. Water samples were collected for analysis in both lagoon sites to test whether SGD could be the primary source for nutrients to enter the lagoon. Ammonium concentration was found to be 2 to 8 fold higher in the device water than in the lagoon water at the Isola la Cura site, dependent on season and 10-30 times higher at the Fusina site.

The primary goal of the investigation is to determine the significance of the SGD flux on both the hydrological and chemical budget of the lagoon, especially the role of SGD as a pathway for nutrients to enter the system. This coincides with the fourth theme of this meeting involving budgeting methodologies in coastal waters. In addition the comparison between the pristine northern lagoon site and the industrial site has shed some light on the anthropogenic influence on the water quality of the SGD which enters the lagoon, as well as the role that anthropogenic modifications have on the general SGD signature, which coincides with themes three and five.

Estuarine Continuum in a Temperate Lagoon: Spatial and Temporal Patterns

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Objective of this study was to delineate the hydraulic and biotic patterns of the Nemunas river-Curonian lagoon-Baltic Sea system. Application of the SHYFEM 2D finite element hydraulic model to the circulation in the Curonian lagoon (SE Baltic Sea) described the seasonal variation in the retention times and division into the riparian (freshwater and hydraulically active), limnic (freshwater and stagnant), and estuarine (brackish and hydraulically active) parts of the lagoon. Duration of life cycles of dominant plankton species vs. retention time was used as criteria of pelagic zonation. Spatio-temporal observations of phytoplankton and zooplankton communities, primary production and organic carbon revealed a continuum in a way similar to one described for the riverine systems. Plankton community structure variation (cyanophytes vs. diatoms and cladocerans vs. copepods) correspond the hydraulic zonation of the river-lagoon-sea system quite well. Bottom sediment composition and benthic macrofauna assemblages were used to couple pelagic and benthic communities. The system spatial and temporal variability appeared to be mostly defined by the discharge from the Nemunas river and brackish water intrusions from the Baltic Sea.

Common Sense and Common Ground in Marine and Terrestrial Resource Management

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Oceans and coastal management are coming of age. Decades of terrestrial preoccupation are giving way to advances in marine and coastal science, and marine management issues are beginning to share the world stage with their terrestrial counterparts. In an effort to define a distinct identity and justify their contributions to resource management discourse, marine scientists and managers frequently emphasize the differences between ocean and land ecosystems. This division is perpetuated by human institutions driven by jurisdictional territoriality, interagency competition, and disciplinary pride. Resource management, however, is about managing people, not resources, and from a social science perspective, the terrestrial experience offers a number of important lessons for marine managers. Coastal communities that have engaged in terrestrial management processes in the past find that marine management objectives are consistent with the terrestrial experience, and that many of the same issues and challenges are present in terms of managing marine resource users. Similarly, at the local level, history and personal experience in terrestrial resource management can and will influence efforts to advance the marine agenda. Coastal communities have both a front and back yard, and the terrestrial and marine resources associated with each are linked in terms of local culture, experience and capacity, decision-making, and willingness to partner with specific agencies and organizations. Understanding these linkages offers a valuable source of information for scientists, managers, and policy makers. Examples from Haida Gwaii/Queen Charlotte Islands in the Pacific Northwest, British Columbia, Canada will be provided.

Water and Nutrients Budget in a Semi-enclosed Area of the Coastal Ligurian Sea: the Port of Genoa

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Coastal areas are particularly important sites, since they are very sensitive to anthropogenic impact and likewise economically very valuable. Models application provides a useful framework for the integration and synthesis of existing knowledge about artificial and natural ecosystems, and may offer important contributions for understanding the scale of human disturbance and the potential effectiveness of restoration actions.

In this study, we applied the LOICZ biogeochemical model to the Port of Genoa, a harbour in the Ligurian Sea subjected to high anthropogenic pressure. The harbour receives domestic and industrial effluents both through watercourses and through

sewage water discharges. Therefore, significant amounts of nutrients are released in the semi-enclosed basin (Old Port Area, Multedo Oil Terminal, Voltri Container Terminal), producing substantial phosphorus and nitrogen enrichment. The budgetary analyses have been performed in the different basins on a seasonal basis during 2002 and 2003. The model outputs evidenced that anthropogenic activities affect the three harbour basins to a different extent, in response to local water renewal and the position to the pollution sources. Adverse effects, such as pollutant accumulation in the sediment, generally occur in the more confined areas, like the Old Port Basin. This area presents a very complex morphology and a high water residence time. Besides, it receives freshwater discharge with high contaminant load accumulating in the basin, that acts as a sink for both dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP). The net ecosystem metabolism (NEM) is highly positive, indicating high productivity especially in summer and autumn. On the contrary, Multedo Oil Terminal basin is a source for DIN and DIP and shows negative NEM values. Therefore, it can be considered as a heterotrophic system that appears to be unaffected by seasonal variability. Our third sub-system, Voltri Container Terminal shows comparatively lower nutrients concentrations due to the lack of significant terrestrial pollution sources. The net ecosystem metabolism is slightly positive and indicates good balance between production and respiration.

The LOICZ model allows a useful simplification of complex sites, where various processes and conditions are present. This simplification must be taken into account when the model is applied to peculiar environments such as harbour areas, where local morphology and hydrodynamics may dramatically affect the water and nutrient exchange and additional pollution may alter the natural processes of production, consumption and storage in the sediments. Nevertheless, compared to *in situ* data related to the autotrophic component and to the heterotrophic-detrital component, the results provided by the model seem to be very realistic and capable to predict some of the biogeochemical processes occurring in the study system. Hence, this model can be a useful tool for assessing and predicting the environmental impacts and the potential vulnerability of coastal artificial area under high anthropogenic pressure.

Interdisciplinary Assessment of Fundamental Driving Forces and Transformation Processes in a Tidal Basin, Southern North Sea

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Tidal systems are an important feature of coastal zones under different climatic and current regimes worldwide. They harbour some of the most productive ecosystems on Earth and support the basic needs particularly of many birds and youth stages of marine organisms. They play an important role in the global biogeochemical cycles, and are, both, source and sink of sediment and anthropogenic pollution. In addition, tidal flats contribute to the protection of coastal areas from erosion.

An interdisciplinary research project was established to obtain a fundamental understanding of important physical and biogeochemical processes in a tidal flat system. The backbarrier tidal flat of Spiekeroog Island on the East Frisian coast

(southern North Sea) was chosen as the study area. As an important tool, a weather-independent times-series station was positioned in the main channel of the tidal inlet near the southern tip of the island. It automatically records meteorological data, physical parameters of the water body (e.g., temperature, salinity, current speed and direction, wave height) as well as its total load and size distribution of suspended matter. Nutrient, selected heavy metal and methane concentrations in the water column are measured at frequent intervals, and the deployment and further development of automatic monitoring devices for these parameters are underway. Biogeochemical transformations and material fluxes are determined on water-column-suspended particles, at the sediment-water interface and in the sediments. An important focus are the composition and activity of the microbial systems on the suspended particles, in the pore system of sand flats, in the oxic surface layer of (mixed) mud flats and in the deeper anoxic layers of the tidal flat sediments. Mathematical modelling addresses the hydrodynamic system and the ecosystem including the biogeochemical transformation and transport processes and includes the development of novel tools in the modelling of complex systems. The presentation provides an overview of the research approach as well as the most important results after four years of investigation. These results include (i) significant time-dependent variations detected by continuous monitoring at the times-series station, which would have escaped discontinuous measurements, (ii) the pressure-driven emission of microbial transformation products from the pore system of sand flats, (iii) the description of new and unexpected microbial species and their physiological properties, and (iv) the development of a new method to quantitatively distinguish between active bacteria and resting spores in tidal flat sediments.

The Future of Managed Realignment in Northern Europe – A Comparative Study of Southern North Sea Coastal Areas

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The coastal management measure ‘managed realignment’ has aroused increasing interest over the past decade. A growing awareness of the potentially adverse impacts of accelerated sea-level rise has focused attention on the increasing loss potential of already declining intertidal habitats. These habitats fulfil various, important, functions in coastal systems, such as acting as pollution sinks, contributing to flood defence and sustaining invertebrates.

This doctoral research project aims to determine the potential for managed realignment (to create intertidal habitat) in Great Britain, the Netherlands, Germany and Denmark. Managed realignment is a topical issue; in the United Kingdom, it has been widely discussed as a sustainable coastal management measure. To date, there has been little research on its use in other countries. The following methodologies will be used for this project: a quantitative survey of coastal practitioners involved in managed realignment schemes (to be concluded by May 2005), interviews with coastal experts and policy makers and an extensive topographical analysis using GIS software – all supported by an extensive literature review. This research has evolved from a (2001) Masters thesis on managed realignment in Germany and England, which

included undertaking qualitative interviews with key coastal stakeholders and an extensive literature review. In the current project, the student has to date updated her knowledge on the managed realignment situation in England and Germany, which had progressed considerably since 2001. Conclusions to date include: managed realignment is widely perceived as a positive development, although the likelihood of its increased future use is judged differently. The existing schemes (about 36) are mostly concentrated on the coasts of eastern England, Lower-Saxony and Mecklenburg-Western-Pomerania. Motivation for managed realignment in England, and to a certain extent on Germany's Baltic Sea coast, seems more driven by long-term, multi-causal factors (such as flood defence, habitat creation for conservation purposes, sustainable development) than on Germany's North Sea coast, where managed realignment has to date only been motivated by habitat mitigation needs. However, there are signs that on this coast, conservation could be an important driver for its increased future use in the 21st century. Thus managed realignment is now firmly on the agenda in both countries, reflecting a radical departure from the past. However, take-up is likely to differ significantly both between and within these countries.

The student would thus like to present on the managed realignment situation in England and Germany, as described above, as well as on the quantitative survey with coastal practitioners, analysis of which will be concluded by the end of May (it aims to determine driving factors for managed realignment and to support the creation of an extensive database).

As such, this topic would relate especially well to LOICZ II theme 2, 'implications of global change for coastal ecosystems and sustainable development'. The project will help to predict to what extent future coastal systems will be equipped with valuable buffering/filtering intertidal habitats. It will also identify barriers to the increased future use of this soft engineering method and suggest ways to overcome these.

Contrasting Inherent Optical Properties and Inferred Carbon Metabolism between five Northeastern (USA) Estuary-Plume Systems.

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The goal we are working toward is the retrieval of metabolic rates and variables in coastal waters using remotely sensed data. We have recently developed the ability to rapidly assess surface inherent optical properties (IOP), oxygen concentration and pCO₂ in estuarine-plume systems using flow-through instrumentation. Since the spring of 2004, several estuarine-plume systems have been surveyed including the Pleasant (ME), Penobscot (ME), Kennebec-Androscoggin (ME) and Merrimack (NH-

MA). Continuous measurements of surface chlorophyll and colored dissolved organic carbon (CDOM) fluorescence, beam attenuation, temperature, salinity, oxygen and pCO₂ were taken at each system along a salinity gradient from fresh water to near oceanic endmembers. CTD and IOP profiles were also taken at predetermined surface salinity intervals. These were accompanied by discrete determinations of chlorophyll (HPLC and fluorometric), total suspended solids (TSS), dissolved organic carbon (DOC), particulate organic carbon (POC) and alkalinity. IOP data were calibrated using chlorophyll, DOC and TSS data to enable the retrieval of these constituents from IOP data.

Considerable differences in the data sets were observed between systems. These ranged from the DOC-enriched, strongly heterotrophic Pleasant River System to the high-chlorophyll autotrophic Merrimack River System. Using pCO₂ and oxygen saturation measurements as proxies for water column metabolism, distinct relationships were found between trophic status and inherent optical properties. The nature of these relationships varies between systems and is likely a function of watershed and estuarine attributes including carbon and nutrient loading, in-situ production and related autochthonous inputs of DOC and alkalinity. Our results suggest that IOP data contain significant information about the trophic status of estuarine and plume systems. Logical applications of remotely sensed data to the issue of retrieving metabolic variables will be discussed.

Soil-Catchment-Coast Continuum: Legacy of the Past

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Land-based activities impacting on the coastal zone and international waters are not restricted to the coastal zone itself but often have their origin in activities in the river catchments. These socio-economic activities change the load of nutrients, heavy metals and cause the discharge of xenobiotic compounds like pesticides, endocrine disrupters and other kinds of man-made chemicals. Important in this respect are activities like agriculture, deforestation and mining which all cause major changes at the catchment level. The loads to the catchment and further transport to the estuary and coastal zone are further modified by biophysical processes. The soil-catchment-coast is a slow responding system with regard to contaminants which are transported in the solid form. The legacy of the industrial revolution and the legacy of human activities before environmental regulation came into force are still present as contaminated industrial areas, soils, waste dumps, contaminated sediments in the catchment (floodplains, behind dams etc.). These particle bound contaminants are transported to the coastal zone through erosion or become mobilised through changes in environmental conditions such as pH, redox and other capacity controlling parameters (CCP) like organic matter content of the soil; conditions which are subject to changes with climate change. Examples will be given on the links between climate change, change in capacity controlling parameters and change in mobility of contaminants as well as a framework of analysis for assessing the delayed impact of stored pollutants in catchments on the quality of sediments in the coastal zone.

Coastal Fisheries of Bangladesh: How to Adapt with Sea Level Rise?

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Bangladesh is highly vulnerable to sea level rise. A one-meter Sea level rise will affect vast coastal area and flood plain zone of Bangladesh. A total of 29,846 km² coastal area will be inundated, 14.8 million people will be landless and 40 million people will be environmental refugees. Most of them are fishermen that will have to face adverse impacts of sea level rise. Soil and water salinity of coastal zone will be increased. The Sundarbans will be totally destroyed. Fisheries, especially shrimp is the second largest foreign exchange earner sector of Bangladesh, will be ruined by sea level rise induced salinity intrusion. Fisheries are the only protein source and main earning source of the coastal people of Bangladesh. So, an effective adaptation policy to sea level rise for coastal fisheries is emerge need to ensure protein source of coastal people and their income source. Salinity tolerant species should be introduced in coastal fisheries. Artificial mangrove afforestation should be introduced in the coastal zone to create breeding ground of shrimp. Cage culture, pen culture, pearl culture, etc. innovative fisheries culture should be introduced. Disaster preparedness activities should be undertaken. A special radio network for coastal fishermen should be developed and weather forecasting system should be easily understood by illiterate fishermen. Dietary manner of the coastal people should be changed to recover protein deficiency. A participatory approach to coastal fisheries planning, inventory and zoning should be developed. Participatory community fund for fishermen should be developed to meet the crisis themselves. Institutional capacity should be build up. A brief adaptive guideline to sea level rise for coastal fisheries sector in Bangladesh is explained in the paper with the help of Causal Loop Diagram (CLD).

Implementation of the European Water Framework Directive in the Baltic Region: A River Basin – Coastal Sea Approach

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On 23 October 2000, the "Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy" or short the EC Water Framework Directive was agreed. It is a framework for the protection of inland surface waters (rivers and lakes), transitional waters (mostly estuaries), coastal waters and groundwater. The key objectives are general protection of the aquatic ecology, specific protection of unique and valuable habitats, protection of drinking water resources, and protection of bathing water. All these objectives must be integrated for each river basin. Some new aspects are:

- Management by river basin - the natural geographical and hydrological unit - instead of according to administrative or political boundaries.

- The plan is a detailed account of how the objectives set for the river basin (ecological status, quantitative status, chemical status and protected area objectives) are to be reached within the timescale required.
- The plan will include all the results the river basin's characteristics, a review of the impact of human activity on the status of waters in the basin, estimation of the effect of existing legislation and the remaining "gap" to meeting these objectives; and a set of measures designed to fill the gap.
- An economic analysis of water use within the river basin must be carried out to enable a rational discussion on the cost-effectiveness of the various possible measures.
- All interested parties are fully involved in this discussion, and in the preparation of the river basin management plan as a whole (public participation).

The Water Framework Directive integrates river basins, transitional and coastal waters and the ongoing implementation process revealed a lot of gaps in the scientific knowledge. Therefore, the implementation is accompanied by intensive scientific work.

The presentation will outline the WFD, its implementation process in the Baltic Region and point out some scientific challenges. Results concerning the development of a **Baltic coastal typology** and the calculation of **water quality background conditions** based on a river basin approach will be presented in more detail.

Impact of the extension of Alexandria Coastal Road on the Transformation of Material of the Nearshore Marine Environment

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During the last decade, several changes took place along the coastal area of Alexandria city. The widening of the existing coastal road of Alexandria(Alexandria Corniche), extending about 20 km was done without any Environmental impact assessment studies (EIA) before and after the extension. This exposed the coastal area of Alexandria to severe negative consequences mainly erosion.

Necessary steps must be taken to study the impact of the coastal road widening on sediment transport, changes in bottom topography , water productivity as well as the biodiversity of plant and animal populations.

The necessary measures must be taken to protect the submarine archeological sites as well as the distribution and spawning grounds of fishes.

Impacts of Human Activities on Region wise Budget and Ocean ward Flux of Sediment in South Asia

K. P. Sharma

South Asia, a landmass draining to the Bay of Bengal, the Arabian Sea and the India Ocean, consists of extreme physiographic, geologic, and climatic variability. The home of about one-quarter of the global population, South Asia is also the source of some of the highest sediment laden rivers of the world. Since the region contributes one-fourth to one-fifth of the global oceanward sediment flux, changes in river basins are likely to disturb the balances in coastal areas. This study focuses on the regional pattern of sediment delivery characteristics of the South Asian rivers and their major tributaries. Out of about nine million square kilometres, the region consists of about one and half million square kilometres high mountains, three million square kilometres plateaux and one million square kilometres plains. Analyses based on sediment information available at 208 locations in the region showed that almost three and half million square kilometres inland areas have insignificant contribution to the continental sediment delivery. The rest of the areas have a high spatial variation of sediment yield ranging from almost insignificant rate to the rates exceeding several thousand tonnes per square kilometre. Statistical relationships relating sediment yield to the basin size were developed for different regions within South Asia considering the homogeneities and nature of available data. The statistically significant relationship obtained for the Hindu Kush-Himalayan region can be expressed as: sediment yield (t) = 6310(Basin Area in km²)^{0.83}. Similarly the relationship obtained for Central and southern part of the Indian subcontinent can be expressed as: sediment yield (t) = 930(Basin Area in km²)^{0.95}. These relationships were used to estimate sediment yield in areas lacking sediment data. Among the six different homogeneous regions of the study area, Tibetan Plateau had a relatively low sediment delivery rate averaging at 100 t km⁻². Considering the areas exceeding 5000 km², the average for the Himalayas was about 2200 t km⁻². The average sediment delivery rates of the Deccan Plateau, the mountains and valleys of Myanmar, and the great plains of the Indus, Ganga, and Brhmaputra were generally limited to 600 t km⁻². Considering the resolutions of available data and the scale of sediment transport in the region, it was difficult to quantify the impacts of land-use changes in the region; however, the influence of more than 6000 large dams in South Asia showed distinct impact on the oceanward delivery of sediment. The study showed that the oceanward sediment flux from South Asia could exceed three billion tonnes per year in its natural stage. With the consideration of sediment trapping by the major reservoirs, the existing sediment flux was estimated at two billion tonnes per year.

Evaluation of Anthropogenic Impact on Coastal Marine Sediments of Heavy Metals Transported by Water Streams Affected by Mining in North-Western Mexico: Semi-Desertic Santa Rosalía, Baja California Sur and Tropical Marabasco River – the Barra de Navidad Lagoon, Colima

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The influence of mining activity on the geochemistry of the river-sea systems depends strongly on the climatic conditions and geomorphology of the basin, as it can be seen from case studies, done in coastal zone of Mexico.

Episodic inputs of dry streams cutting Santa Rosalía copper mining region of semi-desertic eastern coast of the Baja California Peninsula have introduced large amounts of wastes into the coastal marine environment. The marine sediments from Santa Rosalía harbor and adjacent zone, as well from of the mouths of San Luciano and El Boleo arroyos are moderately or heavily polluted by heavy metals (1950 mg kg⁻¹ Cu, 2750 mg kg⁻¹ Zn, 450 mg kg⁻¹ Co and 220 mg kg⁻¹ Pb). Twenty years after the cessation of these activities in 1984 were not sufficient to disperse the pollution “hot spot” and to return heavy metal contents in marine sediments back to natural levels.

The different case is a tropical system: Marabasco River-Barra de Navidad Lagoon in Colima state where acting Peña Colorada iron ore mine is located in the mountainous basin below the river source. Sediments of the entire river course display mostly natural levels of the metals (Co, Cr, Cd, Cu, Ni, Pb, and Zn). This is a result of effective flushing of the system after moderate or heavy rains frequent in this basin, sparsely populated and covered by rainforest vegetation. Only sediments collected just below the mine and in the lower plain part of the river are moderately enriched in Cu and Co (89-758 mg kg⁻¹ and 63-340 mg kg⁻¹ correspondingly). Suspended particulate matter (SPM) collected in the river in November 2002 during high water discharge (about 100 m³s⁻¹) shows low contents Pb and Zn (2.3 to 29.3 mg kg⁻¹ and 62.5–230 mg kg⁻¹ correspondingly). However, strong enrichments were found in the SPM of the river for Cu (several hundreds of mg kg⁻¹) and for Cd (0.4- 5.8 mg kg⁻¹), achieving 1655 mg kg⁻¹ Cu in the particles collected 2 km downstream of the deposit of tailing wastes. Lagoon sediments are completely free of any anthropogenic influence for heavy metals (e.g. 5.1-87.5 mg kg⁻¹ Cu, 15-142 mg kg⁻¹ Zn). Elevated concentrations of metals were found in the sediments from the middle of the lagoon, where fine-grained particles rich in Fe and organic matter are accumulated. Background levels were registered for Zn and Pb in SPM of the lagoon (52.7 – 82.6 mg kg⁻¹ and 2.7-22.9 mg kg⁻¹ correspondingly), except the particles from the

northeastern part of the lagoon with high traffic of boats (118 mg kg^{-1} of Pb). Cu and Cd keep high enrichment in lagoon particles ($154\text{-}1182 \text{ mg kg}^{-1}\text{Cu}$, $1.0\text{-}59 \text{ mg kg}^{-1}$ Cd). Highest Cd content (59 mg kg^{-1}) was observed in SPM from inner part of the lagoon, probably due to a remobilization of this metal by a tidal resuspension of mud bank or direct diffusion of from interstitial waters into overlaying water column, followed by its co precipitation with Fe and Mn oxyhydroxides, or by selective uptake by a phytoplankton.

Applicability of LOICZ derived Indexes in Complex Ecosystem. A multibox Analysis for the Lagoon of Venice

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LOICZ is an IGBP core project established in 1992, whose aim is to develop a predictive understanding of the effects of changes in climate, land use and sea level on the global functioning and sustainability of coastal ecosystems. One of the goals of the project was the compilation of biogeochemical budgets for a number of coastal areas as larger as possible. A biogeochemical modelling procedure was released, which aimed to lay out a robust, widely applicable, uniform methodology, based on minimal data requirements on the use of secondary data. In agreement with it, a water budget was set up first, in order to estimate fluxes at the open boundary, then salt water were taken into consideration, in order to estimate diffusive exchanges. Finally, non-conservative tracers were considered, and budgets on Phosphorus and Nitrogen were computed in order to indirectly derive an index on ecosystem metabolism (Net Ecosystem Metabolism) and estimates on the difference between nitrification and denitrification processes.

Such methodology, however, relies on a few strong assumptions, which not always are verified in practise. The major one is that data give an accurate representation of a system that is homogeneous and in steady state. Multi-box analysis has been proposed as well, in order to overcome the homogeneity constrained, and enable one to apply the procedure also to complex coastal area.

In the present work, a coupled water quality transport model is used to produce a synthetic data set which is assumed to represent reality, the output is sub-sampled by mimicking a monitoring program, and LOICZ modelling procedure is applied, both in the traditional and in the multi-box frame. The resulting indexes are then compared among themselves, and with the synthetic reality. In this way it is possible to assess reliability of the estimates provided, underline the limits of the procedure and derive a number of suggestions for 'best' application of the LOICZ biogeochemical modelling procedure, and proper interpretation of its results.

Response of the Northwestern Black Sea Shelf Ecosystem to Nutrient Load and Climate Change

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The study addresses coupling between physical and biogeochemical numerical models and provides an extensive analysis on the response of the Northwestern Black Sea ecosystem to nutrient load and climate change. The physical models are a one-dimensional mixed layered model and a three-dimensional, primitive equation hydrodynamic model, based on the Princeton Ocean Model. The biogeochemical model is based on the European Regional Seas Ecosystem Model (ERSEM), which includes five modules: (1) primary producers, (2) microbial loop, (3) mesozooplankton, (4) benthic nutrients, and (5) benthic biology. The model is validated against in-situ and remote sensing (SEAWIFS) data. We address here the response of ecosystem to meteorological forcing, vertical stratification and changes in the water and nutrient discharges from the Danube River. The climatological variability associated with changes in nutrient loads over the last four decades is also addressed. Seasonal and inter-annual variability is discussed, based on targeted simulations with high frequency forcing for the period of 2002-2003. A hierarchy of model scenarios is developed to predict the impact of future changes in nutrient load on the Northwestern Black Sea ecosystem.

The Threat and Cascade Method of Estuarine Health Assessment - a Logical Sequence from Human Impact to Biological Degradation via System Physics and Chemistry

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A methodology for the comparative assessment of estuarine health over a range of systems is presented. It is based on the assumption that anthropogenic impact is the causative variable regarding negative effects on estuarine health. The methodology follows a logical cascade of estuarine health assessment protocols. Firstly, socio-economic factors in the catchment are assessed followed by the forcing and manifestation sequence of system physics, chemistry and biology. The first step in the Threat and Cascade (TaC) methodology incorporates socio-economic factors into an algorithm that produces a scaled indicator that identifies estuarine systems that are potentially threatened by anthropogenic inputs. The socio-economic algorithm incorporates the following variables: land cover; population density; per capita wealth; state of the mouth; abstracted mean annual runoff; encroachment of

development; estuary use and sewage input. If the socio-economic index identifies the estuary as being threatened, then the second stage of the TaC Method is instigated. This is an assessment of the system's physics and is accomplished by considering the following variables: residence time, estuary number (freshwater inflow/ tidal prism), coastal exchange and the proportion of the time the estuary mouth is closed to the ocean. The Threat and Cascade Method assumes that an anthropogenically threatened system with a short residence time is less likely to be impacted than a threatened system with a long residence time. If the system does not meet the physics criteria then the next step of the TaC Method is performed. This involves assessing the chemistry and then the biology of the threatened estuarine system. The Threat and Cascade Method is being tested using both local (South African) and international case studies. The results show that the TaC Method can be applied as a universal methodology and a major benefit is that estuarine researchers can assess the "health" of a number of systems, concentrating mainly on those that are likely to be impacted. Applying the TaC Method in reverse permits an assessment of the success of remedial action to impacted systems.

The Impact of Humans on the Flux of Terrestrial Sediment to the Coastal Ocean on a Global basis: Long-term Averages and Seasonal Variability.

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This study provides the first attempt to predict the global flux of sediment on a river-by-river basis under Modern conditions, and before the influence of humans (but under 20th-Century climate). In addition the study includes an analysis of the seasonal global sediment flux. The study quantifies the influence on fluvial sediment supply of basin characteristics, regional climate, and the global distribution of reservoirs. The pre-Anthropocene flux of suspended-sediment is estimated to have been 14 BT/yr and may have reached 18 BT/yr during the period of land development. The Modern suspended-sediment flux is presently 12.6 BT/yr, largely reflecting the trapping of sediment behind reservoirs, and other land use practice improvements. Regionally there are large differences in the relative change in the sediment transport to the coast, e.g. Africa and Asia provide much less sediment than they once did, Indonesia is now delivering much more sediment. Sediment flows to the coastal zone year round, but seasonal patterns emerge, conditioned both by precipitation patterns (convective versus frontal events, monsoon seasons), snow-release periods, and human-influenced water release from reservoirs.

Vulnerability Assessment to Coastal Natural Hazards in Amazon Region (Brazil) using GIS

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Studies carried out in the State of Pará (Amazon region of Brazil) reveal that the northeastern part of the coastal zone has been severely impacted by storm floods and erosion processes in the last 25 years. Global climatic changes and sea-level rise (SLR) impacts, together with the effects of disordered development are factors that will be able to raise this record of negative events. In response to these impacts a variety of coastal structural protection measures (e.g., Seawall), accommodation (e.g. public insurance, building code) and planned retreat strategies have been applied in the region, but with only limited success. The work described here intends to identify, assess and classify the coastal zone's overall vulnerability to flood and erosion risks.

This is achieved by using a Geographic Information System in order to create a so-called composite vulnerability index (CVI). The CVI includes sixteen different variables, describing both the natural and socio-economic conditions which determine the risk situation in the coastal zone. By means of GIS (Arcview 3.2) these variables are classified, weighted and combined to yield a single vulnerability indicator. This index now provides a reliable, easily applicable tool for the measurement and description of the coastal hazards within and among the 22 municipal districts in the State of Pará. The vulnerability index describes five classes, from very low to very high vulnerability. The key results are presented in maps, showing the natural vulnerability, the socio-economic vulnerability and the total (=composite) vulnerability for each of small census tracks of the municipal districts. This work critically analyzes the confidence levels for the results obtained and the possibilities to update the present variables or to include new ones.

A Proposed Framework for Managing (Land-Based) Marine Pollution Sources in the BCLME Region

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The United Nations Office for Project Services ("UNOPS) commissioned the CSIR Environmentek to conduct a study on the management of land-based marine pollution in the Benguela Current Large Marine Ecosystems (BCLME) Region. The BCLME region is situated along the coast of south-western Africa, stretching from east of the

Cape of Good Hope in the south, northwards to Cabinda in Angola and encompassing the full extent of Namibia's marine environment

The primary purpose of this project is to standardise on the approach and methodology with which land-based pollution sources in the BCLME region are managed. This will be achieved through the preparation of a generic management framework for the management of such sources, including protocols for the design and implementation of monitoring plans.

This paper discusses an integrated framework for the design and implementation of marine water quality management programmes that was developed by the CSIR in response to recent advances in policies and legislation pertaining to sustainable utilisation of the marine environment. The framework provides an integrated scientific base within which to set, for example wastewater emission targets, taking into account ecosystem process complexity. By making its scientific assumptions and outcomes explicit, it also aims to support and stimulate local stakeholder empowerment and involvement.

Based on a review of international practice and own experience, the following is considered as key components to be included in a marine water quality management framework:

- Identification of Legislative Framework
- Establishment of Management Institutions and Responsibilities
- Determination of Environmental Quality Objectives
- Specification Marine Pollution Sources
- Scientific Assessment Studies
- Specification of Critical limits and Mitigation
- Long-term Monitoring Programmes.

Understanding Human Vulnerability to Coastal Hazards and Adapting to Uncertain Futures

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Extreme natural phenomena occurring at the coast, such as the 1991 Bangladesh cyclone, Hurricane Mitch in Central America in 1998, the 1999 Orissa cyclone, and the 2004 Indian Ocean Tsunami result in large scale disasters when they affect societies' poorest and most vulnerable people. Complex and dynamic social, economic and environmental factors influence who is vulnerable to natural hazards and the ability of those affected to cope, recover and adapt to such shocks. Research undertaken at the Stockholm Environment Institute and elsewhere indicates that certain individuals and groups are particularly exposed to the direct impacts of coastal hazards as well as vulnerable to socio-economic processes and changes during the medium to long-term recovery stages. These include:

- Particular social groups including: women, the elderly, children and orphans, ethnic and religious minorities, single-headed households;
- Particular livelihoods: fishers and others involved in fisheries (traders, processors), people in the informal tourism economy, those previously engaged in economically marginal livelihoods;
- Socially excluded groups: ‘illegal’ settlers and others whose rights and claims to resources are not officially recognized;
- Economically marginalized groups: those with inadequate access to economic (credit, welfare) and social capital (networks, information, relationships).

This paper will present some key research findings on human vulnerability to coastal hazards and their implications for improving disaster preparedness and building social resilience by drawing on case study research from India, Honduras, Vietnam, and the Indian Ocean. Much of this work has been undertaken in the SEI *Poverty & Vulnerability Programme* which was initiated in 2002 as an institutional agreement with the Swedish International Development Cooperation Agency (Sida). Its long-term objective is to improve the situation of the poor and the highly vulnerable in the world by improving our understanding of human vulnerability to environmental change and by identifying opportunities to reduce that vulnerability and to build resilience. Focusing in particular on food insecurity, sustainable livelihoods and natural disasters, the *Poverty and Vulnerability Programme* is being undertaken in close collaboration with international and local research and policy institutes, non-governmental and civil society organizations, national governments, regional and local decision-makers, and local communities.

A MULTI-STEP SCENARIO ANALYSIS FOR ASSESSING POSSIBLE STRATEGIES AIMED TO REDUCE THE EUTROPHICATION IN THE NORTH ADRIATIC COASTAL ZONE

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In order to achieve the goals and objectives of the Water Framework Directive (WFD) 2000/60/EC there is a need to develop a multi-disciplinary approach able to combine economic, social and natural sciences. Among the major targets and objectives to be achieved, the WFD requires the development of strategies such as the River Basin Management Plan (RBMP) (Art. 13 of WFD) that allow to achieve a Good Environmental Status (GES) by the year 2015 (Art. 4-WFD). The trophic conditions of the North Adriatic Sea are strictly related to the nutrient loads carried by the Po River. Thus, the reduction of this environmental issue depends upon the implementation of a sustainable development of socio-economic activities in the Po Basin. In order to evaluate possible strategies able to achieve the GES, three types of scenarios were developed: the Business-As-Usual (BAU), Policy Target (POT) and Deep Green (DG) scenarios. The Driver-Pressure-State-Impact-Response (DPSIR) framework was used for the characterization of the integrated system, according to the WFD requirements (Art. 5 WFD), and evaluating the causal mechanisms linking

anthropogenic pressure originating in the Po basin with the corresponding eutrophication level observed in the North Adriatic.

Different narratives were analysed according to the socio-economic development of the Po Basin Area in the last 20 years and policy measures adopted by major Italian Institutions such as the Po River Basin Authority (ABP) addressed to reduce the nutrients load released to the Po River-Adriatic Coastal Zone continuum. In order to assess the relative contribution of major patterns affecting nutrients transport in the catchment-CZ system for the BAU, POT and DG scenarios the MONERIS model was used for assessing nutrient transport pathways in the Po catchment, whereas the WASP model was used for assessing the dynamic processes of nutrients in the North Adriatic Coastal zone.

Data Requirements for Global-Scale Coastal Vulnerability Analysis and the DINAS-COAST Database

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The susceptibility of the coastal zone to sea-level rise in conjunction with its importance in terms of its social, economic and ecological characteristics highlights the need for consistent global-scale evaluations of coastal vulnerability and for the assessment of potential impacts of this global phenomenon. Such evaluations are essential for the formulation of effective international climate policies. Global vulnerability assessment (GVA) studies have provided quantitative assessments of potential impacts of sea-level rise at global and regional scales and have been extensively used for further analysis. However, the consistency and reliability of GVAs have been plagued by several limitations, a principal one being the lack of appropriate data sources. Within this context, the lack of a coherent global database, specifically designed for addressing the needs of coastal vulnerability analysis has constituted a major limitation to improving our understanding in this area.

For addressing these data needs, a new global coastal database of physical, ecological and socio-economic parameters has been developed within the DINAS-COAST project (**D**ynamic and **I**nteractive **A**ssessment of National, Regional and Global Vulnerability of **C**oastal Zones to Climate Change and Sea-Level Rise). The database design has been originally developed within a Geographic Information System and has been based on a linear data model for the representation of coastal information.

According to this model, all the data in the database are referenced to linear coastal segments of variable length, thus giving the database a fundamentally different data structure to the more common raster datasets used in global studies. In this way, the database aims to provide not only a collection of geo-referenced data but rather a data system needed to underpin our understanding of coastal vulnerability to sea-level rise. It is expected that the DINAS-COAST database will provide researchers and modellers with an efficient and consistent basis for studying the coastal systems, assessing coastal vulnerability and formulating broad adaptation policies at regional and global scales. This paper contributes to the aims of LOICZ II Themes 1, 2, 4 and 5 as it presents a novel tool for assessing the major impacts of sea-level rise on the coastal zone.

Chlorophyll and Sea Surface Temperature Time Scales for Global Oceans and Nearshore Retentive Embayments off California

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Tracking the transformation of chlorophyll and sea surface temperature (SST) features within coastal and open ocean surface water was made possible with lagrangian decorrelation time scale analysis of drifter trajectories. The evolution of surface water features and their time scales were determined by overlaying available chlorophyll a estimates and SST satellite data onto water following drifter trajectories. This created an oceanographic tool to employ satellite data as an in situ sensor on the water following drifter. Drifter derived decorrelation scales were determined not only on a global scale but also as a localized process study for the NSF Coastal Ocean Processes (CoOP) “Wind Events and Shelf Transport” (WEST) project in northern California. From the Gulf of the Farallones to Point Arena, an interesting phenomenon occurs whereby loss processes (e.g. advection) are slowed sufficiently to allow increases in phytoplankton growth. As surface waters encounter the Point Reyes promontory, retentive embayments for phytoplankton are found both north and south of this point with increased chlorophyll and SST levels. From the drifter data overlaid with satellite imagery, evolutions of retentive embayment features are qualitatively identified as chlorophyll a and SST increase with drifter traversal within the retentive embayments. The quantitative calculation of decorrelation time scales also afforded a definitive time scale of variability of water in these retentive features, providing a decorrelation scale at a higher resolution than for the global time decorrelation time scales in the same area.

The global and coastal time scales of variability are important for many applications of oceanographic research including carbon budget modelling purposes, comprehending ecosystem dynamics and explaining key biogeochemical cycles. Further understanding of retentive embayments is also scientifically significant as

longer resident water supports productivity, allows planktonic larvae to thrive as passive drifters and may create a possible sink for carbon over the shelf region. Therefore, investigating these long-residence areas along the coastline has large implications for coastal zone research, requiring an interdisciplinary approach to explain their occurrence and implications.

Fine Sediment Retention in Estuaries in Amazon Estuary

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Estuaries and coastal areas are the last reservoir of fine sediments yield in the continental basins. One of the most interesting questions for each particular system is where the fine sediments are trapped in larger quantities.

In the early 90's, a thorough measurement project was held over the Continental Shelf and coastal zone. One of the results of this project was the register of a huge amount of sediments in suspension over the Shelf, where the turbidity maximum would be located. The quantity of sediments in suspension is of the order of the total sediment discharge delivered by the Amazon River over the year. This means that the residence time of the sediments through the turbidity maximum in this environment is of about one year. As a consequence, no correlation can be found between the seasonality of the sediment river supply and the quantity of sediments found over the Shelf along the year. This also means that we need some mechanisms to keep the sediments in suspension without dispersing to the ocean, what is referred here as fine sediment trapping mechanisms. Finally, we can conclude that maximum depositional area in this system concur with the location of the turbidity maximum.

In order to promote the formation of a turbidity maximum zone, conditions for trapping and deposition are necessary as well as a source of energy to keep sediments in suspension, in general in a feed back way. The role of waves in the Amazon Shelf hasn't been evaluated yet, but the strong tidal signature would indicate that the main source of energy for keeping the sediments in suspension and the mechanisms for trapping sediment may be related to the tides.

Several mechanisms can be pointed as responsible for trapping sediments in estuaries and coastal areas. Sediments are carried by currents and the question could be established as which are the main features in the hydrodynamics which contributes to the formation of the turbidity maximum? Flocculation induced by the changes in the flow structure, mainly the reduction in turbulence, can be regarded as one of the mechanisms which contribute to the formation of the turbidity maximum. In fact, in-situ measurements showed floc sizes as big as 600 μ m over the Amazon Shelf. Other feature which strongly affects hydrodynamics and hence trapping sediments is the creation of recirculation zones, related to the estuarine morphology. This aspect, especially important in open areas, is evident in the Amazon Shelf. The river plume coming out of the mouth turns north, helped by wind driven currents and the North Brazilian Current. The presence of the Cabo Norte Shoal would induce the

detachment of the plume and the consequent recirculation and vortex formation behind it. The water level asymmetry observed in the estuarine region with river influence, is not indicative of velocity asymmetry in the sense is currently considered for tidal bays, without significant river discharge. In order to conserve mass, the ebb phase is longer and its flow velocities are stronger than during flood, even when the water rising is fast and last much less than the water falling. Thus, fine sediments are flushed out of the mouth and will find proper conditions to deposit over the Shelf. The role of the shear stress asymmetry and the transport capacity asymmetry both related to the salt stratification structure are evaluated in order to assess the salinity driven circulation as a mechanism for sediment trapping.

Watershed-Coastal Interactions: Building and Supporting Institutions for Positive Change

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Many inspirational stories of collective action to improve the condition of interconnected terrestrial, freshwater and estuarine environments can be found at the watershed level. A recent meeting of global oceans experts and stakeholders determined that sharing such stories is an important step in advancing stewardship of ocean and coastal resources (SFU 2005). Other international commissions and reports stress the importance of governance mechanisms that address land-freshwater-ocean interactions (RCEP 2004, Glover and Earle 2004, POC 2003, UN 2002). A study of Canadian community-based watershed management institutions suggests that positive outcomes can be achieved in enhancing and/or stemming decline of primary production and water and sediment quality through sustained watershed management efforts. The study focused on initiatives within small to medium sized systems on both Atlantic and Pacific coasts. Research findings suggest that collaborative management and restoration efforts at the watershed scale can assist in achieving multiple sustainability objectives, including linking science (natural and social) and local knowledge with management, public education and engagement, social learning, sustainable livelihoods and capacity building in addition to ecosystem protection and restoration. While case studies from British Columbia, Cape Breton Nova Scotia and Newfoundland demonstrate positive results in each of these areas they also point to the need for: greater integration, moving beyond a primary focus on fisheries; improved stewardship networks at multiple scales, local to global; strong and clarified policy support; mechanisms for revenue generation; along with explicit linkages between watershed and integrated coastal zone management efforts such as those launched under Canada's Oceans Act.

Estuarine and Coastal Zone Ecohydrology

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Throughout the world, estuaries and coastal waters have experienced degradation. Present proposed remedial measures based on engineering and technological fix are not likely to restore the ecological processes of a healthy, robust estuary and, as such, will not reinstate the full beneficial functions of the estuary ecosystem. The successful management of estuaries and coastal waters requires an ecohydrology-based, basin-wide approach. This necessitates changing present practices by official institutions based on municipalities or counties as an administrative unit, or the narrowly-focused approaches of managers of specific activities (e.g., farming and fisheries, water resources, urban and economic developments, wetlands management, nature conservationists). Without this change in thinking and management concept, estuaries and coastal waters will continue to degrade, whatever integrated coastal management plans are implemented.

To help in this process of change there is a need to (1) develop a profound understanding of the effects of biota and biotic processes on mediating estuary response to changing hydrology, sediment and nutrient flux and of the biota on hydrology at the river basin scale, and (2) to develop science-based remediation measures at the river basin scale, with elements of ecohydrology and phytotechnology at their core, to strengthen the ability of the biota to sustain and adapt to human-induced stresses.

One such scientific tool, made possible by support from the UNESCO ecohydrology program, UNESCO-ROSTE, NOAA, and the Australian Institute of Marine Science, is the development and use of an estuarine ecohydrology model. This model has now been applied, and the results communicated to management, for four cases

- the Guadiana Estuary in Portugal and Spain
- the Great Barrier Reef of Australia
- Darwin Harbour, Australia
- Estuaries in Micronesia.

The ecohydrology model was initially developed, calibrated, and applied to the low flow conditions in the Guadiana Estuary. The model integrates physical and biological processes in the estuary and it predicts the ecosystem health as determined by the following variables: nutrients, suspended particulate matter, phytoplankton, zooplankton, bivalves, zooplanktivorous fish and carnivorous/omnivorous fish. The estuarine ecosystem health is shown to depend on human activities in the catchment, including river flow regulation through dams, particularly the giant Alqueva dam, and changes to land-use through irrigation farming. The model quantifies the efficiency of various ecohydrologic remediation measures. The model is a tool that may enable an interaction between scientists, economists, and the public and decision makers to enable sustainable development of the Guadiana River catchment based on ecohydrology principles.

For Darwin Harbour, the model predicts the ecosystem health as determined by the following variables: salinity, nutrients, detritus, suspended particulate matter, phytoplankton (two size classes), zooplankton (two size classes), detritivores, zooplanktivorous fish and carnivorous fish. The model is used to assess to what degree the estuarine ecosystem health may degrade as a result of possible future human activities in the catchment, particularly land clearing, nutrient enrichment, and destruction of mangroves.

For Micronesia, the model highlighted the beneficial role of mangroves, resulting in a legislative protection in at least one state (Palau).

A further ecohydrologic model was developed for the Great Barrier Reef of Australia. This model, verified against field data, suggests that land-use has contributed to degradation of the health of the Great Barrier Reef and to an increased frequency and intensity of crown-of-thorns starfish infestations. The model also predicts that the health of the Great Barrier Reef will significantly worsen by the year 2050 as a result of global warming. However, the model also suggests that much-improved land-use practices will enable some regions of the Great Barrier Reef to recover, even with global warming. Finally, the model suggests that, if global warming proceeds unchecked, biological adaptation is necessary to avoid a collapse of the Great Barrier Reef health by the year 2100.

Vulnerability and Adaptation in Coastal Communities: A Case Study in Adaptation on Change Islands, Newfoundland following Closure of the Cod Fishery in 1992

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Historically the cod fishery sustained the coastal communities of Newfoundland and Labrador off Canada's East Coast. When the moratorium on northern cod was declared in 1992 over 40,000 people in Atlantic Canada were affected by the closure. It is now over a decade since the cod fishery closed and their expected return never materialized. Alternate species are being exploited but the fishery is more expensive and requires fewer people and bigger boats. All of these coastal communities are vulnerable. Sustaining one of these coastal communities, Change Islands off the northeast coast of the island of Newfoundland is the subject of this paper. This community attempted several alternatives in its struggle for sustainability – heritage tourism, a small manufacturing operation, and processing alternate ocean species. This article examines each business venture and considers the elements of sustainability required within small coastal communities. Each alternate business venture experienced difficulties and what endures is not only based on the skill of the people involved but leadership, strategic planning and marketing knowledge that is not usually acquired from involvement in traditional fishing. The future sustainability of coastal communities is a balancing act between the ways of the past and building adaptations that fit with the lifestyle.

Land Use Conflicts and Coordination in Fast Urbanized Coastal Zones

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Coastal zones with dense human settlements are interlaced but vulnerable ecosystems sensitive to environmental changes. Driven by urbanization, population and economic activities are fast concentrating in coastal zones, resulting in a series of land use conflicts. The mostly expressive are three types of conflicts: those between expanding urban land use and other land uses; those between land resource utilization and conservation; and those between increasing demand for land and degrading land quality. All in all, they reflect the fundamental conflict between short-term economic development and long-run food/ecosystem security. These conflicts can only be resolved through coordination according to the principle of sustainable development. This also signifies the importance of integrated coastal management.

This is a case study of the Shandong Peninsula in China to probe into the issue of land resource conflicts and coordinated development in its fast urbanized coastal zone. There are 7 cities along the coast of the peninsula. Between 1996 and 2003, residential and industrial land uses increased by 50,313 ha, with an average of 7187.57 ha per year. During the same period, however, farmland decreased by 46,824 ha, with an average 6,689.14 ha per year. As a result, many environmental problems have occurred. According to the rising economic trend since 1995, the urbanization level in the Shandong Peninsula is forecast to reach 59.6% in 2010, and 68.4% in 2020. As urbanized land expands further, more conflicts in resource use and environmental management will perforce occur.

The coordination is based on the theory of sustainable development. All land uses are sorted into three categories: (1) land that cannot be used for construction (including nature reserves, protected area for freshwater source, and basic farmland in conservation); (2) construction land that consists of lands in urban built-up areas, economy-technology development areas (i.e., industry parks), infrastructures, towns and rural settlements; (3) controlled development land that generally surrounds cities and towns for future utilization. In land use planning, we first draw out the various reserved land, and then suggest/designate lands for construction and other uses, so as to guarantee the long-term environmental and ecological benefits in the coastal zone's development. We also propose a functional zoning scheme and a regional ecological security pattern. Based on food security, a flexible policy for basic farmland conservation is put forward for different regions on the peninsula and for different development phases. Through controlling the gross area of various types of land uses, improving land use efficiency, and using flexible policies, we attempt to resolve the conflicts between fast urbanization and resultant resource and environment problems, so as to realize integrated and coordinated coastal management.

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Changes in the Use of Ecosystem due to the Loss of Eelgrass Bed in the Estuarine Lagoon, Lake Nakaumi, Japan

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At a eutrophic estuarine lagoon, Lake Nakaumi (area 86.2km², mean depth 5.4m), eelgrass (*Zostera marina*) had been intensively harvested as fertilizer especially for cotton. We estimated the amount of nitrogen (N) and phosphorus (P) removed from the lagoon through eelgrass harvesting. The coast of L. Nakaumi is governed by Tottori and Shimane prefectures. At Tottori prefecture, annual amount of harvested eelgrass in the late 1940's was estimated by the local fisheries station as at least 56,250 t in wet weight. Because no eelgrass grows in present L. Nakaumi, we sampled eelgrass at Akkeshi Bay, north of Japan. Its wet weight was 956.2 g including sediment, detritus and epiphytic organisms. After cleaning, the wet weight/dry weight of vital leaf, senescent leaf, and underground part were 552.6/44.7g, 67.4/4.2g, and 190.7/25.3g, respectively. C/N/P concentration of dried vital leaf, senescent leaf, and underground part were 31.7/1.85/0.353 %, 30.5/1.15/0.150%, and 31.2/0.70/0.219%, respectively. Thus the nutrient content of 56,250 t of eelgrass is 61.4 t of N and 12.8 t of P. Present annual nutrient loads to L. Nakaumi are 1,164 t N and 116 t P, respectively. Therefore, the former eelgrass harvest would be equivalent to 5.3% and 11% of the present N and P loads to L. Nakaumi, respectively. Since we excluded from consideration nutrients removed from Shimane prefecture, and also because the lake should now be more eutrophic than in late 1940's, these percentages should be considered minimum estimates.

We interviewed local people who used to harvest aquatic plants for fertilizer. They said that eelgrass beds were mostly lost in L. Nakaumi within a few years during mid 1950's. It is often said that loss of sea grass beds is caused by increase of turbidity due to eutrophication. However, phytoplankton was not so abundant in L. Nakaumi even in 1961. The largest Chl-a concentration in 1961 was 6.1µg l⁻¹, which was far less than the suggested threshold of 15µg l⁻¹. The loss of eelgrass bed was apparently coincided with the beginning of the widespread use of herbicides in the area. The record by Shimane Agricultural Experimental Station showed that 2,4-D might have been used as early as 1950; the first record of the amount of 2,4-D used was 12.99 t in 1957.

Before the loss of the eelgrass beds, shrimps, crabs, bottom fishes, edible seaweed and cockles were chief target of commercial fisheries in L. Nakaumi. Comparing the fisheries yield in L. Nakaumi between 1958 and 1996 with statistics, we can see that seaweed and cockles fisheries were completely destroyed, and the catch decreased in half. In the present L. Nakaumi, the chief primary producer is phytoplankton showing up to 60µg l⁻¹ of Chl-a, and opportunistic species of filter-feeding bivalve, *Musculista*

senhausia, is the dominant macrobenthos. The secondary production of this bivalve at L. Nakaumi is so abundant that the population of wintering diving ducks which mainly eat on *M. senhausia* is one of the largest in Japan.

New Perspectives for the Future of Venice

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The Venice lagoon (Italy), that is the main Mediterranean lagoon, is the result of a number of human interventions leading to increased sensitivity and vulnerability of both the ecotone and the city to environmental problems that require protecting works. For many centuries, efforts have been made in the attempt to maintain the lagoon system in a state of unstable equilibrium by contrasting its natural evolution and by remedying past anthropic harms. One of the best known and most debated problem is that of global climate changes, which may have significant impacts on the ecotone through the modulation of sea levels.

In this connection, the MOSE (an Italian acronym for electro-mechanical experimental module) project - the defensive system planned to contrast exceptional high-water floods that requires the installation of a system of watertight gates at the three lagoon inlets of Lido, Malamocco and Chioggia - is probably useless for the mitigation of the possible impacts due to long-term fluctuations (interannual to decadal) of the mean sea level. In fact, increasing of lagoon erosion, sudden modifications of biological equilibriums, loss of wet lands and salt aggression may cause serious troubles to the ecological system, even in presence of the flood barriers at the inlets, that will be raised only in concomitance of exceptional high water events.

In addition, some reservations exist about former projections of sea-level changes in the Venice lagoon for the next century, that were based on estimates of the global sea-level rates, neglecting that the Mediterranean Sea has an evaporative nature so that in recent years its sea-level trends have been substantially different from those based on global ocean-related estimates. In particular, in the northern Adriatic Sea (the Mediterranean sub-basin to which the Venice lagoon is connected), seasonal to decadal sea-level oscillations are generally much larger than those associated with secular trends.

Assuming that the interannual and decadal variability of sea levels in the Adriatic Sea is inextricably linked to the Atlantic Sector response, the dominant influence of the North Atlantic Oscillation coupled with the peculiar nature of the northern Adriatic basin, are key factors for gaining an accurate understanding of the long-term dynamics of sea levels in the Venice lagoon.

In this contribution it is discussed how the interannual to decadal variability of sea levels in the Adriatic Sea is inextricably linked with the Atlantic Sector response, with longer inter-decadal shifts in the Pacific climate regime and with cycles of solar activity. It is discussed also why the MOSE project may become inadequate to the safeguarding of the Venice lagoon ecosystem within a few decades. The discussions are supported by the indications for the next five decades of the interannual patterns of the sea levels in the Venice lagoon obtained from a climatic model based on indices of solar activity.

Limits of Cost-Efficiency Based Nutrient Management for River Basins

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Nutrient emissions from River Basins endanger coastal zones by eutrophication. Nutrient management has to consider the whole Basin in order to develop efficient strategies for protection of the coastal waters.

Within the frame of the daNUbs project “Nutrient Management in the Danube Basin and its Impact on the Black Sea” 17 organisations from several scientific disciplines including natural sciences, engineering and economy studied the sources, pathways and sinks of nutrients in the Danube Basin and the effects on the Western Black Sea shallow waters. Based on numerical models scenario runs for the development in agriculture and the waste management sector were carried out and evaluated in respect to the impact on the Black Sea ecosystem and the cost efficiency of various measures. Finally recommendation for future management strategies could be derived.

From a scientific point of view it is clear that quantitative assessments of nutrient fluxes on a basin scale and thus of the effectiveness of measures have to be considered as uncertain. This is due to lacking and insufficient data to describe the high regional variability, restrictions in assessment tools (models) depending on the considered scale, restricted process understanding and the high influence of natural factors (climate, hydrology etc) on nutrient fluxes. Based on experiences from the daNUbs project this contribution will discuss restrictions in our knowledge and how they might influence decisions in respect to strategies which are based on the cost effectiveness of measures (e.g. nutrient trading). Furtheron, this contribution will show, how a strategy based on a combination of emission control and environmental monitoring could help to avoid undesired developments in nutrient management if the right indicators for assessment of management strategies are chosen (emission control, load monitoring and assessment of the status of the coastal area).

The contribution is completely in line with LOICZ II theme “Anthropogenic influences on the river basin and coastal zone interactions” addressing river catchment-based drivers/pressures that influence and change the coastal domain. The whole water cascade (source to sea) is considered as a single system.

The results presented come from the project "Nutrient Management in the Danube Basin and its Impact on the Black Sea" (daNUbs) supported under contract EVK1-CT-2000-00051 by the Energy, Environment and Sustainable Development (EESD) Programme of the 5th EU Framework Programme. Details on the project can be found on the project homepage: <http://danubs.tuwien.ac.at/>.

Poster Presentations

Invasion of Anthropogenic CO₂ Recorded in Stable Isotopes of Planktonic Foraminifera from the northern Gulf of Aqaba, Red Sea

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The stable carbon isotopic composition of the planktonic foraminifera *Globigerinoides sacculifer* and *Globigerinoides ruber* (white) and sedimentary organic matter from the northern Gulf of Aqaba have been investigated to estimate changes in $\delta^{13}\text{C}_{\text{DIC}}$ in surface waters during the last 1000 years. The high sedimentation rates at the core sites (about 54 cm/k.y.) provide high temporal resolution (~10 years). Recent sediments at the top of the cores reflect conditions younger than 1950. The $\delta^{13}\text{C}$ records of the planktonic foraminifera from three multicores display similar trends, showing a uniform and consistent pattern before the 1750s, and a gradual decrease of approximately 0.63‰ over the last two centuries. This decrease seems to track the decrease of $^{13}\text{C}_{\text{DIC}}$ in surface waters, which is mainly caused by the increase of anthropogenic input of ^{13}C -depleted CO₂ into the atmosphere. Similarly, a trend toward lighter values of the carbon isotopic composition of sedimentary organic matter ($\delta^{13}\text{C}_{\text{org}}$) during the last 200 years supports the interpretation obtained from the planktonic foraminiferal $\delta^{13}\text{C}$. Furthermore, direct measurements of seawater show that $\delta^{13}\text{C}$ of the dissolved inorganic carbon (DIC) in the northern Gulf of Aqaba has decreased by about 0.44‰ during the period 1979-2000. The average annual decrease is 0.021‰, which is similar to that observed globally. The $\delta^{13}\text{C}$ values of planktonic foraminifera combined with organic matter $\delta^{13}\text{C}$ from marine sediments are good indicators for reconstructing past changes in atmospheric CO₂ concentrations from the northern Gulf of Aqaba.

PRECIPITATION EVENTS ASSOCIATED WITH LANDSLIDES IN THE TROPICS - GUARUJÁ CITY, AN EXAMPLE OF BRAZIL

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Landslides in slopes with urban occupation has been intensified in many regions of the world, exposing the necessity of studies focused on the evaluation of their causes, in view of preventing and/or mitigating the associated losses.

Specific combinations of rainfall volumes, lithology, topography, sparse vegetation, impervious ground, past soil moisture conditions and land use engender these events, but their impacts depend upon the vulnerability of the social groupings. They are particularly common and severe in tropical regions, where the impoverishment of

significant population segments, their disarticulation to demand essential rights, the lack of alternatives for living in safer areas, and the inadequacy of basic infrastructure and organizational systems to prevent or limit the impacts, contribute to the continuous growth of the society's vulnerability to these episodes.

Guarujá city, Brazil, is an area that has been experiencing an increase in this sort of hazard, despite its "glamour aura": in the last decades Guarujá became an elegant resort for the higher classes of São Paulo city and surrounding areas (easy access by fast and modern highways, paradisiac beaches, constant good weather conditions) so that the city witnessed a *boom* in the buildings, which brought in turn an important contingent of workers who occupied the unstable slopes of Serra do Mar Escarpment. Besides, the population of Guarujá increases up to 40% during summer vacation or special dates, bringing problems such as lack of appropriate waste treatment and sanitation. It is noteworthy that summer time coincides with the period of more intense and frequent rainfall, with more events of landslides, floods and associated victims.

The study aimed to correlate precipitation to landslides in Guarujá in order to evaluate their temporal and spatial distribution pattern. Rainfall analyses were carried out at annual, monthly and daily levels, considering the data of five rain gauges spread up into the area, comparing two periods (1965–1988 and 1991–1999). Events of landslides were collected from local newspapers and the Municipal Civil Defense.

The results revealed a substantial increase of landslides triggered by rainfall in the recent period (1991-99): 518 events against 81 in the previous period (1965-88). However, any appreciable change in the rainfall totals was found; besides, the recent events were engendered by lower daily rainfall amounts, emphasizing the impressive environmental degradation of Guarujá due to changes such as deforestation of the Atlantic Rainforest, damages to mangroves, as well as fast and aggressive modifications in the land use, many times without any planning. Moreover, these aspects brought in turn an increase in the associated vulnerability of the inhabitants of the risky areas.

The strongest rainfall episode (February 19th. 1993; 135mm registered) induced 60 landslides. It was caused by convective rainfall, a regular process within the area, but other atmospheric mechanisms, such as cold fronts and ZCAS, play important role in triggering landslides, terrain collapses and floods.

Deposition of Polycyclic Aromatic Hydrocarbons Emitted from Ship Engines into the North Sea

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According to a study concerning emission scenarios for air pollutants within Europe conducted by the Clean Air for Europe (CAFE) programme of the EU emissions from ship engines are playing an increasing role for air quality issues. While more and

more stringent controls are placed on land-based sources of atmospheric emissions, ship emissions which have received less attention in the past will even rise and, thus, turn into dominating contributors to air pollution within the next 20 years. While the above mentioned study was mainly focused on major pollutants like NO_x and SO_x, the same conclusion will likely apply to polycyclic aromatic hydrocarbons (PAHs), too. For cost reasons, ships are operated with fuel of inferior quality, which promotes the formation of PAH during combustion processes. As most PAHs adhere to particles, they are usually deposited near their sources. That means that the deposition of these hazardous substances into coastal ecosystems will in the near future be largely influenced by shipping activities.

For the beginning, studies were conducted about Benzo(a)Pyrene (BaP), a well investigated PAH with known adverse effects on ecosystems and human health. To estimate the BaP depositions into the North Sea between England, France, Belgium, Holland, Germany, Scotland and Denmark simulations of ambient air concentrations and depositions were carried out with a BaP Version of the Acid Deposition and Oxidants Model (ADOM) where BaP is treated as if it were completely adsorbed to particles. This Eulerian model operates at a time resolution of one hour and a spatial resolution of ca. 50x50 km² grid cell size. So far, only little data is available about BaP emissions from ships. Therefore, the used emission factors for BaP in ng/m³ exhaust gas were in most cases derived from the much better investigated NO_x emission factors. Basically, the ship category, the installed engine type on board a ship and the fuel used largely dictates the amount and composition of the emitted air pollutants. To cover the possible range of the emitted BaP amounts, three scenarios according to our assumptions were simulated: One where all ships were low emitting passenger ferries (best case), one with only heavy emitting container ships (worst case) and one mean case calculated from 7 different ship types.

The model was run for one month with the weather conditions of March 1999 and – due to a lack of newer data – emissions from 1990. As total BaP depositions for this time period an amount of 17.2 kg was calculated. The depositions from ship emissions turned out to be in the worst case ca. 5% of those from only land sources. However, in some grid cells near the coast or in the English Channel this rate rose up to 25%. Further, it must be kept in mind that this simulation reflects the situation of more than 10 years ago, when the land sources of BaP were much more dominating those at sea than it is the case now.

Internet Tools for Coastal Issues: A Project Database

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European policy like the Water Framework Directive, the Strategy on Integrated Coastal Zone Management, Natura 2000, the Marine Strategy or the Strategic Environmental Assessment Directive (SEA) recently caused a lot of activities

especially in the coastal zone. The consequences of the implementation as well as the integration of this policy are still not entirely visible. However, all these directives and strategies call for spatially integrated approaches, ask for management plans and an improved information, participation as well as co-operation between authorities and across hierarchies.

As a result of this policy many projects, case studies and expertises about the coastal sea, the coastal zone as well as river basin - coast systems were and are funded by international organisations like UNEP or LOICZ, the European Union and the all the member states. To avoid a replication of work and to ensure an efficient progress all these data, results and information have to be made and kept available for the public.

To promote the sustainable development of the coastal zone, the dissemination of data and information and to improve participation are major aims of EUCC – The Coastal Union and the background for the development of a coastal database.

The database is designed for different users and organisations and the main features and advantages compared to existing systems will be presented in detail.

Impacts of Gold Mine Waste Disposal on the Sustainability of Deep Water Fish in a Pristine Tropical Oceanic System.

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Lihir Island is a volcanic sea mountain situated in Papua New Guinea's New Ireland Province. An open cut gold mine has operated since 1996 disposing two types of waste into the marine environment: (i) the excavated overburden dumped into deep near shore ravines and (ii) the tailings slurry from the processing plant which is deposited onto the sea bed via a pipeline at 128 m depth. However, nothing was known of the impacts of this waste disposal on the local fish communities. A three-year sampling program, stratified by year, depth and proximity to the mine commenced in 1999 to investigate the impacts of the mine on fish populations. Data on fish abundances was compared between sites (i) adjacent to the mine site, (ii) neighbouring regions north and south of the mine site, and (iii) distant from the mine. Data was also collected on the age, growth and fecundity to assess the resilience of these species to human impacts. Fish tissues were also collected to assess the body burden of heavy metals and reported separately. This study is the first published account the impact of at-sea mine waste disposal on fish communities.

A total of 458 stations were fished during the study collecting data on 975 fish of 98 species. Seventeen species made up 61% of the total catch and their catch rates were compared between regions to provide an assessment of the impact of the mine. The probability of catching fish, and the total numbers of fish caught was significantly lower at sites adjacent to the mine than the neighbouring regions to the north and south of the mine; with the highest probability in regions distant from the mine. Eight of the 17 species had lowest catch rates at sites adjacent to the mine, while three species had highest catch rates adjacent to the mine. Two species had highest catch rates in the neighbouring region to the north of the mine site, while four species showed no difference between sites. Species with highest catch rates adjacent to the mine included the trevally, *Caranx tille*, and the snappers, *Lutjanus argentimaculatus* and

L. timorensis. These species are reef associated in the sizes caught during this study, but appear to prefer the habitat provided by the more turbid waters near the mine. Two of the species with lowest catch rates adjacent to the mine (Comet grouper, *Epinephelus morrhua* and Goldband snapper, *Pristipomoides multidens*) had highest catch rates in the partially affected area to the north of the mine.

Most of the deepwater fishes caught are long-lived, slow-growing species with low natural mortalities. Catch rates of all 17 species analysed in detail were relatively low and variable, with mean catch rates of about one fish or 1.5 kg per line hour. Biomass estimates, life history characteristics and catch rates suggests that these deepwater species are highly susceptible to human impact and that their populations should be protected from fishing exploitation and monitored into the long term. The impact from mine waste disposal on local fish populations adds significantly to the subsistence fishing impact from local village communities. This highlights the need to provide assessment and prediction of indirect mine impacts on local communities.

ENVIRONMENTAL VARIABLES SHAPING PHYTOPLANKTON STRUCTURE IN TAGUS ESTUARY

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Phytoplankton composition and abundance as well as environmental data obtained from 15 sampling sites in Tagus estuary, May 2002, were analysed by applying a multivariate method. The environmental variables measured consisted of temperature (T), salinity (S), dissolved oxygen (DO), nitrate (NO₃), ammonium (NH₄), phosphate (PO₄), silicate (Si(OH)₄), total nitrogen (TN), total phosphorus (TP) and suspended particulate matter (SPM). The phytoplankton community was dominated by Bacillariophyceae.

Ordination of sites through non-metric Multi-Dimensional Scaling (MDS) applied to phytoplankton species provided very good spatial representation (stress is very low, 0.08). Some of the environmental variables superimposed one at a time on the phytoplankton MDS show their magnitude at each site. The application of BIO-ENV technique, linking the observed phytoplankton structure to the measured environmental variables in Tagus estuary, during growing season, allowed to define the optimal subset of environmental variables which best explained the biotic structure. The combination of environmental variables, which gave rise to the largest rank correlation ($\rho_w=0.82$) between biotic and abiotic samples similarities, is represented by S, T and NO₃. Further, the importance of some other environmental variables as explanatory of phytoplankton trends is referred and also considered useful information regarding future sampling planning. A statistical test was applied to search for the most influential species in the estuary reproducing the pattern for all the species.

Examples and Achievements of Typological Applications

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Because of its applicability to diverse systems and questions, typology offers ways to explore linkages among systems and subsystems that are interactive or related, but poorly understood. It also offers a useful tool for both up-scaling and down-scaling, in space or time.

Because one of the best ways to understand the diversity and potential of the approach is by example, this presentation illustrates a range of the typologic applications that have been published and/or used for practical purposes, both within and outside of the LOICZ context.

In a more focused LOICZ sense, typology has been used to both explore and analyze coastal nutrient fluxes and loads, by focusing on nutrient yields of river basins. It has also been applied to large-scale classification of the marine ecosystem effects of river water fluxes, and to the geography of submarine groundwater discharge. These applications have led directly to its use in classification and prediction of the vulnerability of estuarine systems to eutrophication.

Biogeographic applications in the marine realm have included habitat classification on the basis of organism occurrences and environmental variable data, range predictions, and the testing of hypotheses about controls on organism ranges and habitats. In terrestrial ecology, applications to time series classifications are being actively pursued.

At a more practical level, overlapping human dimension applications, typology has been used in support of developing a hydrologically appropriate geographic basis for groundwater, and it has also been applied to sociological research questions.

The Global Water System Project

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The Global Water system Project (GWSP) is a new project under the Earth System Science Partnership, comprised of the International Geosphere-Biosphere Programme, the International Human Dimensions Programme on Global Change, the World Climate Research Programme, and DIVERSITAS. The concept of the GWSP is based on a systems approach that is needed to accommodate both the multi-faceted dimensions of water resources and the accelerating pace of globalization and human development. The global water system includes the water cycle and three major interacting elements: the physical, the biological and biogeochemical, and the human

components. Major drivers of change that affect the system are climate change, population growth, land cover change, the development of water diversions, economic development, and governance. Changes in any component of the system will cascade throughout the whole system.

The scientific plan for the GWSP focuses the project on freshwater systems, and frames the following overarching question – How are human actions changing the global water system and what are the environmental and socioeconomic feedbacks arising from anthropogenic changes in the global water system? The research is organized into three themes: 1) What are the magnitudes of anthropogenic and environmental changes in the global water system and what are the key mechanisms by which they are induced? 2) What are the main linkages and feedbacks within the earth system arising from changes in the global water system? 3) How resilient and adaptable is the global water system to change, and what are the sustainable water management strategies?

The GWSP and LOICZ are clearly complementary. Areas for future collaboration include: the changing boundaries of the estuarine environment; the impact of river diversions and land use change on coastal processes; the effect of global change on the integrity of aquatic ecosystems; the issue of saltwater intrusion to coastal aquifers; large-scale nutrient cycles; and data exchange.

Advective Travel Time Variability in Stream Networks

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In dealing with the problem of eutrophication that threatens coastal environmental quality globally, processes of nitrogen in-stream attenuation and delivery to basin outlet need to be better understood and quantified for modeling catchment-scale nitrogen transport from land to coast. Different catchment-scale nitrogen budget models use and base management recommendations on quite different process representations of and spatial resolution approaches to, for instance, coupled transport-biogeochemical nitrogen removal, by denitrification, biological assimilation and mass exchange with relatively immobile water, along the different pathways of water within the catchment.

In a previous study (Darracq & Destouni, 2005), we directly compared three such different process-resolution approaches to modeling nitrogen loss rates in stream networks of the Norrström drainage basin in Sweden. We have shown that commonly used spatial model aggregation may lead to artificial decrease of calibrated nitrogen loss rates with increasing stream depth (or flow), in addition to any such dependences that may prevail in independently measurable reality. Coastal nitrogen impact predictions and practical management implications of large-scale model aggregation of nitrogen attenuation rates may further differ considerably from those based on rates from finer resolution modeling or independent measurements.

Processes of nitrogen in-stream attenuation and delivery to basin outlet need therefore to be better understood and quantified in order to be able to infer efficient management and mitigation measures for reducing coastal nitrogen loading within drainage basins. A single characteristic instream solute travel time is commonly used for representing and quantifying coupled transport/biogeochemical removal conditions in streams for both diffuse and point nitrogen inputs on large stream-reach/sub-catchment scales, thus neglecting actual in-stream travel time variability and distribution, from different nitrogen input points along a stream network to the stream monitoring/outlet location. In general, use of a simple, single characteristic solute travel time value, however, may be far from representative of either a realistic mean value or the variability range of prevailing solute travel time distribution in streams over large model aggregation scales.

In this study, we continue to use the Norrström drainage basin case for an example quantification of advective travel time variability in stream networks. We find significant travel time variability within sixty sub-catchments of the Norrström drainage basin, and show how this variability increases with sub-catchment area and mean travel time in the sub-catchment stream network. Solute travel time variability that complicates the quantification of relevant characteristic travel time measures may imply compensating misleading estimates of nitrogen attenuation/retention rates, even for perfectly calibrated nitrogen transport-attenuation/retention models on (sub-) catchment scales. Such estimate errors may have important practical implications, for instance for predictions of abatement measure effects and nitrogen impacts under changed future conditions.

Biogeochemistry of N, P and Si Fluxes to the East Brazil Coastal Zone.

A Tropical Reservoir Functioning or Multiple Impact Scenario.

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The East Brazil Coastal Zone (EBCZ, AB= 545,000 km²), delimited by the São Francisco River (~10.3° S) in the north to the Paraíba do Sul River (~21.5° S) in the south includes ca. 24 small to medium sized river-estuaries, being affected by the worldwide phenomena of hydrological alterations. Dam constructions are considered the major anthropogenic alterations in Brazilian river basins, as up to 90% of the Brazilian power supply is furnished by hydroelectric dams. The EBCZ has 19 large ($V > 0.1 \text{ Km}^3$), 29 medium ($0.01 < V < 0.1 \text{ Km}^3$) and 167 small ($V < 0.01 \text{ Km}^3$) dams.

Nutrient retention and changes in the nutrient mix in dam reservoirs has become a notorious feature. The magnitude of such alterations depends on operational strategies of the dam (which controls freshwater fluxes and residence times), biogeochemical features of the new artificial lake (which controls the extent of nutrient incorporation, accumulation and release) and the basin area controlled by the impoundment (which ultimately will control the extent of further natural and anthropic inputs). In this study,

we compare the impact of dams upon material fluxes and yields between the river systems by adopting a simple index, which relates the drainage basin area of the impoundment to total river basin area, and measured material fluxes to the coast, downstream of the dams. This strategy results in a comparative system approach of net material fluxes of river basins, influenced by material retainance behind dams and downstream material replenishment (natural and anthropic), under different degrees of impoundments. The index serves as a relative measure to assess the proportion of river basins which are intercepted by the dam and embody the distance of the dams from the coast, the hydrological setting and further potential anthropogenic inputs downstream of the dam. The impacts of the impoundments upon nutrient fluxes to EBCZ were analyzed for the wet and dry seasons and for percentage intervals of dam basin control ranging from uncontrolled to nearly to entirely controlled (>90%).

The reservoirs of EBCZ exerted substantial changes in the nutrient mix, particularly affecting the dissolved inorganic nitrogen (DIN) and phosphorus (DIP) fluxes and ratios, and to a lesser extent dissolved silica (DSi) fluxes. Changes in the DSi:DIN ratios were largely brought about by DIN variability and were for most rivers well above the ideal ratio of 1:1 for phytoplankton diatom uptake. DSi served as an indicator for weathering processes linked to water input and the replenishment of materials downstream of the dams. DIN and DIP were indicators of material replenishment by domestic effluent inputs downstream. One of the major feature which affected changes in the nutrient mix and fluxes downstream from the dams, were the age and biogeochemical characteristics of the reservoirs and the flow patterns controlled by the operation of the dams as determined by the regional energy demand. Overall results suggest other factors of tropical reservoirs biogeochemistry (such as mean depth, age, residence time, biological activities) or land-use changes (erosion, deforestation, monocultures, fertilization) or domestic and industrial effluents, as controlling the biogeochemistry of nutrient fluxes to coastal zone.

How does Gold Mine Waste Disposal affect Shallow Coral Reef Fishes and Habitats at Lihir Is, Papua New Guinea?

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The impacts of at-sea disposal of excavated overburden and tailings slurry from the Lihir Gold Mine on the adjacent shallow reef-fish communities were assessed during 1999-2002. The research focussed mainly on the potential impacts of sediment on the adjacent coral reef habitats and subsequent impacts on the reef-associated fish populations. A second objective of the research was to assess the potential for a sustainable shallow water artisanal or commercial fishery at Lihir Island, to address the long-term development of the island's coastal communities following the mine's closure. The gold mine began production in 1996 with an expected life of approximately 30 years.

Underwater visual census (UVC) surveys were undertaken in the summers of 1999, 2000 and 2002 to quantify the distribution and abundance of reef fishes and habitats in relation to the mine site. Possible impacts of the Lihir mine on the shallow reef-

fish communities were assessed by comparing species abundance and diversity at transects adjacent to the mine site, in the neighbouring regions north and south of the mine and in regions distant from the mine. At each transect, a diver estimated the numbers and sizes of all “conspicuous” fishes in a 100 m by 10 m belt transect. At the completion of each dive transect, the reef-edge habitat was characterised by standard abiotic and biotic categories; including live and dead standing coral cover.

A total of 23,318 fishes from 110 species and 16 families were recorded during the UVC surveys. The fish families showed a generally homogenous distribution around Lihir Island although the predatory families, including lutjanids, lethrinids, serranids and labrids, were more abundant in the southwest. A total of 23 fish species from 9 families were ubiquitous and 35 species were recorded at the mine site. The topsail drummer *Kyphosus cinerascens* was the most numerically abundant species in the study (52 ha⁻¹). The estimated overall densities of reef-fishes from the UVC surveys were low compared to other coral reef habitats and comparable between years (530 – 641 individuals ha⁻¹). There were no significant downward trends over time for the fish families, suggesting the populations were in a steady state for the years studied. Species diversity and abundance were significantly lower at the mine site compared to the neighbouring or distant regions around Lihir Island. Fish abundance was also significantly lower adjacent to the mine and in neighbouring regions compared to the distant region. However, some species were as abundant or more abundant in the neighbouring regions. Future monitoring with UVC is strongly recommended to evaluate possible long-term impacts of mining activities.

Assessment of the potential for a sustainable shallow water artisanal fishery showed that even with high exploitation rates, the yield would be low (25 – 28 t.yr⁻¹). The estimated harvest of the current subsistence fishery was similar to this range providing very limited opportunity for a long-term sustainable fishery based on the shallow water fish population.

This research documents a rapid assessment of gold mine derived sediment on adjacent coral reef habitats and their associated fish populations. The impacts of the mine on these fish populations directly affect the subsistence fishery of the coastal communities. We estimate the carrying capacity of the system and show that there is limited potential for the development of an artisanal fishery to secure long term incomes to the local communities after the mine closes.

IOI - OceanLearn; The Training and Education Programme of the International Ocean Institute

Werner Ekau

IOI-Operational Centre Germany, Director

The International Ocean Institute (IOI) is a worldwide network of 24 Operational Centres (OC) with its secretariat in Malta, and promotes the concept of *Pacem in Maribus* - Peace in the Ocean and its management and conservation - for the benefit of future generations. It has three areas of activities: Research & Development in

Ocean Governance, Awareness Creation and Information (*Ocean Outreach*) and Training & Education (*OceanLearn*).

All Training and education activities of the IOI Network are developed and delivered under the *OceanLearn* (OL) programme. The programme is coordinated by the OL Implementation Committee (OLIC), that also guarantees a network wide quality standard for all courses. Operational Centres and IOI partners contribute courses and expertise to the OL Programme, which range from short (1-2 week) courses that may be thematic and geographically focused (from the community level to the United Nations), to longer courses (up to 10 weeks) which provide a comprehensive pluridisciplinary overview of topics such as Ocean Governance. OL is also responsive to client needs, and its pedagogic experts will work with governments, organizations, and individuals to provide customized training in a multitude of topics ranging from the applied sciences, to law, policy, and management. The objective of OL is to deliver high quality and cost-effective training and education to professionals who wish to remain at the forefront of the rapidly changing field of ocean science and governance.

“The Social” in Ecosystem Research: Pitfalls and Potentials

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Increasing attention to the social dimensions of sustainable ecosystems management in recent years has not generated a universal concept or operationalisation. This stands in considerable and uncomfortable contrast to the environmental and economic sustainability dimensions for which universal concepts have been defined and accepted operationalisation rules devised. Ecosystems research often considers social dynamics only in terms of whether they support or undermine environmental objectives. Depending on the respective natural science, the representation of “the social” is then frequently limited to the discipline-specific predatory or polluting anthropogenic impact. The identification of universal social functions which need to be maintained in order to sustain society and achieve sustainable dynamics between nature and society is still outstanding. In more process- and actor-oriented participatory approaches to sustainable ecosystem management, the social dimension appears more strongly but, with few exceptions, lacks the analytical dimension to move it beyond the ever-changing, context-specific lists of social issues and indicators which now dominate the field.

The presentation provides a critical overview of concepts and operationalisations of the social conditions for sustainable ecosystems management. Social sustainability definitions which reduce the social requirements for a holistically sustainable management approach to the economic dimension of sustenance provision are contrasted with a range of other approaches such as definitions of the social which emphasize equal opportunities and inter- and intra-generational justice. Social resilience, the systemic ability to withstand shocks to institutions and norms while maintaining essential social functions, and the capacities for self-organisation, learning and adaptation, is an approach with potential for social-ecological analysis

but with specific operationalisation problems. The social capital approach moves beyond the narrow economic viewpoint by focussing on social features which improve the efficiency of society and increase individual returns such as trust, reciprocity, cooperation and tolerance as well as on norms and networks. While offering great potential within livelihoods analysis, the social capital concept does not entirely succeed in conceptualising the non-economic functions of society which are nonetheless important for a conflict and violence-free social life. The presentation will give a comprehensive working definition of social sustainability in ecosystems management with an explicit focus on the missing analytical elements in most derivations of the concept. A number of issues will be discussed which arise in the operationalisation of “the social” in stakeholder-based processes of planning, and monitoring sustainable ecosystem management. The specific area of reference of our operationalisation attempt is a mangrove ecosystem on the North Brazilian coast. Operationalisations of our working definition in other geographical contexts are then used to undertake a first analysis of the universal and the culturally, ecosystemically and socio-politically specific elements of social sustainability.

The Redistribution of Coastal Dune Plants – A Global Issue

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The ecology of the world’s temperate coastal sand dunes is threatened by the human-related dispersal of coastal dune plants. Movement of species has occurred within and between the northern and southern hemispheres. This is a global issue, because of the number, extent and ecological consequences of these invasions. Case studies are presented from two countries, Australia and New Zealand. These demonstrate that (i) the transgressive dune systems of Australasia are vulnerable to exotic plant incursions; (ii) exotic species threaten the natural dynamism and ecology of dune systems; (iii) there is low public and government recognition of the problem; and (iv) there is currently little active control or management of these species.

The foredune communities of Australia and New Zealand are dominated by just three species - two grasses (*Spinifex sericeus* and *Austrofestuca littoralis*) and, in New Zealand, a sedge (*Desmoschoenus spiralis*). A greater range of species, many of them specialist dune species, occurs in back-dune environments, however, the vegetation cover and total biomass in active, transgressive dune systems is often low. There is widespread evidence of episodic transgressive dune development during the late-Holocene, probably related to climatic variations and foredune vegetation stress. This process is closely linked to habitat and landscape diversity.

Australasian dune systems have been greatly modified over the last 100 years, as a result of the introduction of European strandline and foredune species. Marram grass (*Ammophila arenaria*) and European Sea Rocket (*Cakile maritima*) are widespread in southern Australia and New Zealand. Sea Wheat-grass (*Thinopyrum junceiforme*) and Sea Spurge (*Euphorbia paralias*) occur across the south coast of Australia. Three South African species, Bitou Bush (*Chrysanthemoides monilifera*), Capeweed (*Arctotheca populifolia*), and Pyp Grass (*Ehrharta villosa* var. *maxima*) are also

naturalised and spreading in temperate southern Australia. These species are invasive because the vegetation cover of dune systems in Australasia is low, there is a lack of competition from other plants and a dearth of associated parasites. Individually or collectively, these invasive species have been shown to displace native flora and fauna, provide habitat for other introduced species, change landscapes and establish new dune forms. Over longer time scales, 10^2 - 10^3 years, they may inhibit dune dynamics, dune system development and dune biodiversity.

The above species established in Australasia throughout the 20th century. Most were deliberately introduced with no assessment of their long-term ecological impact. Control or eradication operations have been attempted or are underway at some sites of significant conservation value. Most of the above species disperse by marine-rafted rhizome or seed and management is only effective when carefully coordinated and consistently funded. Inadequate funding stems from low levels of understanding of the natural character of coastal dunes, albeit the control of some species by community groups has proved highly effective. Safeguarding the ecology of coastal dunes requires that (i) potential invaders are anticipated and processes of invasion researched; (ii) awareness of the bio-security risk posed by exotic dunes species is raised; (iii) methods of control are researched and the knowledge disseminated; (iv) monitoring and surveillance is supported; and that (v) national/state strategies for dune system conservation are developed.

Process Contributions to Shelf-Ocean Exchange

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Shelf-ocean exchange studies have been motivated by questions of sediment movement, nutrient and carbon cycling. Processes causing exchange include along-slope currents and associated Ekman layers, “overshoots” at spurs, upwelling and filaments, more general wind-driven exchanges, eddies, dense water “cascades”, internal tides, waves and associated turbulence mixing and dissipation. Many of these are illustrated from “community” experiments off western Europe. Several processes individually contribute exchange of order $1 \text{ m}^2/\text{s} \equiv 1 \text{ Sv}/(1000 \text{ km})$; typical western European values are $2 - 3 \text{ m}^2/\text{s}$ overall. In the NW Iberian area, estimates of order $3 \text{ m}^2/\text{s}$ derive from: drifters, salinity loss from pole ward along-slope flow, direct measurements of currents, adding individual process contributions. The encouraging consistency between overall and process estimates supports a modelling approach to estimating exchanges elsewhere.

Such measured or process-based exchange estimates are needed because LOICZ budgeting methodology is sensitive to the small and uncertain differences in shelf-sea salinities and large variations in along-shelf flow.

Current-induced bed stresses often suffice to move local upper-slope sediment. Hence sediment reaching the shelf edge is liable to export, especially in the down-slope Ekman layer under the slope current.

Off NW Europe, the spring bloom generally progresses northwards and becomes nutrient-limited when the initial near-surface charge is exhausted. Summer growth is limited to that sustained by biologically regenerated nitrogen and nutrients mixed through the thermocline. An autumn bloom may be fuelled by nutrients entrained in the deepening mixed layer. Typical shelf-sea production is $O(100-250 \text{ gC m}^{-2}\text{yr}^{-1})$; the shelf/ocean distinction is reduced at these latitudes. Upwelling or mixing can increase production.

Organic carbon and/or related budgets have previously been estimated over Goban Spur, sub-areas of the north-west European shelf, the North Sea, Irish Sea, at the Hebrides shelf edge and off northern Norway. Modelled fluxes across shelf sectors will be shown.

Effects of the Tsunami to the Human Society due to the Negligence towards the Coastal Zone of Sri Lanka.

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Sri Lanka is an Island within the tropical climatic zone of Indian Ocean. It covers 65,610 square kilometers. The length of the coastline open to the sea including bays is 1639 km. The country's principal coastal resources are; coastal habitats, fishery, mineral deposits, land and water resources. These natural coastal habitats include coral reefs, estuaries and lagoons, mangroves, seagrass beds, tidal flats or salt marshes and barrier beaches, spits and dunes. Fishing, tourism, industry and agriculture sustain the growing economy of the coastal region. Expanding trade and commerce accelerated population shifts to the coast. Therefore more bare lands have been converted into residential, commercial, industrial and other infrastructure development areas. Then the increase of human activities contributed to destroy the existing natural environment within the coastal zone. This paper highlights the effects of the Tsunami to the Coastal Zone of Sri Lanka and some relationship with the destroyed natural environment.

According to the Coast Conservation Act (CCA), the limit of the Coastal Zone (CZ) in the land is marked 300 meters from the high water line of the sea level. It also marked 2 kilometers distance along the inland area of estuaries and rivers. Large tourist hotels, housing schemes, settlements of fishermen, towns with infrastructure facilities, various industries and factories are situated within this Coastal Zone of Sri Lanka. Destruction of coastal vegetation for commercial activities, sand mining from rivers, beaches and dunes for construction industry, coral mining for lime, explosives use for fishing, industrial water pollution are the other activities of the people to earn money. According to the CCA all these constructions and activities are illegal and prohibited. Since there are no actions against these illegal activities the coastal zone has been subjected to severe environmental degradation and directly allowed to increase the coastal erosion.

The worst ever natural disaster was occurred in Sri Lanka on 26th of December 2004. The seismic sea waves or Tsunami caused by a massive earthquake off the west coast of Northern Sumatra devastated the whole coastal zone in the Island except a few locations. As an estimated 31,000 persons living in and around the Coastal Zone of Sri Lanka were killed by this Tsunami. It destroy several thousand of houses, many permanent buildings, schools, religious places, tourist hotels, highways, railways, major cities and towns, vehicles and trains, agriculture and all personal properties of the people. Nearly 800,000 persons were displaced and homeless immediate after the effect. 90% of the damages occurred within the 300 meter limit. In some locations it has gone to 1 km distance.

The development plan of the Coastal Zone of Sri Lanka was unable to implement due to the various objections of the higher level administration and political influence. This is the best time to remove the all unauthorized structures and even large hotels and other illegal activities from the defined Coastal Zone to the other places, beyond 300 meters.

Bridging Biodiversity and Tourism towards Sustainable Development of Sandy Beaches

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The biodiversity of sandy beaches, and the impact of tourism on their biodiversity, is a subject currently generating great scientific interest in Europe. To meet the challenge of progressing ICZM and governance, baseline interdisciplinary research is required. Present understanding of the pressures exerted by tourism on beach biodiversity is difficult to apply. Baseline figures have been collected through surveys and questionnaires filled in by tourists. These reveal that, from the tourist's point of view, only a clearly visible fraction of biodiversity counts: charismatic species and landscapes (few travel far to enjoy the beauty of biodiversity indices). From the conservationist's point of view, habitats are key issues - and the more of them we protect the better. From the ecologist's point of view, functional biodiversity is most important. That may mean the fascination with the variety of microbial biochemical adaptations in stinking, deep anoxic zone of the Black Sea. Here the seal counts for nothing, and the most important part of biodiversity is the invisible one. From the local user's point of view - only the visible part of biodiversity counts, the part that directly support personal needs.

A study of the coastal ecology in the Baltic and Thyrranian revealed a discrepancy between public perception, declarations, expressed will etc, and actual activity. Approximately 80% of the people surveyed answered that their ideal mode of

recreation on the sandy shore was to have "...long, undisturbed, secluded coastlines, to share only with birds and waves, rather than other people". Although the quest for isolation was overwhelming in the questionnaires, on-site study showed that 90% of tourists stay within 200m of the parking lot. Today, wealthy tourists are enjoying the nature from the comfort of a limousine, not getting into direct contact with it, yet they will buy the wildlife products from the locals that some people will collect for them. In effect they need both the facilities (roads, cars, services) to enjoy the safe distance, and they exploit indirectly the resources, most often in a very devastating way.

This remark leaves us with a single question: what gaps are there in our knowledge of biodiversity (which includes humans and human ecology) that must be filled to allow us, tourists in our millions, to enjoy our holidays on beaches in a way that our living world can sustain? As to knowledge gaps, more sociological studies are needed, mainly of the EO Wilson, science-oriented type, about the relations of developed populations and nature/biodiversity. Can we have the same economic benefit from artificially created "wildlife trips" that would save the real wildlife? A lot depends on where the clients are directed to by tour operators and land-planning managers, and what is the story to tell. People will go to less fragile and less diverse habitats if wisely guided. From the sociological point of view, the absence of permits, tickets, restrictions make areas more popular. The lack of facilities on the other hand could help keep areas pristine, whilst well organized, attractive visitors centers, and localized activities will absorb the great majority of tourists.

This paper focuses on adaptation of communities and populations along the coasts and it highlights the need of common protocols and frequent exchanges between the partners of the research network on beaches. It also intends to sensitize public opinion about scientific and social issues connected to beach biodiversity in Europe, and to link beach biodiversity to tourist impacts, using both a descriptive and an experimental approach.

Geo-morphological influences to protect the hazard ness of tsunami waves at coastal belt of Yala, Sri Lanka.

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The major natural hazards which experienced in Sri Lanka are cyclones, heavy rainfalls leading to floods or landslides, lightning, coastal inundations due to high sea waves and tsunamis. Those entire major natural disasters are weather related. However, tsunami is ocean based high frequency waves that are most destructive for coastal communities and properties.

The 9.0 magnitude massive earthquake which was occurred 26th December 2004 at Northern Sumatra was the recent cause to generate most destructive tsunami waves. That tsunami gave much kind of bad experiences to Indian ocean nation countries specially in South and East asian countries. The tsunami caused widespread destruction to property creating millions of homeless and killing over 250,000 peoples

in the effective regions. Since Island nation country, more than $\frac{3}{4}$ of the coastal belt of Sri Lanka was affected by 26th December tsunami and total death were more than 50,000.

Coastal geo-morphology, coastal oceanography, meteorology and topography of the sea bed (including natural as well as man made structures) are the major factors determining the influence and severity of the disaster of the tsunami. However, a narrow continental shelf similar to surrounds Sri Lanka. Especially in east coast, coastal geo-morphology (sand dunes, barriers, river mouths) coral reefs and natural barriers hinder to wave progression towards the coast.

This post tsunami study was carried out at south eastern coastal stretch of Sri Lanka. The aim of this research was to identify the effect of tsunami waves of this area and how severity of the damage and what are the protection criteria relevant to coastal morphology.

Sand dunes, bays, hinterlands and river and lagoon mouths are the major geomorphological features along the south-eastern coast of Sri Lanka. Mahaseelawa, Butawa, Patanangala and Yala safari hotel area are the four highly destructed areas on south-eastern coast. Horizontal inundations of these areas vary from 1.5 – 2.0 km. The wave run-up heights are 4.5 – 6.5, 3 – 4, 8 – 10 and 6 – 8 m at Mahaseelawa, Butawa, Patanangala and Yala safari hotel respectively. Thus, destruction at Yala safari and Patanangala are most severe among the four sites.

Patanangala is located with in a bay on a sand dune coast. The bay has funnelled the tsunami wave and the younger sand dunes at low lands between older dunes were breached by tsunami waves causing severer damage. The coast line of Yala Safari Hotel is inundated into two bays segregated by foreland. The bays funnelled the tsunami waves similar to Patanangala. In addition, tsunami wave height is further enhanced at Yala Safari Hotel due to overlapping of incoming tsunami wave with the reflected tsunami wave at the foreland. The study clearly establishes that the coastal morphology serve as a critical parameter in protecting the coast line from ocean based disasters.

The use of phytoplankton and macrophytobenthos as potential quality elements in coastal waters of Algeciras Bay and surrounding areas

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The Water Framework Directive (WFD) is the most substantial piece of EC water legislation to date. It requires all inland and coastal waters to reach "good status" by 2015. This will be done by establishing a river basin district structure within which demanding environmental objectives will be set, including ecological targets for surface waters. The implementation of WFD forces the EU members to adapt their water quality assessment procedures to mostly new criteria based on biological

components such as taxonomic composition and structure of the phytoplanktonic and macrophytobenthic communities

The present work summarizes a part of a report entrusted by the Autonomic Government (“Junta de Andalucía”) to get insight into the current state of the environmental quality of the Algeciras Bay (and nearby areas), a densely populated zone that supports heavy industries and the largest Spanish harbour.

The report included a broad analysis of the spatial variability of the phytoplanktonic community and to evaluate the present conditions of the phytobenthic communities (macroalgae and seagrasses) in Algeciras Bay as well as their potential utility as biological elements of the water quality.

In the present work the main results according to the main specific objectives of the report are presented. These results include:

- Characterization of the phytoplanktonic community (abundance and biovolume of the main taxa).
- Taxonomic composition and diversity of phytoplankton
- Environmental diagnosis of the phytoplanktonic community
- Study of the general zonation patterns of the main macrophytobenthic species
- Evaluation of the response of macrophytobenthic communities to environmental pressures detected in the area.
- Selection of endangered species and recommendations of general procedures for monitoring biological quality in the application of monitoring plans to assess the environmental quality in Algeciras Bay.

The Influence of Land Use Activities on Nutrient and Sediment Loading into Upland Catchment Streams of Ghana

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Half-billion hectares in Africa, corresponding to one-third of all potential cropland, are moderately to severely degraded. Many countries have already lost a significant quantity of their soils - over 50 tonnes of soil/ha/yr – with resulting nutrient depletion of essential elements such as nitrogen, phosphorus and potassium. In Ghana these losses are in the highest category, with more than 60 kg NPK/ha/yr mostly as a result of leaching, soil erosion and low recycling of crop residues. This study investigates nutrient and sediment loads in upland streams of three headwater catchments in the Ashanti Region of Ghana, representing three succession stages of land use development - natural vegetation, moderately cultivated and intensively cultivated land. This is of major concern as the impacts to water quality and ecology are not only limited to upland waters but are transported further downstream to affect estuaries, deltas, coastal, and marine environments. Currently, empirical studies are being undertaken to quantify concentration loads of nutrients (N & P) and sediments, assess habitat and ecological health using standard invertebrate bio-indicators and habitat surveys, and livelihood assessment to analyse farming practices in order to determine influencing social factors. In addition, fingerprinting methods using Ce₁₃₇

are being used to assess the spatial location and nature of the major sediment sources within each catchment area. Understanding the major sources of nutrients and sediments, and when there is a higher potential for its export from the catchment into the stream, in addition to recognising its impacts on the stream ecology and water quality, are important issues in designing effective and optimal land use management schemes.

‘Natural’ and ‘Anthropogenic’ Vulnerability of the coastal zones of Morocco. A preliminary integrated analysis.

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Coastal areas are priority areas in Morocco, due to their ecological, economic and social importance, and the conflicts of use and intensive pressures for development which they face. The coastal zone of Morocco is composed of a variety of ecosystems which consist of low lying lagoons, estuaries, wetlands, rocky coasts and sandy beaches, and the shelf zones. These ecosystems support a great variety of plant and animal species, some of them economically important for the population. However, these areas are currently under severe and increasing pressures from increasing urban, industrial, agricultural, ports and cities development, tourism and recreational activities. The increased use of restricted space and natural resources provokes environmental problems which extend beyond the coastal area.

This paper aims to analyse the vulnerability degrees of the coastal zones of Morocco as starting points for coastal managers to think about the complexity of interactions and uses of a particular coast, and then, prepare a strategic plan with correctives and/or adaptative measures for the most vulnerable areas.

The methodology used is based on (i) selected natural criteria that make these areas vulnerable such as: topography and lithology, sheltered or exposed coasts, etc., (ii) selected anthropogenic activities such as port development, industry, tourism, etc. and (iii) selected socio-economic criteria such as population, population density, main economical sectors, and GDP per inhabitant.

A matrix has been drawn from crossing between the ‘natural vulnerability’ and ‘the anthropogenic vulnerability’ and at more or less homogeneous coastal sectors, and finally a map of the global vulnerability has been established. The most vulnerable areas are: the lagoon and city of Nador on the Mediterranean coast, and the bay of Tangier and the littoral between Rabat and Agadir on the Atlantic side. The vulnerability of these areas would certainly be exacerbated by the future climate change and specially the accelerated sea-level rise and extreme events. A particular interest should therefore be given to the future planning of these areas.

Heavy Metal Uptake by Coral Reef Fishes at Lihir Is, Papua New Guinea: Relative Importance of Gold Mine Wastes and Natural Sources of Heavy Metals

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Heavy metal uptake from gold mine waste disposal can be a major problem for aquatic animals and lead to a number of chronic illnesses in humans that digest them. Most of the current knowledge of these impacts comes from studies in temperate regions and mainly from freshwater. In the south-western Pacific Ocean, the Lihir Gold Mining Ltd operates a large open-cut gold mine on Lihir Island, northern Papua New Guinea. Lihir is a volcanic seamount surrounded by a fringing coral reef. The gold mine, which began in 1996, disposes of two types of waste (1) excavated overburden, which is dumped about 0.5 km offshore and (2) tailings slurry from the gold processing plant, which is de-aerated and then pumped out on the seabed at a depth of 128 m.

We examined how these sources of heavy metal may have affected the coral reef fish fauna in three ways: (1) muscle and liver samples were analysed for 10 heavy metals (Ag, Al, As, Cd, Co, Cu, Hg, Ni, Pb, Zn) from fish collected both before the mine (in 1994) and in 2000 – 2001; (2) reproductive patterns and fecundity of 58 species of fish (3) compared the concentrations of 10 trace metals (Al, Ba, Li, Cu, Mg, Mn, Na, Rb, Sr and Zn) in otoliths of fish species from the proximity of the mine outfall and elsewhere.

Comparison of the muscle concentrations of the 10 heavy metals with their recommended Australian Food Standard (AFS) concentration showed that many of the 56 species examined had excessive concentrations of at least one of the four metals (As, Cd, Hg and Pb). Almost 80% of fish muscle tissues examined had As concentrations above the AFS recommended concentration of 2 mg.kg⁻¹. One species, the Orange-lined Triggerfish *Balistapus undulatus* had among the highest As concentrations recorded in fishes anywhere. Only two species of fish showed a significant increase with As at sites adjacent to the mine and one had high As and Hg. The majority of species had similar concentrations of As in tissue samples collected before and after the mine started. Contamination of fish tissues by other heavy metals was less widespread. Only three species from the recent sampling had excessive Hg and another two species had elevated Cd and Pb.

The fecundity and egg sizes of four (of 19) species of mid-water Lutjanid showed a trend of fewer, smaller eggs in fish caught at the mine site. The mine may be having an affecting on their reproduction as the analysis of trace metals in otolith suggest some species spend extended periods at the mine site. The trace metals examined in otoliths of other fish species caught at the mine and in the nearby affected region showed a variety of patterns. Two species had higher concentrations of mine-derived metals and two had increased metal concentration since the mine began. These results have important consequences for marine resource use by coastal communities on Lihir Is and elsewhere in the tropical Indo-Pacific. They show that heavy metal pathways

through the food web of coral reefs are complex and can involve both natural and anthropogenic sources.

This study will show how terrestrial-derived natural sources and mine-derived sources of heavy metals both impact on heavy metal accumulation and uptake by fishes in tropical coral reef systems. It will highlight the complexity of potential pathways within tropical systems and demonstrate how this can have flow-on impacts on marine resource use by coastal communities that rely on near shore coral reef fishes for their food.

The Biogeochemical Linkage that Governs the Dependency of Mangrove new Production Fluxes and Food Web Responses to River Boundary Characteristics: Catchment2Coast Programme Study in Maputo Bay, Mozambique.

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Mangroves fulfil a number of essential ecological functions in tropical and sub-tropical systems which include shelter and energy supply to early life stages of economically important species. These functions are, in many systems such as the Maputo Bay – Incomati system, dependent on changes in the river input characteristics. Understanding the nature and the scales of these linkages is central to forecasting ecosystem yield and their vulnerability to human development pressure in river basins as well as climate change.

In this study, a combination of numerical modeling and observational programmes were used firstly, to test through sensitivity analyses the most important nitrogen flux pathways and secondly to quantify the microphytobenthos productivity rates that were available to support the early life stages of economically important species such as the shrimp *Peaneus indicus*. The preliminary observational programme showed strong differences in the production / remineralization activity measured between the wet season (January – March) when they were high and the dry season (June – November) when they were low. This timing was in agreement with the nursery function production requirements fulfilled by mangrove systems during the wet season.

The mangrove model (Delwaq-G) was set up as a 1-Dv 23 layer scheme that incorporated the external CNP fluxes from river, mangrove leaf litter and N-fixation. Boundary forcing reflected hourly tidal, daily river flows and solar radiation frequencies. The model processes included most biogeochemical processes that drive fluxes or influence the redox profiles. Two yearlong runs were used to test model stability to initial conditions and for sensitivity analyses. The system scale extension was achieved by coupling the data outputs to EcoWin, a spatially aggregated model that incorporates high resolution physics, biogeochemistry and the shrimp life cycle production.

Modelling sensitivity analysis results showed that nitrogen fixation was the most likely source of new nitrogen to support the food web energy requirements. The new nitrogen flux provided by the remineralization of N-fixers that live along the shallow rhizomes of *Avicennia marina* supports the surface microphytobenthos production and biomass. The freshwater control in the seasonal and sub-seasonal variability in microphytobenthos production is thought to be linked to the salinity dependency of N-fixation bacteria. This is being investigated as part of an observational programme that will be concluded shortly.

The understanding derived from this study provides some new direction to the strategies to manage the sustainability of economically important mangrove ecological services as well as the implications of exploiting mature rather than growing mangrove systems.

The LOICZ- Erasmus Mundus Joint Master in Water and Coastal Management

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The selection of the first ERASMUS MUNDUS master programmes in September 2004 included the LOICZ Joint Master in Water and Coastal Management as well as a Master in Hydro-informatics and Water Management. The new ERASMUS MUNDUS programme extends the international participation to third country students, scholars and institutions, facilitating the transfer of the findings of European research globally.

The objective of the Master in Water and Coastal Management is to train managers for Integrated River-Basin and Coastal Zone Management. The Master is a LOICZ II deliverable under Theme 5. It is an opportunity for the LOICZ community to work together in training and capacity building as well as higher education.

The study programme lectures are grouped into specialist modules on particular fields of expertise in environmental, water, and coastal management. There are both studentships for exceptional candidates and scholarships for academics. The qualification obtained is a European Joint Master Degree in Water and Coastal Management which is awarded by the universities that the student visited as part of the Erasmus Mundus programme.

ESTUARINE PROCESSES INVOLVING ORGANIC CARBON AT DIFFERENT TIDE CONDITIONS

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Studies regarding dissolved organic carbon (DOC) on Sado estuary revealed that this fraction of organic carbon behaves non-conservatively and as an outcome, an internal production of DOC has been observed.

In October 2000 and July 2001, concentrations of DOC, particulate organic carbon (POC), suspended particulate matter (SPM) and dissolved oxygen (DO) were measured at ebb and flood tide in Sado estuary, along a salinity gradient from 0 to 17, in order to better understand the processes involved in DOC production.

Regardless different river flow conditions ($1.3 \text{ m}^3 \text{ s}^{-1}$ in October and $0.4 \text{ m}^3 \text{ s}^{-1}$ in July), examination of measured parameters point out to mineralization of POC as the foremost source of DOC at ebb tide. The occurrence of this process is more clear in surface waters and DOC net internal flux is one order of magnitude higher ($26.4 \times 10^6 \text{ mmolC d}^{-1}$ in October and $17.1 \times 10^6 \text{ mmolC d}^{-1}$ in July), when compared with bottom waters ($5.3 \times 10^6 \text{ mmolC d}^{-1}$ in October and $7.9 \times 10^6 \text{ mmolC d}^{-1}$ in July).

On flood tide, mineralization is not so noticeable and DOC production very likely is associated with desorption processes due to fluid mud resuspensions, induced mainly by the opposite forces between surface river waters and more saline waters flowing at bottom. In fact, higher values of SPM were observed at flood tide in bottom waters and DOC net internal fluxes reached values of $9.6 \times 10^6 \text{ mmolC d}^{-1}$ in October and $2.7 \times 10^6 \text{ mmolC d}^{-1}$ in July. As a matter of fact, the conditions which occurred in October of river flow three times higher, flood tide stronger (salinity up to 17) and SPM showing values up to 1000 mg l^{-1} , highly favour desorption processes.

The results suggest that DOC internal production, locally generated in Sado estuary may be mainly due to processes identified as mineralization of POC and particles desorption.

Environmental problems in the coast of Southeastern Brazil: determinants and impacts

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The Brazilian coastal zone encompasses more than $8,500 \text{ Km}^2$ ranging from 4° N to 33° S , and presents a rich mosaic of ecosystems. It is a place of interactions among the terrestrial, maritime and atmospheric environments, with resources that have potential

to generate important economic fluxes. These resources are attractive for both competitive production and tourism.

The coastal sector of the Southeastern Region of Brazil, in particular, deserves special attention: it presents high population density and responds for considerable parcels of all economic activities at national and regional levels. Moreover, some human activities in this area of natural low threshold generate losses of coastal land and biodiversity (including coral reefs, mangrove ecosystems, estuarine wet-lands, and marine mammals and birds), pollution, acid rain, impermeable surfaces; besides, these activities change hydrological regimes and place people into risk-prone locations. The urbanization process also creates a marginal population segment not absorbed in the economic activities, who occupy the unstable hillslopes of the Serra do Mar Escarpment and mangrove areas.

Rainfall is the primarily environment factor in the Southeastern coast of Brazil, influencing all physical, biological and socio-economic aspects in the area. Its maximum occurs in Austral summer and spring, being highly convective and strongly modulated by the presence of the South Atlantic Convergence Zone (SACZ). Tropical climate forcing, mid-latitude weather systems and local features, like mountain belts, give rise to significant local variations in the amounts and distribution of precipitation. The Serra do Mar Escarpment, which follows the coast, contributes to precipitation enhancement in some sectors. The area is also influenced by several large-scale phenomena, such as strong events of El Niño.

The study aimed to evaluate the increase of hazardous episodes in the area in association with local features, rainfall totals (which typically trigger floods and landslides) and land use changes, considering a spatio-temporal perspective. Results revealed that the rainfall pattern in the region did not show any important change, especially in summer and spring, periods that concentrate precipitation and events of floods, landslides and mudslides. On the contrary, some areas demonstrated decrease of precipitation in spring. However, especially in the last decades the levels of urbanization (mostly without any planning) grew steadily in the area, contributing to the continuous growth of the society's vulnerability to natural events in the coastal zone. In addition, the area also experiences an aggressive process of deforestation of the Atlantic Rainforest (that originally covered Serra do Mar Escarpment), which not only presents an important biodiversity but also provides more stability for the slopes of Serra do Mar Escarpment. Therefore, the recent increase in environmental hazards seems to be more related to changes in the land use in the area.

Shallow Ponds as Sediment and Nutrient Retainers, Buenos Aires Province, Argentina

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The trophic state of the shallow lakes in Buenos Aires province is influenced by hydrologic conditions and the characteristics of the soils. Most of these water bodies belong to endorreic basins. The alternation of periods drought and flood has generated fluctuations in the physical, chemical and biologic parameters of these ponds. The main object of this research is to determine the contribution of this water bodies in the stability of global levels of available nitrogen (N), phosphorous (P), carbon (C) and sediments. Data from shallow lakes of the southern Buenos Aires Province south (“pampean shallow lakes”) were employed.

The retention of C N and P was evaluated trough the analysis of the particulate organic matter decomposition. in different oxidation states, several of which are important in the chemistry of the lagoon. The interpretation and analysis of satellital images showed that the shallow lake areas increased in the last years. Finally, P, N and C retention was considered one of the most important attributes of the “Pampean shallow lakes”. The nature of the “pampean” basin (without drainage) increased the concentrations of these elements along the time.

Eutrophication Adjacent to the Mississippi River Plume

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The northern Gulf of Mexico receives the freshwater and constituent flux from the Mississippi River, which integrates 40 percent of the lower 48 United States. In the last half of the 20th century, the flux of nitrogen tripled, phosphorus concentration appears to have increased, and silicate concentration decreased. These changes result from landscape alterations over two centuries with an intensification of human activities that increased the flux of nitrogen and phosphorus particularly in the 1960s to 1980s. Evidence for eutrophication in the coastal ecosystem includes an increase in algal biomass, carbon accumulation from nutrient-enhanced production, worsening oxygen deficiency in the lower water column, and shifts in food web structure. The extent of the oxygen deficiency reaches 20,000 km² of the inner continental shelf over long periods in summer with the potential for affecting commercially important fisheries in the Gulf. There are multiple lines of evidence to implicate changes in riverine nutrient loads with overall primary and secondary production, carbon accumulation at the seabed, and low oxygen conditions on the shelf. The change in nutrient loads and responses of the northern Gulf coastal ecosystem, including widespread, severe seasonal hypoxia, parallel similar conditions in the coastal ocean on a global scale.

Arctic Coastal Processes

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The coastal zone is the interface through which land-ocean exchanges in the Arctic are mediated and it is the site of most high-latitude human activities. The coastal margin represents a complex interface of numerous processes and states, and this zone is extremely vulnerable to predicted environmental changes, such as decreased sea ice extent and thickness, sea level rise, increasing storm frequency, biodiversity destabilization, and anthropogenic stressors. These coasts are typically permafrost-dominated and exhibit rapid erosion with serious implications for ecosystems and communities, e.g. infrastructure damage, loss of housing, damage to hunting and fishing grounds, etc. (see Arctic Climate Impact Assessment (ACIA) – key finding #5).

Changes in the coastal zone will not only affect regional biological and human systems, but are also likely to exert influence on the global system through the degradation of coastal and offshore permafrost, which can lead to the release of greenhouse gases (GHG). Fluxes of sediment, carbon, and nutrients resulting from coastal erosion play an important role in the material budget of the Arctic Ocean.

This presentation provides an overview of the results of Arctic Coastal Dynamics (ACD) which is a multi-disciplinary, multi-national project of the International Arctic Science Committee (IASC), the International Permafrost Association (IPA) and a LOICZ regional project. The overall objective of ACD is to improve our understanding of circum-Arctic coastal dynamics as a function of environmental forcing, coastal geology and cryology and morphodynamic behavior. In particular, the ACD program aims to:

- establish the rates and magnitudes of erosion and accumulation of Arctic coasts and to estimate the amount of sediments and organic carbon derived from coastal erosion;
- develop a network of long-term monitoring sites including local community-based observational sites;
- refine and apply an Arctic coastal classification (includes ground-ice, permafrost, geology, etc.) in digital form (GIS format) and produce a series of thematic and derived maps (e.g. coastal classification, ground-ice, sensitivity etc.);
- compile, analyze and apply existing information on relevant environmental forcing parameters (e.g. wind speed, sea-level, fetch, sea ice etc.);
- identify and undertake focused research on critical processes;
- develop empirical models to assess the sensitivity of Arctic coasts to environmental variability and human impacts.

Finally, an outlook on future Arctic coastal activities, which are currently underway within the framework of the 2nd International Conference on Arctic Research Planning (ICARP II) and the International Polar Year (IPY) 2007/2008, will be given.

Tróia Peninsula evolution: Foredunes as a accretion/erosion indicator

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Tróia Peninsula is located in the western Portuguese coast, 50 km south of Lisbon, near Setúbal, at the southwest end of the Sado estuary. The peninsula is a sand body of approximately 14 km long by 1,5 km wide, mainly covered by sand dunes.

From roman's epoch to present days, testimonies and spatial data (maps and aerial photography's) indicates that the northern part of the peninsula has been very active. In fact, roman infrastructures were described as being located in an island and some of the ruins are presently underwater.

Although the majority of the peninsula has been classified as a natural park, tourist infrastructures are already installed, and plans for new developments are already approved.

Most people tend to regard coastlines as a stable features. However, from a geological point of view, coastline is always changing. Tróia Peninsula is one particular case where we know that coastline has changed significantly during the last 2000 years. And it's still changing. Recent aerial photography's (since 1950) shows us that the peninsula has grown very rapidly in some areas, especially in its northwest part.

The study of the dunes can help us to understand Tróia Peninsula evolution prior to maps and aerial photography registers. Since foredunes grow adjacently to the beach, if they are preserved, may indicate where the beach was in the past. Also, foredunes associated with prograding beaches are different from foredunes associated with eroding beaches. Consequently the identification of foredunes tell us a lot about coastline changes.

Fortunately, foredunes, in the north part of Tróia Peninsula, are particularly well preserved. Seventeen different sedimentary episodes can be traced by dunefield geometry. A detailed look to these dunes shows that the past history of the peninsula has shifted from accretion periods to erosion periods.

Although quantitative dating is still not available, spatial relationship between dune crests indicates us how the peninsula shape and morphology has evolved.

The study of Tróia peninsula morphology based on dune sequence and eroding/accretion periods opens a new perspective of the peninsula evolution and can give a strong contribution to spatial environmental use planning.

Understanding Tróia Peninsula natural evolution processes is essential to characterize the system vulnerability and the degrading risk due to human activities. Additionally it can also give a strong contribution to predict natural hazards to humans.

Critical Evaluation of an Internet-Platform for Regional Coastal Management

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The EU demonstration projects on Integrated Coastal Zone Management (ICZM) and other national ICZM case studies and projects showed that insufficient awareness about coastal problems, the necessity and advantages of integrated approaches as well as insufficient access to data and information are major aspects, who hamper a sustainable development of the coastal zone and a successful ICZM.

Usually, regional ICZM-case studies and projects are funded only for a certain period of up to 3 or 5 years. The budget is, compared to initiatives in the field of economy, infrastructure and industry, very limited. On the other hand, efficient public relation and awareness rising is expensive and time consuming.

During the decade the internet became an important and low-cost media for information, awareness-rising and dissemination. Nowadays nearly all ICZM-initiatives and projects possess a homepage and make basic information available. The ICZM project and regional case study “Research for an Integrated Coastal Zone Management in the Oder estuary region (ICZM-Oder) (www.ikzm-oder.de) goes one step beyond and provides a regional information platform for the German/Polish coastal border region.

Aim of this presentation is the critical evaluation of the success of this internet-platform compared to the national German Internet portal of EUCC – The Coastal Union Germany. Based on a detailed and comprehensive analysis of long-term access data the following questions shall be answered:

How often is the Internet information system used? Who are the customers, who is the target group and where are the users coming from? Does the system reach local people? Which pages are preferred and what kind of information has to be presented? How fast can an internet system be established and how fast does the acceptance grow? How expensive is it compared to traditional public relation and information measures and how efficient? When does it pay or what is the critical size of an information system? Is it possible or even necessary to support its release by traditional public relation measures? How can a long-term strategy for the maintenance look like?

THE PRESENT AND ANTICIPATED RIVER BASIN AND COASTAL IMPACTS OF WATER ABSTRACTION ALONG THE RUFJI RIVER CATCHMENT, TANZANIA

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Rufiji river catchment, with a total area of 177,000 km² (20% of the area of the country) is the largest river catchment in Tanzania. It is composed of three major tributaries, Luwegu, Kilombero and Great Ruaha, supplying respectively 18%, 62% and 15% of the total inflow. The Rufiji river which draws its water from the three tributaries, has the mean annual mean discharge of $30 \times 10^9 \text{ m}^3$.

In the Upper parts of the catchment, particularly along the Great Ruaha tributary (at Usangu plains), large-scale water abstraction for irrigation and its impoundment of by damming are reported to be taking place. The reported water abstraction for irrigation was largely driven by the population growth (mainly due to in-migration), which has increased six times during the last 50 years. The population growth is reported to increased four times during the last 30 years, compared to less than double which occurred during the preceding years. The rapid population growth at Usangu plain has been paralleled with growth of the total cultivated area from 33,121 ha in 1958 to 71,658 ha in 1978, growth of irrigated land, from less than 5000 ha in 1950 to more than 40,000 ha at present and about 200,000 cattle in 1950's which peaked to about 550,000 during the 1970's and decreased to the current figures of over 300,000. Other observed changes associated with the increased water abstraction at the Usangu plain include: changes in dry season flow in the Great Ruaha river, decreased seasonal flooding of the western wetland at Usangu plain, decreased dry season flows in some tributary rivers at Usangu.

Large impoundment of water is taking place further downstream of the Usangu plains, where two reservoirs, the Mtera (with live storage capacity of about 3200Mm³) and Kidatu (which is about 25 times smaller than Mtera) during 1970's. The two hydropower plants together contribute about 50% of the national electrical power supply. Among the possible envisaged impacts at the coast due to the effects of the two dams at the coast include, reduced sediment fluxes and river flow discharges. The two dams are also envisaged to reduce the coastal sediment fluxes due to the increased rain fed and irrigation agricultural on the catchment.

Further abstraction of water for irrigation and its impoundment by damming have been planned on the lower parts of the catchment. About 65,000 ha have been designated for irrigation (mainly rice) along the lower Rufiji floodplain and delta. The anticipated annual water abstraction due to irrigation would be about 6% of the total current Rufiji river discharges to the sea. The planned multipurpose dam at Stieglers Gorge which is designed to cover approximately 1250 and 550 km² at high and low regulated water level, respectively. The planned abstraction of water for irrigation and the impoundment by damming will altogether have significant impacts at lower Rufiji flood plain delta. and the offshore areas which have during the past sustained both the local communities as well as the ecological functioning.

Anthropogenic Changes, Nutrient Biogeochemistry and Net Ecosystem Metabolism of the Estuary of Cachoeira River, Brazil

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The estuarine waters of Rio Cachoeira (Bahia state, northern Brazil; 14° 46' S to 39° 05' W and 14° 50' S to 39° 01' W) are widely used for recreation, sailing, fisheries and shellfish collection. They also receive the industrial and domestic effluents of the city of Ilhéus, and indirectly from the city of Itabuna, through the fluvial input of Rio Cachoeira. The organic pollution prejudices the mentioned uses of the estuary. Mangrove covers about 13 km² but it has been subject to intensive logging. A sewage treatment plant (ETE) began operation in September 2000. This plant makes the primary treatment of part of the sewage of Ilhéus city. The effluent is disposed in the upper estuarine portion. Changes in the sedimentary dynamic driven by the construction of an offshore harbour in the 60's are tending to obstruct the mouth of the estuary. The consequent increase of water residence time can also alter the water quality. Another anthropogenic change planned is the construction of a dam to increase the water supply to the city of Itabuna.

Budgets of water, salt and dissolved nutrients were done with data of four surveys (February and September 2000, May and August 2001) in order to assess the effect of changing waste disposal in the estuary. An efficiency of about 30% of sewage treatment was assumed. Stoichiometric linkage of non-conservative fluxes of nutrients was used to estimate net metabolic rates. Water residence time was lower than 5 days during these months. Anthropogenic inputs of dissolved inorganic nitrogen and phosphorus were at least twice the fluvial inputs. The net ecosystem metabolism of the estuary gradually changed from about - 48 mmol m² day⁻¹ in February 2000 to - 12 mmol m² day⁻¹ in August 2001. The balance between N₂ fixation and denitrification estimated by non-conservative fluxes and organic matter stoichiometry also varied along the surveys from + 6.3 mmol m² day⁻¹ in February 2000 to + 1.5 mmol m² day⁻¹ in August 2001.

These results suggested that the operation of the ETE and the diversion of sewage to a region that originally presented no significant outfall promoted a reduction of net ecosystem autotrophy and nitrogen fixation. Data of 8 sampling surveys conducted from November 2003 to October 2004 are being interpreted to assess the variability of these rates in different hydrological conditions. These anthropogenic changes in the estuarine zone and watershed can alter the estuarine functioning, and consequently the quality and quantity of the fluxes of nutrients and organic matter to the coastal waters.

Organic Matter Cycling in Sediments of Gulf of Manfredonia, Southern Adriatic Sea

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In coastal environments, chemical reactions at sediment-water interface, playing an important role in settling nutrients and oxygen benthic fluxes, establish a close relation between pelagic production and sea floor biogeochemical processes (Hammond *et al.*, 1984, Cloern, 1996). The aim of this study was to examine mechanisms responsible of the recycle of nutrients and carbon at the sediment-water interface and understand the role of the sediments to the nutrients mass balance in the Gulf of Manfredonia (Southern Adriatic sea). This shallow gulf, characterized by limited cyclonic circulation, can be nutrient enriched by the southward Adriatic coastal current coming from the northern basin (Artegiani *et al.*, 1997). This current, bordering the whole western Adriatic coast, connects northern and southern Adriatic ecosystem regimes and can significantly affect large-scale distribution of biogeochemical properties (Zavatarelli *et al.*, 2000). Moreover, the gulf of Manfredonia is considered a complex area where anthropic pressure (industrial, agricultural, urban, harbour and tourist activities) plays an important role for pollution phenomena and alteration of marine ecosystem. While several works deal about the biogeochemical cycling in the Northern Adriatic (Hammond *et al.*, 1999; Giordani *et al.*, 2002), the same processes are poorly investigated in the Southern Adriatic Sea.

The study sites were located in area characterized by high sedimentation rate (~ 0.4 cm/y) where Northern Adriatic inputs and local rivers inflow are relevant. Pore waters was collected, benthic chamber fluxes and hydrographic profiles were measured in two stations, one inside the gulf and the other at the offshore boundary of the gulf, during two oceanographic cruises carried out in October 2002 and March 2003. Porosity, resistivity $^{210}\text{Pb}_{\text{ex}}$, ^{234}Th , ^{137}Cs , organic C and total N analyses were performed on solid phase and pH, Eh, O_2 , dissolved inorganic nutrients, Ca, Mg, Fe, Mn, alkalinity, DOC, DIC measurements were determined on water samples.

Pore water profiles suggest oxic and suboxic degradation of organic matter more intense in autumn, due to higher input of fresh organic matter and higher temperature of water column, hence higher microbial activity. In the same season, benthic fluxes measurements show higher fluxes of organic matter degradation products, specially in offshore site, supporting a higher remineralization rates. In both season, diagenetic processes in the inner station progress in a thinner layer than the outer site due to lower organic matter input in this site.

Finally, a diagenetic modelling of pore waters was implemented and a comparison between benthic chambers and pore waters fluxes was useful to indicate which transport processes (irrigation or molecular diffusion) operate a relevant role in solute exchange rates between sediment water interface.

Enhanced open ocean storage of CO₂ from shelf sea pumping

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Contributing to the LOICZ II focus IV a carbon cycle study has been carried out in the North Sea, which was primarily funded through the Netherlands Foundation of Scientific Research (NWO). The main aims of the study are to balance and to understand internal and cross-boundary carbon fluxes and to verify the continental shelf pump hypothesis for the North Sea. The study is based on an intense field program sampling the entire North Sea for carbon cycle and related parameters at approximately 100 stations consecutively during each season.

Seasonal field observations show that the North Sea, a northern European shelf sea, is highly efficient in pumping CO₂ from the atmosphere to the North Atlantic Ocean. The bottom topography controlled stratification separates production and respiration processes in the North Sea, causing a CO₂ increase in the subsurface layer, which is ultimately exported to the North Atlantic Ocean. The carbon budget of the North Sea is dominated by the exchange with the North Atlantic Ocean, while the net carbon flows are dominated by the carbon inputs from rivers, the Baltic Sea and the atmosphere. The North Sea acts as a sink for organic carbon and thus can be characterised as a heterotrophic system. Globally extrapolated, the net uptake of CO₂ by coastal and marginal seas would be approximately 20% of the world ocean's uptake of anthropogenic CO₂ thus enhancing significantly the open ocean CO₂ storage.

Identification of monitoring criteria for transitional waters

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In this presentation we review the major variables that can be used to monitor sediment and water quality in transitional water-bodies with respect to the identification of monitoring criteria. Most of the water quality variables are affected

by the shallow depth and the influence of water-sediment interactions, sediment resuspension and flushing.

Sedimentary status variables, namely organic matter, total nitrogen and phosphorus contents, are easily determined but they are not sufficiently informative to be used as individual specific indicators. A good understanding of sedimentary processes can be achieved by determining speciation analysis of nitrogen, phosphorus, iron and reduced sulphur and measuring benthic fluxes and process rates, but analytical techniques are too expensive to be applied in conventional monitoring programmes.

Finally we present a tentative integrated index, based on a few low cost simple measures of water quality (dissolved oxygen, nutrients and chlorophyll-a) and sediment characteristics (granulometry, organic matter, carbonates, reactive iron and acid volatile sulphides), which, in parallel with the freshwater retention time, could provide a rapid assessment of sediment vulnerability status.

Internet Tools for Coastal Issues: Awareness Rising and Education

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ICZM training and education became part of the university curriculum all over Europe. Authorities, coastal stakeholders and existing decision makers did not really benefit from this development. To attract this group and to provide an advanced training, the national German, free of charge and open Internet platform for learning and teaching modules in German language, ikzm-d Lernen (www.ikzm-d.de), was established. This platform compiles different modules with relevance for the coast and ICZM. It further provides tools, which allow a fast development and provision of additional modules. For example, existing and successful case studies can be added and linked to modules, which impart knowledge on ICZM basics.

A general module is ICZM ('Integriertes Küstenzonenmanagement' – integrated coastal zone management) which was developed for the University of Rostock (<http://www.ikzm-d.de/main.php>). The online module is free of charge, but as a semi-annual study course with two semester periods per week (including online support, homework, a practical presence weekend in Rostock, final examination and certificate) a registration at Rostock University is necessary and tuition fee is charged. Further, the module ICZM is part of the Master of Arts distance learning study courses 'Environmental protection' and 'Environment and Education' at Rostock University.

During the last year several new modules especially on coastal management case studies have been developed and will be presented in detail.

Definition of a Tsunami Safe Boundary for Sri Lanka: A Case Study in the Coastal Zone of Galle, Matara and Hambantota Districts.

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A huge tsunami, generated by an earthquake with a magnitude of 9.0 on the Richter scale occurred, at 00:58:53 (UTC), on 26th December 2004 in the depths of the Indian Ocean off the west coast on western Sumatra at 3.307⁰ N and 95.947⁰ E. Being the fourth largest earthquake in the world since 1900, it generated a tsunami that devastated the coastal areas of Indonesia, Sri Lanka, India, Thailand, Malaysia, Maldives, Somalia and Kenya, killing more than 2, 25,000 people. This was the first occurrence of a tsunami which hit Sri Lanka in the last 100 years and therefore was not anticipated.

The south-western and the eastern coasts of Sri Lanka are the most populated regions in the country. Major cities have evolved around numerous natural harbours, and hundreds of fishing villages were located along the shores. The tropical sea beaches were also a traditional tourist attraction, with a well developed infrastructure. As existing government legislation bears no regulations on coastal constructions with respect to a tsunami safe boundary, the coastal line consisted of hundreds of unplanned settlements. Most of these centers were heavily damaged by tsunami, causing a great loss of human lives.

It is now felt that the country should enforce a regulation procedure to control the unplanned developments in the coastal zone. It is also emphasized that a tsunami vulnerable zone should be defined and all permanent constructions should be moved inland beyond this zone. Various proposals for the demarcation of this zone are forwarded. Most of the proposed boundaries demarcate a fixed horizontal distance from the shoreline. However the findings of the survey described below suggest that such definition would be inappropriate.

The International Water Management Institute (IWMI), in its tsunami relief efforts in Sri Lanka, is carrying out a Rapid Needs Assessment Project for Hambantota district in Sri Lanka. As part of this exercise, a Tsunami Affected Boundary Line (TABL) mapping was carried out in this district. Analysis of the elevations of the area bounded by this line, showed that 72% of the tsunami affected area lies below 6m elevation from the Mean Sea Level (MSL). Based on this observation, it was hypothesized that the maximum run-up of the given event in Sri Lanka is about 6m MSL. A hundred and thirty eight (138) km of additional TABL mapping along the coastal zone of Galle and Matara districts were carried out to test this hypothesis.

The results indicated that the suggested maximum run-up height is in good agreement with the measured values. Based on these observations, the paper describes criteria to develop a tsunami safe boundary along the coast, depending on the elevation and horizontal distance from the shore line. A tsunami safe boundary map for the coastal zone of Sri Lanka is produced with this method. Finally, the paper discusses the various other factors (e.g. magnitude of tsunami, coastal geomorphology, etc) that should be taken in to account to further modify this boundary.

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Seitzinger, S (USA)	TBA	Day 3, Session 15
Sharaf El Din, S (Egypt)	Impact of the extension of Alexandria coastal road on the transformation of material of the nearshore marine environment	Day 3, Session 14
Sharma, K (Nepal)	Impacts of Human activities on regionwise budget and oceanward flux of sediment in South Asia	Day 1, Session 3
Shumilin, E (Mexico)	Evaluation of anthropogenic impact on coastal marine sediments of heavy metals transported by water streams affected by mining in North-Western Mexico: Semi-deseric Santa Rosalia, Baja California Sur and Tropical Marabasco River-the Barra de Navidad Lagoon, Colima	Day 1, Session 19
Sinninghe Damste, J (Netherlands)	Carbon, N, P etc. under human influence	Day 2, Session 12
Solidoro, C (Italy)	Applicability of LOICZ derived indexes in complex ecosystem. A multibox analysis for the lagoon of Venice	Day 1, Session 4
Staneva, J (Germany)	Response of the Northwestern Black Sea shelf ecosystem to nutrient load and climate change	Day 3, Session 15
Stevens, V (South Africa)	The threat and cascade method of estuarine health assessment- a logical sequence from impact to biological degradation via system physics and chemistry	Day 2, Session 9
Syvitski, J (USA)	The Impact of Humans on the Flux of Terrestrial Sediment to the Coastal Ocean on a Global basis: Long-term Averages and Seasonal Variability	Day 2, Session 8
Szlafsztein, C (Brazil)	Vulnerability assessment to coastal natural hazards in Amazon Region (Brazil) using GIS	Day 2, Session 10
Taljaard, S (South Africa)	A proposed framework for managing (land-based) marine pollution sources in the BCLME region	Day 3, Session 13
Thomalla, F (Sweden)	Understanding human vulnerability to coastal hazards and adapting to uncertain futures	Day 1, Session 1

Name	Abstract title	Programme
Trombino, G (Italy)	A multi-step scenario analysis for assessing possible strategies aimed to reduce the eutrophication in the north Adriatic coastal zone	Day 2, Session 11
Vafeidis, A (Greece)	Data requirements for global-scale coastal vulnerability analysis and the DINAS-COAST database	Day 3, Session 18
Vander Woude, A (USA)	Chlorophyll and sea surface temperature time scales for global oceans and nearshore retentive embayments off California	Day 2, Session 10
Vinzon, S (Brazil)	Fine Sediment Retention in Estuaries in Amazon Estuary	Day 2, Session 20
Vodden, K (Canada)	Watershed-coastal interactions: building and supporting institutions for positive change	Day 3, Session 21
van der Weerd , V (Netherlands)	TBA	Day 3, Session 13
Wolanski, E (Australia)	Estuarine and Coastal Zone Ecohydrology	Day 2, Session 9
Woodrow, M (Canada)	Vulnerability and adaptation in coastal communities: a case study in adaptation on Change Islands, Newfoundland following closure of the cod fishery in 1992	Day 1, Session 5
Xu, X (China)	Land use conflicts and coordination in fast urbanized coastal zones	Day 3, Session 14
Yamamuro, M (Japan)	Changes in the use of ecosystem due to the loss of eelgrass bed in estuarine lagoon, Lake Nakaumi, Japan	Day 1, Session 19
Young, B (Australia)	Human dimensions and global environmental change.	Day 1, Plenary 1
Zanchettin, D (Italy)	New perspectives for the future of Venice	Day 3, Session 14
Zessner, M (Austria)	Limits of cost-efficiency based nutrient management for river basins	Day 2, Session 11