LAND-OCEAN INTERACTIONS IN THE COASTAL ZONE

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LOICZ NEWSLETTER

Carbon-nitrogen-phosphorus fluxes in the coastal zone: the LOICZ approach to global assessment, and scaling issues with available data

by
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October 31, 2001

Background

One of the major questions within LOICZ is to evaluate the role of the coastal ocean in global carbon-nitrogen-phosphorus cycles. Carbon is generally considered to be the "major currency" within the IGBP, and the nitrogen and phosphorus cycles are intimately linked to carbon. This question, within the IGBP aim, has some particular challenges within the coastal zone. Unlike much of the IGBP, the "domain" of LOICZ (nominally 200 m below sea level to 200 m above sea level, with emphasis on the reactions within the marine portion of the strip) is tremendously difficult to describe in detail. Because the zone is relatively narrow (visualize a strip of coastal real estate that is about 500,000 km in length but only averages about 50 km in width), it is not well represented in gridded global data bases. Further, the zone is heterogeneous both along the length of this strip and across its width.

Arguments can be made that both the large load of materials from land and the human influence along the seashore cause much of the net reaction of this zone to occur in bays and estuaries along the landward margin of the strip. The region is not well represented as an extension of oceanic processes up onto the shelf and into the bays and estuaries, because the influence of both bottom chemical reactions and terrestrial inputs (including especially those associated with human activities) render this region very different from the open ocean. Much of IGBP deals primarily with vertical fluxes: land-atmosphere, ocean-atmosphere.

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While LOICZ is concerned with these vertical fluxes, it also deals heavily with the horizontal flux of material from land, largely through lateral flow of water to the shoreline, and then lateral transport away from the shoreline.

Analytical Methods and a Strategy for Progress

Within the limits of these considerations, the LOICZ project set up a "globally applicable" method of estimating fluxes within the coastal ocean, especially the bays and estuaries of the inner coastal zone. It was necessary to erect a methodology that could depend largely on secondary data, because, within the time span of LOICZ, funding was not likely to be available for collecting significant amounts of new data. Secondly, if the methodology were to be useful for most of the coastal zone, the data requirements had to be minimal. Thirdly, in order to allow effective comparison among sites, the methodology had to be widely applicable and uniform, rather than tailored to specific sites. Finally, it was deemed desirable that the method be informative, at some level, about processes influencing CNP fluxes.

The LOICZ approach is based on one of the most fundamental concepts of the physical sciences: conservation of mass. Details of the approach are given in Gordon *et al.* (1996) and on the LOICZ Modelling web page (http://data.ecology.su.se/MNODE). Briefly, the procedure is as follows. Water volume and salt content in the system remain constant over time, as water flows through the system and mixes with adjacent systems. The net flow of water can be described by a water budget. Information about mixing can be deduced from a salt budget of non-reactive materials. The data to establish at least crude water and salt budgets can be found for many sites around the globe.

Nutrients not only move with the water but also undergo reactions within the system. Nutrient data (especially data on the dissolved inorganic forms of phosphorus and nitrogen, here termed DIP and DIN) can be found for many of these same sites and used to establish nutrient budgets. These nutrient budgets include the water flow and mixing, as defined by the water and salt budgets, and an additional term that describes net uptake or release of these nutrients within the system. In the jargon of oceanography, these are termed "nonconservative fluxes," because the nutrients do not exactly follow the flux pathways of water and salt.

The nonconservative flux of DIP can be used as an approximation of net uptake of phosphorus into organic matter during primary production or release from organic matter by respiration. The DIP flux is scaled to an estimated carbon flux via a scaling ratio (typically a molar C:P ratio of 106:1, representing the so-called "Redfield Ratio).

While it would be desirable to have direct measurement of carbon uptake into organic matter, such data are not available for most locations. Therefore, the flux of DIP becomes a proxy for net carbon flux. The primary shortcoming of this proxy is that systems with high amounts of suspended mineral material (e.g., from turbid rivers) may show evidence for DIP adsorption onto the particulate materials or desorption from them.

In the open ocean DIN is often scaled in exactly this manner to carbon. That scaling in general does not work well in the coastal ocean, for a reason that contains a great deal of information itself. Nitrogen fixation and denitrification are important metabolic processes in bottom-dominated systems and can account for most of the observed nonconservative flux of DIN. Therefore, calculations derived from the budgets use DIP flux as a proxy to calculate how much net carbon uptake or release has occurred, scale this to expected nitrogen flux (typically using the Redfield N:P ratio of 16:1), and then use the deviation between the observed DIN flux and the expected flux to estimate the net of nitrogen fixation and denitrification. As is true with carbon, it would be desirable to have "direct measurements" for these important nitrogen fluxes- and the global data are extremely limited. As is also true in the use of DIP as a carbon proxy, the mineral reactions involving DIP are probably the greatest shortcoming of the DIP proxy for nitrogen metabolism. Despite these limitations, semi-quantitative insight is gained into the rates of the processes of primary production minus respiration (abbreviated [*p-r*]) and nitrogen fixation minus denitrification [*nfix-denit*].

A strategy and funding were required to implement this process globally. The strategy was to mount a two-pronged attack on acquainting the scientific community with the budgeting procedures. The first prong has been publication of a web page (http://data.ecology.su.se/MNODE) that summarizes and updates the budgeting procedures, provides tools for implementing the procedures, provides various forms of teaching materials, and posts existing budgets as they are developed. The second prong has been to hold a series of workshops around the world, in order to teach people how to do the budgets and to get them to prepare budgets that can be used by LOICZ. At this writing, about 200 site budgets have been developed, largely as products of more than 15 workshops held around the world. This effort would not have been possible without financial support. The initial workshops were held using LOICZ core project funding, critical funding and in-kind support from local host institutions, and funding from The Netherlands government agency, WOTRO. Funding from the GEF programme of UNEP supported the majority of this effort.

The Global Network of LOICZ Scientists

To date, budgets have been developed and posted on the web pages for approximately 170 sites worldwide (Figure 1). About 30 more sites are under development and will be available for the final LOICZ synthesis.

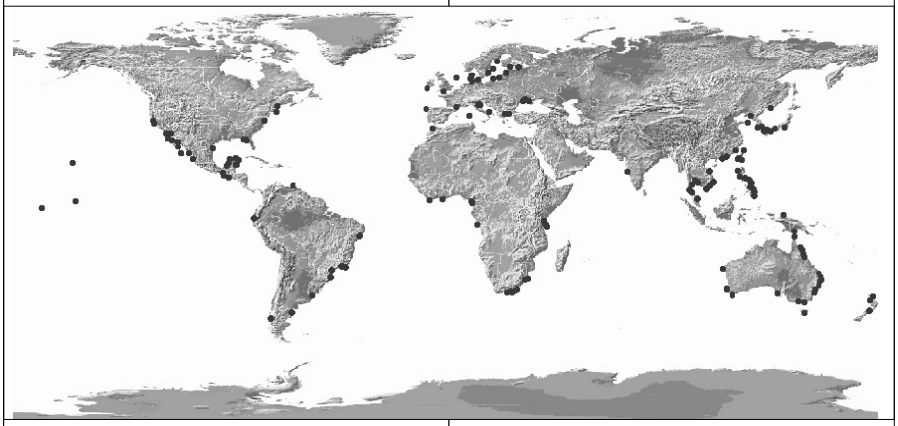

Figure 1.
Map of LOICZ budget sites, October 2001.

Nearly 150 persons have authored or co-authored those budgets. Many of those persons have attended one or more of the LOICZ workshops. Even without discussing the scientific results of these labors, the process of budget development has represented a remarkable success in developing a network of coastal zone researchers from around the world to represent some of their results within a common conceptual framework.

Beginning to synthesize the results - spatial scaling of available budget data

This article considers some spatial scaling issues with respect to nutrient fluxes in the coastal zone. The budget sites (Figure 1) vary dramatically in their characteristics: from lagoons and estuaries less than 1 km^2 in area, to the 106 km^2 East China Sea; from sites that are decimeters deep to sites that are hundreds of meters deep; from sites that are virtually devoid of loading from land to sites that receive heavy loads of inorganic nutrients derived from human wastes, agriculture, and other sources; from sites that are river-dominated estuaries to hypersaline embayments; from tropical to arctic climate zones. For some sites data quality and quantity are both high; other sites suffer in the quality and quantity of information available.

Such a wide diversity of site descriptions and data quality poses significant challenges to comparison, and that comparative effort is presently underway. For the present analysis we have set aside systems for which the basic data are incomplete, open shelf systems, and systems with an average depth >100 meters, in order to facilitate comparisons among sites. This parsed data set includes about 80 systems. The remainder of this section is devoted to a brief overview of material loads from land to the coastal zone, exchange between the inner coastal zone and offshore waters, and some characteristics of net biogeochemical fluxes.

Figure 2 illustrates frequency distributions of the apparent rates of production minus respiration [*p-r*] and nitrogen fixation minus denitrification [*nfix-denit*] as calculated from the nonconservative nutrient fluxes for these systems. Note that these are net rates, the difference between storage and release processes. These net rates are more relevant than gross rates to evaluating the role of coastal systems in carbon-nitrogen-phosphorus exchange. The rates cluster near 0 for both [*p-r*] and [*nfix-denit*].

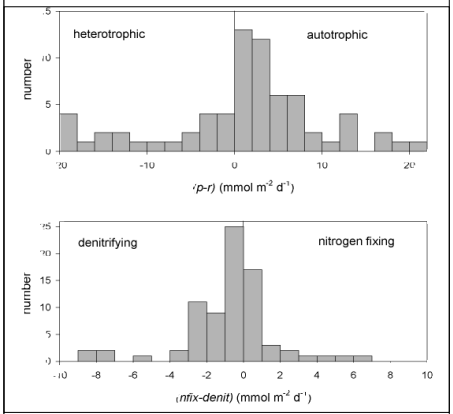

Figure 2. Frequency distributions of [*p-r*] and [*nfix-denit*] at the budget sites.

Further analysis will be required in order both to extrapolate from these individual site measurements to estimates of net metabolism for the global coastal zone and to evaluate the regional distributions

of these rates. In the meantime, further insight into comparisons can be derived from these data.

Figure 3 illustrates terrestrial nutrient loading to the budget sites. In order to allow comparison across sites, the data have been normalized to the budgeted area of the receiving water bodies. Two important aspects emerge from this figure. First, the area-normalized loading spans 3-4 orders of magnitude.

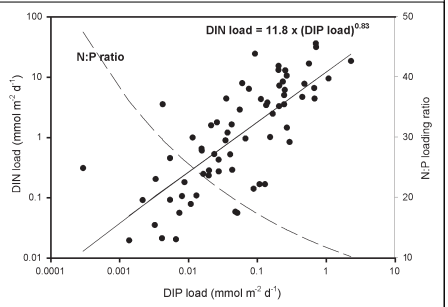

Figure 3. Area-normalized DIP load versus DIN load to the budget sites. The N:P loading ratio diminishes as total load increases.

Nutrient loading at the low end of the range is roughly equivalent to upward mixing of nutrients from the deep ocean to the oligotrophic mid-latitude gyres of surface ocean. At the other extreme, the high loads are roughly equivalent to direct waste discharge from one person for every 30m^2 of area budgeted! Clearly this range of conditions imposes dramatic differences on the water bodies receiving these loads.

A second important aspect of this loading pattern is that the DIN:DIP loading ratio changes by a factor of about 4 over the loading range. This changing loading ratio represents a change from both low loading and high N:P loading ratio for oligotrophic systems not dramatically influenced by human activities, to both higher loading and lower loading ratio under the influence of human waste discharges. DIN:DIP flux ratios of around 30:1 typify discharge from relatively pristine river systems, while values near 10:1 typify domestic waste discharge.

Net nutrient reactions in coastal ecosystems clearly respond to nutrient load. The upper panels of ***Figure 4*** demonstrate that in general, as nutrient load goes up, the absolute values of nonconservative fluxes increase. DIP and DIN behave somewhat differently. At low DIP loads nonconservative flux is near 0; at loads in excess of about 0.01 mmol m^{-2} d^{-1}, nonconservative DIP flux may become either positive or negative, reflecting either uptake or release within the systems. Nonconservative DIN flux also responds to loading; as DIN loading increases above about 1 mmol m^{-2} d^{-1} systems tend to take up DIN.

Coastal ecosystems not only receive inputs from land but also exchange water with the adjacent ocean. The ocean water may have a range of nutrient levels, but these levels typically approximate natural oceanic nutrient concentrations. Usually this water is low in both DIN and DIP, relative to the terrigenous load, and has an N:P ratio of <10. Water exchange time is a measure of the time it takes for the coastal water body of interest to exchange its volume with the adjacent ocean. Exchange time is expressed as the ratio of water volume in the system of interest to the sum of water flow through the system plus mixing between the system and adjacent water. The budgeted systems have exchange times ranging from <1day to several years. The lower panels of Figure 4 demonstrate that water exchange times of <100days generally promote more rapid nonconservative DIP and DIN fluxes.

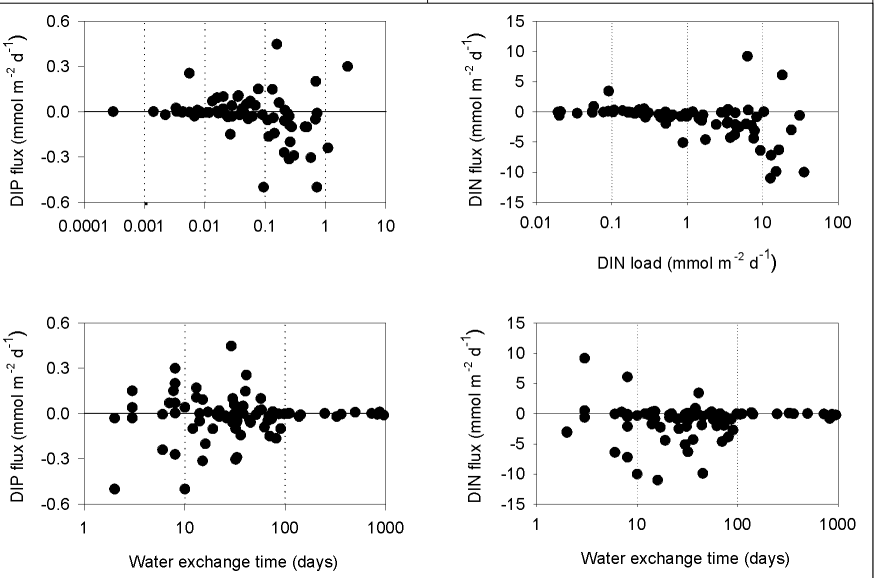

Figure 4. Non-conservative nutrient fluxes in response to nutrient loading (top panels) and water exchange time (bottom panels). Absolute rates of nonconservative fluxes are higher at high loads and short exchange times.

Where to, from here?

These sorts of scaling analyses are useful for generalizing loading, internal reaction, and exchange of materials in coastal ecosystems. However, the data are inevitably biased by the availability of sites for which budgetary analyses are possible. The next challenge of the analysis is to extrapolate these site-specific results to the global coastal zone. Towards this end, the budgeting group is working closely with the typology group in LOICZ (LOICZ Newsletter No. 15, June 2000) in order to accomplish this extrapolation. The combined typology and budgeting studies have led to a "global synthesis workshop" that was held in Lawrence, Kansas, in November 2001; further analyses are proceeding.

The major expected product of the combined typology and budgeting efforts is a chapter to be written for the LOICZ synthesis book. A preliminary draft of that book will be prepared over the next year.

There have been literally dozens of contributors to this effort (see the list of contributing authors, on the LOICZ Modelling web page, http://data.ecology.su.se/MNODE/). The core team consists of the following individuals: S. Smith, F. Wulff, D. Swaney, V. Dupra, V. Camacho, L. David, M. McGlone, H. Waldron. In addition, we have close interaction with the Typology Team (headed by R. Buddemeier) and from the LOICZ International Project Office (C. Crossland et al.).

Sustainability and Human Use of Coastal Systems

by
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Introduction

In 1998 the British House of Commons Select Committee on Agriculture report on Coastal Flooding and Erosion called for a fundamental change in the way we plan for and manage human activities because massive human intervention in coastal systems cannot be sustained and is resulting in increased hazards to life,

property and investment. The prospects for achieving this basic change are limited by poor conceptual linkages between natural sciences such as Geomorphology and social sciences such as Economics. They are also weakened by sector-based institutional systems which govern human development activities and which have neither the spatial or temporal perspectives to deal with the dynamics of coastal change.

The longer-term nature of coastal change is also difficult for politicians to deal with as sustainable and equitable human uses of coastal systems require a radical shift away from focusing on short-term sectoral development objectives and towards more integrated systems-based planning and management. All of these limitations will have to be addressed by innovative scientific research in a number of disciplines and the integration of the knowledge gained to form more robust guidelines to help politicians, planners and mangers formulate more appropriate policies, investment strategies and natural resources management plans to guide coastal development. These issues are highlighted in the findings of the LOICZ programme, and the EU-funded demonstration programme on Integrated Coastal Zone Management (ICZM) (EU 2000). The need for more integrated scientific information is also recognized in the draft EU Strategy to promote more integrated approaches to coastal management and the sustainable use of resources (EU 2000).

The question of sustainability

Burbridge and Pethick (2001) argued that comprehensive knowledge and understanding of the dynamic process and functions of coastal systems are required to avoid inappropriate policies, investment and human use of coastal areas that can only be sustained through major investment of man-made capital. The authors examine the implications of such subsidies of man-made capital using the concepts of "Weak" and "Strong" sustainability set out by Turner et al. (1998) in the LOICZ Focus Four programme using examples of natural and man-induced change in coastal systems. These examples demonstrate that failure to understand powerful and dynamic coastal processes can result in a loss of natural capital and in inefficient allocation of man-made capital that could be used in better ways to improve human welfare. This forces us towards "weak" sustainability and effectively forecloses options for developing more sustainable human uses of natural and man-made capital.

The term "Sustainability" is as much an expression of social choice as it is an expression of the ability of the environment to continue to support human needs and aspirations. What at first may appear rational social choice can lead to unsustainable coastal development where such choices are based on inadequate knowledge of coastal processes. A good example is the choice of an eroding coastline for the location of an atomic power station as in the case of the Sizewell power station in Britain. The benefits of a cheap site away from major human settlements with easy access to abundant cooling water at first seem good reasons to choose the site. However, as we have learned to our great cost, the site is on an eroding shore and to avoid damage to the plant we have to invest millions of pounds to counteract the erosion which would otherwise undermine the plant's foundations. The economic benefits derived from a coastal location for the generation of electricity have been eroded because insufficient attention was paid to the long-term dynamics of the coastal system. This is by no means an isolated case.

"Weak" sustainability

The need to defend coastal infrastructure such as power stations from natural coastal processes could be termed "weak sustainability" because of the need to allocate natural resources (stone and sand = natural capital) and man-made capital (money and machines to build engineered shoreline defences to sustain the viability of the power plant). Weak sustainability is also associated with the assumption that there can be unlimited substitution possibilities between different forms of capital via technical progress. For example, the reclamation of intertidal mudflats and marshes has proceeded on the basis that there was little capital value represented by these coastal ecosystems and greater man-made capital could be achieved by their transformation into dry land. However, advances in scientific knowledge have identified highly valuable functions performed by wetlands as well as grave risks to the sustainable use of reclaimed areas resulting from both the destruction of the functions of wetlands and other coastal systems, and rising sea level. We will return to this point later.

"Strong" sustainability

Strong sustainability is associated in economic thinking with the conservation of different forms of capital (man-made, human, natural, social/moral) in respect to meeting the needs of human populations over time. Strong sustainability applied to marine and coastal systems would mean that their natural capital expressed in terms of biological diversity, generation or renewable resources, and maintenance of natural processes and functions would remain constant or increase.

Solutions to the problems of sustaining human uses of coastal areas and resources posed by the series of errors committed through past management practices become increasingly difficult to find, because we continue to compound the errors by inappropriate developments of all kinds. This drives us further and further away from strong sustainability.

A future response

We are at a crossroads in respect to sustainable use of many of Europe's coastal regions. The spiral towards weak sustainability where coastal defences encourage development that, in turn, create the need for enhanced defences must be broken. The natural defence of coastal areas provided by wetlands, tidal deltas and other components of the coastal mosaic have yet to be fully appreciated by policy makers, planners and managers. If we adopt a more dynamic viewpoint, however, then it appears that these same coastal landforms remain intact, it is only their location that will change. If we persist in applying our static coastal management systems as sea levels rise then an increasing disparity will arise between our needs and the coastal resource. This will mean a further move away from "strong" sustainability and a loss of sustainable development opportunities. Instead we must move toward "strong" sustainability by beginning to manage change at the coast in a more positive manner.

References

Burbridge, P.R. and Pethick, J. (2001) Sustainability and management of coastal systems: our great challenge. Proc. Hanse Conference on a Marine Policy for Europe, Bremen, March 2000 (forthcoming).

European Union (1999) Towards a European Integrated Coastal Zone Management (ICZM) Strategy: General principles and policy options- A reflection paper. European Commission, Brussels.

European Union (2000) A Communication from the Commission to the Council and the European Parliament on "Integrated Coastal Zone Management: A Strategy for Europe". (COM/00/547 of 17 Sept. 2000), Brussels.

House of Commons (1998)
Flood and coastal defence. House of Commons Agriculture Select Committee. HMSO.
Turner, R.K., Adger, W.N. and Lorenzoni, I. (1998)
Towards integrated modelling and analysis in coastal zones: principles and practices. LOICZ *Reports and Studies* No. 11, IGBP/LOICZ, Texel, the Netherlands, iii+122 pages.

LOICZ IPO NOTES

From all of us at the LOICZ International Project Office:

THE BEST WISHES FOR 2002

Over the last few months, LOICZ scientists have been involved with the design and collaborative development of new programs of science and assessment. With other representatives of several of the IGBP core projects, LOICZ participated in the second technical design workshop for the Millennium Ecosystem Assessment in Capetown, South Africa. The work plan design is in final draft for consideration by the MEA Board and a call is out for scientists, globally, to contribute to the work of the Assessment. There are a number of areas in which LOICZ-associated scientists could assist. More information can be found on the MEA web-site: www.ma-secretariat.org.

As part of the development of the Global Ocean Observing System (GOOS), LOICZ has helped in the planning for the Coastal-GOOS module over the last two years. A decision was made to combine the plans for the coastal, living marine resources and health of the oceans elements into one programme. The combining efforts were the basis of a workshop in Trieste in June, and the new panel -Coastal Ocean Observations Panel (COOP)- is completing the work for adoption and implementation. The goal is to establish an international operational framework of regional scaled observation elements that will monitor, assess and predict effects of natural variations and human activities on the marine environment and ecosystems of the coastal zone. Fundamental scientific research information, tools and assessment methodologies – such as those coming from the LOICZ core project of IGBP – will provide underpinning of the "monitoring" system. The COOP framework is an exciting and vital initiative that, while providing some challenges to the coastal scientists, managers and users, has a real capacity for networking global skills and science to meet the needs of the wider community by providing systematic data sets and products.

The 2002 World Summit on Sustainable Development in Johannesburg is the focus of much attention from scientific, environmental and policy sectors at the moment. The Summit will review the progress and global response on environmental issues since the Earth Summit in Rio de Janeiro 10 years ago. In early December, the Intergovernmental Oceanographic Commission (IOC) hosted an "Oceans and Coasts at Rio+10". The meeting attracted about 400 people from all sectors interested in the coastal and ocean environment and, through a structured set of plenaries and workshops derived a "progress report" for use in the preparation of the coastal-marine assessments to be provided in Johannesburg. The general outcome was a strong realisation that science knowledge and programmatic tools and information have progressed markedly in the last 10 years

Literature Review: Trace Gases in the Coastal Zone

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Aim

- to establish the relevance of the coastal zone for atmospheric sources and sinks of trace gases (except CO_2) on the basis of a literature review.

Why do coastal seas differ from the open ocean with respect to the air-sea exchange of trace gases?

- the coastal ocean is more efficiently and more often affected by the anthropogenic drivers of environmental change than is the open ocean.
- the ecosystem functioning and structure in the coastal zone is changing more quickly and to greater degree.
- biogeochemical cycling of chemicals, including sea-air exchange of trace gases, is affected by differences between the coastal seas and the open ocean.

Issues specific for air-sea exchange for trace gases in the coastal ocean

- Proximity to the emission sources and regions.
- The tidal regime of some estuaries leads to an increased residence time of fresh water in the estuarine mixing zone and pronounced changes in the speciation of various chemicals.
- The shelf break zone as the area where the sea-air exchange processes for many trace gases are the most effective, resulting in enhanced production of trace gases.
- Turbulence in tidal estuaries due to the tidal currents and their interaction with wind and bottom topography clearly depends on the tidal energy and the depth and morphology of the estuary.
- The continental margin plays a significant role in air-sea exchange through the activities of organisms, more available in coastal areas than in the open ocean.
- The role of natural wetlands in the generation of trace gases.

Concluding remarks

- The coastal ocean is an important source of CH_4, N_2O, DMS, COS and Hg emission to the atmosphere.
- Flux rates from the surface water to the air for these gases are up to several orders of magnitude higher in the coastal areas than in the open sea.
- Estuaries can contribute a few percent to the total emissions of CH_4, DMS and COS and a bit more to N_2O on a global scale.
- Coastal areas contribute up to 50-60% to the total oceanic emissions of N_2O and COS on a global scale, and 10 to 30% for CH_4, DMS and Hg.
- More research is needed to better understand future changes of trace gas fluxes in the coastal zone. On the basis of the past trends of global warming, frequent formation of algal blooms, increased transport of particulate matter, including organic matter with rivers and to some extent atmospheric deposition, and enhanced primary production in the ocean, it can be expected that the sea-to-air flux of trace gases in coastal areas will increase in the future.

Acknowledgements
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- Dr. Michel Frankignoulle of the University of Liege, Liege, Belgium
- Dr. Jack J. Middelburg of the Netherlands Institute of Ecology, Yerseke, the Netherlands and
- Dr. Hermann W. Bange of the Institute for Marine Research, Kiel, Germany.

Type gas	Estuary to open ocean flux rate ratio	Qunatity of estuary emissions in Europe, ktonnes/yr	Estuary contribution in total European emission %	Costal sea contribution to the total sea to air flux	Costal sea contribution to global emission %
CH2	- 1000	580	2.5	up to 30%	0.2 - 2.0
N2O	- 100	120	9.4	up to 60%	2.0 - 15.0
DMS	1 - 3	60 (as S)	1.0	up to 10%	2.0
COS	10 - 100			up to 50%	
Hg	- 10	12×10^{-3}	3.5	up to 20%	- 0.5

Contribution to the total European or global emissions of sulphur

This work has been prepared within contracts from the LOICZ International Project Office and the Norwegian Research Council (NFR). The authors are grateful for the financial support of LOICZ and NFR.

(but there are major difficulties in objectively determining environmental quality), as has the development of conventions and top-down accords and governance instruments. However, there remains a significant gap between the science and understanding and the policy arena, such that concerted actions based on the intergovernmental instruments are still limited. Despite the continued general trend of decline in global environmental quality, the efforts of community, science and governance appear to be tracking in a favorable direction – but it is a long slow progress.

ERA

The status of the ELOISE project cluster, perspectives for improved synthesis in the new European Research Area, ERA, and links into the competitive surrounding of the 6th Framework Program (2002-2006) were discussed at the 4th Annual ELOISE conference held in Rende, Italy 5-7 Sep. 2001. The Commission pointed out that future European coastal research needs a balance of fundamental and applied science encapsulated in a sound synthesizing and communication mechanism. The objective is to overcome the current fragmentation of activities through system-based integrated approaches and improved scaling including river catchments and socio-economics. Meeting these and related policy objectives will allow both better testing of the robustness of, for example, the products of ELOISE (with currently 35 projects still in operation) and a better contribution to sustainable development in Europe as outlined in the recently formulated communication to the Parliament. However, the global change dimension will be a crucial link for up-scaling and inter-comparison of the European research.

In the longer term the European Research Area, a newly formed initiative proposed in 2000, will be the platform where both national programs and the 6th Framework Program and thus any sort of continued ELOISE cluster will fit. The ERA aims to facilitate the development of a European Policy for research and to anticipate the future science and technology needs on EU level. It needs to build on research which meets the above criteria with special emphasis on interdisciplinarity, transboundary scaling and on an improved coherence of national research agendas. The future of the projects which will meet the new criteria for support in this context will therefore include much broader networks of excellence than in the past aimed to also form a sort of "virtual" laboratories. An improved visibility for and operational links to the global change science arena will be another key feature of European coastal research. LOICZ is expected to play an important role in complementing and supporting this effort through its own synthesis and in bringing in the global perspective and a global set of links to application. The ELOISE synthesis, to be executed in 2002, has to call for tenders.

LOICZ Basins: Regional assessment of river catchment - coast interaction and human dimensions: Caribbean coastal states and Africa

Following recommendations of the 4th LOICZ Open Science Meeting, Bahia Blanca, Argentina 1999, to include island-dominated regions into the global assessment of river catchment–coast interaction, a CariBas core group, supported by LOICZ and the IOC, held its synthesis meeting at the Rosenstiel School for Marine and Atmospheric Science, Miami, USA, in June 2001. Key investigators mainly from the CARICOMP network evaluated natural and human-induced flux changes to the coastal seas, impacts and critical loads in this heterogeneous area including islands and continental, mountainous countries. Coastal change in this sub-region originates from driver patterns such as seasonal tourism, agriculture, oil exploitation and urbanization. Natural drivers include climatic extreme events.

Sites addressed in detail were the Magdalena River, Colombia, Golfo Triste and Aroa-Yaracuy River along the Venezuelan coast. Agriculture and urbanization affect the reefs where live coral cover has fallen from 35% to 5% and total biodiversity is down to 20%. In Costa Rica, agricultural and logging activities in the Estrella River catchment caused deterioration in the Cahuita reef. Both cases indicate that respective ecological critical thresholds for coastal system stability based on riverine material flux have been exceeded visibly. Trend expectations are pessimistic.

In a broad sub-regional approach, the whole Meso-American Reef area stretching from Mexico via Belize south to Guatemala and Honduras was evaluated. This, the world's second largest barrier reef, currently the subject of a broad GEF/WB research project, shows signs of environmental impacts. However, while indicators such as live coral cover, coral disease rates and macroalgal cover are still s relatively healthy, the distances to the respective critical thresholds are decreasing and trend expectations for the drivers of impacts are pessimistic. Island-based sites included in the more detailed CariBas assessment are the polluted and urbanized area of Kingston Harbor, Jamaica and the Caroni River basin and Gulf of Paria on Trinidad/Tobago.

Future regional LOICZ activities will seek links to the GEF/WB project on the Meso-American Reef. Further island sites e.g., on Cuba and Hispaniola, are likely to be included in the proposal development at a later stage. Potential for links to UNESCO/ IOC's IOCARIBE Sub-Commission are being pursued.

Supported by START/NORAD and UNESCO/IOC and hosted by UNEP's Regional Office for Africa in co-operation with the Pan African START Secretariat, PASS, the second LOICZ AfriBasins workshop took place in Nairobi, Kenya 29 Oct-2 Nov 2001. Two working groups (western and eastern coasts) identified coastal change and river catchment-based forcing of change in eight sub-regions by considering coastal geomorphology, coastal habitats/biodiversity, climatic conditions, people relationships (demography and drivers), catchment size and seasonal runoff, land use and cover. The sub regions were:

- the Nile, including the wider coastal stretches influenced by the Nile catchment reflecting land-based drivers including the Aswan dam, Cairo urbanisation and agriculture in the Delta.
- East Africa (Somalia to northern Mozambique), featuring the small- and medium-sized catchments under monsoonal forcing (seasonal flushing) and subject to damming, and extensive coral reefs.
- Southern/central Mozambique, again with high seasonality in runoff characteristics and transboundary issues including damming and impacts such as salinisation in the coastal zone.
- South-east Africa, ranging from subtropical in the north to the warm temperate on the Cape coast and characterised by generally small catchments that are subject to various human use patterns with plans in place for intensive damming.
- South-west Africa (Cape of Good Hope to southern Angola), mainly dominated by the upwelling system of the Benguela current, cool and temperate in the south, arid in the north with limited river runoff to the coastal sea.
- the Congo, a central African sub-region with a very large catchment with extensive rainforest but little information available about its land-based drivers and how they relate to coastal issues.

- West Africa, featuring a variety of large rivers subject to major damming resulting in reduced sediment and water fluxes and reduced coastal stability as a growing threat to the lagoon-based cities.
- North-west Africa, a relatively arid sub-region with seasonal runoff and, at least in Morocco, major human pressure through diversion and damming causing a variety of coastal change issues.

The sub-regions show wide variations in both biophysical nature the availability and quality of existing material flux data. The catchments chosen were considered representative for their sub-region. The big four (Nile, Zambezi, Congo and Niger) have been included, as have the important basins of the Senegal, Volta, Cross and Gariep rivers on the western coast, and the Limpopo and Incomati on the eastern coast. Medium and small basins have also been assessed including the Sebou and Moulouya in Morocco, the Olifants and Berg west of the Cape and Tugela, Kariega, Kromme and Groot Brak rivers east of the Cape in South Africa, the Rufiji in Tanzania and the Sabaki and Tana in Kenya.

Coastal geomorphological change, erosion and sedimentation were identified as a significant and progressive impact in nearly all of the sub-regions, the problem being acute on the Nile delta and in West African lagoon systems. Damming was viewed as the principal driver in such change, with consequent reductions in stream flow and sediment flushing. Other coastal impacts ascribed to river damming include salinisation, e.g., in the Incomati estuarine plain in Mozambique, and nutrient depletion in coastal seas e.g., Kwazulu-Natal. In most sub-regions deforestation and agriculture were seen as important drivers, particularly in respect of coastal sedimentation from medium and small catchments, e.g. the Tana and Sabaki rivers in Kenya. Human settlement was regarded as a major contributor to eutrophication and the occurrence of aquatic weeds in the large West African catchments. Elsewhere, while eutrophication and pollution were recognised as important issues, they were related in many cases to local (coastal) urban-industrial sources e.g., Alexandria, Mombasa, Saldanha Bay and Cape Town. Loss of biodiversity or biological functioning was another common issue, though related probably to complex ranges of human and natural drivers. In general these data are characteristic of developing economy situations where economic growth and water use exceed development of the necessary urban and industrial infrastructure. This finding parallels those made in the South American (Lacerda et al. 2002 – LOICZ R&S 21 in press), and East Asian basins assessments (Hong et al., in prep.). However, the heterogeneity of the African sub-regions seems to be more pronounced, making the ranking of issues and drivers in Africa a more complex challenge.

A second task was to use this assessment to identify potential demonstration sites for future holistic studies on coastal change and human dimensions. For this purpose "hot spots" important for future research evaluation and a project design applicable to various spatial and temporal scales had to be identified. The workshop concentrated on the draft "AfriCat" proposal, which was developed from the ongoing "EuroCat" project. The emphasis was on adjustment of this project draft to the regional African needs and case studies – a process that is ongoing. In close co-operation with IOC and the Advisory Committee on the Protection of the Sea (ACOPS), results of this LOICZ effort complement the development of a bigger African project to be established through a Partnership Conference at Johannesburg.

Biogeochemical Budgets and Integration

Some 180 biogeochemical budgets have been developed for estuaries and coastal seas using the LOICZ approach, supported especially by a network of global researchers and the UNEP GEF-funded project (see lead article). The spatial coverage is now fairly much global with the exception of the South Asia region – field and assessment work is current in South Asian sites through national programs and support from APN. Integration of the budget sites information to address core LOICZ questions about C, N and P sinks/sources and fluxes is being conducted by a networked group of scientists, making use of the LOICZVIEW typology tools as a key approach.

Several regional workshops have been held over the last six months to add to regional coverage of "budget" sites and to extend the training, use and assessments with the typology techniques.

Howard Waldron, University of Cape Town, hosted a well-attended workshop in early September to develop additional budgets and to provide further training and awareness in Africa. The sub-Saharan region now has a broad representation of budget sites across a range of climatic and landscape settings, with the workshop adding a dozen new budgets in the region, plus a budget assessment for the Nile Delta.

A workshop hosted by Fred Wulff, University of Stockholm, successfully developed a range of budget assessments for estuarine and regional seas across the Russian polar coast, and within the Bothnian Sea. This provided a vital latitudinal extension to the LOICZ information with indications that the N and P inputs are predominantly from the ocean rather than from land sources.

These two workshops, along with the workshop held in Ensenada in April 2001 addressing additional Latin American sites, will contribute an additional 30-40 new sites across Africa, the Americas and the polar region and significantly increase our capacity to build global and inter-regional understanding of the material fluxes in the global coastal zone.

Regional application of the LOICZ typology approach was extended to the Africa-Europe regions in a workshop hosted by Maarten Scheffers, Coastal Zone Management Centre-RIKZ, The Hague in early July. Around 30 participants applied the tools to sub-regional questions of scaling and to issues relating to biogeochemical budgets. The LOICZ-View tool was further developed to include additional statistical elements.

An integration workshop was held in Kansas, 11-14 November 2001, that drew together the existing biogeochemical assessments and developed a number of general trends and relationships between the biogeochemical budgets. The typology tool, LOICZView, was applied to the regional and global synthesis, particularly to the development of coastal classifications based on climate and other physico-chemical factors, and to the question of land-derived loads of nutrients to the coastal zone. The workshop marked the final activity of the UNEP GEF project carried out by LOICZ and outcomes are contributing to the overall LOICZ Synthesis activities. Further synthesis and assessment of the biogeochemical characteristics of the global coastal zone are proceeding through a networked group of LOICZ scientists.

Publication of the reports from these workshops will be available in January 2002, as hard copy in the LOICZ Reports and Studies series (with a CD-ROM version of all typology outcomes) and accessible through the LOICZ web-site.

HAVE YOU SEEN

Aguirre-Minoz, R.W. Buddemeier, V. Camacho-Ibar, J.D. Carriquiry, S.E Ibarra-Obando, B.W. Massey, S.V. Smith and F. Wulff 2001. Sustainability of coastal Resource use in San Quintin, Mexico. Ambio **30 (3)**:142-149.

S.V. Smith, W.H. Renwick, R.W. Buddemeier and C.J. Crossland 2001. Budgets of soil erosion and deposition for sediments and sedimentary organic carbon across the conterminous United States. Global Biogeochemical Cycles **15 (3)**: 697-707.

The European Geophysical Society (EGS) has launched a new interdisciplinary working group (IWG) on Biogeosciences (BG). The goal of this IWG is to increase the visibility of biological disciplines within EGS, attract new members and promote interaction of biology with geology, hydrology and geophysics. Tight coordination with the existing EGS sections and IWG will be achieved through co-sponsorship of symposia. Interaction with the Biogeoscience section of the American Geophysical Union (AGU) will also be sought, beginning with the upcoming joint EGS-AGU meeting due to take place in 2003. Additional information on BG can be found at http://www.obs-vlfr.fr/~gattuso/jpg_bg.htm and a more detailed document can be downloaded at http://www.obs-vlfr.fr/~gattuso/files/EGS_BG.pdf.

LOICZ PUBLICATIONS

LOICZ Publications are available as printed copies and are downloadable from the LOICZ web-site

Coastal and Estuarine Systems of the Mediterranean and Black Sea Regions: C, N and P fluxes. Eds. V. Dupra, S.V. Smith, J.I. Marshall Crossland and C.J. Crossland. LOICZ R&S 19, 2001. LOICZ UNEP, NCMR, ELOISE workshop report.

WHAT'S ON THE WWWEB

LOICZ web-site: Biogeochemical Budgets and Modelling - new sites and tutorial materials (http://data.ecology. su.se/MNODE/)

LOICZ Typology web-site: (http://water.kgs.ukans.edu:8888/public/Typpages/index.htm) and (www.kgs.ukans.edu/Hexacoral/Workshops)

LOICZ Basins preliminary web-site: http://w3g.gkss.de/projects/loicz_basins/ which links to GKSS through http://coast.gkss.de/themen/anthro/ - a final version will be available by the end of January

LOICZ CALENDAR

LOICZ SSC Meeting, 27 May & 2 June 2002, Miami, Florida, USA

LOICZ Synthesis and Futures meeting, 29 May - 1 June 2002, Miami, Florida, USA (by invitation). Contact LOICZ IPO.

OTHER MEETINGS

International Conference on "Coastal Zone Management and Development (ICCZMD)", 18-20 March 2002, Kuwait: Dr. Mohammad Al-Sarawi (sarawi@epa.org.kw or alobaid@epa.org.kw).
Visit: www.epa.org.kw/cc/

Coastal Zone Asia-Pacific: "Improving the State of the Coastal Areas" May 12-16, 2002, Bangkok, Thailand. Deadline for abstracts 15 January 2002: www.vims.edu/czap or: Dr. Ratana Chuenpagdee (ratana@vims.edu)

Advanced Training Institute on Climatic Variability and Food Security at the IRI (International Research Institute for Climate Prediction (IRI) of Columbia University, New York) 8-26. For more details check on the web-site (http://iri.columbia.edu/outreach/meeting/ATI2002).

Two forthcoming ACSYS/CliC events, 15-17 and 18-19 April 2002:
1) A workshop on 'Sea-ice extent and the global climate system'. http://acsys.npolar.no/meetings/toulouse/ice.htm .
2) A mini-conference on 'Long-term variability of the Barents Sea region'. http://acsys.npolar.no/meetings/toulouse/barents.htm>. These events will be held one after the other at Météo France in Toulouse, France, with the hope that some researchers will participate actively in both. Contact: Tordis.Villinger@npolar.no.

The European Geophysical Society (EGS) XXVII General Assembly, Nice, France, 22-26 April 2002. In the Section Nonlinear processes there will be a session on NP 6: Climate models: nonlinear response and thresholds, organized by Ulrike Feudel, Institute for Chemistry and Biology of the Marine Environment, University Oldenburg, Germany (u.feudel@ icbm.uni-oldenburg.de) and Martin Claussen, Potsdam-Institute for Climate Impact Research, Potsdam, Germany (claussen@pik-potsdam.de).

11th International BiennialConference on Physics of Estuaries and Coastal Seas (PECS'02), September 17-20, 2002., Hamburg, Germany. For information visit: http://www.pecs-conference.org.

Joint IAMAS/CACGP/IGAC Scientific Conference on Atmospheric Chemistry in the Earth System: From Regional Pollution to Global Change, 18-15 September 2002, Crete, Greece. Abstract deadline submission March 2002 Contact: igac2002@chemistry.uoc.gr Visit: http://atlas.chemistry.uoc.gr/IGAC2002

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