LAND-OCEAN INTERACTIONS IN THE COASTAL ZONE

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LOICZ NEWSLETTER

The threat mud poses to the Great Barrier Reef of Australia.

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The Cairns coast (Figure 1) of the Great Barrier Reef of Australia has been severely impacted by man-induced erosion. Over the last 100 years in this area much of the forest and natural coastal vegetation and wetlands have been modified to permit urban, port, industrial and agricultural development (Wolanski 1994, Larcombe et al. 1996, Wachenfeld et al. 1997). The coastal rivers have become drains bringing eroded mud to settle in the estuaries, in the coastal shallows and on the inshore reefs. Additional mud from dredging Cairns port is dumped in coastal waters. The resulting addition of nutrient-rich mud to the sea is considered by some to be of the most threatening impacts on coastal reefs of the Great Barrier Reef (Bell and Elmetri 1995).

This is the fourteenth newsletter of the Land Ocean Interactions in the Coastal Zone (LOICZ) International Project of the IGBP. It is produced quarterly to provide news and information regarding LOICZ activities.

HISTORICAL CHANGES

The impact of man on this sector of the coastline of the Great Barrier Reef has been dramatic. Old photographs of the Cairns waterfront suggests that the Cairns beach was sandy at the end of the 19th century, it is now muddy and the bed is 1.5 to 2 m higher. This is affirmed by oral accounts gathered from people living in Cairns through 1930 to the 1950s. The consensus is clear and uniform, namely there was a sandy beach before, the Esplanade was used as a swimming and picnicking recreational area and there was even an open saltwater swimming enclosure at the mouth of Trinity Inlet - now a mud bank.

Further evidence for this very rapid accumulation of mud comes from a comparison of the navigation charts from 1878 and 1972 (Figure 2).

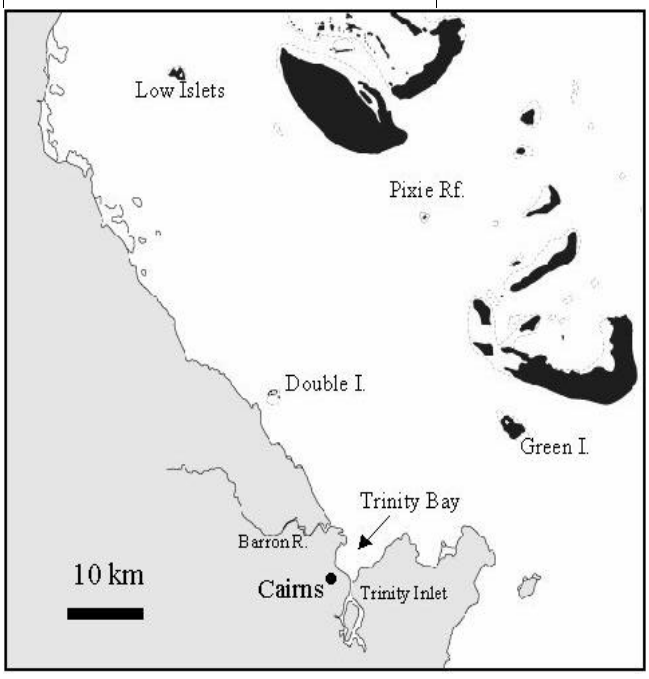

Figure 1: Map of the coast of the Great Barrier Reef near Cairns

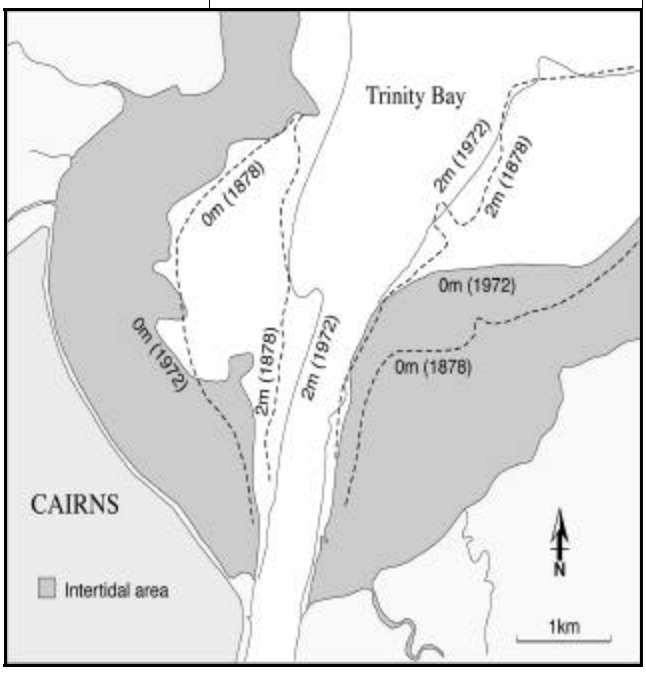

Figure 2: Chart of Trinity Bay showing the 0 and 2 depth contours (at low spring tides) in 1878 and 1972.

This suggests that on the wave-sheltered eastern side of Trinity Bay the intertidal flat has prograded seaward by up to 1 km (see the changes in the 0 m depth contours). Also the 1878 chart refers to the tidal flat as a sandy mud bank that dries at low water spring tides. In 1999 this tidal flat dries at 1.5 m above low spring tides and is soft mud. The 1878 chart refers to the Cairns beach as a white sand beach barely covered at high water. In 1999 the only sand there is a strip of sand a few meters wide and dumped there by man to beautify the area, everything else is mud. Thus a 1.5 m thick layer of mud has apparently accumulated in the last 100 years and covered the original beach. This increased siltation has also apparently resulted in the recent (since 1952) colonisation of mangroves along the coast between the airport and the city (Figure 3).

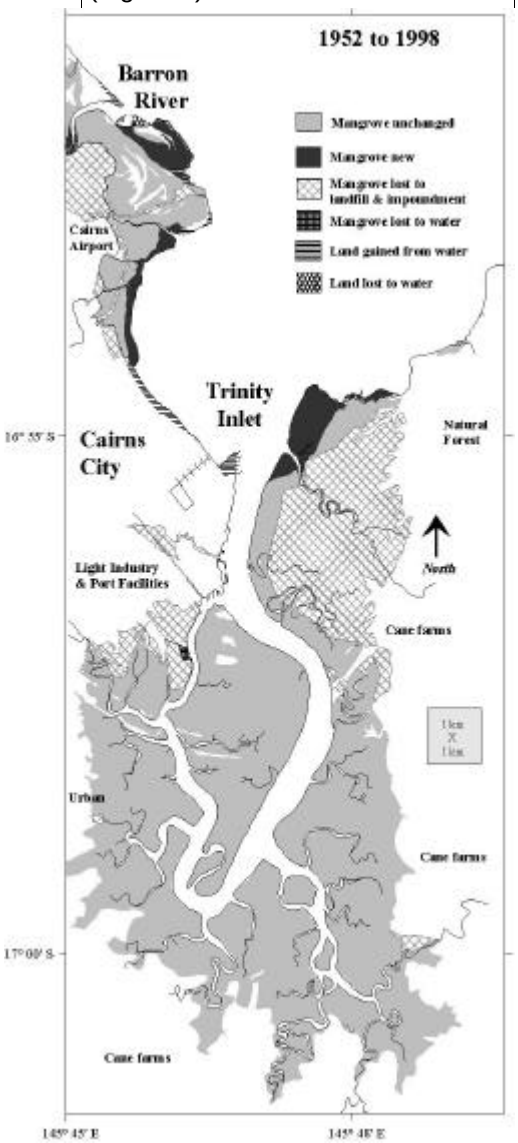

Fig 3 Changes to mangroves of Trinity Inlet and the mouth of the Barron River (1952-1998).

Before European settlement, the holocene deposition rate of mud in was about 6 m in 6000 years, ie 1 metre/1000 year (P. Larcombe pers. com.). In the 20th century, man apparently increased this deposition rate to 1 to 2 metres/100 years, resulting in: the 1897 sandy beach now buried by 1-2 m of mud; the establishment of new mangroves on the western coast of Trinity Bay since 1952; a wider mud flat over the western side of Trinity Bay; and shallower water by 1-2 m on the eastern side.

THREATS TO THE GREAT BARRIER REEF

Mud from Trinity Bay is readily resuspended by wind and is exported northward alongshore in a turbid coastal band during southeast trade winds. This season lasts six months of the year. Wolanski and Spagnol (submitted) collected oceanographic data to assess the offshore extent of the dispersion of the mud along the coast north of Cairns. For six weeks in August and September 1997, five oceanographic moorings were maintained in a cross-shelf transect just north of Double Island from the coast to Pixie Reef. The moorings logged data every 10 min on currents and turbidity.

In coastal waters the suspended solid concentration fluctuated widely, peaking at 1,000 mg l^{-1} (1 kg m^{-3}) on windy days, at which time the visibility was zero (the divers could not see their hand against the face mask). Terrigenous mud was also found to be exported to offshore in a near-bottom muddy layer a few metres thick (a nepheloid layer). In these offshore waters events of high suspended solid concentration (>50 mg l^{-1} peaking in one event at 200 mg l^{-1}) occurred occasionally. This suggests that the mid-shelf reefs of the Great Barrier Reef in the Cairns area are also ultimately threatened by mud.

Mud in suspension decreases the visibility, an indicator of the ability of light to be transmitted through the water. Without light there can be no photosynthesis and plants cannot survive, neither can they sustain other species which depend on the plants for their food. Knowledge of the past visibility is derived from the 1928-1929 British Museum Expedition. This pioneer study was mostly carried out near Low Isles offshore Port Douglas. The scientists measured visibility weekly and found clear water (mean visibility ~ 11 m) during the South East trade wind season (the windy, dry season when river runoff is negligible). In 1997, for the same dry season and distance offshore, the visibility offshore from Double Island was only 50% of what it was 70 years ago near Low Isles (Wolanski and Spagnol submitted). Assuming the 1927 data are an indicator of natural conditions, these data suggest mud is increasingly being exported from Trinity Bay toward the Great Barrier Reef.

Long-term effects of low-level sedimentation on coral reefs include tissue lesions and diseases, decreased calcification, net productivity and growth, and shifts in abundances and species composition (Dodge et al. 1974, Cortés and Risk 1985, Peters and Pilson 1985, Rogers 1990). Mud in suspension as muddy marine snow also physically smothers coral reef organisms (Fabricius and Wolanski, 2000). Along this coast, muddy marine snow is probably enhanced by runoff from farms and pastures, and appears to be the norm rather than the exception.

THE PROTECTIVE ROLE OF MANGROVES

The mangrove forests in the Cairns area are located mainly along the Barron River and Trinity Inlet, and they have been measurably reduced since 1952 (Figure 3); despite some local increases there has been a net loss of 15% for the Barron River mouth, and a net loss of 24% for Trinity Inlet. Mangrove losses are due to the expansion of the airport, urban areas, industry, port facilities and land reclaiming for sugar cane farms. In particular a bund wall has destroyed a large area of mangroves along the eastern shore of Trinity Inlet. These losses have occurred mainly in downstream areas, where mangroves best trap mud they capture from suspension in coastal waters (Furukawa & Wolanski 1986). Based on studies of sedimentation in mangroves near Cairns airport (Furukawa et al. 1997), the 8.22 km^2 of mangroves that have been lost would have trapped about 12-

25,000 tonnes of sediment per year, or 0.5-1 million tonnes over the last 40 years since the mangroves were destroyed. This mud is now polluting coastal waters of the Great Barrier Reef. This estimate is approximate. However even if it was too high by a factor of 2 or 3, it still shows the vital role of mangroves in protecting Great Barrier Reef waters from excessive turbidity (see also Duke 1997).

Historically these mangrove-fringed estuaries have undergone dramatic changes also prior to European settlement (Duke 1997). Trinity Inlet was once the mouth of the Mulgrave River before volcanic activity, many thousands of years ago, redirected this large river to join the Russell River which enters the sea much further south. More recently the Barron River mouth has shifted dramatically to its present location. In 1876 when the first Europeans arrived in Cairns, the Barron River opened into the bay where the Cairns airport is now located (see Figure 3). Since then the mouth has shifted north in at least two steps (QH&M 1981). The mouth at the easterly point of land (Ellie-Casuarina Point) closed after 1939 when the sand ridge north of the point was breached. The river's potential to change its course remains today with the continued widening of the Thomatis-Richters channel (a previously small deltaic tributary to the north), and the eroding banks opposite accreting banks of river meanders.

Sediments in the Barron River mouth and Trinity Inlet today are a mixture of silt, clay and organic residues (Bird 1972, 1973). Fine grain sediment settles in quieter waters. The pulsing of depositional events has created a series of roughly parallel sandy ridges built up over and between earlier tidal mudflats. This topography typifies those found across the Cairns coastal plain and relic formations, to around 6,000 years before present, are now dissected and truncated by tidal creek meandering.

In the Barron and Trinity estuaries, mangroves have taken advantage of the extensive depositional plain, particularly in downstream locations. These places usually have relatively low biodiversity of mangrove plants compared to upstream stands, but they are the sites of dominant biomass and widest spatial extent. The reason for this occurrence is related to the supply of nutrients with seasonally reduced salinities, but the main reason is the supply of sediment. Mangroves, particularly *Rhizophora* species, readily colonise mud banks and by doing so, they can trap and bind-up sediments for thousands of years. These areas may remain stable provided the processes of recruitment and tree replacement are not interrupted. In this way, established mangrove forests act to regulate and improve water quality. Without mangroves, these sediments would be readily flushed further offshore during both seasonal and episodic incidents of increased land catchment runoff and severe coastal wave action. Mangrove detritus also helps in generate mangrove flocs, thereby protecting seagrass beds in coastal waters. Mangroves therefore act directly to buffer and reduce water turbidity in the Great Barrier Reef lagoon. Throughout past times, the mangroves have responded naturally in unison with geological and geomorphic changes to help stabilise mud banks. A delicate balance has been maintained allowing the creation of the Great Barrier Reef as we know it.

With the recent removal of mangroves, this balance has been disrupted and the Great Barrier Reef has lost some of the protective role of mangroves in trapping mud. The waters now leave these estuaries much dirtier than ever before. This process is exacerbated with the increased sediment loads in the land drainage systems from vegetation cleared further up in the catchment. To protect the Great Barrier Reef, the area of mangroves should be increased to stabilise the excess mud. In the Cairns area, this can be done by encouraging the colonisation by mangroves of the mud banks in Trinity Bay and by actively planting seedlings where the rate of colonisation is too slow. The current practice of removing naturally-recruited mangrove seedlings fronting the Cairns muddy beach is encouraging pollution by mud of coastal waters. Mangroves should be restored along all undeveloped sections of the Barron and Trinity Inlet, beginning with the removal of the bund wall in Trinity Inlet. In this latter case, however, tis would have to be done in a controlled manner to avoid large-scale contamination by acid sulfates formed since the bund walls were constructed. Finally, the mud dredged from Cairns port should be readily used to help mangroves colonise muddy intertidal areas, instead of dumped at sea where it pollutes coastal waters. In this way mangroves can be used to protect this and other areas along the Great Barrier Reef from excess mud.

CONCLUSIONS

The Great Barrier Reef region is justly inscribed on the World Heritage list because it is one of the mega-biodiverse prime natural assets of Australia. Our generation has the opportunity to enjoy this immense and wonderful asset but there is an incumbent responsibility not to adversely affect its natural qualities and its enormous range of habitats and species. Mud from man-made erosion in the catchment areas is a serious threat to the Great Barrier Reef. Inshore reefs of the Great Barrier Reef cannot be sustainably managed without managing the adjacent land. Careful, understanding and coordinated land care in the catchments draining into the Great Barrier Reef is imperative together with careful consideration of the impacts of dredging, land clearing, stream modification, wetland destruction and mangrove removal.

There is an additional way to combat pollution by mud, namely by planting mangroves and encouraging natural recruitment. Mangroves planted over the new mud banks and reclaimed mangrove land returned to mangroves, would go a long way toward protecting the Great Barrier Reef from mud pollution.

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SURVAS holds successful workshop

Robert Nicholls and Anne de la Vega-Leinert of Flood Hazard Research Centre, Middlesex University, UK, hosted the first of a series of workshops of the SURVAS Project (**S**ynthesis and **U**pscaling of sea-level **R**ise **V**ulnerability **A**ssessment **S**tudies). This was held in Trent Park Campus, North London on 17/18th January 2000.

Twenty-six invited experts attended this workshop from a range of academic and governmental organisations in Europe, the Americas, Africa and Asia. The major goal was to provide the international delegates the opportunity to comment upon the proposed SURVAS methodology, and discuss relevant ways of improving it. Three critiques covering four major aspects of the methodology were the basis of dynamic group debates.

These were :

- physical and ecological aspects (Dr. M. Capobianco, Tecnomare, Italy),
- socio-economic aspects (Dr. N. Adger, University of East Anglia, UK), and,
- end-users' needs (Dr. T. Downing, University of Oxford, UK).

A number of key actions were decided upon during the workshop, including more focus on indicators of Adaptive Capacity. The revised methodology is presently being tested by five country case studies (Germany, India, Poland, Senegal and UK). The improved SURVAS methodology will be first applied at the European workshop in Hamburg in June 2000.

For more information on SURVAS goals, methodology & work programme, please either log onto **http://www.survas.mdx.ac.uk** or contact Dr. Anne de la Vega-Leinert at **survas@mdx.ac.uk**

Submarine Groundwater Discharge – intercalibration of methods

(IOC-SCOR-LOICZ initiative; 2-4 February 2000)

Direct discharge of groundwater into the ocean can be an important component in coastal budgets not only of water but also of chemical constituents. The problem coastal zone managers face is: (1) they may not be fully aware of the the importance of SGD; (2) if they are aware, they may not know how to decide whether or not SGD is relevant to their situation; and (3) if they do decide this is important to them, they may not know how to quantify it.

The joint SCOR-LOICZ-IOC-IHP working group meeting at the Intergovernmental Oceanographic Commission, Paris, in accordance with an earlier IOC Assembly decision, aimed to formulate a program to address these three issues. An important aspect of the methodological intercalibration project was ability to disseminate the results widely in the hopes that national authorities will encourage the scientific community to investigate this phenomena properly, in all likely locations. Such information could ultimately be compiled into a database and/or an atlas.
The crucial design objectives were to gain ability to better define and test the SGD measurement tools. While it is relatively easy to produce numbers, it is very difficult to assess the quality of these estimates.

To meet the growing consensus within the scientific community working on SGD that some type of intercalibration program is needed to resolve the measurement issues, the workshop addressed: (1) the site selection; and (2) the selection of techniques and the experimental design of the actual intercomparison. For example, while some sites may have lower flows, the impact of SGD may be greater because of high nutrient concentrations. About four to five sites that span a broad range of conditions were identified, emphasising the need for the involvement of local expertise (both scientific and managerial) and some provision for training be made part of the dissemination effort.

The proposal will be delivered to IOC in time for consideration by its Executive Committee which meets in May, 2000. The first intercalibration study is proposed for Pert, Western Australia in December 2000.

Global Change and Continental Aquatic Systems

Olasumbo Martins GKSS, Geesthacht, Germany

(IGBP Synthesis Workshop, Stockholm, Sweden, 7-9 February, 2000) The workshop, which was organized in conjunction with the Royal Swedish Academy of Sciences and the Swedish Agricultural University, was also supported by the Millenium Committee of Sweden and the Foundation for Strategic Environmental Research, Sweden.

Focusing on global change and continental aquatic systems (CAS) i.e., fluvial pathways, groundwater transport through the catchments and the coastal zones, the workshop sought to answer the leading question: "Are the changes observed in continental aquatic systems over the last 50 years and foreseen for the next 50 years caused by global climate change or by anthropogenic drivers?" Emphasis was plavced on the multiple impacts on land and water use generated through changes of physical, hydrological, chemical and biological processes affecting the occurrence and fluxes of water resources.
In four working groups (Water Quality, Biogeochemical Cycles, Suspended Sediment Fluxes, Global Changes), the 20 participants from the wider IGBP community and projects such as HELP, ORSTOM (IRD), and IHP addressed 5 subset questions:

- How have water resources evolved since the development of agriculture?
- How have water resources been modified by human activities?
- How have these changes affected the coastal zone?
- How will climate change and anthropogenic changes affect future water resources?
- How have biogeochemical cycles been, and how will they be affected by changes of river and groundwater fluxes?

Major findings of the meeting pointed out that human activities seem to encompass the most prominent drivers of environmental changes rather than climate. The cumulative changes observed in the hydrological cycle at a global scale are significantly driven by damming, water diversions and withdrawals. These modify the physical components of aquatic environments, particularly in river systems in terms of, for example, sediment retention and reduction of water flow. Land-use changes through engineering, constructions, deforestation and agriculture, which have been of increasing influence for over the last 2000 years, now are proceeding at an accelerated rate and leading, for example, to severe deforestation in the humid tropics and desertification in the arid tropics. Increasing water demand for irrigation is expected and has been seen to cause severe drops in water quality through salinization of surface and ground waters.

In conclusion, global climate change therefore might not be the most immediate critical issue, partly because it follows a moderate timeline compared to human-induced changes. However, it cannot be neglected that in areas where specific geomorphologic settings are more sensitive to changes in the water balance, global climate change exerts a major pressure and is the primary cause for system function and services changes. Such areas include the coastal zones where salt water intrusion will affect the coastal aquifers following sea-level rises.

A full report of the workshop shall be published in Science journal in April/May, 2000.

Nutrient budgets and modelling in South Asia

(LOICZ UNEP biogeochemical workshop, 14-17 February 2000)

LOICZ has developed over 100 site budgets describing the net metabolism and models of nutrient flux in estuarine and coastal lagoon systems globally, using the LOICZ approach developed earlier in the life of LOICZ. The target of an array of settings, in excess of 200 site descriptions, is needed if we are to make a first assessment of global changes in material fluxes and the coastal system responses across the salinity interface. The recent support from UNEP with GEF funding has provided a major impetus to this LOICZ effort, providing for training and evaluation workshops across most regions.

The recent workshop in India was generously hosted by the National Institute of Oceanography in Goa and addressed ecosystems in the South Asia region. Representatives from India, Bangladesh and Sri Lanka joined in the workshop of tutorial and plenary activities to train and use a variety of recently developed modelling tools, and to develop coastal site models using existing data. Relatively unimpacted to highly polluted systems were considered as working examples. The strong achievement and outputs will be reported in a LOICZ R&S report and placed on the LOICZ web site. It is expected that participants will continue to make contribution to this wider LOICZ effort by further assessments of nutrient transfer and fluxes in additional coastal systems from the region.

Caribbean "Data Mining"

(IOCARIBE-GODAR project)

Paul Geerders, Regional Project Co-ordinator, IOCARIBE-GODAR. (email:pgcons@wxs.nl)

Historical ocean and coastal data form an essential basis for research on processes in the coastal zone such as carried out in the framework of LOICZ. Such datasets serve to build time series of variables which can be used to detect changes and trends, they provide an insight in the
behaviour of variables which in turn can form a basis for the development of models, and the behaviour of variables in the past contributes to the tuning of the characteristics of measurement and monitoring systems for an improved efficiency of these.

GODAR stands for Global Oceanographic Data Archeology and Rescue Project, a project initiated by IOC at its Seventeenth Session, March 1993. It was observed that many of the historical data sets of

the region are still in manuscript form or some analogue form, often there are no backups available and there are no established procedures for their management. As a consequence, historical data sets may easily be lost due to deterioration of the carrier or media, calamities or accidental erasure. In several cases it is even doubtful whether the required hardware still exists to read the digital or analogue media of the past.

Institutions and organisations in the IOCARIBE region hold a wealth of historical ocean and coastal data sets, while other datasets on this region are kept in archives outside the region. A part of these was identified at the IOC Regional Workshop for Member States of the Caribbean and South America, GODAR-V, held in October 1996 in Cartagena de Indias, Colombia.

In view of the importance of historical ocean and coastal data for research and other activities in the IOCARIBE region, such as for LOICZ, the IOCARIBE-GODAR project was initiated in April 1999. This project will have the following Terms of Reference:

- identify historical marine and coastal data sets in the IOCARIBE countries,
- compile and publish an inventory of these data sets on CD-ROM and on a Web Site,
- set priorities for recuperation of data sets taking into account current and on-going activities in the IOCARIBE region, and
- carry out recuperation of specific data sets, taking into account the priorities defined and the availability of funding.

During a short workshop of experts from the region 21-23 February 2000, again in Cartagena de Indias, a Project Plan has been developed. This Plan defines in more detail the Terms of Reference of the IOCARIBE-GODAR project and its Implementation Plan, and also identifies possible funding sources.

The Way Ahead – towards an IGBP II & implications for LOICZ

SC IGBP and IPO Meeting Cuernavaca, Mexico, February 2000.

No argument, Water, is important. Thus it did not really surprise that a relatively small piece of frozen water seems to show the way into an IGBP II future. The Vostok ice core provided a major thrust for the discussions on an evolution of the IGBP programme. The main theme taken from the ice was – we have to respond to the earth as a system and enter into integrative "Earth System Science". This means a future IGBP will follow a systemic approach to earth system functioning and effects of global change.

However, while there was broad agreement on the importance of interfaces such as water-land-atmosphere, the strength of a continued IGBP is to come out of a compartmented structure addressing the three spheres. "Futures" meetings for each compartment in 2000 will provide a road map for the scientific community, guiding questions and necessary links between the compartments.

While this may be indicative of a shift to a more holistic perspective into the biogeochemical IGBP world, the point was frequently made that "people" are central to the global providing the major forcing function of the interfaces. The urgent need for closer operational agendas with IHDP and WCRP was emphasised.

Scientifically, the most appropriate response for "holistic thinking" for the moment seems to be the "cross cutting activities" addressing carbon, food and fibre (LOICZ made a clear point here that "fin" has to be included) and water. Thus, these activities will be crucial issues for presentation in the IGBP Open Science Conference in Amsterdam in July 2001 www.sciconf.igbp.kva.se. There, insights into the achievements of IGBP's synthesis and the integrative activities will provide an "historical" perspective on which to envision the future needs and strategies. The recent Stockholm meeting on "WATER" allows an important glimpse of how far we have progressed.

A key to bringing the Programme message across will be an IGBP wide Communication providing for dissemination of results, applicable products and perspectives. This will be a priority item on the agenda of the new IGBP science communicator and for improved web based by core projects.

What are the issues and how will LOICZ respond?

Earth System Science will have to deal with interfaces and the boundary conditions set by people. The drivers of systems change and change itself will have to be reviewed in a dynamic context: i.e. what are the uncertainties, the non-linearity and the teleconnections we see when applying a truly global perspective. No longer can we neglect the extent of human interference with the earth system – realizing that it is a crucial part, the term "anthropocene" was developed during the meeting to best describe the current geological age.

LOICZ neeeds to account for the effects of changes and their inherent value in coastal systems functions, goods and services. The various foci will continue to provide the scientific information to describe the fluxes and state changes but additional efforts will concentrate on the drivers of change and the potential responses. We see the life support function of the coastal resource system as a crucial outcome from Focus 4 activities and integrating the other Foci. Evaluations of environmental goods and services will thus become a further target of LOICZ integrative modeling efforts.

Increased collaboration with other projects (BAHC, LUCC, GLOBEC) will help address the water continuum as a whole, to describe the pathway of material transport and how changes and affect the systems. LOICZ Typology efforts have already started to enable this collaboration. Jointly with PAGES, LOICZ is trying to differentiate the anthropogenic influence on sea level rise phenomena on global scales. This will contribute to the discussions of coastal vulnerability, management and protection. The continuing work on typology questions – identifying the similarity and dissimilarity features of coastal settings and allow for use of secondary data for upscaling – may provide a vital tool in development of management response options.

Announcing a Symposium on *Nutrient Over-enrichment in Coastal Waters: Global Patterns of Cause and Effect*

October 11-13, 2000

The National Academy of Sciences,Washington DC, USA

This symposium, which is co-convened by the U.S. National Committee to the Scientific Committee on Oceanic Research (SCOR), the American Society of Limnology and Oceanography (ASLO), and the Estuarine Research Federation (ERF), will be hosted by the Ocean Studies Board of the National Academies.

Through two and one-half days of plenary discussion, highlighted by presentations from distinguished scientists from around the world, this symposium will explore a number of recent investigations into the role of nutrient over-enrichment in the declining environmental quality of the world's coastal regions. Topics to be covered include recent expansion of our understanding of the sources of nutrients, fate and effects of excess nutrients in coastal environments, patterns of temporal response to enrichment and abatement, and political and social aspects of nutrient control. Results of national and international efforts to assess, understand, and mitigate this growing problem (e.g., International SCOPE Nitrogen Project, Coastal GOOS, GEOHAB, U.S. Clean Water Action Plan) will be presented in an effort to facilitate the exchange of understanding and experience between scientists and managers working in coastal areas around the world.

For more information about this event, please contact Dr. Dan Walker, Symposium Director, by email at dwalker@nas.edu, by telephone at (202) 334-2714, or by mail at the National Research Council, HA 470, 2101 Constitution Ave., NW, Washington, DC, U.S.A., 20418.

LOICZ, with other core projects, has agreed to contribute to the overall IGBP efforts towards stronger internal and external communications. Here we are trying to improve communication not only among the scientific community and clients (IGBP) but to pursue stronger engagement with the user community, particularly acting as a "broker" to relate scientific work with interest groups.

HAVE YOU SEEN.....

Impacts of Populations & Markets on the Sustainability of Ocean & Coastal Resources – Perspectives of developing and transition economies of the North Pacific. 2000. Collection of Papers from the International Conference, 3-4 June 1999, Seattle, 277pp. Eds. Vlad M. Kaczynski and Dave L/ Fluharty, School of Marine Affairs, College of Ocean & Fishery Sciences, University of Washington, Washington, USA.

SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH

EXECUTIVE DIRECTOR

The Scientific Committee on Oceanic Research (SCOR) is seeking an Executive Director. SCOR is an interdisciplinary committee of the International Council for Science and is the leading non-governmental organization for the promotion and coordination of international oceanographic activities. Scientists from thirty-nine member countries participate in SCOR activities that include working groups addressing tightly focused scientific problems. SCOR has also proposed and planned large international collaborative efforts such as the Joint Global Ocean Flux Study (JGOFS) and Global Ocean Ecosystem Dynamics (GLOBEC). SCOR often works in association with intergovernmental organizations such as the Intergovernmental Oceanographic Commission and the International Council for the Exploration of the Sea.

The duties of the Executive Director include i) the daily operation of the SCOR Secretariat, raising funds, and administration of the budget; ii) liaison with national SCOR committees; iii) liaison and support of working groups and scientific committees of large programs; iv) organization of the annual meeting of SCOR; v) representation and promotion of SCOR and the ocean sciences at meetings of other international research organizations; vi) preparation of reports of SCOR meetings and other publications.

The successful candidate will i) preferably have a Ph.D. or the equivalent in a field of Marine**,** Earth and Environmental Sciences; ii) have a proven interest and involvement in oceanic or global environmental change research; iii) be well acquainted with international scientific collaboration in general; iv) excellent English oral and written communications skills are essential (knowledge of other languages is an advantage); v) have a proven record of writing successful grant proposals; and vi) possess some understanding of basic accounting and financial management practices.

The position should preferably continue to be based in the Department of Earth and Planetary Science, Johns Hopkins University in Baltimore. The initial appointment period is three years.

*Letters of application, a curriculum vitae, and the names of three referees should be sent no later than **15 May 2000** to the SCOR Secretariat, Department of Earth and Planetary Science, Johns Hopkins University, Baltimore, MD 21218, USA. Tel. 410-516-4070, Fax. 410-516-4019, E-mail: scor@jhu.edu, Web page: http://www.jhu.edu/~scor/*

Margin Flux in the East China Sea (MAFLECS) 1999. Eds Dunxin Hu and Shizuo Tsunogai, 247pp. China Ocean Press, Beijing.

The Adriatic Sea. Ecosystem Research Report No 32. 1999. Proceedings of the workshop "Physical and biochemical processes in the Adriatic Sea, Portonovo Italy 23-27 April 1996. Eds T.S. Hopkins, A. Artegiani, G. Cauwet, D. Degobbis and A. Malej. Directorate-General for Research, European Commission. EUR 18834, 638pp.

Web site: Integrated Coastal Zone Management. (www.nos.noaa.gov/icm/). A global web service on integrated coastal management – a cooperative undertaking of the Intergovernmental Oceanographic Commission (IOC), the National Ocean Service of NOAA, the Centre for the Study of Marine Policy at the University of Delaware, and the World Bank.

LOICZ PUBLICATIONS

(Available as printed copies or from the LOICZ web site (www.nioz.nl/loicz/) *LOICZ OSM4. 1999.* Conference Proceedings of Open Science Meeting, Bahia Blanca, Argentina, November 1999. Eds. C.J. Crossland, H. Kremer and J.I. Marshall Crossland.

Estuarine Systems of the South China Sea Region: C, N, P Fluxes 2000. LOICZ UNEP workshop report. Eds. V. Dupra, S.V. Smith, J.I. Marshall Crossland and C.J. Crossland. LOICZ R&S no. 14.

Estuarine Systems of the South American Region: C, N, P Fluxes 2000. LOICZ UNEP workshop report. Eds. V. Dupra, S.V. Smith, J.I. Marshall Crossland and C.J. Crossland. LOICZ R&S no. 15.

LOICZ Web site: *Typology* (http://water.kgs.ukans.edu:8888/public/Typpages/index.htm)

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

LOICZ CALENDAR

- LOICZ-UNEP workshop on estuarine systems of East Asia June 2000, TBA. *(by invitation)*
- AfriBasins I workshop on catchment/ coastal fluxes and human dimensions. July 2000, Nairobi or Mombassa *(by invitation)*
- South American Basins on catchment/ coastal fluxes and human dimensions SAMBAS II. September 2000, Caracas, Venezuela. *(by invitation)*
- LOICZ-UNEP Africa workshop on estuarine systems. September 2000, Zanzibar. *(by invitation)*
- LOICZ SSC Meeting, 2-5 October 2000, Arcachon, France. *(by invitation)*
- Meditteranean, Black Sea, North Africa workshop on estuarine systems. November 2000, Athens, Greece. *(by invitation)*

OTHER MEETINGS

- JGOFS 2nd Open Science Conference. 13-17 April, 2000, Bergen, Norway.
- Sustainable use of estuaries and mangroves: challenges and prospects. 22-28 May 2000, Recife, Brasil.
- 5th Congress on Marine Sciences Marcuba. 19-23 June, 2000, Havana, Cuba.
- Large Deltas and their impact on coastal zones. 5-7 July 2000, Ispra, Italy.
- 6th Annual CERCI Conference on Marine Environment: Science and Law. 10-13 July 2000, Scarborough, UK.
- Coastal Zone Canada 2000. 17-22 September, New Brunswick, Canada.
- International training workshop on Integrated Coastal Area Management and its integration with Marine Sciences. 25-30 September, St. Petersburg, Russia.
- IEP 2000: Issues in Global Change. 16-18 October 2000, Lisbon, Portugal.
- 9th International Coral Reef Symposium. 23-27 October 2000, Bali, Indonesia.
- The Third World Fisheries Congress. 31 October-3 November 2000, Beijing, P.R. of China.
- IGBP Open Science Conference. 10-14 July, 2001, Amsterdam, The Netherlands.
- Detecting Environmental Change: science and society. 16-20 July 2001, London, UK.
- Joint IAPSO-IABO Assembly, Mar del Plata, Argentina, 21-28 October 2001.

IPO STAFF

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