

# LOICZ NEWSLETTER

## Estimation of the nutrient inputs into medium and large river basins — A case study for German rivers

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One of the main objectives of LOICZ is to determine the fluxes of nutrients to the coastal zone. Because most of the load to the coastal zone is carried by medium and large rivers, there is a need for tools to estimate the nutrient load from such river basins into the

This is the twelfth 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.

coastal zones. These depend on the uses of nutrients in the human sphere and on the inputs reaching the river system by different point and diffuse pathways.

The model **MONERIS**<sup>1</sup> (**MO**delling **N**utrient **E**missions in **R**iver **S**ystems) was developed to estimate the nutrient inputs into river basins of Germany from point sources and various diffuse pathways. The model is based on data of river flow and water quality as well as on a geographical information system (GIS), including digital maps and extensive statistical information. Whereas point inputs from waste water treatment plants and industrial plants are directly discharged into the rivers, diffuse inputs into surface waters are caused by the sum of different pathways, which are realised by separate flow components (see Figure 1) and different nutrient concentrations. Consequently seven pathways are considered:

- point sources
- atmospheric deposition
- erosion
- surface runoff
- groundwater
- tile drainage
- paved urban areas

Along the path from the source into the river, substances are governed by manifold processes of transformation, retention and loss. Knowledge of these processes is necessary to quantify nutrient inputs into the rivers. Since this knowledge of the processes and the database is limited, the description of the processes could not be done by detailed dynamic models. Therefore, MONERIS estimates the pathways with existing and new conceptual approaches. The main topics of the model development were:

- to develop a GIS-supported

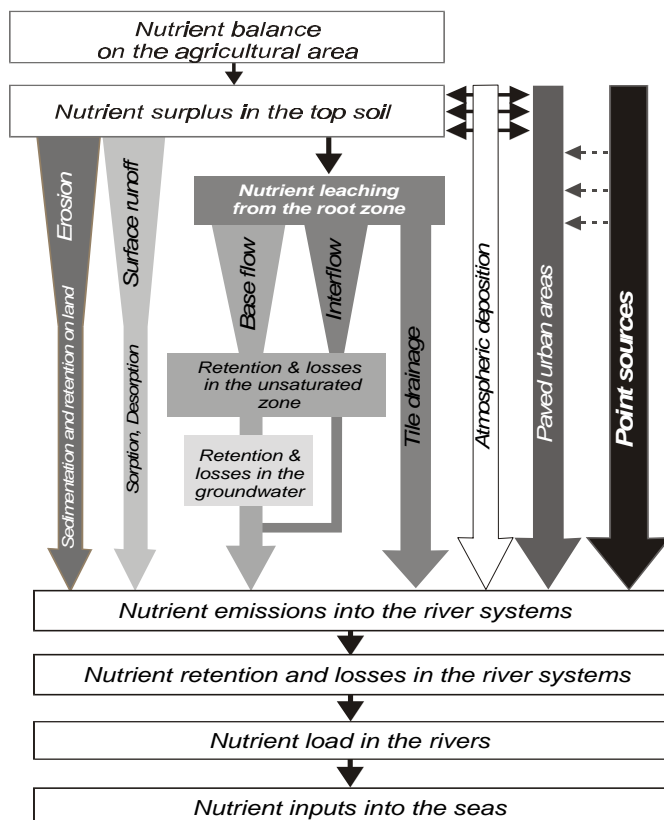


Figure 1. Pathways and processes within MONERIS

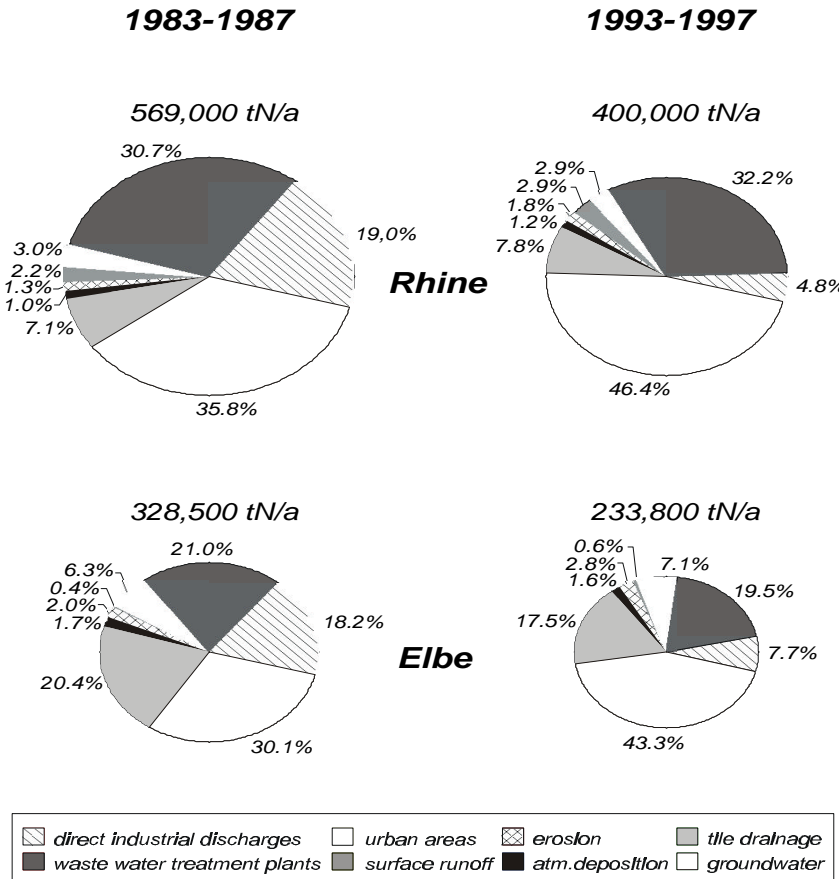


Figure 2. Nitrogen emissions from the different pathways into German river basins in the time periods 1983-1987 and 1993-1997

temporal changes of nutrient inputs were calculated considering the difference in hydrological conditions for both periods.

The results include the calculations of the nutrient inputs for the basins of the most downstream German monitoring station of the largest German rivers: Rhine (159,700 km<sup>2</sup> upstream of the monitoring station at Lobith; located at the Dutch-German border) and Elbe (134,900 km<sup>2</sup> upstream of the monitoring station at Zollenspiker; last station not influenced by tide) emission data are presented in Figures 2 and 3.

**Nitrogen**

Total nitrogen input to the river system of the Rhine basin in the period 1993-1997 was 400 kilotonne N/annum (ktN/a). This represents a reduction of 169 ktN/a or 28% since the mid-eighties. Some 46 % of the total nitrogen inputs into the Rhine basins is from groundwater. The second major source is the discharges from municipal waste water treatment plants. Whereas the direct industrial discharges were the third dominant pathway in the mid eighties, this source contributes now only 4.8 % to the total inputs.

For the Elbe basin, total nitrogen inputs into the river system of 233.8 ktN/a are estimated for the period 1993 to 1997. This is a decrease of 95 ktN/a or 29% since the mid-eighties. In the Elbe basin, the groundwater pathway is also the major source of N-input with 43.3 %. Contrary to the Rhine situation the contribution of municipal waste water treatment plants is lower, reflecting a lower population density. Otherwise the proportion of tile drainage is much higher in the Elbe area, because more agricultural land was artificial drained by tiles. The direct industrial discharges show also the largest reduction. The main reason for the decrease of the N-inputs into the river systems was the large reduction of N-discharges from point sources (46%). The estimated decrease of diffuse inputs was only about 10%.

In spite of the substantial decrease of the nitrogen surplus in agricultural areas, only a slight reduction

method for regionally differentiated estimation of diffuse and point inputs into river basins of a size of more than 500 km<sup>2</sup>,

- to establish a submodel for regionally differentiated estimation of nutrient discharges from municipal waste water treatment plants by a detailed inventory of these plants,
- to establish a submodel for inputs of nutrients and suspended solids caused by erosion, which is based on the uniform soil loss equation but considers only those areas, which are connected to the river system,
- to develop a submodel which allows the estimation of groundwater concentrations of nitrogen from the surplus in agricultural areas by means of a retention function, which is influenced by hydrogeological conditions and the rate of groundwater recharge,
- to develop a submodel for estimation of the agricultural areas modified by tile drainage; the submodel is based on soil types and soil water conditions,

- to establish a submodel for different pathways of nutrient losses from urban areas considering the regional differences in the sewer systems, and
- to establish a submodel for nutrient retention and losses in surface waters, which can be applied for all river basins. This model is based on the relationship between the nutrient retention and the hydraulic load, or the specific runoff in the river system.

One specific topic of the model development was to validate the different submodels by using independent data sets. For example, the ground water model was developed on the basis of the observed nitrogen concentrations in the ground water and not on the observed nutrient loads in the rivers.

The use of a GIS allows a regionally differentiated quantification of nutrient inputs into river systems. Therefore, estimations were not only carried out for large river basins. Altogether the MONERIS model was applied to 300 different river basins for two time-periods, 1983-1987 and 1993-1997. The

of the nitrogen inputs from the groundwater was estimated for the Rhine basin. In other river basins the nitrogen inputs along this pathway will still increase during the nineties due to the long residence times of water in the unsaturated zone and in the aquifer. However, after the year 2000 the reduced nitrogen surplus will be followed by slow reduction of the nitrogen inputs from groundwater. The consequence is that the nitrogen load from these rivers in the coastal zone will further decrease after the year 2000.

**Phosphorus**

For the Rhine (upstream of Lobith), a total P-input of 20,500 tP/a is estimated for the period 1993-1997. In comparison with the mid-eighties, this is a reduction of 30,600 tP/a or 60%. The enormous reduction in the discharges from municipal wastewater treatment plants could only partly change the dominance of this source. This pathway still counts for 42.8% of the P-inputs. However, the sum of the diffuse inputs now represents more than half of the P-input to the Rhine basin. Among the diffuse pathways, erosion is the major source for inputs of dissolved phosphorus via surface runoff and diffuse inputs from urban areas.

For the Elbe basin above Zollenspieker, a total P-input of 12,500 tP/a is estimated for the 1993-1997 period. The reduction amounts about 52% (13,300 tP/a) since the 1983-1987 period. Also in the Elbe basin, the point sources represent the major source of phosphorus inputs but the sum of the total diffuse pathways is now more than 60%. The dominant diffuse pathway is also erosion, followed by the dif-

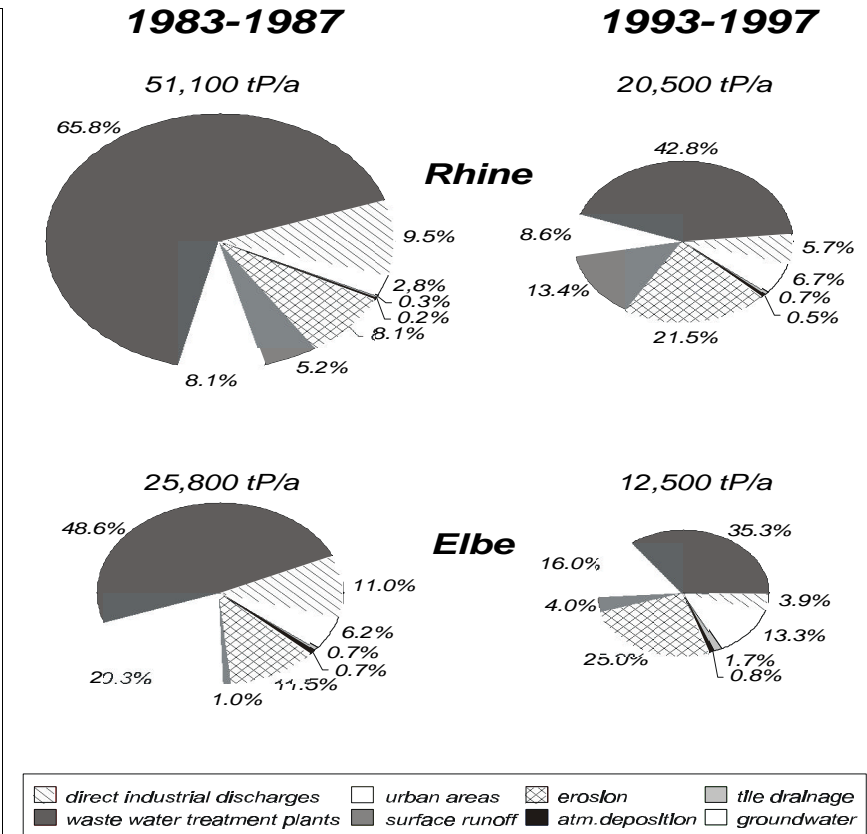


Figure 3. Phosphorus emissions from the different pathways into German river basins in the time periods 1983-1987 and 1993-1997

fuse inputs from urban areas.

The decrease of phosphorus inputs is again mainly caused by a 80% reduction of point discharges. The decrease of diffuse phosphorus emissions was larger than for nitrogen, which is caused by a 56% reduction of the emissions from urban areas.

Among the basins of the large rivers, the changes of nutrient inputs into the river systems as well as the contribution of the individual pathways to the total inputs vary over a wide range.

As shown in Table 1 the observed N- and P-loads in the Rhine and

Elbe are lower as are the inputs, which is caused by retention and loss processes (e.g., denitrification, sedimentation, adsorption) within the surface waters of the basins. The level of the retention within the river system of Elbe is much higher than in the Rhine, which can be explained by the different hydrological and morphological conditions in both basins. If the conceptual model approaches of Behrendt & Opitz (1999) are applied the load can be calculated from the inputs.

The nutrient loads, which were calculated on the basis of measured flow and nutrient concentrations, show for the investigated river basins similar changes as the nutri-

Table 1: Nutrient inputs and calculated loads of total phosphorus and dissolved inorganic nitrogen (DIN=NO<sub>3</sub>+NH<sub>4</sub>+NO<sub>2</sub>) for the Rhine and the Elbe

			Rhine		Elbe	
			1983-1987	1993-1997	1983-1987	1993-1997
N	Sum of all inputs	[ktN/a]	569.0	400.0	328.5	233.8
	DIN-load calculated from inputs	[ktN/a]	382.6	259.9	159.3	107.6
	DIN-load cal. from monitoring	[ktN/a]	355.2	267.2*	145.1	111.7
P	Sum of all inputs	[ktP/a]	51.1	20.5	25.8	12.5
	Load calculated from inputs	[ktP/a]	36.5	14.1	10.2	4.7
	Load calculated from monitoring	[ktP/a]	35.3	14.2*	11.7	4.6

\*average load for the years 1993-1996 only

ent inputs for the time period between 1983-1987 and 1993-1997 (see Table 1).

The calculation of different scenarios shows that the target of a 50% reduction of the nitrogen load into the coastal zone, as required by the Helsinki Commission (HELCOM) and the International Conference for the Protection of North Sea, can not be reached only by measures focused on the decrease of the nitrogen inputs from point and diffuse sources. Additional measures for an increase of the nitrogen retention and losses near to or within the surface waters of a river system (e.g. buffer strips, reconstruction of wetlands, ...) are necessary.

The experience from the analysis of German river basins shows that MONERIS can be a tool which helps to explain and to manage some problems in the coastal zone caused by riverine inputs.



### Making Science useful – Exploiting Scientific products and fostering a European Strategy for ICZM

*Hartwig Kremer, LOICZ IPO*

Science is increasingly under critical review for deliverables and applicability. So it was no surprise that the EU Commission in Brussels being aware of the problem and human welfare orientation of its recently launched 5<sup>th</sup> R&D Framework Program, and entered this discussion on two occasions in July 1999.

The first joint meeting of the project leaders of ELOISE (European Land Ocean Interaction Studies, supported by Directorate General, DG, XII) and the EU ICZM Demonstration Program (run by DG XI) discussed potential of promoting exchange of knowledge and information between coastal science and management. Communication between stakeholders in the science and management community, and questions on what EU policy could contribute received priority attention. Followed by a plenary of several Directorates General and user groups, the question was posed of how these links might facilitate the

implementation of a European Strategy for ICZM, as previously recommended in 1992/94 by the European Council of Ministers.

From a LOICZ perspective, focus was on how to better include socio-economic science in integrated modelling of coastal change processes (as flagged in last year's second annual ELOISE meeting in Huelva, Spain). Also aspects of science communication and dissemination were touched on.

The major issues to come out are:

- Finding a common language to overcome cross-sector communication barriers (in this context – to generate increased understanding of science relevance to socio-economic and management issues);
- Weighing management expectations against science deliverables;
- Matching the different spatial and temporal scales of natural and administrative systems/units;
- Providing science and scaling tools to allow for policy making aimed at management processes and/or procedures on different geographical and societal levels; and
- Making science responsive to the coastal issues through better linking with socio-economic factors

The user needs for scientific products were discussed at an associated gathering of executive bodies of the EU Commission, clients and users including the EEA (European Environment Agency, Copenhagen) and the EUCC (European Union for Coastal Conservation), as well as national CZM centres. The political and scaling dimension also received more detailed consideration.

Important for LOICZ/ELOISE is that within Europe alone scales of policy-making and executing structures are so variable that a proper scaling of scientific outcomes to the needs of respective management action is a real challenge. Transboundary processes – here in a geographical and intercultural rather than biogeochemical sense – further complicate science - management interaction.

Since LOICZ and its core project

ELOISE encompass a huge array of interdisciplinary science and provide a good spatial coverage, these large synthesising projects may take a leading role as a "broker" in transfer of issue-driven science and products between client groups and scientists. They can facilitate horizontal and vertical networking, which have been identified as crucial means for preparing the ground for joint ownership of issues and research. Response options can thus be derived and underpinned from well-reviewed science, provided that the consultation and dissemination processes will use well-accepted mentors who link science and non-science players.

To allow for proper scaling, research must explicitly address domains of drivers of change and state descriptions of ecological and economic systems and the respective impacts. The co-evolution and interaction of the two systems will then create quantified pictures of the impacts induced on both systems by the respective drivers. Science must also allow for the evaluation and determination of past, current and future response performance and options. Policy-making and management decisions will thus be subject to review on relatively neutral ground.

Being responsive to these needs, for LOICZ this can be seen in the development and application of standardised scientific approaches taken for biogeochemical and socio-economic modelling, and efforts to link these models. The development of indicators describing natural and human driven change and the efforts taken to generate a broader scientific picture of the consequences for environmental and human welfare will enable various issues of multi-client groups to be addressed. Two features within LOICZ will be of particular interest here:

- **The BASIN approach** (outlined by Wim Salomons – Newsletter 9 12/98) which aims to encompass the system functions and changes along whole river catchments and capture it by means of the critical loads of nutrients carbon and sediments entering or passing through the coastal basin as a receiving body.

This aims to translate human- and natural-driven state changes of even freshwater systems into respective coastal systems employing the currency of biogeochemical cycles and their flux changes as indicators from which to derive critical loads. To apply the DPSIR framework here allows the inclusion of impacts on the society into the integrated modelling. In IGBP this "water-continuum link" is captured through the approach taken by the cross project exercise "Continental Aquatic Systems". Horst Behrendt (this issue) gives a practical example of the sort of research that will contribute significantly to this LOICZ approach.

The EU Commission is promoting interdisciplinary science in its 5<sup>th</sup> R&D-Programme and tries to channel the outcomes into the WAtER (Wetland and Aquatic Ecosystem Research) science programme and the Water Directive thus putting science into practical policy making. Institutional capacities involved on this European level can include for example the JRC (Joint Research Centre, Ispra) and the EEA, Copenhagen.

• **The Typology approach.** Encompassing the biophysical/geochemical in combination with the human dimension of coastal changes, LOICZ can provide tools for a considerable range of applications, which may prove beneficial for management purposes.

Appropriate scaling is a key feature and applies to the societal, economic and administrative scales of a certain coastal and change regime as well as to the natural, i.e. environmental or habitat scale. The collection of data in an interdisciplinary typology database, as in LOICZ, provides the platform from which to pull out the information (processed data) needed to address coastal change issues on temporal and spatial scales from local to national to regional to global.

This typology may even become more beneficial if a good coverage of natural and socio-economic data can be gathered for each coastal pixel in order to be fed into a standardised descriptive framework like the DPSIR (Driver, Pressure, State,

Impact, Response framework as outlined by OECD in 1994 and developed further with LOICZ by Turner and co-workers – see LOICZ R&S Report No. 11). Employing specific cluster and similarity analysis may then enable gathering sets of comparable DPSIR regimes from different locations to provide sound scientific information for areas in which the same policy and management approach may apply. Summarised the tool to be developed here: a DPSIR-Typology. The establishment of standardised monitoring schemes such as the IOC-GOOS (Global Ocean Observing System) is another aspect.

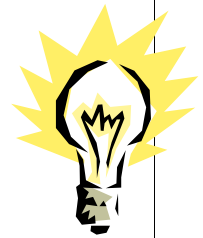
The platform on which to perform the necessary development of joint issues and the continuous science development and dissemination process together with the users has already been identified in several regions including Europe. The EU-ICZM Demonstration Programme - comparable to the "Stakeholder Dialogue Groups" used in the CRC Reef Programme in Australia - has established "Coastal Fora" for example in UK which aim to function as a hub for generating joint ownership and deliberate issue-led science exploitation. LOICZ as well as ELOISE can play a major brokering role, providing the stage on which to talk and to deliver sound scientific information on neutral grounds to these multi-user dialogue groups.

However, one final and more psychological argument that came up frequently in Brussels in the discussion on indicators and prediction of scenario developments should not be neglected. In managing uncertainty there is a mismatch of expectations towards science and scientists and what can be delivered. Integrated modelling for instance, often refers to other temporal and spatial scales than administrative or management units. Furthermore, even hard scientific results mostly operate with some error probability. Of course hind-, now- and in particular fore-casting of the development of indicator functions and scenarios is requested, but understanding of those "scientific uncertainties" should be developed in parallel and the implications for decision-making should be deliberately discussed. And, last but not

least, it might be helpful – in terms of following a responsible precautionary policy – to credit scientific results and scenario modelling with a bit more patience and respect. This already happens every day without too much doubt in cases of the "weather man/woman" whose statements as a scientist are received with much more respect and flexibility towards uncertainty than those of "professional scientists". However, one has to be cautious here because there is considerable difference in the spatial and temporal scales applying to prediction of coastal change scenarios and to the weather forecast of the following days....

### UNEP-GEF: Vital Support for LOICZ

*Chris Crossland*



LOICZ has received a major boost – to the tune of USD720 000 - by winning a major project funded by United Nations Environment Programme – Global Environment Facility (UNEP-GEF). The project (*The role of the coastal ocean in disturbed and undisturbed nutrient and carbon cycles*) runs over 30 months and started in July 1999.

This is a huge stimulus to the nutrient budget and up-scaling activities of Foci 2 and 3. The work will result in several hundred empirical models of carbon and nutrients in undisturbed and disturbed (impacted) coastal ecosystems, assessing the state of eutrophication and carbon sink/source status of the coastal seas.

Upscaling, using model-derived empirical data as surrogate information, will provide regional and global estimates of carbon flux required for balancing the global carbon budget and assessing the role of the coastal ocean in the global carbon cycle.

The project has a major training and capacity building focus, building on the earlier regional workshops and using the LOICZ Biogeochemical Budgets protocols. Some 7 regional workshops will be

held in Asia, Africa and the Americas - the first was in Manila (July 1999) addressing the South China Sea. The workshops will promote use of the LOICZ model guidelines and train a large numbers of developing country scientists, including additional specialist training of 6-8 developing country scientists and a network of modelling advisors in the three developing regions. In addition, three thematic workshops will develop budgetary generalisations for major coastal systems types, using as a framework LOICZ typology methods. A global synoptic workshop will complete the project work.

The Universities of Hawaii, Stockholm and Kansas are focal points for specialist training and development, and regional mentors are planned to be located in Mexico, the Philippines and India in the first instance. Further information can be obtained from LOICZ IPO.



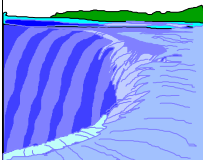
### More budgets... Central America and South East Asia

More than 70 coastal and estuarine budgets have been added to the LOICZ compendium (see LOICZ website) in the last 12 months. Two recent workshops – one in Merida, Mexico (February 1999) and one in Manila, Philippines (July 1999) – have contributed about 40 site evaluations.

The 14 regional and international scientists at the Merida workshop developed budgets across the Central America region, with a focus on the Yucatan – an area with geographically distinct water-flow regimes (predominantly surface waters in the southwest; groundwater in the northwest). In addition to site budgets and training, the workshop delivered a new protocol and guidelines for estimating groundwater fluxes to the estuarine systems and a framework for typological assessment of the region. The workshop was hosted by CINVESTAV-Merida and a comprehensive report (LOICZ Reports & Studies No. 13) was published in June 1999.

The Manila workshop was the first of the UNEP-GEF supported suite and addressed the South China

Sea area. Scientists from China, Indonesia, Malaysia, Philippines, Thailand, and Vietnam joined a LOICZ resource group. About 25 site budgets were developed for the region, and training was provided in the use of the LOICZ Biogeochemical Guidelines. New assessment guidelines for waste load calculations and water catchment inputs were developed, along with a preliminary regional typology on water flux and population parameters. Nguyen Huu Huan, from Vietnam, has accepted the first UNEP-LOICZ Traineeship and is currently working with Steve Smith and Vilma Dupra at the University of Hawaii. Liana Talaue-McManus and the "dynamic crew" from the Marine Science Institute, University of the Philippines, hosted the workshop and a full LOICZ R&S Report is in preparation.



### Groundwater Studies Progress

About 25 participants attended the SCOR/LOICZ working group on groundwater discharge (SGD) met at the, University of Birmingham, UK July 22-24, 1999 in conjunction with the IUGG Congress.

Some key elements and activities include:

#### Task 1: Assessment and Modeling

- Components of SGD include freshwater and/or brackish water originating from on-shore recharge areas, recirculating seawater, and saline groundwaters, but a clear definition is being developed, with a focus on the quantification of fluid discharge by SGD.
- Scaling is an issue, encompassing: (1) the meter scale, for example, seepage meters, (2) the ten-meter scale characteristic of saline water intrusion and recharge, (3) the ten-kilometer scale common in the assessment of nutrient fluxes to the near-shore environment; and (4) the hundred meter to hundred-kilometer scale relevant to regional oceanographic studies and typology.
- A report describing and discussing the strengths and limitations of each modelling and

#### Task 2: Measurement, Sampling, and Experimental

- Various regions were considered and information reviewed including: Perth region and Spencers Gulf, Australia; Southern India; Florida; Japan; and continental US. Limited published data on water flux estimates is available from South America, Africa, India and China.
- The intercalibration plan intends to assess the different methods and uncertainties of determining SGD. Funding is being sought from the IOC. Some initial work will proceed in Florida and Perth.

#### Task 3: Typology, Globalization, and Integration

- Typology may be applied to the estimation of groundwater flux potential using parameters like soil type, precipitation, evaporation, or aquifer thickness. In addition, it may be applied as a means of scaling up site-specific or local studies to a regional or global estimation based on similarity of coastal types or regions.
- Some typology data which are needed in the correct form are: rock type (e.g., limestone or granite coverage), depth of geologic features, geologic settings (e.g., coastal plain or volcanic terrain coverage), and aquifer characteristics (hydrogeologic parameters). Also required are morphologies relevant to SGD such as karats, deltas, coastal plains, volcanic terrain and urban systems.
- Fractal dimension of the shoreline should provide a measure of the shoreline's tortuosity, and hence, the degree to which SGD is focused into embayments as opposed to a more diffuse discharge into the open coastal ocean.

### Trace gas in marine systems

A recent monograph (see "Have you seen...") by Hein de Wilde; provides a vital assessment of marine systems and emissions of two key trace gas greenhouse gasses: methane and nitrous oxide. These

**4<sup>th</sup> LOICZ Open Science Meeting,  
Regimes of Coastal Change,  
Bahia Blanca, Argentina, 15-18 November 1999**

The 4<sup>th</sup> LOICZ Open Science Meeting – where are we right now?

**Participation**

- Representing a range of scientific disciplines from about 200 scientists and coastal managers from South and South East Asia, Africa, Australia and Oceania, Europe, and Latin America and North America.
- More than 100 topical abstracts addressing the different major issues.
- IAPSO (Argentina), having its regular meeting.

**OSM - programme**

- Programme covers five topical sessions and 3 working groups:
  - 1: Interregional Comparisons: Regional Pressure-State Issues
  - 2: Human Dimensions of Fluxes
  - 3: Sediments Fluxes and Budgets in the Coastal Region
  - 4: Interregional Comparisons: A LOICZ Biogeochemical Approach
  - 5: Typology & Scaling
    - WG1: Typology developments river catchments – coastal seas
    - WG2: Integration of coastal change regimes: applications, communication, networking
    - WG3: LOICZ in Global Small Island States and the Caribbean
- Three pre-meetings mostly having a strong focus on Latin America:
  - LATIN BASINS
  - Biogeochemical Budgets of Latin America
  - SARCS WOTRO LOICZ – first phase synthesis
- 10<sup>th</sup> LOICZ SSC meeting.

**Scientific key issues**

Key scientific issues for LOICZ:

- **Human dimension** of coastal change, i.e. how anthropogenic drivers affect the ecosystems.
- **Biogeochemical budgeting** will provide insight into regional pictures of C, N, P cycling.
- Science for the **Continental Aquatic Systems** initiative of IGBP (CAS) addressing the whole water-continuum from the catchment to the ocean margins.
- **Fluxes of groundwater** into the coastal sea and how they influence the cycling of chemicals.
- **Typology and Scaling** from local to global.
- Networking the **Wider Caribbean** and **Small Island/Atoll Regions** (incl. **Oceania** and **South Asia**).
- Brokering **issue-led science** and determination of **implications for users**.

**Tourism and Social affaires**

The local organizers are providing a variety of exciting touristic offers. Details can be taken from the website – arrangements have to be made directly with the local organizers.

**Support and Sponsoring**

Strong support (60% of funding) from organizations including

NIOZ	RIKZ	BAHC	IAO	IOC	IAI	WOTRO
LOIS	NWO	GLOBEC	KNAW	APN	UNEP	LOICZ
						IGBP

**Products**

The Netherlands Journal of Sea Research, ELSEVIER, and Regional Environmental Change, SPRINGER, will provide opportunity for LOICZ scientists to share their findings with a broad science community.

studies, carried out by de Wilde and collaborators mainly within the ELOISE project BIOGEST, have resulted in a number of valuable conclusions. Estuaries are found as an important source of nitrous oxide emissions relative to their areal coverage. These emissions per unit area are about two orders of magnitude higher than the oceanic emis-

sions of this gas. Estuaries are also important source of methane emissions in the marine areas. They contribute about 5 to 15 % to the total marine methane emissions, although the contribution to the total atmospheric budget of this greenhouse gas is less than 0.5 %. It is also concluded that most prob-

ably river discharge is the major source of methane to the coastal sea. The results from studies in estuaries, coastal waters and upwelling regions, presented in the monograph, contribute to the improvement of our understanding of the role of the marine environment as a source of atmospheric nitrous oxide and methane.

## HAVE YOU SEEN.....

- ◇ *Nitrous oxide and methane in marine systems* by Hein de Wilde. Rijksuniversiteit, Groningen. 1999.
- ◇ *Strategic Action Programme for the South China Sea and Transboundary Diagnostic Analysis for the South China Sea.* UNEP, East Asian Seas Regional Coordinating Unit. 1999.
- ◇ *Perspectives on Integrated Coastal Zone Management* Ed. by Wim Salomons, R. Turner, Luiz Drude de Lacerda L.D., Ramachandran S. Springer. 1999.
- ◇ *Sustainable Development of Deltas SDD '98. Conference proceedings.* Delft University Press. 1998.
- ◇ *ELOISE Implementation Report Phase 2.* Ecosystems Research Report 33. European Commission.
- ◇ *Multidimensional Global Change.* Kirill Ya Kondratyev. John Wiley & Sons. 1998.

## LOICZ PUBLICATIONS

- ◇ *Estuarine Systems of the South China Sea Region: Carbon, Nitrogen and Phosphorus Fluxes.* V. Dupra, S.V. Smith, J.I. Crossland and C.J. Crossland. LOICZ Reports & Studies no. 14. (In progress).

## LOICZ CALENDAR

- LOICZ-SCOPE Workshop on land-ocean nutrient fluxes: the changing silica cycle 3-4 October 1999, Linköping, Sweden.
- North Asia workshop on basins and coastal systems 10-12 October 1999, Qingdao, P.R. China.
- LOICZ-UNEP Workshop on biogeochemical budgets in South America estuarine systems, 10-12 November 1999, Bahia Blanca, Argentina
- LOICZ Workshop on Latin American basins 11-13 November 1999, Bahia Blanca, Argentina
- SARCS-WOTRO-LOICZ Workshop 12-13 November 1999, Bahia Blanca, Argentina
- **LOICZ 4th Open Science Meeting 15-18 November 1999, Bahia Blanca, Argentina.**
- LOICZ SSC meeting 18-20 November 1999, Bahia Blanca, Argentina
- LOICZ-UNEP workshop on estuarine systems of South Asia late January 2000, TBA, India (by invitation)
- LOICZ-UNEP workshop on estuarine systems of East Asia April 2000, TBA. (by invitation)
- The International Conference on Science and Technology for the Assessment of Global Climate Change and its Impact on Indonesia Maritime Continent. 29 Nov. - 1 Dec. 1999, Bukittingi, Sumatra, Indonesia.
- Third ELOISE Annual meeting. 1-4 December 1999, Noordwijkerhout, The Netherlands.
- AGU Fall Meeting. 13-17 September 1999, San Francisco, USA.
- International Conference on Ocean Science, Technology and Industry - ICOSTI'99 - 1-3 December 1999, Bali Island, Indonesia.
- Regional Seminar on Conflict Management of International River Basins. 7-9 December 1999, Dhaka, Bangladesh.

- OS04 Continental margin biogeochemical fluxes, Ocean Sciences 2000. 24-28 January 2000, San Antonio, Texas, USA.
- 15th SC-IGBP Meeting & IPO Executive Officers Meeting. 22-26 February, 2000, TBA, Mexico.
- JGOFS 2nd Open Science Conference. 13-17 April, 2000, Bergen, Norway.
- 9th International Coral Reef Symposium. 23-27 October 2000, Bali, Indonesia.
- 5th Congress on Marine Sciences Marcuba. 19-23 June, 2000, Havana, Cuba.
- IGBP Open Science Conference. 10-14 July, 2001, Amsterdam, The Netherlands.

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