

## 1. OVERVIEW

The key objectives of the Land-Ocean Interactions in the Coastal Zone (LOICZ) core project of the International Biosphere-Geosphere Programme (IGBP) are to:

- gain a better understanding of the global cycles of the key nutrient elements carbon (C), nitrogen (N) and phosphorus (P);
- understand how the coastal zone affects material fluxes through biogeochemical processes; and
- characterise the relationship of these fluxes to environmental change, including human intervention (Pernetta and Milliman 1995).

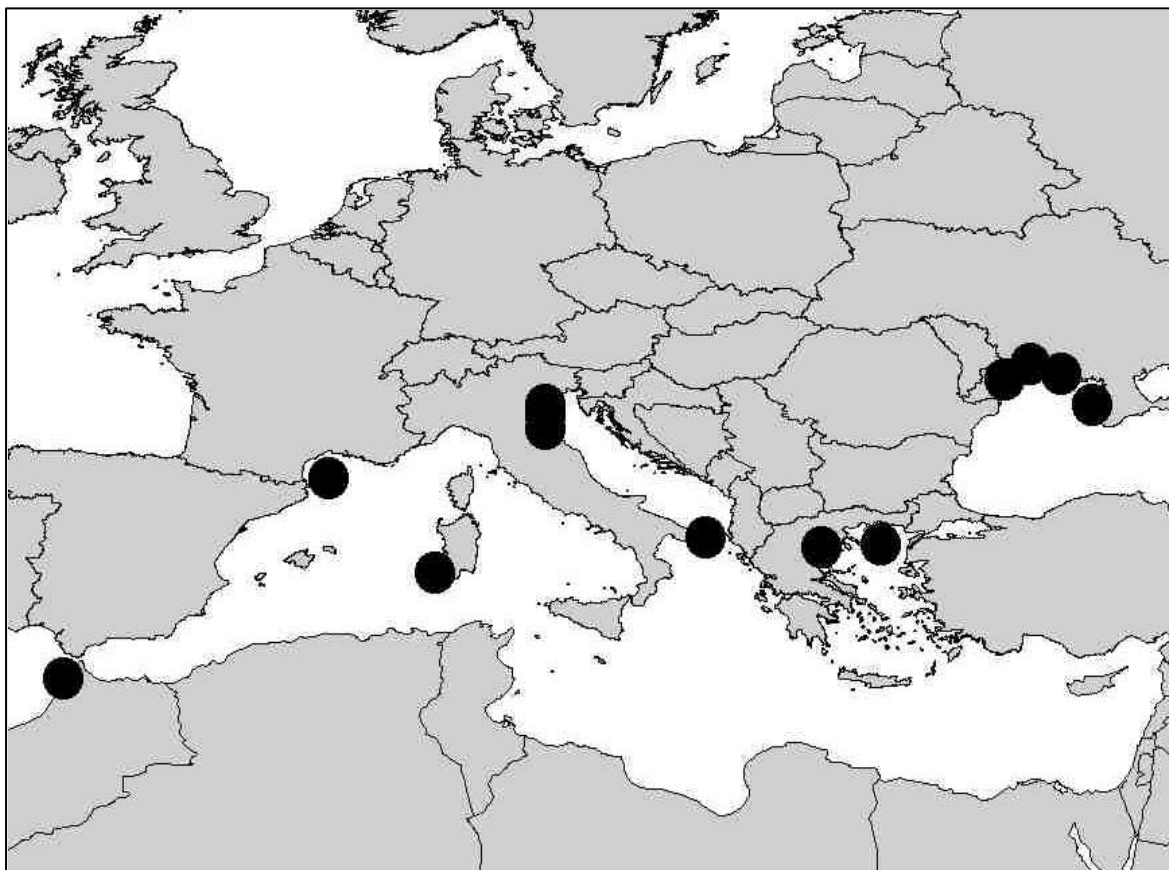
To achieve these objectives, the LOICZ programme of activities has two major thrusts. The first is the development of horizontal and, to a lesser extent, vertical material flux models and their dynamics from continental basins through regional seas to continental oceanic margins, based on our understanding of biogeochemical processes and data for coastal ecosystems and habitats and the human dimension. The second is the scaling of the material flux models to evaluate coastal changes at spatial scales to global levels and, eventually, across temporal scales.

It is recognised that there is a large amount of existing and recorded data and work in progress around the world on coastal habitats at a variety of scales. LOICZ is developing the scientific networks to integrate the expertise and information at these levels in order to deliver science knowledge that addresses our regional and global goals.

The United Nations Environment Programme (UNEP) and Global Environment Facility (GEF) have similar interests through the sub-programme: “Sustainable Management and Use of Natural Resources”. LOICZ and UNEP, with GEF funding support, have established a project: “The Role of the Coastal Ocean in the Disturbed and Undisturbed Nutrient and Carbon Cycles” to address these mutual interests; this Workshop is the sixth of a series of regional activities within the project. The European Union through its support of the LOICZ-associated ELOISE programme has similar interests in coastal material flux research and, importantly, integration of project-based scientific results to European regional syntheses. Consequently, the EU co-sponsored the workshop, thus providing an opportunity for a number of key ELOISE scientists to trial the LOICZ approach for system comparisons and to gain an overview of the typological approach to scaling questions.

The Mediterranean and Black Seas are unique marine water bodies subject to strong and changing conditions of human pressures. Large riverine inputs from central and southern European basins provide a tapestry of conditions for point source discharges, with variable pollutant and contaminant loads. Submarine groundwater flows have been identified, but rarely quantified for either load or flux rates. Coastal embayments and lagoon systems occur across a range of scales and are influenced by natural and human-induced changes in run-off and a variety of point source and diffuse outflows. Differences in water residence times in coastal systems, marked seasonal climatic conditions and a variety of scales for external forcing across the region yield opportunities for “natural experiments” to better understand material flux processes and responses. Importantly, there have been a number of coastal management policies enacted and enforced in the region that are now in some places reflected in diminishing loads of nutrients. These conditions coupled with the often extensive databases about loads and systems monitoring provide an opportunity to develop comprehensive “baseline” evaluations from which to establish time-series assessments of coastal system function and response to management practices. The African coastline of the Mediterranean region stands in contrast to the northern shore and systems. Relatively arid conditions with event-driven run-off adds to the contrast of settings. Limited data and information exists about these estuarine and coastal systems.

This Workshop is a first step by LOICZ to gain representative descriptions of the biogeochemical performance of the coastal zone ecosystems within the region, in order to address the goals of assessing global changes in material flux processes and the human dimension.



**Figure 1.1 Location of budget sites developed by the Mediterranean- Black Sea regional workshop.**

The Workshop was held in Athens, Greece on 5-8 February 2001. Ms Inna Yurkova, a postgraduate student from Ukraine and one of the Workshop participants, was awarded the LOICZ/UNEP Regional Training Scholarship to work with Prof. Fred Wulff at the University of Stockholm during May 2001.

The terms of reference for the Workshop (Appendix IV) and the activities (Appendices I and III) are contained in this report. The resource personnel worked with Workshop participants (Appendix II) from seven countries (Greece, Ukraine, Bulgaria, Italy, France, Turkey and Morocco) to develop and assess biogeochemical budgets for thirteen coastal systems in the region, ranging from estuaries and lagoonal environments to large bays. Further site budgets are being developed at home institutions and will be posted to the archival LOICZ web site.

The development of typology approaches and the integration of regional data were discussed as a key strand of the Workshop, and the computer programme for calculation of sites budget and model (CABARET) was tested by the Workshop participants.

The initial plenary session of the Workshop outlined the tools and information developed at earlier workshops, which provide a platform for site assessment and budget derivations. Presentation of the CABARET computer programme by Dr Laura David added a further dimension to the tools and training elements, with participants providing vital feedback for the design of the computer programme. Vilma Dupra demonstrated use of the LOICZ modelling approach. The LOICZ Budgets Modelling web-site was described by Prof. Fred Wulff and Dennis Swaney, and the pivotal role of the electronic site and its use by global scientists in making budget contributions to the LOICZ purpose was emphasised. It was noted that contributing scientists are clearly attributed as authors of their

contributed budgets, and that there is provision to update and provide additional assessment of their budgets.

The group moved into small working groups to further develop the site budgets, returning to plenary sessions to discuss the budget developments and to debate points of approach and interpretation. Eight budgets were developed during the Workshop (Figure 1.1, Table 1.1), with additional sites in Ukraine and further sites in Morocco and Italy refined and completed post-workshop. Budgets for sites for the Bulgarian coast of the Black Sea and for the Sea of Marmara have been partially developed. Additional field samples or data from archival material is required to complete several of the budgets brought to the Workshop. Those budgets will be added to the LOICZ web-site when they are completed.

The final day of the workshop was spent considering approaches that can be taken to synthesise the locality budgets and information at regional and global scales. Dennis Swaney described the LOICZ typology tools, including databases and the clustering tool (LOICZView). On-line demonstrations of the typology use were made and some of the applications were shown. Potential for application to the EU regional synthesis needs was discussed. The plans for a LOICZ-UNEP training workshop in typology applications, scheduled for July 2001, were outlined and strong interest in attending was expressed by participants.

The common element in the budget descriptions is the use of the LOICZ approach to budget development, which allows for regional and global comparisons, and application of the typology approach. Differences in the descriptive presentations reflect the variability in richness of site data, the complexity of the sites and processes, and the extent of detailed process understanding for the sites. Support information for the various locations, describing the physical environmental conditions and related forcing functions including the history and potential anthropogenic pressure, is an important part of the budget information for each site. These budgets, data and their wider availability in electronic form (CD-ROM, LOICZ web-site) will provide opportunity for further assessment, comparisons and potential use with wider scales of patterns in system response and human pressures.

The budget information for each site is discussed individually and reported in units that are convenient for that system (either as daily or annual rates). To provide for an overview and ease of comparison, the key data are presented in an “annualised” form and nonconservative fluxes are reported per unit area (Tables 1.1 and 1.2).

Key outcomes and findings from the Workshop include:

1. A set of thirteen budgets representing a range of coastal settings for the Mediterranean/Black Sea region – estuaries, coastal lagoons and large embayments. These budgets provide insights into seasonality, influence of human activities as drivers of change and sensitivity of system performance to nutrients derived from land and ocean. Further development of a number of these budgets and additional site models were foreshadowed by participants. To date participants have acted on this intent and additional models are in draft for addition to the LOICZ web-site. These will contribute to “replication” of system types and support further trend analyses of climatic and human forcings on biogeochemical processes in the region and in the global assessment being carried out by LOICZ.
2. A variety of site examples and different measurement/data types which show approaches that can be taken under the LOICZ Modelling protocol for first-order evaluation of the system physics and estimation of net metabolism of coastal systems, and modelling to meet LOICZ global change goals, UNEP project objectives and EU synthesis developments.
3. Assessment of systems across a range of areal scales, water residence conditions and under differing regions of riverine and oceanic dominance of fluxes. There is potential to nest some of the sites (within the Black Sea and across the north-western Mediterranean region) on completion of further budgets.

4. A new tool (LOICZView) for scaling and regional synthesis was demonstrated. Its potential was enthusiastically embraced by a number of the participants for application in their research questions.
5. Research information was drawn from several EU-supported projects in the development of a number of site budget assessments, notably NICE, ROBUST and METRO-MED, making the workshop a preliminary step in the EU intention to build a wider synthesis of ELOISE and related research results.
6. A proposal was made by the ELOISE Office-JRC and the University of Parma to convene a joint ELOISE-LOICZ Workshop to develop very detailed CNP flux budgets for the whole of peninsular Italy.

The Workshop was hosted by the National Centre for Marine Research, Athens Greece, and the local coordinator was Dr Christos Anagnostou. LOICZ is grateful for this support and indebted to the Director of the Institute of Marine Biological Resources, Dr K. Papakonstantinou and Institute staff, and to the Workshop resource scientists for their contributions to the success of the Workshop. LOICZ gratefully acknowledges the effort and work of the participants not only for their significant contributions to the Workshop goals, but also for their continued interaction beyond the meeting activities.

All participants gratefully acknowledged the support from the GEF-funded UNEP project and the EU sponsorship that provided opportunity to work together and to extend professional networking.

**Table 1.1 Budgeted regional sites for the Mediterranean-Black Sea region - locations, system dimensions and water exchange times.**

System Name	Long. (E)	Lat. (N)	Area (km <sup>2</sup> )	Depth (m)	Exchange Time (days)
<b>GREECE</b>					
Inner Thermaikos Gulf	22.50	40.30	336	22	15
North-eastern Aegean Sea	25.00	40.40	19500	230	280
<b>UKRAINE</b>					
Dnieper- Bug estuary system	31.50	46.60	800	4	8
Dniester estuary	30.48	46.08	360	1.5	12
Donuslav River estuary	33.00	45.50	48	3	31
Malii Adzalik estuary	32.02	46.59	8	2	126
<b>ITALY</b>					
Sacca di Goro Lagoon	12.29	44.80	26	1	3
Valle di Comacchio	12.28	44.63	115	0.8	247
Valle Smarlacca	12.23	44.58	2	0.8	434
Lake Alimini Grande	18.45	40.20	1.4	1.5	232
S'Ena Arrubia Lagoon	8.67	39.83	2	0.4	72
<b>FRANCE</b>					
Gulf of Lions	4.50	43.00	12000	76	70
<b>MOROCCO</b>					
Moulay Bouselham Lagoon	6.27 (W)	38.83	35	1	14

**Table 1.2 Budgeted regional sites for the Mediterranean-Black Sea - loads and estimated (*nfix-denit*) and (*p-r*).**

System	DIP load	DIN load	DDIP	DDIN	( <i>nfix-denit</i> )	( <i>p-r</i> )
	mmol m <sup>-2</sup> yr <sup>-1</sup>					
<b>GREECE</b>						
Inner Thermaikos Gulf	248	2354	-18	--347	-55	1825
North-eastern Aegean Sea	5	81	-11	-183	0	1095
<b>UKRAINE</b>						
Dnieper-Bug estuary	251	1576	73	-766	-1825	-7665
Dniester estuary	99	3779	-36	4	730	4015
Donuslav River estuary	2	8	-1	15	36	146
Malii Adzalik estuary	64	246	-66	-1	730	6935
<b>ITALY</b>						
Sacca di Goro Lagoon	28	2358	55	3358	2445	-5840
Valle di Comacchio	<1	2	0	-11	-11	0
Valle Smarlacca	1	128	-4	-255	-182	365
Lake Alimini Grande	2	235	0	-11	-11	0
S'Ena Arrubia Lagoon	73	320	-36	-328	402	5110
<b>FRANCE</b>						
Gulf of Lions	10	635	-55	-1679	-475	5840
<b>MOROCCO</b>						
Moulay Bouselham Lagoon	1	834	0	-620	-620	0