



Evaluation of fluxes and derived ecosystem functions in the transition zones along the Italian Coast

G. Giordani¹, P. Viaroli¹, C. N. Murray², J. M. Zaldivar², M. Ponti³, M. Abbiati³, A. Barbanti⁴, C. Castellani⁴, A. Basset⁵, I. Cappello⁵, A. Pomes⁵, L. Palmisano⁵, S. Bencivelli⁶, A. Bergamasco⁷, M. Azzaro⁷, G. Carrada⁸, G. Castaldelli⁹, M. Mistri⁹, A. E. Fano⁹, A. Castelli¹⁰, C. Lardicci¹⁰, F. Maltagliati¹⁰, G. Ceccherelli¹¹, F. Trebini¹¹, B. M. Padeda¹¹, N. Sechi¹¹, S. Guerzoni¹², S. Rabitti¹², F. Collavini¹², L. Zaggia¹², R. Zonta¹², R. Danovaro¹³, A. Pusceddu¹³, M. Fabiano¹⁴, P. Povero¹⁴, N. Ruggieri¹⁴, S. Fonda Umani¹⁵, P. Giordani¹⁶, M. Ravaoli¹⁶, F. Frascari¹⁶, P. Giordano¹⁶, T.S. Hopkins¹⁷, V. Hull¹⁸, M. Falcucci¹⁸, M. Innamorati¹⁹, S. Marsili-Libelli²⁰, G. Izzo²¹, C. Creo²¹, M. Lenzi²², P. Magni²³, G. De Falco²³, E. Manini²⁴, F. Spagnoli²⁴, M. Mauri²⁵, X. F. Niell²⁶, R. Pastres²⁷, G. Pernice²⁸, S. Porrello²⁹, P. Gennaro²⁹, V. Saggiomo³⁰, C. Solidoro³¹, G. Cossarini³¹, M. Vazzoler³², A. Mazzola³³, T.L. Mauger³⁴, A. Bernstein³⁵, G. Ceconi³⁵, L. Montobbio³⁵.

¹LaguNet Coordination (pierluigi.viaroli@unipr.it) and Secretary (giordani@nemo.unipr.it). Dipartimento di Scienze Ambientali, Università di Parma. ²IES-JRC, European Commission, Ispra. ³Centro Interdipartimentale di Ricerca per le Scienze Ambientali in Ravenna, Università di Bologna. ⁴Thetis S.p.A., Venezia. ⁵Dipartimento di Scienze e Tecnologie Biologiche e Ambientali, Università di Lecce. ⁶Amministrazione Provinciale di Ferrara. ⁷CNR-Istituto Talassografico, Messina. ⁸Dipartimento di Zoologia, Università Federico II, Napoli. ⁹Dipartimento di Biologia, Università di Ferrara. ¹⁰Dipartimento di Scienze dell'Uomo e dell'Ambiente, Università di Pisa. ¹¹Dipartimento di Botanica ed Ecologia Vegetale, Università di Sassari. ¹²CNR-ISMAR, Venezia. ¹³Dipartimento di Scienze del Mare, Università Politecnica delle Marche. ¹⁴DIPTERIS, Università di Genova. ¹⁵Laboratorio di Biologia del Mare, Università di Trieste. ¹⁶CNR-ISMAR, Bologna. ¹⁷CNR-IAMC, Napoli. ¹⁸Laboratorio Centrale di Idrobiologia, Roma. ¹⁹Dipartimento di Biologia Vegetale, Università di Firenze. ²⁰Dipartimento di Sistemi e Informatica, Università di Firenze. ²¹ENEA, Roma. ²²LeaLab, Orbetello. ²³IMC, Oristano. ²⁴CNR-ISMAR, Lesina. ²⁵Dipartimento di Biologia Animale, Università di Modena e Reggio. ²⁶Universidad de Malaga. ²⁷Dipartimento di Chimica Fisica, Università di Venezia. ²⁸CNR-IAMC, IRMA, Mazara del Vallo. ²⁹ICRAM, Roma. ³⁰Stazione Zoologica A. Dohrn, Napoli. ³¹OGS, Trieste. ³²Arpa Regione Veneto. ³³Dip. di Biologia Animale, Univ. di Palermo ³⁴Dip. di Biologia Animale ed Ecologia Marina, Univ. di Messina. ³⁵Consorzio Venezia Nuova, Venezia.

LaguNet is a scientific observational network studying the fluxes of nutrients and other contaminants from lagoon catchments to the near coastal environment.

The objectives of LaguNet are to support and encourage co-operation of research groups studying lagoons, wetlands and salt marsh systems situated along the Italian coast and to evaluate the application of the LOICZ (Land Ocean Interactions in Coastal Zones, a core project of IGBP) biogeochemical flux model and typology classification to such sites.

In Italy there exist numerous studies, including over the long-term, investigating coastal processes, it thus seems important to propose and develop a working network in which the LOICZ methodology could be applied to sites and studies of transitional ecosystems along the Italian coast.

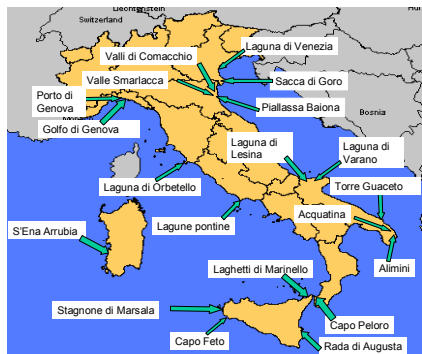


Main Activities

1. Application of the LOICZ Biogeochemical model to 19 coastal sites which correspond to 22 independent systems for a total of 79 applications considering different periods.
2. Development of a "Network of Excellence" presented to the EU as "Expression of Interest".
3. Participation to the implementation plan for coastal activities within the UN sponsored Global Terrestrial Observing System (GTOS) (www.fao.org/gtos).
4. Organisation of the International Conference: Southern European Coastal Lagoons: The Influence of River Basin-Coastal Zone Interactions. Castello Estense Ferrara 10-12 November 2003 (www.dsa.unipr.it/lagunet/med03).

LaguNet sites

Presently LaguNet comprises of sites distributed around the whole of the Italian peninsular and islands. Some such as the Port of Genoa and the Marinello lakes consist of several independent systems. In total there are presently 22 ecosystems under investigation where the Biogeochemical Model of LOICZ has been applied for well-defined time period. In total 79 flux estimations have been undertaken considering a wide range of systems and different time periods. For some sites, for example, such as the S'Ena Arrubia lagoon it has been possible to compare the results obtained with the model for different periods of time, such as to obtain valuable information on the evolution of the lagoon. Certain results have already been published in LOICZ Report and Studies volume 19, while others are in course of evaluation.



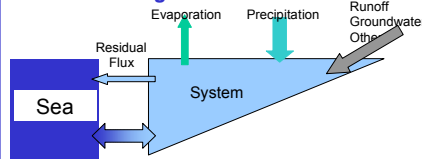
Due to the shape of the Italian peninsular it has been possible to study systems that cover a wide range of latitudes: from the Venice lagoon in the North (45.40° N) to the Rada di Augusta in the South (37.21° N). Although the distances between these ecosystems are relatively modest compared to other LOICZ studies that have been organised at continental-level scales, the present network of sites present a very wide range of varying characteristics and a very high density of data.

Sites range from very large ecosystems such as the Venice lagoon (area open to tidal expansion and assessed as relevant for budgeting: 360 km², total area of the system 550 Km²) to extremely small ones such as Lughetto Fondo Porto (0.013 km²), from deep coastal systems such as the Gulf of Genoa (28 m) to very shallow ones such as Torre Guaceto (0.38 m) or S'Ena Arrubia (0.40 m). Further the biological communities are very diversified; in some systems the dominant primary producers are phytoplankton, whereas in others they may be macroalgae or rooted phanerogams. Also the exploitation and management of these systems are very varied: fish farming, oyster or mussel farming, tourism, recreation and water sports or nature reserves. Many of the ecosystems are in protected areas, others are subject to intense anthropogenic pressures, others to only slight human impact and stress.

Relevant Web sites:
LOICZ: <http://www.nioz.nl/loicz>
LOICZ Biogeochemical modelling node: <http://data.ecology.su.se/MNODE/>
LaguNet: www.dsa.unipr.it/lagunet

#	Name of the system	Italian province	Lat. 'N	Long. 'E	Area for budgeting Km ²	Mean depth (m)	Investigated Period
1	Laguna di Venezia	Venezia	45.40	12.40	360	1.50	1999-2001
2	Sacca di Goro	Ferrara	44.80	12.29	26	1.00	1997
3	Valle di Comacchio	Ferrara-Ravenna	44.63	12.28	115	0.80	1997
4	Valle Smeralda	Ravenna	44.58	12.23	2	0.80	1997
5	Piailassa Baiona	Ravenna	44.50	12.25	11.8	0.75	2000
6	Laguna di Lesina	Foggia	41.88	15.35	51.5	0.80	1995-1999
7	Laguna di Varano	Foggia	41.41	15.47	54	4.00	1999-2000
8	Torre Guaceto	Brindisi	40.71	17.80	1.19	0.38	2001-2002
9	Acquatina	Lecco	40.44	18.24	0.45	0.50	1995
10	Alimini Grande	Lecco	40.20	18.45	1.4	1.50	1998-1999
11	Rada di Augusta	Siracusa	37.21	15.23	23.5	14.90	1998-1999
12	Capo Feto	Trapani	37.68	12.48	1.4	1.75	2001
13	Stagnone di Marsala	Trapani	37.83	12.45	20.0	0.95	1996
14	Lago Ganzirri	Messina	38.26	15.62	0.34	2.50	1998-1999
15	Laghetto di Marinello (Fondo Porto)	Messina	38.13	15.05	0.017	1.60	1997-1998
16	Laghetto di Marinello (Veduggia)	Messina	38.13	15.05	0.013	1.50	1997-1998
17	Laguna di Orbetello	Grosseto	42.44	11.23	35.25	1.00	1995-2000
18	Golfo di Genova	Genova	44.40	8.93	52.0	28.00	1996
19	Porto di Genova (old port area)	Genova	40.40	8.90	2.7	13.00	2002
20	Porto di Genova (Molino di Sanmichele)	Genova	40.40	8.90	1.4	15.00	2002
21	Porto di Genova (Valli Costiere Terminali)	Genova	40.40	8.90	2.1	15.00	2002
22	S'Ena Arrubia	Oristano	39.83	8.67	1.2	0.40	1994-1995 2001-2002

LOICZ Biogeochemical model



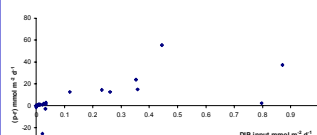
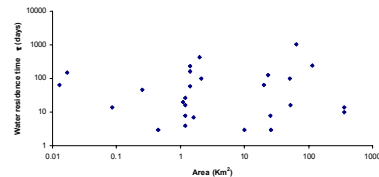
The LOICZ biogeochemical model is based on mass balance of water, salt and nutrients, in which their conservative behaviour is used to estimate the mass movement of water; non-conservative behaviour is used to estimate important ecosystem processes such as net metabolism (i.e. the difference between production and respiration) or the difference in the rates of nitrogen fixation and denitrification (nfix-denitr.). The application of the LOICZ approach to very widely varying coastal systems has allowed the comparison and classification of some 200 sites worldwide.

The LOICZ biogeochemical model is described in detail on the web page: <http://data.ecology.su.se/MNODE/index.htm>

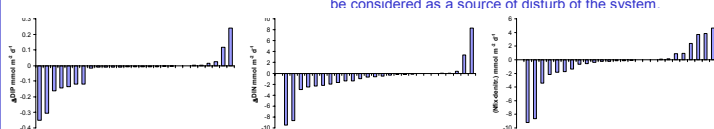
Preliminary results

The highest annual external loads of dissolved inorganic phosphorus (DIP) and nitrogen (DIN) were estimated for the Piailassa Baiona lagoon (0.79 and 18.8 mmol m⁻² d⁻¹ respectively) while the systems with the lower nutrients loads are the Stagnone di Marsala and the system of Capo Feto which are located in areas with low human activities.

The theoretical water residence time estimated with such models can be considered as a rough indicator of vulnerability of the system. In particular large systems with high water residence time such as Valli di Comacchio and Laguna di Varano can be considered highly sensitive to pollution (graph on the right, log scale).



Increasing the nutrient load (in particular DIP), the Italian systems appear to move towards instability dominated by production processes instead of respiration (positive values of (p-r): graph on the left). The extreme values of the estimated (p-r) as highly heterotrophic or highly autotrophic are estimated for systems dominated by floating macroalgae such as Sacca di Goro and S'Ena Arrubia (-41.2 and +55.4 mmol C m⁻² d⁻¹, respectively) indicating that this kind of primary producer can be considered as a source of disturb of the system.



Considering annual budgets, most of the Italian lagoons can be considered almost in balance between storage and release of nutrients (2 firsts graphs), even if systems with negative values of ΔDIP and ΔDIN, which indicate that the system act as a net sink of nutrients, are more common than systems with positive values (source of nutrients).

A general dominance of denitrification over N-fixation can be observed in the Italian systems (last graph).