Land-Ocean
Interactions in the
Coastal Zone

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Interpreting brown waters and a real time status of ecosystem productivity is a scientific challenge. ESA's COAST COLOUR is aimed to uncover the secrets of these costal waters by exploiting the MERIS colour radiometry information for a set of globally distributed pilot sites. Retrieving multifaceted information on ecosystem health is a central objective for this ambitious approach.

Coastal vulnerability assessment and adaptation to global environmental change, e.g., sea level rise, flooding, as well as increasing pressures and fluxes from land – the so called coastal squeeze – require holistic information and meaningful concepts of participation and knowledge sharing to inform adaptation strategies. These issues are featured from various perspectives.

Luisetti et al. showcase ecosystem service valuation in scenarios of managed realignment. The Affiliate COMPASS explores the vulnerability to sea level building on tools and experiences from former LOICZ Affiliates. RADOST and IMCORE are focusing on interdisciplinary and – in the Baltic case – transboundary dialogue and participation as a means to advanced adaptation strategies.

LOICZ Open Science Conference and Youth Forum: Coastal Systems, Global Change and Sustainability

The initial draft session programme and organization are available. Multi and interdisciplinarity and knowledge exchange across traditional boundaries are central in this conference.

IHDP's Earth system governance project launches new online forum on international environmental governance (a key UNEP concept)

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LOICZ OSC 2011 海

Incl. OVERALL SESSION SCHEDULE for the LOICZ OSC 2011

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Bianca Seth, Barbe Goldberg

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Contact:

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research
Institute of Coastal Research
LOICZ IPO
Max-Planck-Str. 1
21502 Geesthacht, Germany
phone: +494152 87-2009 · fax: +49 4152 87-2040
e-mail: loicz.ipo@loicz.org · URL: www.loicz.org

Content

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LOICZ Regional Nodes

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Anna University

South Europe MENA/PALOP Node – Portugal
Luis Chicharo
International Centre for Coastal Ecohydrology

LOICZ IPO

Hartwig H. Kremer
Chief Executive Officer
hartwig.kremer@loicz.org

Juergen Weichselgartner
Senior Science Coordinator
j.weichselgartner@loicz.org

Ellen-Barbe Goldberg
Communications Manager
Editorial: LOICZ website and INPRINT
ellen-barbe.goldberg@loicz.org

Christiane Hagemann
Office Administration, Finance
c.hagemann@loicz.org

Marcus Lange
Congress & Project Manager,
Affiliated Projects and Research
marcus.lange@loicz.org

Address updates and subscription
Please use the LOICZ online database for address updates and subscription to the LOICZ newsletter. If you have any questions, please contact the IPO at loicz.ipo@loicz.org This newsletter is also available online at www.loicz.org

LOICZ in brief

LOICZ aims to provide science that contributes towards understanding the Earth system in order to inform, educate and contribute to the sustainability of the world's coastal zone. LOICZ is a Core Project of the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme on Global Environmental Change (IHDP). The LOICZ IPO is hosted by the Institute for Coastal Research at the Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research, which is part of the Helmholtz Association of National Research Centres.

LOICZ research as outlined in the Science Plan and Implementation Strategy, SPIS, is organised around five themes:

- Vulnerability of coastal systems and hazards to society
- Implications of global change for coastal eco-systems and sustainable development
- Human influences on river-basin-coastal zone interaction
- Biogeochemical cycles of coastal and shelf waters
- Towards coastal system sustainability by managing land-ocean interactions

The Science Plan and Implementation Strategy is available electronically on the LOICZ website and in hard copy at the LOICZ IPO.

As a temporary priority the project focuses on scientific hotspots of Earth system change, currently Arctic Coasts, Urbanized Coasts and Megacities, River Mouth Systems including Deltas and Estuaries and Islands.

Scientific Highlights

CoastColour delivers water quality information for 27 globally distributed coastal areas

Authors:

Carsten Brockmann
Brockmann Consult,
Max-Planck-Str. 2,
21502 Geesthacht, Germany,

Katharina Poser
Brockmann Consult,
Max-Planck-Str. 2,
21502 Geesthacht, Germany

Elisabete Mota
Fundacão Faculdade Ciências
Universidade Lisboa, Campo
Grande, 1749-016 Lisbon,
Portugal.

Simon Pinnock
ESRIN European Space
Agency, Via Galileo Galilei,
I-00044 Frascati (Rom) Italy

Introduction

To collect synoptic data about the marine ecosystem we need to use data from Earth Observation platforms, otherwise known as remote sensing data. Visible spectral radiometry, commonly known as ocean colour radiometry, is the only option available to do this at the moment. No other method exists for synoptically studying the marine ecosystem, whether it be for the open ocean or, more particularly, for coastal ecosystems, where processes tend to operate at higher frequencies and at shorter spatial scales than those offshore.
A characteristic of coastal waters is that they are optically complex (compared with the open ocean) and large optical gradients can be found (Sathyendranath et al 1989). Such strong optical gradients are favourable for the development and refinement of radiative transfer models of ocean colour: instances can be found where each one of the major optically-active substances (chlorophyll, Gelbstoff, inorganic suspension, organic detritus) dominates. In turn, the bio-optical models so refined can be useful in open-ocean applications, where the optical gradients are often much more subtle.
There are many reasons why one would want to monitor the coastal ecosystem using ocean colour techniques.
One of the more important advantages of the method is its abillity to estimate the bulk seawater concentration of chlorophyll as found in the phytoplankton (Morel, 1980),) which have photosynthesis as the basic anabolic metabolism (Sathyendranath, 1986). Coastal zones are amongst the most biologically productive regions in the ocean. Hence, the role of the coastal zone in the planetary carbon cycle is of fundamental importance, and it can be quantified using remotely-sensed data of ocean colour.
In coastal regions, the input of sediments from river drainage can have an adverse effect on ecosystem habitat, as can coastal erosion (Warrick et al 2004). Ocean colour remote sensing provides an ideal method to monitor sediment movements, thus providing invaluable information for the aquaculture and fisheries sector. Similarly, the influx into the coastal zone of coloured material in solution (so-called Yellow Substance) through river drainage can also be monitored using ocean colour. The delivery of pollutants to coastal waters can be seen directly (if they have a colour signature), or indirectly through their effect on the phytoplankton. A good example of the latter is the input of inorganic fertilizers from agriculture leading to the development of algal blooms, including also harmful ones. This latter topic is of very particular interest to aquaculture industries who wish to have this information continuously to hand. More generally, ocean colour is particularly useful for monitoring water quality at high temporal and spatial resolution, and over extensive areas, which is relevant, for example, to the Water Framework Directive of the European Union.
Harvest fisheries can also benefit greatly from the use of ocean colour data. For more than hundred years, it has been recognised that we might be able to account for the observed fluctuations between years in exploited fish stocks by studying their larval stages. Because the larval stage is usually planktonic, studying this stage means studying a mostly passive component of the pelagic ecosystem and its variable forcing.
It can be concluded that colour remote sensing is an ideal vehicle for retrieving a broad range of objective indices of ecosystem status and ecosystem health. These are difficult to quantify, but could be characterized using a series of metrics measurable by remote sensing. These so-called ecological indicators provide a compact description of the pelagic ecosystem at a given time and place. The comprehensive information they embody affords an invaluable background to biological oceanographic research, constitutes important ecological intelligence for fisheries management, and for ecosystem-based management of marine resources in the broadest sense. Rational management requires information. Because the ocean is highly dynamic (especially the coastal zone), the information needs to be updated frequently. We cannot hope to accomplish this using just ships as the observing platform. Our only hope is through remote sensing. For the ecosystem, our only avenue is via ocean-colour remote sensing.
The European Space Agency has launched the CoastColour project to work towards these objectives by developing, demonstrating, validating and intercomparing different Case 2 (i.e. coastal waters) algorithms over a global range of coastal water types, identifying best practices, and promoting discussion of the results in an open and public form (Brockmann

et al, 2010). CoastColour will fully exploit the potential of the MERIS instrument for remote sensing of coastal zone water. The product requirements have been derived through a user consultation process. These have been translated into algorithm requirements and subsequently into algorithm specification and implementation.

CoastColour sites

CoastColour aims at serving a worldwide distributed OceanColour Remote Sensing Community helping them to find and evaluate regional algorithms for the derivation of specific water related parameters. A total number of 27 test sites has been defined (see Figure 1), each with one or more local champion users who are aware of its characteristics and challenges applying ocean colour techniques. To date 47 champion users have registered for the project. Most of them are scientists involved in research which will directly serve the local end-users. Others members are end-users themselves, charged with coastal water quality monitoring, algae bloom detection, management of harbour sediments or monitoring of bathing waters, as examples.

In-situ data play an essential role within the project, as they are needed to (1) develop regionally adapted algorithms and/or (2) validated these algorithms. The champion users have made available to the project a large amount and variety of physical and biological data. After a critical quality check and harmonisation of the data, they now form a comprehensive data base compiling a total of 1,293,396 measurement records for 19 of the 27 CoastColour sites to date. This database provides information about metadata, radiometry, inherent optical properties (IOPs) of the water body and biochemical optical data. A short summary of the most relevant parameters and their availability per test site is given in Table 1. Besides acquisition time and geo-location, which are preliminary information for the usability of the data, the most frequently measured parameters are water depth, temperature, salinity, chlorophyll a (chl_a), the dissolved material absorption coefficient at different wavelengths ag( ), total suspended matter TSM, spectral downwelling attenuation coefficient kd( ), water leaving radiance Lw( ) and remote sensing reflectance Rrs( ) at different wavelengths .
The number of available data per test site varies strongly. For the North Sea thousands of Ferry-box records are included in the database, whereas for other sides only very few measurement records have been taken for a specific parameter.
Table 2 provides an overview of statistical values (min, max, mean, standard division) characterising selected parameters as they have been measured and made available to the project. Some of these measurements seem contradictory, for example, where a site shows high Secchi Depth values but also high TSM concentrations. It is important here to note that different parameters were not necessarily recorded at the same time and that the measurement records only reflect a specific situation on a specific date. In this respect, the limited number of measurement values cannot be understood as fully characterising the corresponding test sites.

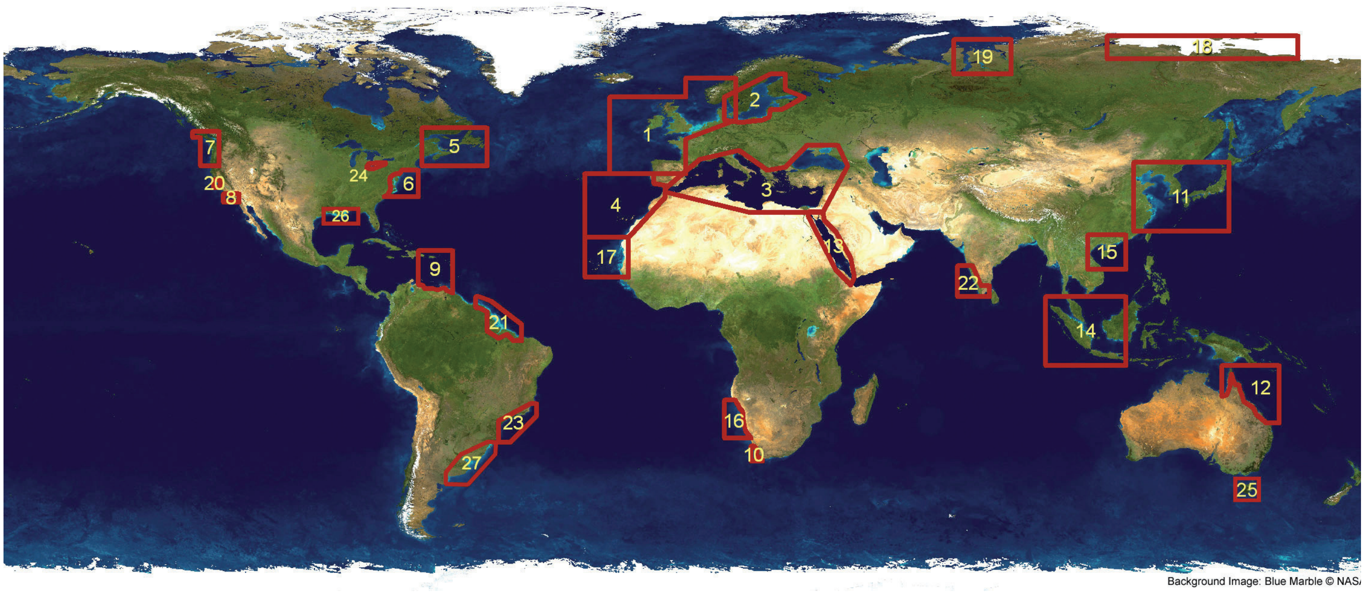


Figure 1: Distribution of all 27 CoastColour test sites.

		North Sea	Baltic Sea	Mediterranean & Black Sea	Morocco	Acadia	Chesapeake Bay	Oregon and Washington	Plumes and Blooms	Puerto Rico	Benguela	China, Korea, Japan	Great Barrier Reef	Red Sea	Indonesian Waters	Cape Verde	Central California	Antares-Ubatuba	Tasmania	Gulf of Mexico
METADATA																				
start Date	Date of begining of data aquisition [yyyy-mm-dd]	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
start Time	Time of begining of data aquisition [hh:mm:ss]	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
LAT	Minimum Latitude [degree]	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
LONG	Maximum Longitude [degree]	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Wind_Speed	Wind_Speed [m/s]	x	x												x					
Cloud_Cover	Cloud_Cover [%]	x	x												x					
Secchi_Depth	Secchi_Depth [m]	x	x									x		x	x					
Water_Depth	Water_Depth [m]	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x		x
Conductivity	Conductivity [mS/cm]		x	x	x															
Temperature	Temperature [°C]	x	x	x	x	x	x	x	x	x		x					x			
EUz_m	Depth of euphotic layer [m]	x																		
BIOGEOCHEMICAL_OPTICAL_DATA																				
Salinity	Salinity [psu]	x		x	x		x	x		x		x	x				x		x	
Density	Density [sigma]	x										x								
turbFNU	Turbidity: Formazine Nephelometric Units	x																		
chl_a	Chlorofill a by Fluorometric Method [mgm-3]	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x
agXXX	Dissolved Material Absorption Coefficient at wavelength XXX [1/m]	x	x	x	x	x	x		x			x	x		x	x		x	x	
SPM/ ss/ STM	Suspended Particulate Matter / Suspended solids / Total Suspended Matter [mg/l]	x	x	x	x							x	x	x	x				x	x
kpar	Diffuse downwelling coefficient for PAR (Photosynthetically Available Radiation)	x			x	x	x		x	x					x	x				
z_YY	Depth of YY% light level of PAR [m]	x			x	x	x		x	x					x	x				
RADIOMETRIC_DATA																				
kdXXX	Spectral downwelling irradiance Attenuation Coefficient at wavelength XXX [1/m]	x			x	x	x		x	x	x	x			x	x				
LwXXX	Water Leaving Radiance at wavelength XXX [uW/cm²/nm/sr]	x			x	x	x	x	x	x	x				x	x	x	x		x
RrsXXX	Remote Sensing Reflectance at wavelength XXX [1/sr]	x						x			x	x	x		x					x
IOPs																				
aXXX	Absorption Coefficient at wavelength XXX a(z,l)			x					x											x
bXXX	Scattering Coefficient at wavelength XXX [1/m]																			x
bbXXX	Backscattering Coefficient at wavelength XXX (fit) [1/m]	x			x	x			x							x				

Table 1: Availability of selected in situ measured parameters per test site.

The following examples give an impression of the variety of characteristics the worldwide distributed test sites are showing. Each one brings with it its own challenge for remote sensing applications which have to be accounted for in the development of regionally adapted algorithms.

In the North Sea massive blooms of harmful algae such as Chattonella can frequently being observed, with corresponding high concentrations of chl-a. The Baltic Sea is dominated by high concentrations of yellow substance, which strongly influences algorithm performance, and shows a strong shift in salinity. The area where the Nile discharges into the Mediterranean sea shows high sediment loads, and the water carries many nutrients, whereas concentrations of nutrients are generally low elsewhere in the Mediterranean Sea. Sites such as Benguela, China/ Korea/ Japan and Rio La Plata are characterized by exceptional high concentrations of sediments (TSM), which have to be accounted for when algorithms are being developed. The Indonesian Waters have very low water depth and also show high TSM and chlorophyll values. In the Chesapeake Bay high concentrations of particulate organic carbon (POC) can be measured. At the Great Barrier Reef a significant challenge for remote sensing of coral reef water is the requirement to map water quality (Secchi depth, Kd, PAR, tripton, CDOM) and substrate cover type (sea-grass, algae, sand) in a mixture of both clear and turbid waters.

Site		Water_Depth [m]	Temperature [°C]	Salinity [psu]	Density [sigma]	kd489	kpar	Secchi_Depth [m]	z_01 (depth of 1% light level of PAR [m])	chl_a [mg/ m^3]	SPM / ss / STM [mg/l]	ag440	turbFNU [Turbidity: Formazine Nephelometric Units]	POC [mg/l]
site 1	min	4	-1.34	0.53	4.83	0.049	0.075	4.30	34.00	0.04	0.2	0.01	0.00	47.89
	max	85	27.55	36.90	7.48	0.082	0.191	13.00	100.00	197.50	31.2	0.33	41.16	98.02
	mean	51	11.60	25.89	6.45	0.060	0.132	7.73	70.00	4.92	1.9	0.07	1.20	68.01
	sd	12	5.17	5.38	0.57	0.011	0.055	1.89	25.98	8.53	3.2	0.04	1.44	17.72
site 2	min	34	15.49					4.00		0.04	0.1			
	max	190	4.47					4.80		4.28	7.8			
	mean	104	12.11					4.42		1.76	3.9			
	sd	54	4.04					0.26		1.48	3.0			
site 3	min	92	15.24	36.31						0.02	0.0		0.03	
	max	4101	24.45	37.70						2.23	0.9		0.14	
	mean	1967	19.13	36.78						0.28	0.1		0.06	
	sd	1058	3.26	0.34						0.37	0.1		0.03	
site 4	min	202	16.64	36.36		0.026	0.005		48.00	0.01	25.9		0.03	30.46
	max	1691	23.19	36.84		0.032	0.116		60.00	10.81	506.3		0.07	36.48
	mean	767	19.36	36.58		0.030	0.044		56.00	0.82	38.2		0.05	33.25
	sd	525	2.57	0.14		0.003	0.051		5.66	1.12	22.3		0.01	2.48
site 5	min					0.083	0.191		10.20	0.24				
	max					0.738	0.688		27.20	6.12				
	mean					0.297	0.367		17.83	1.84				
	sd					0.138	0.107		4.54	1.68				
site 6	min					0.041	0.154		5.30	0.30				
	max					0.911	0.825		42.70	22.54				
	mean					0.354	0.430		18.65	8.90				
	sd					0.286	0.231		9.89	7.25				
site 7	min	10	7.45	25.72						0.07				
	max	7000	19.09	33.96						33.82				
	mean	168	12.83	32.33						3.85				
	sd	555	2.86	1.07						5.20				
site 8	min		11.85	0.00		0.039	0.076		14.00	0.08				
	max		19.45	33.54		0.288	0.276		68.00	28.69				
	mean			32.92		0.119	0.151		37.00	2.53				
	sd			3.00		0.082	0.061		15.54	3.52				
site 9	min		22.58	36.17		0.026	0.060		21.50	0.10				
	max		28.44	36.89		0.151	0.202		64.30	3.81				
	mean		24.84	36.72		0.075	0.109		47.86	1.01				
	sd		1.89	0.21		0.042	0.046		13.15	1.20				
site 10	min			0.00						0.30				
	max			0.00						496.51				
	mean									36.57				
	sd									67.47				

Table 2: Statistical values of selected in situ measured parameters per test site.

		Water_Depth [m]	Temperature [°C]	Salinity [psu]	Density [sigma]	kd489	kpar	Secchi_Depth [m]	z_01 (depth of 1% light level of PAR [m])	chl_a [mg/ m³]	SPM / ss / STM [mg/ l]	ag440	turbFNU [Turbidity: Formazine Nephelometric Units]	POC [mg/l]
site 11	min	48	1.90	21.15	25.32	0.009				0.06	0.1	0.00		0.03
	max	2198	23.09	34.75	26.91	2.471				71.63	21.9	0.52		90.91
	mean	508	17.56	33.77	25.92	0.256				6.25	2.0	0.14		5.65
	sd	670	4.06	1.52	0.53	0.331				11.02	2.9	0.08		19.29
site 12	min			27.96							0.6	0.01		
	max			35.94							27.4	0.40		
	mean			34.77							5.0	0.09		
	sd			1.37							4.1	0.06		
site 14	min	1				0.026	0.039	0.10	55.00	0.07	0.0			
	max	40				0.045	0.083	13.00	91.00	47.63	330.0			
	mean	6				0.032	0.053	1.01	77.50	8.90	8.3			
	sd	8				0.006	0.012	1.77	11.47	7.70	15.6			
site 17	min					0.030	0.008		47.00					40.48
	max					0.049	0.102		100.00					56.50
	mean					0.038	0.040		70.50					49.75
	sd					0.007	0.039		20.29					5.84
site 20	min	93	10.29	32.24						0.00				
	max	95	19.20	33.91						1169.73				
	mean	94	14.67	33.07						3.76				
	sd	1	2.05	0.36						27.40				
site 25	min			32.31							0.2	0.03		
	max			35.62							1.7	5.39		
	mean			34.96							0.7	0.51		
	sd			0.76							0.4	1.22		
site 26	Min									0.56	3.0			
	Max									4.56	25.0			
	mean									2.06	9.5			
	sd									1.77	7.5			
site 28	min		20.25	32.45		0.071				0.19				
	max		22.14	35.24		0.267				77.86				
	mean		21.43	33.97		0.147				4.58				
	sd		0.72	1.00		0.073				9.47				
global	min	1	-1.34	0.00	4.83	0.009	0.005	0.10	4.54	0.00	0.0	0.00	0.00	0.03
	max	7000	28.44	37.70	26.91	2.471	0.825	13.00	100.00	1169.73	506.3	5.39	41.16	98.02

Algorithms and products

The light emerging from a water body, the surface reflectance, is determined by the optically active substances in the water. These vary largely in composition and magnitude across the CoastColour sites, as discussed before. The atmosphere is also a very complex system, with, for example, the presence of soot containing particles from industry, heating and traffic biomass burning, contrails from aircrafts and desert dust. The signal measured by the satellite is therefore a mixed signal of unknown atmospheric and oceanic optically active substances. As a consequence a system of procedures is necessary to correct for the manifold atmospheric effects and to reduce the variables to a number of components which can be retrieved from reflectance spectra. At the same time, cases are detected, which require special treatment and cases which lead to errors and therefor have to be flagged. Furthermore, the retrieval uncertainty of parameters has to be computed on a pixel to pixel basis.
The general outline of the CoastColour system of procedures is given in Figure 2.

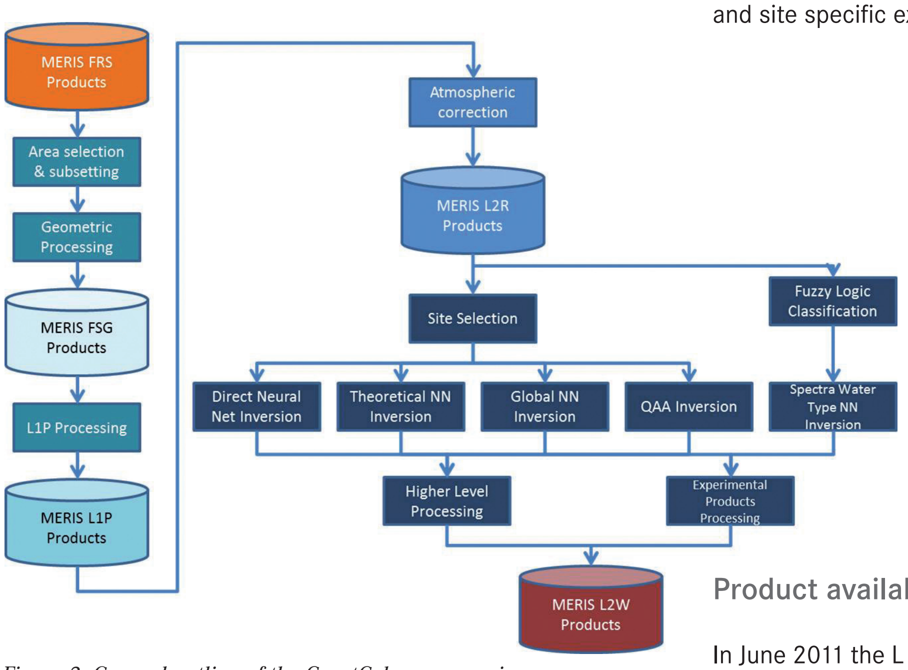


Figure 2: General outline of the CoastColour processing.

CoastColour is working with measurements from the European Environmental Satellite ENVISAT, which carries MERIS (Medium Resolution Imaging Spectrometer), a radiometer, which was specifically built to measure ocean colour in the coastal zone. The starting point in the processing chanin are the MERIS FRS Level 1 products, which provide measurements of the radiance in 15 spectral bands ranging between 412nm and 900nm, and with a spatial ground resolution of 300m. A geographical selection is performed in order to detect products which have an overlap with one of the CoastColour sites. The overlap area is extracted and geometrically processed so that the geolocation of the pixels are known to within an accuracy of better than 70m rms. Furthermore, a radiometric correction, a correction for the so called smile effect, a detector equalisation and a pixel classification (cloud screening) are also performed. The results are CoastColour L1P products. They are one major outcome of the CoastColour project and are useful to remote sensing experts applying their own coastal algorithm to retrieve in-water properties.
Within the CoastColour processing chain the L1P products are then used as input for the atmospheric correction, which performs quality checks and generates directional and normalised water leaving reflectances (L2R products). In the next processing step water pixels are classified by using its top of atmosphere (TOA) spectral signature together with available geographical information. Applying different regionally tuned algorithms the inherent optical properties and concentrations of water constituents are than provided (L2W products).
In summary, CoastColour products include a set of basic quantities which will be generated for all sites and experimental products which are site specific. In Table 3 all standard and site specific experimental products are listed.

Product availability

In June 2011 the L1P processing of all available FRS products covering the 27 CoastColour sites for the years 2005–2009 was completed. The products are available for download, free of charge and with no restrictions. Access to the ftp server can be obtained by sending an Email to office@coastcolour.org. Prototype products of L2R and L2W are available to champion users for the complete year of 2006. With the in-situ data the Users provided to the CoastColour project, matchup have been extracted. Products which contributed to the matchup dataset are provided to the champion users, too. These matchup products cover the full time frame from 2005 to 2009.A process is currently on-going, where champion users and the CoastColour team analyse and improve the prototype products. The results will be presented at the User Consultation meeting in October 2011 (sea announcement below).

Acronym	Product	Dataset	Group of variables
Surface reflectances		L2R	RSURF
RLw	Directional water leaving radiance reflectance		
RLwn	Fully normalized water leaving radiance reflectance		
Inherent optical properties		L2W	IOP
a_total	Total absorption coefficient of all water constituents		
b_total	Total scattering or backscattering coefficient		
A_pig	Phytoplankton pigment absorption coefficient		
A_ys	Yellow substance absorption coefficient		
A_poc	Absorption by particulate organic matter		
Water constituent concentrations		L2W	CONC
Chl.	Chlorophyll a concentration		
TSM	Total suspended matter		
Water transparency/turbidity information		L2W	OTH
kd	Spectral downwelling irradiance attenuation coefficient		
Z90_max	Maximal signal depth		
Z_eu	Depth of euphotic layer		
Z_SD	Secchi disc depth		
FNU	Formazin Nepholometric Units		
Chlorophyll Indices		L2W	FLH
FLH	Fluorescence line height		
MCI	Maximum chlorophyll index		

Table 3: CoastColour product specification (basic quantities)

The following additional experimental, site specific products, will be generated:

Acronym	Product	Algorithm
1%PAR	1% depth of PAR	
PPP	Primary Productivity or Potential Primary Productivity	requires the knowledge of PI parameters, PPP is without nutrient limitations
PPB	Phytoplankton Biomass estimates in gC m-3 or gC m-2 units	
PFG	Concentrations of some taxonomic of functional groups such as coccolithophorides, Cyanobacteria etc	if abundant in dominating concentrations
EF	Effective Fluorescence	Derived from difference of water leaving radiance reflectance between direct output of neural network and difference between top of atmosphere reflectance (RLtoa) and path radiance reflectance (RLpath).

Results

In the more than 9 years of operations, MERIS has produced a very large dataset for coastal waters. To date, the data from 2005 – 2009 have been processed, comprising 50 696 L1P products with a total volume of 16.7 TB. The prototype product set consists of L1P, L2R and L2W for all 27 sites for the year 2006, including 10 960 L1P, 9 660 L2R and 9 102 L2W products, and a total volume of 9.8 TB of storage. In the following, we present a few examples of products now available to coastal users. The use of CoastColour products is demonstrated by two examples, the North Sea and the Chesapeake Bay.

The North Sea is a large sea with a diverse set of optical properties and influences. The southern part is permanently mixed with high SPM concentrations; the deeper northern waters are seasonally stratified with noticeable high scattering coccolithophore blooms between May and early August. Along the Dutch and Belgian coasts large phytoplankton blooms may result in coastal scums being formed and in the eastern parts massive blooms of harmful algae such as Chattonella spp. can threaten fish farms in Norway. Along the coast of Norway the surface outflow from the Baltic containing higher CDOM concentrations can give erroneous chl-a estimates in relatively deep waters. Hence, waters range from Case 1 to Case 2 type waters with the latter dominated by SPM and/or CDOM.

One important processing step is the optical water type classification. A large collection of globally distributed, in-situ measured water leaving reflectance spectra (the NOMAD dataset) has been used to define 8 clusters or classes in spectral space. These classes represent different types of clear and turbid waters. A 9th class has been defined to include the special case of coccolithophores. This was derived from satellite data (SeaWiFS) using the coccolithophore mask. This classification is an important result in itself and can serve as input to an optical-regional optimized processing. Figure 3 shows an example of the optical water type classification as applied in CoastColour. The image shows the dominant class. Classes 1, 2 and 3 represent different types of clear water, classes 4 to 8 different turbid water types, and class 9 the coccolithophores class. The separation of the North Sea into the turbid coastal water and clearer water in the central North Sea can be clearly seen. The algorithm uses a fuzzy logic classification, and the full product includes the membership of each class. The algorithm has been developed by Moore and Dowell (Moore et al, 2009), who both members of the CoastColour consultant team.

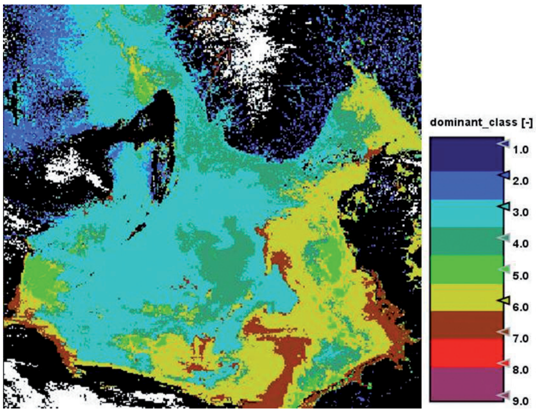
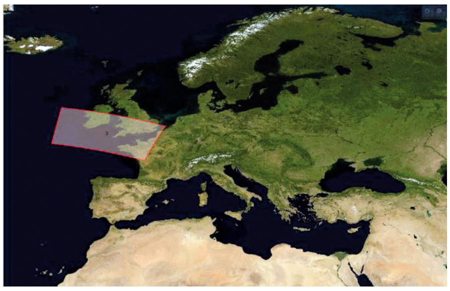
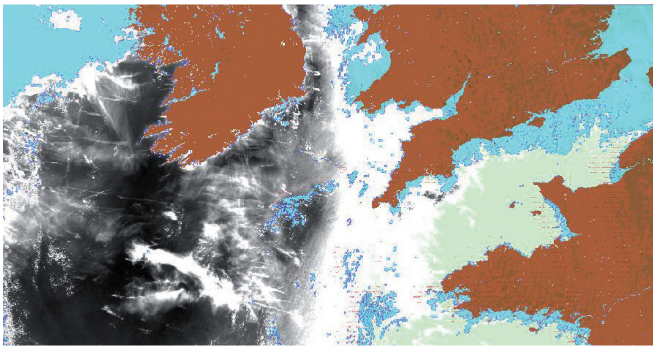


Figure 3: Optical water type classification applied to MERIS FR scene from 20.04.2005, North Sea.

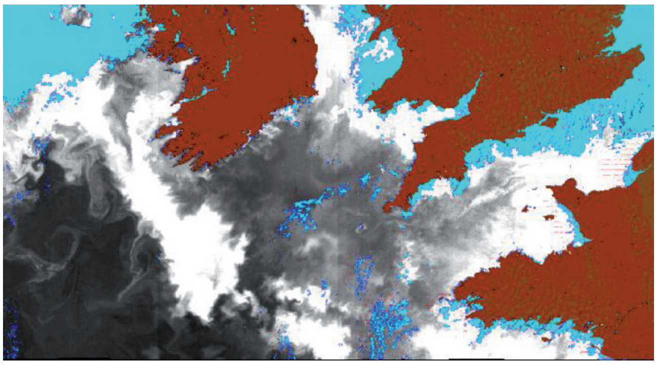
Figure 4 shows key parameters from the CoastColour products derived from a MERIS scene measured on 31.05.2006. In the image showing the top of atmosphere radiance (figure a, L1P product) many thin clouds over the North Sea can be seen. After atmospheric correction (figure b, L2R product) the normalised radiance reflectance does not show any corresponding structures, so the correction can be assumed to perform well for this region. More critical is the calculation of chl a concentration (L2W product). In the lower part of the image, the light structures appear to be coccolithophores (figure d), but are detected as chlorophyll a (figure f). The differentiation is currently being improved using the optical water type classification as the pre-processor and subsequently, the adapted algorithms for either sediment loaded water or coccolithophore bloom, respectively.



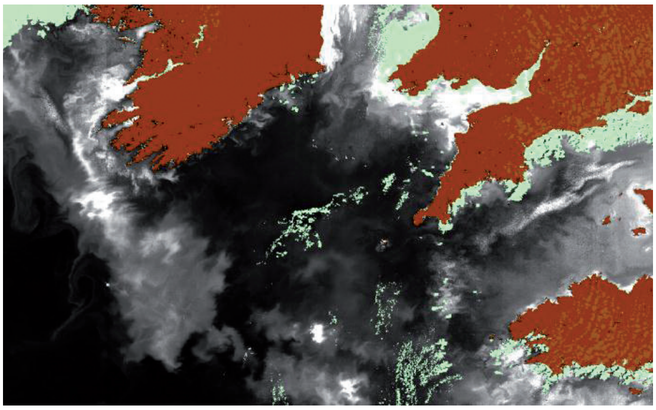
English Channel, 31.05.2006



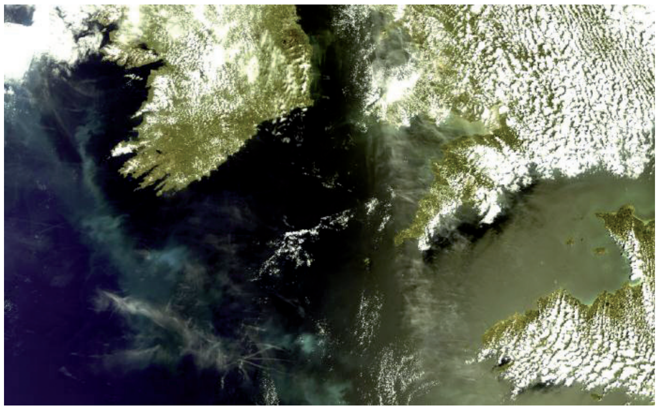
a) radiance, band 13, 865 nm



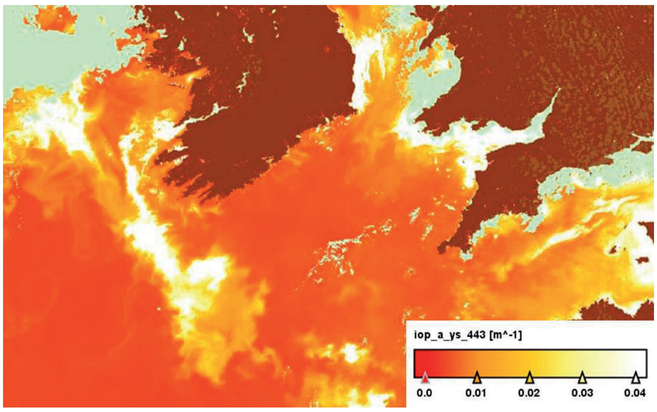
b) norm_refl band 13



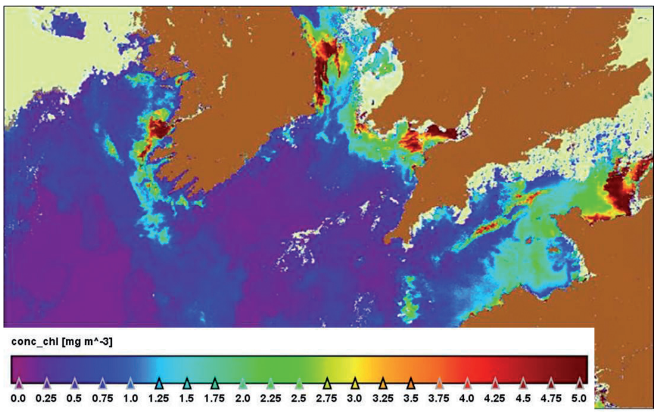
c) kd_443: downwelling irradiance attenuation coefficient at 443 nm



d) RL toa RGB composite



e) Yellow substance absorption

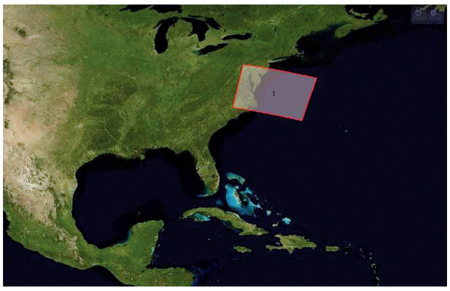


f) Chlorophyll-a concentration

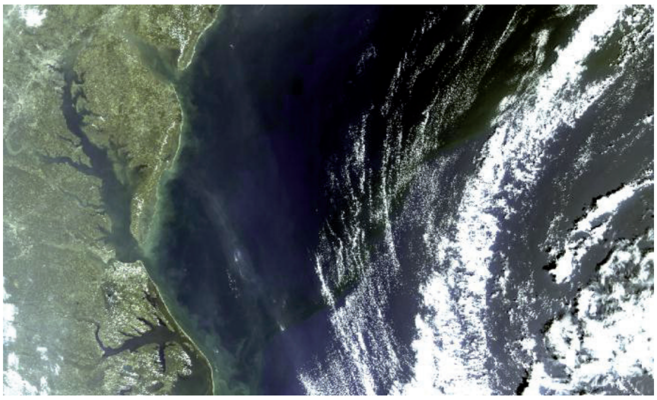
Figure 4: Product examples of the English Channel. a) visualizes the radiance of band13 (865 nm, L1P product), showing fine structures of thin clouds or water vapor b) is the calculated normalized water leaving radiance reflectance of band 13 (L2R product), in c) the downwelling irradiance attenuation coefficient is calculated (L2W product) d) shows a RGB colour composite of the radiometry-corrected top of atmosphere radiance (L1P), e) gives a closer look at yellow substance absorption (L2W) f) shows the concentration of Chlorophyll-a (L2W).

The **Chesapeake Bay** is one of the largest and most productive estuaries in North America. The Bay is fed by a multitude of major and minor rivers and has a wide range of trophic states ranging from highly turbid conditions in the northern reaches to nearly open ocean conditions to the south. An extensive collection of in situ measurements of chlorophyll-a and other water quality parameters spanning the MERIS mission lifetime is available through the SeaBASS archive of NASA, as well as a limited set of in situ radiometry measurements. The Bay has also been extensively studied using NASA remote sensing measurements (e.g., Werdell et al., 2009), and full-resolution MERIS data collected from the Canadian CCRS ground station are now readily available for the region. Figure 5 shows the CoastColour MERIS product taken on 18.09.2006 for the area. The eastern part of the image, over the open ocean is cloud covered, but the coastal zone and the Chesapeake Bay are cloud free (figure a, L1P RGB). Figure b shows the maximum signal depth, which is comparable with the Secchi Depth and is a measure for the turbidity of the water column. The chlorophyll-a and TSM concentrations (figures c and d, L2W product) show the characteristic large difference between the oceanic water with values below 1mg/l chl-a and 1mg/m³ TSM, respectively, to the coastal and bay waters with values larger than 5mg/l and 5 mg/m³, respectively. The extension of higher concentrations from the coast into the open ocean follows the course of the Gulf Stream.

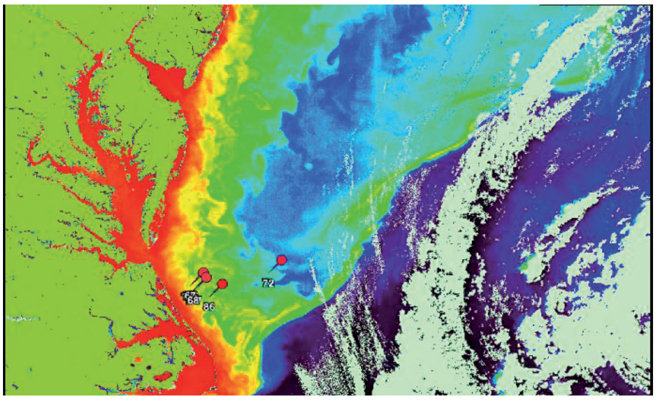
For this particular image 8 match-ups, i.e. correspondences between in-situ and satellite data, for chl-a could be extracted. MERIS and in-situ chl-a show a good correlation (R^2 = 0.8757), but a slight tendency for an overestimation of chl-a concentrations can be observed. (Figure 6)



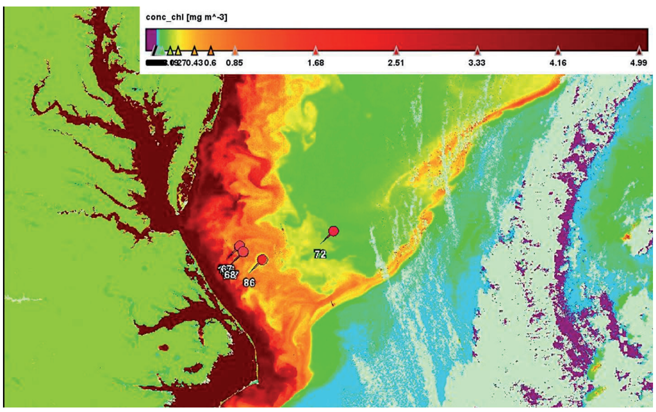
Chesapeake Bay, 18.09.2006



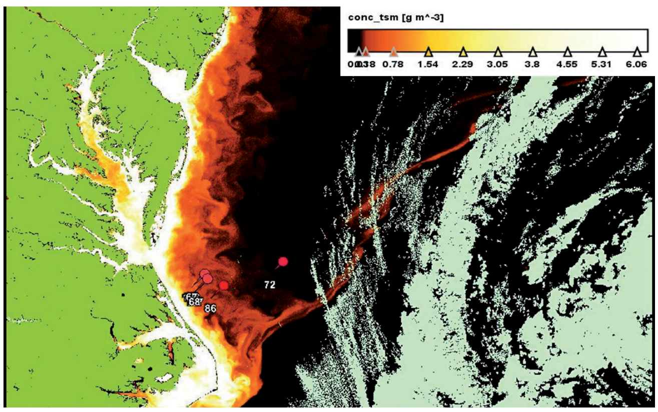
a) L1P RGB composite



b) z_90



c) conc_chl



d) conc_tsm

Figure 5: Product example of the Cheseapeak Bay site. a) radiometry-corrected TOA radiance RGB composite (L1P product) b) maximum signal depth (L2W product) c) concentration of chlorophyll a d) concentration of total suspended matter (both L2W product)

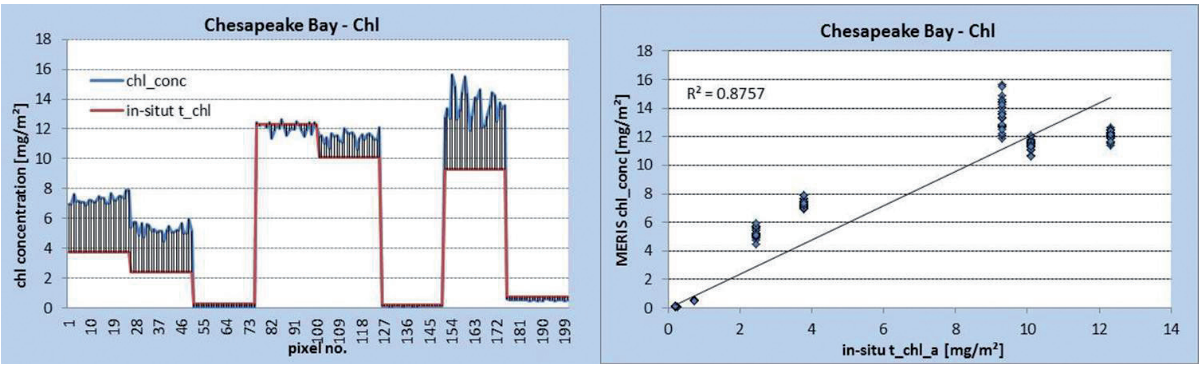


Figure 6: MERIS and in-situ chl-a comparison

Round Robin Algorithm Intercomparison

Reasonable agreement has been achieved in the ocean colour community regarding the optimal method for retrieval of chlorophyll a concentration in open ocean waters (International Ocean Colour Coordinating Group (IOCCG 1998) and an algorithm round robin for such algorithms is reported by O'Reilly, Maritorena et al. (1998). For coastal waters the situation is a lot more challenging because of the greater number of degrees of freedom of the underlying scientific problem - typically spectral reflectance is considered to be a function of 3 or more independent components such as chlorophyll a concentration, coloured dissolved organic matter absorption coefficient and non-algae particle concentration (Sathyendranath, Prieur and Morel 1989). Moreover, conversion from optical properties, such as phytoplankton absorption coefficient, to biogeochemical variables, such as chlorophyll a concentration, may be highly variable in space and time (Bricaud, Babin et al. 1995). Furthermore, the range of output parameters desired by users for coastal waters is large.
As a consequence a wide range of algorithms have been developed within the international community for Case 2 waters and there is no clear consensus on what algorithm should be applied in what circumstances. The CoastColour Round Robin task provides a forum for improving the community's understanding of the performance of the various algorithms and for helping to select the optimal algorithm for a given region and application. 17 algorithm providers participated in a first CoastColour Algorithm Intercomparison Round Robin (CCRR) Workshop, which was held in Brussels on the 28-29th of April 2011. The content of the 4 RR input datasets (i.e. matchups, in situ reflectance, simulated radiance dataset, images) was explained and discussed in detail together with the algorithm providers. A second RR workshop will be held on Friday, 21st October, 2011, following the UCM3 (see below). The results of the comparison between regional CC algorithms and those of algorithm providers will be discussed to help users find the best algorithm for their region and to discuss the major findings on algorithm performance differences.

User Consultation Meeting, 19. – 20.10.2011

User Consultation Meetings provide a platform for users of CoastColour products to discuss the products, the progress of the project, and the science of coastal ocean colour algorithms. The first UCM took place in March 2009 in Cork, Ireland, following by the second UCM in Frascati in November 2010. The users provided very important input for the continuation of project activities. The enormous success of the workshop in Frascati also provided great motivation to the CoastColour team for continuing on to the second phase of the project as well as looking forward to the upcoming User Consultation Meeting in Lisbon, on 19. - 20.10.2011.
The main objective of this meeting is to present the CoastColour regional Case 2 products and algorithms. The improvements in the CoastColour processing chain, including L1P, L2R and L2W processing, will be described in detail. A focus of the meeting will lie on validation and a discussion of the results of the Round Robin algorithm intercomparison exercise.

The main objectives will be:

- Presentation of CoastColour Products, Algorithms
- Possibilities and limits of regional Case 2 algorithms
- User Presentations on validation and usage of CoastColour products
- Results of the Round Robin exercise
- Discussion on the Round Robin, algorithm development, applicability of CC products
- Discussion on the continuation of a forum for the coastal remote sensing community to facilitate international communication and collaboration
- Future of CoastColour

In connection with this meeting the following events will take place:

- A MERIS Validation Team (MVT) Meeting will be holding on 18. October.
- A Training Course with focus on CoastColour products will take place on 21.October.
- A workshop for Round Robin participants will also take place on 21. October.

All meetings are open to all participants.

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The backbone of LOICZ: Affiliated Activities

One aim of LOICZ is to provide a framework to encourage the fullest participation of multi-national, regional, and national research activities in its global research. These activities shall contribute to achieving the goals, aims and objectives outlined in the LOICZ Science Plan and Implementation Strategy (SPIS). A way we accomplish this is to actively engage with the international research community concerned with natural and social sciences on Global Environmental Change in the coastal zone. LOICZ is a forum to assimilate, synthesize and integrate the outputs of the research community. It provides an opportunity to communicate, discuss and disseminate these outputs making them available to the global audience of scientific peers, the general public, and decision-makers in policy and practice. Information on Affiliated Activities is held in a central database that is accessible online through the LOICZ website. It makes basic information and regular updates available to the wider global community as well as to LOICZ for its assessment and synthesis task and its reporting requirements.

We encourage coastal scientists to seek affiliation of their research project/s, PhD thesis or capacity-building activities to LOICZ and become a member of the global science community and network of researchers and practitioners. Since 1993, more than 400 individual activities from all over the world have already been involved in this LOICZ research portfolio.

Early stage research

We particularly encourage early stage researchers from PhD student to Post-Doc level to seek affiliation of their projects. LOICZ acknowledges that much of the work contributing to coastal Earth System science is being carried out by young scientists. Therefore LOICZ wants to support these efforts by enhancing their visibility and introduction to scientific peers in the global research community. Affiliated early stage research will thus contribute to the global research portfolio and its products and information will also feed into the global LOICZ synthesis likewise with the larger affiliated projects.

Affiliation will give early stage scientists comprehensive information about the variety of scientific activities in their field and allow them to foster their network with senior scientists and the global research community. They may also have easier access to participation in workshops, conferences and meetings organized by LOICZ that relate to their own work. By promoting their individual research on a global platform, early stage researchers will be given the opportunity to contribute to LOICZ aims and objectives directly.

Application for affiliation of scientific work at PhD and Post Doc level needs the same set of principle information and delivery of appropriate documents (e. g. thesis outline instead of a project proposal if applicable). In addition and to guarantee a good conduct in quality control LOICZ kindly asks for a co-signature and professional affiliation details of the supervising scientist. The review conducted by the LOICZ scientific peers will apply the same standards as for senior projects. Detailed information on the affiliation procedure is available on the LOICZ website in the ‚Projects' section http://www.loicz.org/projects/index.html.en

Synthesis of Affiliated Activities

Following its succesful evaluation in 2010 LOICZ is presenting its past five year synthesis during the Open Science Conference in Yantai 12-15 September, 2011. The synthesis is an opportunity to share your research findings with the global LOICZ community and value your contribution to coastal and global change research. We therefore encourage you to regularly check and update the project information on the LOICZ database http://kopc01.hzg.de:7777/loiczdb/faces/app/Welcome.jspx, including relevant publications and reports on your research findings. In order to edit your project information on-line, you need to log in with your user name and password. If you require any assistance, please contact the IPO.

Call for affiliation of research activities

LOICZ seeks to expand its network of scientists by endorsing research activities concerned with any of its priority topics on a global, regional or national level.

Within these topics LOICZ strives to develop:

- Methodologies or models that allow data assimilation, processing and synthesis, including up and/or down scaling;
- Scenarios of change and/or response to change in socio-ecological systems;
- Scientific context for the evaluation of existing policies and structures;
- Globally applicable tools for scientific synthesis, decision support and structure development; and
- Dissemination interfaces to provide information and assist sustainablecoastal development on appropriate scales.

To achieve this, LOICZ is calling for proposals to bring high quality research activities into the LOICZ cluster of Affiliated Activities. As well as fundamental science projects, LOICZ also looks for projects that have a multidisciplinary perspective, especially combining natural and social sciences. Projects can focus on global, regional or local scales and address coastal sciences and/or coastal management questions. Projects that collaborate with other Earth System Science Partnership (ESSP) elements, especially with other Core Projects of IHDP and IGBP, are sought in particular. Also projects that synthesize and analyze research outcomes already available or involve dissemination and outreach that will lead to better public knowledge are most welcome. LOICZ particularly encourages affiliation of early stage research at PhD and Post-doc level. Details about projects already affiliated to LOICZ can be found in the LOICZ Project database accessible through the LOICZ website.

Although LOICZ cannot offer funding to Affiliated Activities, its endorsement provides the following benefits:

1. support in the state of proposal for funding;
2. promotion of the project and associated activities, its contributing team, outputs and outcomes through the LOICZ website and/or newsletter;
3. contribution to workshops, conferences and meetings organized by LOICZ and hence establish linkages to other projects operating in similar fields and/or addressing similar issues;
4. access to a wide circle of information related to funding and the science community that is available through the LOICZ database; and
5. Principle Investigators of Affiliated Activities are offered a Corresponding Membership to the LOICZ Scientific Steering Committee (does not apply to PhD level). This appointment is subject to annual review.
6. Affiliated Activities will generally feed into the global LOICZ synthesis (Interim Synthesis planned for 2010).

Researchers whose work fits into the LOICZ portfolio are encouraged to submit proposals to the LOICZ IPO as soon as possible. The required form is accessible after registration to the LOICZ project database and additional information can be obtained from the LOICZ website or via contacting the LOICZ IPO.

The LOICZ conceptual framework and the ecosystem approach: Towards an interdisciplinary appraisal of coastal ecosystem services - the case of the European saltmarshes.

Tiziana Luisetti
and
Kerry Turner
Centre for Social and Economic Research on the Global Environment, University of East Anglia

Chris Adams
University of East Anglia, UK

1. Introduction: Coastal change adaptation in Europe and the UK - the case of managed realignment

Coastal zone policy in the UK and Europe is being re-orientated towards a more flexible, ecological and adaptive approach, while linked water catchment management is also being reformulated under the EU Water Framework Directive (WFD) (2000/60/EC). The WFD requires that EU member states introduce quality objectives for all water bodies (the whole catchment area) including coastal waters. It has a more direct focus on ecological status and came into force to simplify the approach to the different aspects of water management already covered by the other Directives on water issues (e.g. the Bathing Water Directive (76/160/EEC) and its new version adopted in 2006 (2006/7/EC); the Urban Waste Water Treatment Directive, (91/271/EEC) etc.). The overall aim is to protect and achieve 'good ecological status' for all surface and ground water bodies by 2015(i.e. surface fresh waters; ground waters; ground water dependant ecosystems; estuaries; and coastal waters out to one mile from low-water (Environment Agency, 2011). Other relevant Directives for coastal areas, especially wetland areas, include the Habitats Directive (European Commission, 1992), which specifically establishes Marine Special Areas of Conservation and requires a 'like-for-like basis' compensation for displaced habitats (e.g. recreating intertidal habitats) including those lost through natural or semi-natural causes such as sea level rise or coastal erosion. The Habitats and Birds Directives (European Commission, 1979) aimed to create a network of designated areas (known as Natura 2000) to protect habitats and species of community-wide importance. The shift towards an ecosystem approach and more holistic and adaptable management fits perfectly with the LOICZ methodology and its core concept of the coastal catchment continuum.

A key component of this new European thinking could be managed realignment (MR). Saltmarshes have currently been disappearing from coasts because of what is known as the 'coastal squeeze' phenomenon: due to sea level rise the intertidal habitat is gradually constrained on one side by the sea and on the other by sea walls erected between the land and an intertidal habitat to protect the coast. MR involves the deliberate breaching of existing sea defences and the consequent restoration of the tidal flow allowing sedimentation and the storage of nutrients to resume (Adams et al., forthcoming). Depending on their position in the tidal frame, MR areas result in the development/restoration of saltmarshes (or intertidal mudflats) which are a soft and more sustainable flood defence helping to dissipate wave energy. MR allows the intertidal habitat to naturally move inland so that it can continue to protect the coast in combination with manmade or natural 'secondary defences' (using local topography), and inter alia creating opportunities for biodiversity enhancement[1], as well as expanding opportunities for amenity and recreation (i.e. a diversity of ecosystem services, Fisher et al. 2009). However, any comprehensive deployment of this coastal strategy will be conditioned by a complex set of factors in a highly 'contested' political economy context in which continuing uncertainty over ecosystem functioning under stress and shock condition still prevails (Turner, 2007). Argumentation will be focused on the trade-offs between greater resource efficiency, social justice, equity and compensation objectives.

Furthermore, previous research has highlighted that managed realignment policy needs to be appraised across a more extensive spatial and temporal scale than has been the case in the traditional scheme-by-scheme coastal management system (Turner et al., 2007). In other words, whole estuaries or multiple coastal cells need to be treated as a single 'project' encompassing a number of realignment sites, and with linkages into catchments. In fact, many estuaries in northern Europe share a similar history of reclamation and use of their coasts, and a similar biogeochemistry (Andrews et al., 2006). For example, the Humber and the Blackwater estuaries that are located on the east coast of England, the case studies presented here, are typical in this sense. The (negative) historical legacy impacts on the ecosystem services provision (e.g. the build up of contaminants in estuarine and coastal sediments from past industrial/urban development; or chronic eutrophication from intensive agriculture and/or inadequate sewage treatment facilities etc.), can subsequently be difficult and costly to ameliorate (e.g. improving soil quality/productivity; cleaning aquifers or modifying coastal defence structures), and require at least catchment scale action (Cave et al., 2003). The historical catchment and estuary land use

[1] Depending on how successfully the salt marsh communities can re-establish.

changes and other activities, have substantially reduced the area within estuaries in which sedimentation take place, meaning a reduction in the carbon (C), nitrogen (N), and phosphorous (P) storage potential. Furthermore, the loss of intertidal areas has diminished the potential for the decrease of estuarine nitrate loads via the bacterially-mediated process of denitrification (Jickells et al., 2000).

The two case studies were chosen for this analysis because they share physical similarities and risk profiles and are also subject to the same legislative regime. Both estuaries are located on the east coast of England where major issues of flooding because of sea surge can occur and which may be exacerbated due to future climate change effects such as sea level rise and vertical land movements associated with the melting of ice sheets (glacial isostatic adjustment). Impacts and policy responses will be different depending on the area at risk. Sea level rise, increased cliff erosion and more extensive and frequent flooding, is potentially putting at risk private owned houses and business assets – estimated to encompass 4 million people and collateral worth £200 billion across England and Wales (O'Riordan et al., 2008).

The EU has promoted an integrated coastal zone management (ICZM) strategy, which is slowly becoming embedded in national strategies. In estuaries along the English east coast some managed realignment (MR) experimental schemes have already been implemented. But MR is controversial because some previously reclaimed coastal land (usually agricultural land) is sacrificed in order to reduce the threats of coastal erosion and flooding along the coast (Royal Commission on Environmental Pollution, 2010). In general, there is distrust among local communities about government intentions and plans for coastal adaptation measures. This context has been conditioned by uncertainty surrounding the goals of coastal adaptation because of the scientific uncertainties linked to future climate change, and uncertainty about compensation measures for those that will be adversely affected by the changes in the coastline. For all these reasons, a new 18 months (2009-2011) governmental scheme called Pathfinder will support (£11 million budget) fifteen pathfinder authorities (County and District Councils) to explore new ways of adapting to coastal change (DEFRA, 2010). The North Norfolk District Council, in the east coast of England, received the largest amount (£3 million) to implement the scheme in its local area, and it is the first to have put forward, in 2010, a 'compensation' plan using some of the funding of the Pathfinder scheme. The council is making individual offers to the owners of cliff top homes of between 40-50% of the theoretical value of their homes if they were inland and not at any risk of coastal erosion. However, it is not yet clear precisely which kind of support mechanism will be taken up more generally by pathfinder projects (North Norfolk District Council, 2010).

2. A conceptual framework for environmental project and policy appraisal

The state-of-the-art for a robust economic appraisal of ecosystem services can be summarised by the following conceptual framework that encompasses the use of two main conceptual tools: the DPSIR (Drivers-Pressures-State changes-Impact-Response option), which is a scoping procedure; and the ESSS (Ecosystem Services Sequential Steps), which is a sequential decision support system combining the ecosystem approach and the ecosystem services concept.
The DPSIR is a useful device for clarifying the role that socio-economic drivers play in inducing pressures on the environment (over varying timescales and across a range of spatial scales). These pressures result in state changes (often ecosystems degradation or loss) and consequent impacts of the welfare of people and communities locally, regionally and sometime globally. Efforts to modify the impacts (policy responses) produce feedback effects within the drivers/pressures systems (Turner et al., 1998). Figure 1 shows the DPSIR for the North Sea coastal zone.

The British case study estuaries examined in this paper are located in the North Sea region. Figure 1 illustrates the global and regional socio-economic drivers that lead to a series of environmental pressures such as land conversion and reclamation, agricultural runoff pollution etc. Socio-economic drivers and environmental pressures in turn carry changes in the environmental 'state' of the ecosystems: loss of geo- and bio-diversity, eutrophication etc. The effects of those changes are impacts on human welfare such as lower quality of water and recreation experiences etc. The consequent policy responses cover a range of measures. In our case studies we analyse the efficiency of managed realignment as a policy response to the loss of ecosystem services provided by the saltmarshes in the Humber and Blackwater estuaries.

To verify the efficiency of the MR policy in those two estuaries, the ESSS decision support system was applied (Fisher and Turner, 2008; Fisher et al. 2009). Fisher and Turner (2008) define ecosystem services (ES) as 'the aspects of ecosystems utilised (actively or passively) to produce human well-being'. Fisher et al. (2009) see ecosystem services as the link between ecosystems and things that humans benefit from. The ES concept encompasses ecosystem classes as well as ecosystem processes and functions, with the latter becoming final services only if there are humans that (directly or indirectly) benefit from them. In other words, ES are the ecological phenomena, and the benefit (a change - gain/loss - in human well-being) is the realisation of the impact on human welfare. More importantly for environmental valuation the Fisher et al. definition explicitly links changes in ecosystem services (environmental state changes) to changes in human welfare (impacts). The key feature of the definition is therefore the separation of ecosystem processes and functioning into intermediate services (that influence human wellbeing indirectly) and outcomes in terms of final services (that con-

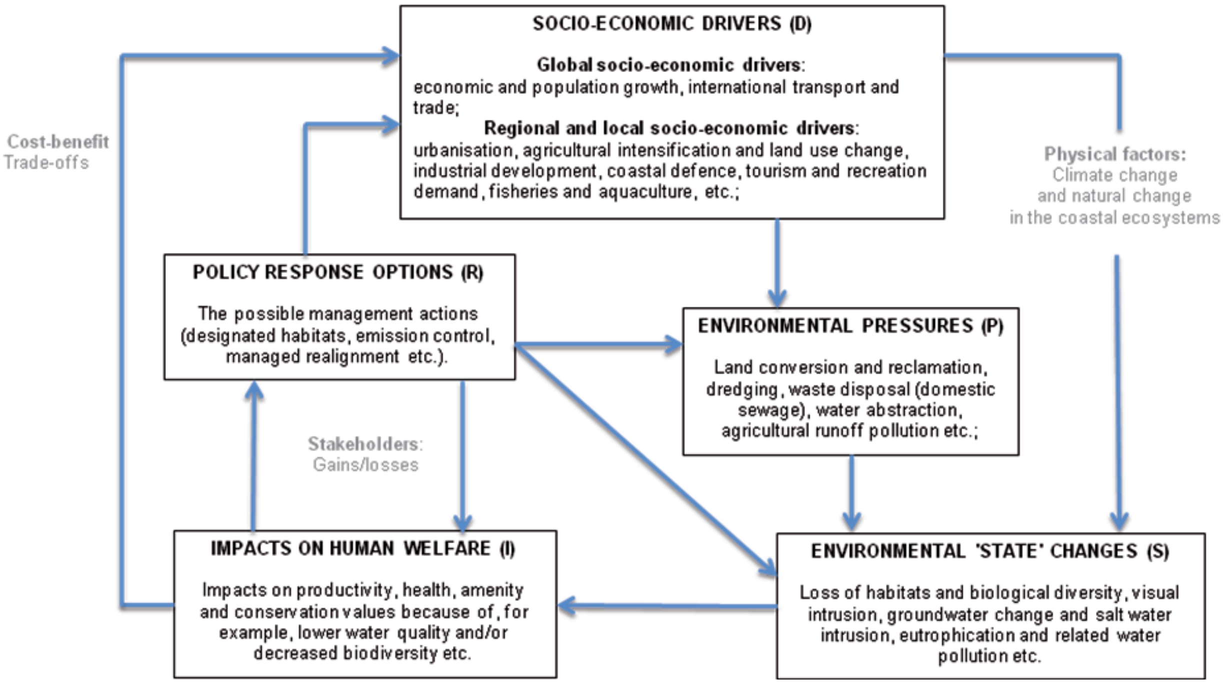

Figure 1: DPSIR for the North Sea coastal zone (Adapted from: Turner et al., 1998; Turner et al., 2003).

tribute directly to human well being), with the latter yielding welfare benefits. In other words, the benefits that humanity gains for ecosystems (e.g. fish production) are derived from the contribution of intermediate services (e.g. clean water; primary production) and final services (e.g. fish nurseries). Figure 2 shows the ecosystem services and benefits for the North Sea coastal areas can be separated into intermediate and final services, and benefits. However, classification of ES into intermediate and final services is context dependent, meaning that the relationships between intermediate services, final services and benefits can vary depending on the context analysed. For example, clean water provision is a final service and benefit (i.e. direct change in human welfare) to a person requiring drinking water, but it is an intermediate service to a recreational angler, who requires a final service in terms of the provision of the fish population in order to get recreation enjoyment (final welfare benefit).

The Fisher et al. (2009) approach seeks to provide a transparent method for identifying the aspects of ecosystem services which are of direct relevance to economic valuation, and critically, to avoid the problem of double-counting. As reported by Turner et al. (2010) to be most useful for policy, ES must be assessed within their appropriate spatial context and economic valuation should provide marginal estimates of value, avoiding double counting, that can feed into decisions at the appropriate scale as summarised in Figure 3.

3. Application of the conceptual framework: case studies

Recent work in intertidal areas of the Humber and Blackwater estuaries has begun to assess the potential scale of the biogeochemical value of natural intertidal areas and MR sites (Andrews et al., 2006; Shepherd et al., 2007). This has included assessments of the C burial and N removal benefits (N burial + denitrification) of these areas and the potential for any production of GHGs within these sites to partially offset the gross C burial benefit, to yield a net C sequestration value. However, due to the relatively young age of most east coast UK MR sites there is a paucity of data to understand long term biogeochemical processes (Andrews et al., 2008). In particular, knowledge of GHG fluxes in MR environments is lacking and recourse is usually made to greenhouse gas flux data from natural intertidal wetlands (Andrews et al., 2006; Parkes, 2003). The availability of such data allowed the contemporary assessment of the economic value of the ecosystem services provided by the Humber and the Blackwater estuary (Turner et al., 2007, Luisetti et al., 2011a).

Of the two case studies presented, the Humber estuary case study (Turner et al., 2007) comes first chronologically and most of its methodology for the ES economic assessment was then used for the Blackwater estuary case study (Luisetti et al., 2011a). Some improvements in the available data sets and in the valuation of the ecosystem services were introduced in the analysis of the Blackwater: i.e. the estimation in situ of new geochemical and biological data and of recreation benefit value estimates with a site-specific stated preference

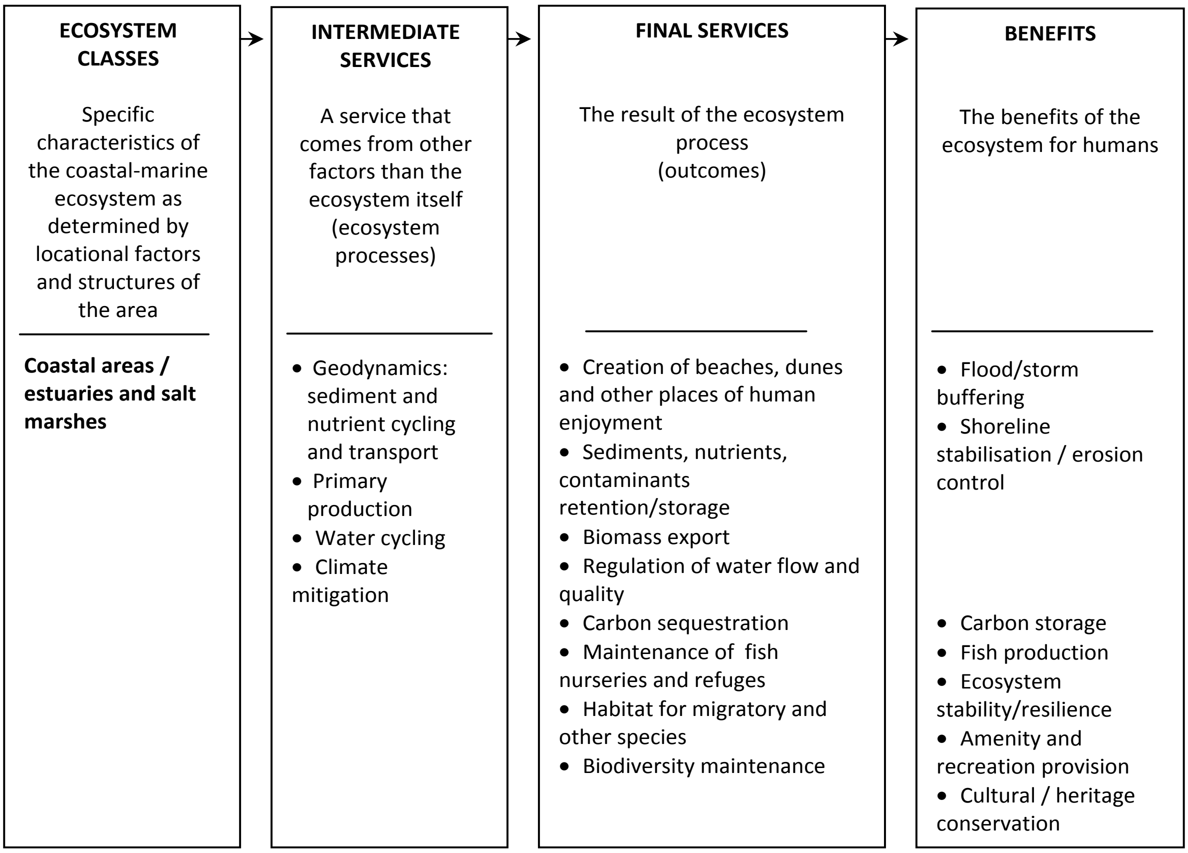

Figure 2: Classification of Coastal and Marine Ecosystem Services

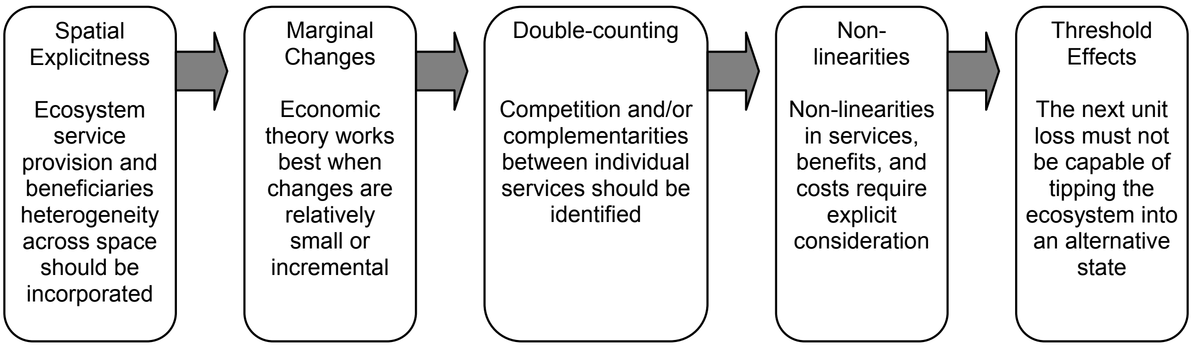

Figure 3: Ecosystem services sequential steps (ESSSs) *Source: Turner et al., 2010.*

study. In this paper we will present a further advance in the biogeochemical data estimated in situ for the Blackwater MR areas in respect to C and N burial potential. C sequestration has an economic value based on the environmental damage avoided by storing rather than emitting each tonne of CO_2, which will help to meet reduction targets set by the UK Climate Change Act 2008, as detailed in the Low Carbon Transition Plan (DECC, 2009). The potential increased storage of N (N burial) in new intertidal sediments, and increased removal of N through denitrification, can lead to improvements in water quality (and eutrophication) necessary for estuaries to comply with objectives set out in the Water Framework Directive and contribute to the ecosystems services provision of the sites (Adams et al., forthcoming). However, during the process of denitrification a small amount of nitrous oxide (N_2O) is released leaving us with the benefit of nitrate/nitrite removal but the production of some N_2O.

The anchor point for our economic analysis of MR projects efficiency assessment is based on a cost-benefit analysis (CBA) and discounting, which was originally applied to the Humber case study (Turner et al., 2007). The same CBA approach was then used for the analysis of the Blackwater MR scheme. It allows for the comparison of the discounted present value (PV) of the 'status quo' (SQ) existing protection system and the present value of MR schemes. The overall CBA result is then found via Equation 1:

(1) $NPV_t^{mr} = (PV_t^{mr} - PV_t^{sq})$

where: NPV_t^{mr} = net present value of the managed realignment scenario compared to the hold-the-line (SQ) scenario for a given stretch of coastline at time t (£ million).

The costs to implement MR projects are: capital costs of realignment, i.e. the realignment of defences, which may involve building a secondary line of defence (although depending on the topography of the area that might not be needed); maintenance costs of realigned (new) and non-realigned (old) defences; forgone agricultural land opportunity costs. Those costs were calculated for both estuaries using the appropriate land market prices.

For both estuaries the benefits were identified using an ecosystem services scheme as in Figure 2. The flood defence cost savings and carbon storage benefits, were calculated with the same economic methodology in the Humber and in the Blackwater. But in the Blackwater case study a further benefit, fisheries production, was considered, and the amenity and recreation benefit was estimated in situ instead of being transferred from other studies as per the Humber.

3.1 Spatial explicitness

In both case studies, first and foremost, spatial explicitness was taken into account. Knowledge of the underlying biophysical structure and processes of any given ecosystem service is crucial. Spatially explicit analysis must then encompass appropriate socio-economic, political and cultural parameters in order to properly identify ecosystem services supply and demand side beneficiaries. Importantly, ecosystem services are context dependent in terms of their provision and their associated benefits and costs, which means that service values may change across the landscape due to geographical variations (scale) in biophysical supply or demand of a service.

To identify the more appropriate sites for managed realignment for both estuaries, geographical information system (GIS) techniques were used in combination with possible future scenarios. The GIS methodology was originally developed for the Humber estuary case study and then replicated for the Blackwater estuary. The GIS-based realignment site location criteria were used to minimise the opportunity costs of realignment involving significant social justice/ethical concerns: urban centres were assumed to be protected and therefore excluded from the analysis; and only the sacrifice of lower quality agricultural land for the purpose of saltmarsh re-creation was taken into account. However, as food security issues continue to rise up the policy agenda the sacrifice of any usable agricultural land will result in escalating opportunity costs.

In the Humber case study, the suitable areas of realignment identified via GIS layers were combined with four possible future policy scenarios: business-as-usual (BAU), which takes into account existing realignment schemes; policy targets (PT), in which economic growth is combined with environmental protection; deep green (DG) is a scenario in which environmental protection takes priority over economic growth; and extended deep green (EDG), which maximises habitat creation. The extent of realignment areas therefore increases from the BAU through to the EDG scenario. A status quo scenario, called hold the line (HTL), acted as a baseline against which other scenarios were evaluated. In the HTL scenario existing defences are maintained to a satisfactory standard, but loss of intertidal habitat will continue. A complete do nothing strategy was not considered given the statutory duties imposed on coastal protection and sea defence agencies. In the Blackwater case study, the same scenarios were considered with the exception of the BAU scenario, because in this study existing experimental realignment areas in the estuary created between 1991-2002 were considered as current saltmarshes (in 2006).

3.2 Marginality, threshold effects and double counting

Economics traditionally requires that for the valuation of ecosystem services to be meaningful such analysis should be conducted "at the margin". This means focusing on relatively small, incremental changes rather than large state changing impacts. Given the scientific uncertainties which shroud ecosystem functioning, it is often difficult to discern whether a given change is 'marginal' or not and when thresholds are being approached or crossed. Since a threshold effect refers to the point at which an ecosystem may change abruptly into an alternative steady state, for marginal analysis to hold true, the 'next unit' to be valued should not be capable of tipping the system over a functional threshold or 'safe minimum standard' (SMS)[2]. On the basis of current scientific knowledge no threshold effects were thought to be relevant in this analysis. The potential problem of double-counting may occur where competing ecosystem services are valued separately and the values aggregated (e.g. separate valuation of recreational and industrial fish nurseries of the same fish species); or, where an intermediate service (e.g. nutrient cycling, or water quality) is first valued separately, but also subsequently through its contribution to a final service benefit (e.g. recreation gains from improved water quality). Care was therefore taken to ensure that the aggregation of benefits values was appropriate.

A CBA assessing the economic efficiency of MR schemes was undertaken comparing all relevant costs and benefits of the scheme. In the Blackwater case study (in line with the Humber analysis) it was assumed that there was no reduction in the level of protection (vis-à-vis hard defences) where new saltmarshes were put in place. Market analysis was used to estimate the cost savings on hard defences. The cost of realigned defences was assumed to be 50% of the non-realigned defences.

Compared to the Humber study, in the Blackwater new geochemical and biological data from study site(s) fieldwork campaigns (Adams, 2008; Fonseca, 2009) were used to estimate the value of carbon storage (climate change impacts mitigation) and the value of an extra benefit (fish production).

An estimate of the fish production value in the newly created saltmarsh nurseries (saltmarsh creeks) was obtained by multiplying the value per hectare of the fish species considered by the hectares of new saltmarsh created. Linearity is assumed in the PT through the EDG scenario (the bigger the extent of the saltmarsh, the higher the fish productivity effect). The fish production function is calculated in Fonseca (2009), and it is based on quantitative estimates of the abundance of juvenile bass up to two years old. The fish considered were only those species sold in the market (in this case, sea bass), and were therefore valued using market prices. Following a conservative approach, the value of bass chosen for the CBA is the mean value per hectare at lowest wholesale price: £7.43/ha.

Climate change impacts mitigation can be difficult to value because the (positive) capture of greenhouse gases has to be balanced against the (negative) release of greenhouse gases in the atmosphere during the process of carbon storage. However, it has been shown that this releasing phenomenon is less likely to occur in salt marsh areas than in fresh water marsh areas. Table 1 shows the details of the carbon storage for the Blackwater estuary following Adams' fieldwork campaign (2008) and the new estimates based on expanded data availability (Adams et al., forthcoming). Table 1 shows the net carbon burial per year, amended to take account of greenhouse gases production (CH_4 and N_2O converted in CO_2eq using Greenhouse Warming Potential GWPs)[3]. Following atmospheric science convention, emissions are reported as positive and sequestration as negative values. Assuming 1.5mm and 6mm sedimentation rates respectively in areas with relic (material from pre-reclamation or older natural intertidal environments) and spartina marsh, which represent the majority of the current Blackwater MR sites (but probably not the long-term situation), there is a positive carbon sequestration: 0.266/t/ha/yr; and 3.347/t/ha/yr. These are the data and estimates used in Luisetti et al. (2011a). The new data reveal a higher level of N_2O emission in the process of carbon burial (Adams et al., forthcoming) that therefore shows a reduced value of carbon storage in the Blackwater saltmarshes. MR sites undergo rapid changes after breaching of sea defences and although they often initially form intertidal mudflat due to the input of new sediment (Dagley, 1995; Garbutt et al., 2003), any areas higher in the tidal frame than mean high water neap are expected to be colonised by salt tolerant plants and quickly revert to saltmarsh. This means that intertidal mudflat or pioneer saltmarsh are usually temporary with changes occurring in months or years as the sites develop (Garbutt et al., 2003). In Table 1, following Adams et al. (forthcoming), the new estimates are based on sampling from a Spartina marsh dominated MR site and an accidental retreat site which more closely resembles natural saltmarsh (Mossman, 2007). We report in Table 1 new

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[2] The safe minimum standard represents the minimum level of a well-functioning ecosystem which is capable of producing a sustainable supply of service (Bishop, 1978; Ciriacy-Wantrup, 1952; Crowards, 1998).

[3] Since CO2, CH4 and N2O all absorb different amounts and frequencies of radiation, and have different atmospheric residence times, the amounts of each gas cannot be compared directly, either as mass to mass or volume to volume. To make such a comparison the masses of each gas are first converted using the Greenhouse Warming Potential (GWP). Over a 100 year time frame the GWP of CH4 is 21 meaning that it contributes 21 times more to anthropogenic global warming than an equal amount of CO2. Over the same time frame the GWP of N2O is 310 (Forster et al., 2007). The conversion gives carbon dioxide equivalent (CO2eq) values of the greenhouse gases allowing a meaningful comparison of carbon burial and greenhouse gas fluxes in intertidal areas.

values based on the estimate of a 5.4mm sedimentation rate, which is an acceptable estimate for long term surface elevation change, given a regional sea-level rise of 6mm per year in the Blackwater estuary (NRA, 1994) and assuming that the sampling area is currently in equilibrium with sea-level rise. Representing the long-term situation, these new values are probably the 'best' option to be used in the CBA.

As for the fish production, linearity is assumed for carbon sequestration in the PT through to the EDG scenario. As shown in Table 2, the bigger the extent of the saltmarsh area, the higher the carbon sequestration potential.

Relic and spartina marsh (assumed sedimentation rate)	C burial	CH_4 (actual flux)	CH_4 (CO_2eq)	N_2O (actual flux)	N_2O (CO_2eq)	Net C burial (C sequestration) tC/ha/yr
First sampling data (Luisetti et al., 2011)						
1.5mm	-1.027	-0.0012	0.025	-0.00237	0.735	-0.266
6mm	-4.108	-0.0012	0.025	-0.00237	0.735	-3.347
New data (Adams et al., forthcoming)						
1.5mm	-0.35	NA	0.030	NA	1.156	-0.03
6mm	-1.41	NA	0.030	NA	1.156	-1.09
5.4mm	-1.27	NA	0.030	NA	1.156	-0.94

NA = not available.

Table 1: Net carbon burial per year, amended to take account of greenhouse gases production (CH4 and N2O converted in CO2eq using Greenhouse Warming Potential - GWPs). 1.5mm, 6mm and 5.4mm assumed sedimentation rate. All figures are in tonnes, per hectare, per year.

Carbon storage was valued, as in the Humber study, with the damage cost avoided method i.e. the monetary value of the avoided carbon releases to the atmosphere because of storage (Pearce, 2003; Stern, 2007; Tol, 2005). For the purpose of sensitivity analysis in both estuary case studies different values of carbon storage were used. In the Humber estuary three distinct values were used: £45 in 2005 (Tol, 2005); £222/tC (Tol, 2005); £4/tC (Pearce, 2003). In the Blackwater case study four different prices were considered: the highest price that could be used is the figure suggested formerly by Pearce et al. (1996) and confirmed by Tol (2005) of about £30 in 2007; another much lower figure that could be applied is £7, which is in the range of the estimates recommended by the Second Assessment Report (Arrow et al., 1996) as well as in the range suggested by Pearce et al. (1996) and confirmed by Li et al. (2004); another more recent estimate for the social cost of carbon (SCC) is the figure proposed by the Stern Review (2007): \$85/tCO_2, which is equal to \$350/tC in 2005 prices (Stern, 2007; Nordhaus, 2007), which is around £230/tC in 2007. However, as reported by Tol (2008) in a meta-analysis on estimates of the social cost of carbon, the Stern (2007) estimate is an outlier with respect to earlier estimates calculated using the same model (PAGE model). Another possible figure is given by the mean price of traded carbon that in October 2007 was equal to €21.50[4] which is about £15.

Table 2 also compares the C sequestration potential based on the Luisetti et al. (2011a) and Adams et al. (forthcoming) estimates. Following a conservative approach, in Luisetti et al. the economic values of carbon sequestration assuming a 1.5mm sedimentation rate as per Table 2 were used. However, as suggested by Adams et al. a more appropriate figure to be used in the CBA should be the 5.4mm assumed sedimentation rate. Comparing the C sequestration estimates assuming the 1.5mm and 6mm sedimentation rates we observe that the new estimates are lower. This is due to the new data on N_2O which are higher than those in previous measurements (see Table 1). However, it is worth noting that, because of the measuring methodology adopted (static chamber methods) in the research, the fluxes presented in Adams et al. are likely to underestimate the true flux of N_2O. The shaded areas in Table 2 highlight the C sequestration potential estimates used in Luisetti et al. and in this paper. In the first paper, a very conservative approach was adopted on the basis of the then available C sequestration data. The conservative approach in the CBA was reflected also in the choice of the estimated social cost of carbon: in Luisetti et al. the lowest figure proposed in the literature (£7) was used. Table 3 compares the economic values used in the CBA of Luisetti et al. and the new economic values based on the new C sequestration estimates in Adams et al., but still using the most conservative figure for the social cost of carbon (£7).

[4] That value is reported by http://www.pointcarbon.com. It should be noticed that this price is higher than usual due to the dollar price that in the same period was anomalously going down.

Scenarios	Tonnes of C sequestration at 1.5mm assumed sedimentation rate/yr	Tonnes of C sequestration at 6mm assumed sedimentation rate/yr	Tonnes of C sequestration at 5.4mm assumed sedimentation rate/yr
First sampling data (Luisetti et al., 2011a)			
PT: 81.6 Hectares	-21.7	-273	NA
DG: 816.5 Hectares	-217.2	-2732.8	NA
EDG: 2404.1 Hectares	-639.5	-8046.5	NA
New data (Adams et al., forthcoming)			
PT: 81.6 Hectares	-2.45	-88.94	-76.70
DG: 816.5 Hectares	-24.50	-890	-767.51
EDG: 2404.1 Hectares	-72.12	-2620.47	-2260

NA = not available.

Table 2: Carbon sequestration estimates in the Blackwater saltmarshes per scenario (Luisetti et al., 2011a; Adams et al., forthcoming).

In the Humber estuary case study an indicative value of re-creation and amenity benefits was obtained using benefit transfer values on the basis of the results of a meta-analysis on wetland values (Woodward and Wui, 2001). In the Black-water estuary case study, the amenity and recreation benefit was estimated in situ with a site-specific stated preferences study: a choice experiment (CE). In a choice experiment respondents are asked to express their willingness to pay (WTP), making a choice between alternative goods or policies that are specified with several attributes and different levels of those attributes (choice set). Conventionally, in one questionnaire an individual is asked to state his/her preference over more than one choice set. Table 4 shows attributes and attribute levels for the CE on the Blackwater saltmarshes.

Based on the ecosystem services approach, the expected water quality improvement and biodiversity enhancement (including fisheries output not sold in the market) are assumed to be captured by the value estimated for the recreational value of the newly created saltmarshes. The logic behind this assumption is that probably very little amenity and recreation benefit would be possible if good quality water and a diverse group of plants and animals were not present. In intertidal habitats, the process of denitrification, which provides water quality benefits, occurs at the same time as the carbon burial process. These two ecosystem services processes, while providing simultaneously enhanced water quality and carbon sequestration benefits, have the side effect of releasing GHGs (CH4 and N2O) into the atmosphere. In this study this side effect was taken into account and the GHGs were converted into CO2 equivalents to get the net estimate of carbon sequestration potential (see Table 1).

	PT 81.6 Hectares (£/yr)	DG 816.5 Hectares (£/yr)	EDG 2404.1 Hectares (£/yr)
Economic value (£) of C sequestration potential at 1.5mm assumed sedimentation rate/yr (Luisetti et al., 2011a)	152	1,520	4,476
Economic value (£) of C sequestration potential at 5.4mm assumed sedimentation rate/yr (Adams et al., forthcoming)	537	5,373	15,820

Table 3: Comparison of annual C sequestration potential economic value per scenario at the social cost of carbon figure of £7/tC/ha using old and new C sequestration potential estimates.

Attribute	Variable label	Levels
Area of new salt-marshes	AREA	25acres = 10fp* 74acres = 30fp 123acres = 50fp 173acres = 70fp
Number of protected bird species observable	BIRDS	2, 3, 4, 5 species
Distance from respondent's home (in miles)	DISTANCE	Near sample: 2, 12, 22, 32 miles Far sample: 42, 52, 62, 72 miles
Access to the salt-marshes	ACCESS	Yes; No
Increase in respondent's council tax per year	TAX	£2, £6, £10, £14

Table 4: Attribute levels used in the choice experiment design.

Attributes and their units of measurement of the CE were selected following a series of preliminary meetings and focus group investigations:

- AREA: the area of new salt-marshes to be created[5]; measured both as acres[6] and as the corresponding number of football pitches[7];
- BIRDS: bird species observable measured as the number of protected species returning in the estuary and reflecting the quality level of the environment in the area[8];
- DISTANCE: the distance from respondent's home to the nearest site measured in miles. As shown in Table 2, the correspondent attribute levels are divided into those seen by the 'Far' sample (living in Norfolk and Suffolk) and those seen by the 'Near' sample (living in Essex – where the Blackwater estuary is located);
- ACCESS: whether the created salt-marsh would be open-access or not. This is a simple binary variable;
- TAX: the increase in the respondent's annual local (council) tax to pay for the option was measured in £ per household per annum.

Interviews were conducted by a team of trained interviewers at various locations within both the 'Near' (within Essex) and the 'Far' (within Norfolk and Suffolk) distance zones[9].

Results to be used in the CBA were estimated on the 'Near' sample with a random effects logit model[10] to take account of the fact that each individual made eight choices showing a positive marginal WTP (MWTP) for all the attribute but 'distance' and 'tax' as expected as shown in Table 5.

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[5] The extent of salt marsh for the AREA attribute based on the future scenarios assumed was determined using GIS techniques as described for the Humber estuary.

[6] For the econometric analysis the acres were then converted in hectares.

[7] In British English a football pitch is the expression to define a football field. In other words, the football pitch defines the extent of the play ground of a football stadium.

[8] Birds represent a final link in the food chain of salt marshes, and they also represent salt marsh biodiversity in general (non-use values), so higher numbers of protected bird species within the estuary were taken as a proxy for greater environmental quality in the area.

[9] Non-probability sampling techniques were adopted, a convenient and frequently used approach for hypothesis testing purposes. The survey was conducted over six weeks during summer 2006.

[10] The logit model is used to model the probability of occurrence of binary responses (yes/no; or, in the case of a choice experiment, preference – choice - over alternative options). In a binary choice experiment the probability that individual i prefers alternative 1 over alternative 0 (the status quo) is modelled by: $P(Y_i = 1) = \frac{Exp(X_i'\beta)}{1 + Exp(X_i'\beta)}$
Where Yi is a bivariate random variable (the choice of individual i); x_i' is a vector of explanatory variables (attributes etc.) and β is the corresponding parameter vector. The model is then estimated by maximum likelihood (Greene, 2007; Kanninen, 2000).

Attribute	Unit	Attribute coefficients	Marginal WTP (£)[1]
LnArea	Hectares	0.2519	1.11
Bird 3	Number of bird species	0.4172	1.84
Bird 4	Number of bird species	0.6937	3.07
Bird 5	Number of bird species	0.8078	3.57
Access	yes/no	0.9746	4.31

Notes: 1. Tax coefficients: Near sample = -0.2261.

Table 5: Implicit prices for the choice experiment attributes (marginal willingness to pay - Marginal WTP) in the Near sample.

In the specification of the model for the econometric analysis of the choice experiment we assumed that the attribute AREA was not linear. After investigation, the logarithmic functional form for this attribute seemed to be most appropriate[11]. That means that the WTP for the attribute AREA does not tell us the respondents' WTP for one hectare increase in the creation of new salt marshes. Instead, the result in Table 5 describes the WTP for a marginal increment of the natural logarithm of the area.

The use of dummy variables for the BIRDS coefficient (BIRD3, BIRD4 and BIRD5) allows quantifying the MWTP of the respondents when they were offered one, two, or three more endangered species respectively, over the basic conservation level of two species. This attribute was used in the CE as an index of general environmental quality of the area and hence representing the non-use values.

The attribute ACCESS was dummy coded. The MWTP for that attribute represents the value that respondents give to the access to new saltmarshes, and the potential to visit and enjoy them representing the use value of the salt marshes.

The DISTANCE variable has the expected negative parameter. This result shows that the utility of new wetland sites diminishes the further away they are from the individual's home (an effect known as 'distance decay'). As shown in Luisetti et al. (2011b) and in Figure 4 here, a deeper analysis of the distance variable on both 'Near' and 'Far' sample highlighted the non-linearity of this attribute.

Figure 4 shows a clear anomaly in responses: a range-bias anomaly. In this figure we observe a jump in moving from the 'Near' sample to the 'Far' sample WTP values. Respondents seem have taken a reference point (probably the lowest distance in each choice set) and set responses to be internally coherent to this reference. This results in preferences which are coherent only in relative rather than absolute terms. Also, the first part of the first curve, which relates to the 'Near' sample results, indicates the same kind of preferences for salt marshes as for housing as predicted by the hedonic literature. This may relate to a fear of flooding in cases where salt marshes are as close as 2 miles to properties.

The cost variable, TAX, represents the cost the respondents were asked to bear for the creation of new salt marsh areas in the Blackwater estuary and therefore is of the expected negative sign.

For use in the cost-benefit analysis, however, aggregate WTP estimates are more appropriate than the MWTPs for single attributes, because the WTP is basically the value for a change in a hypothetical policy and it is possible to derive as many WTP estimates as the policies considered depending on the attributes and attribute levels selected. For each policy, instead, MWTPs are the implicit prices for each attribute of the choice experiment (CE). So, in order to calculate the WTP, we first need to define the policy options and then to estimate the MWTPs (Table 6). Multiplying attribute's MWTPs with the selected attribute levels, and summing them up together, we get the value of the WTP (Kanninen, 2000; Haab and McConnell, 2002).

[11] Nonlinearity was investigated with two random effects logit models: a model with the variable AREA and AREA square and a model with the natural logarithm of the variable AREA. The first model was run to verify if a nonlinear model was actually superior. The second model was run because intuitively considered the more sensible functional form for the attribute AREA. In fact, the quadratic form of the attribute assumes, after a specific point, a declining preference for that attribute. The logarithmic form, instead, assumes that once reached a specific point the preference for the attribute AREA would stay the same. The first model shows an AREA square coefficient negative, but not significant indicating that a linear model would fit better. However, the model with the logarithm shows a positive and highly significant (99% level) coefficient, providing evidence of the appropriateness of this model.

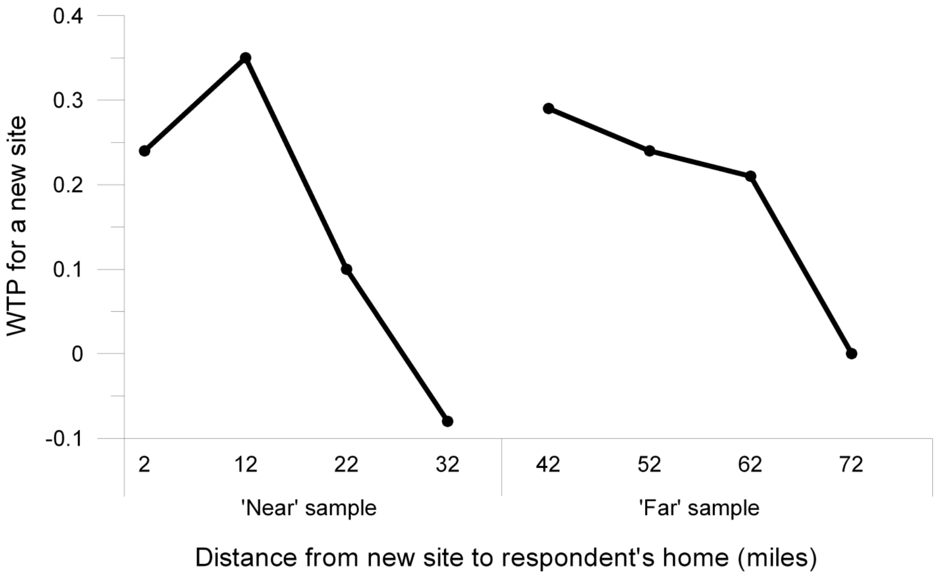

Figure 4: The "distance decay" – diminishing utility of new wetlands related to distance from individual homes.

Assuming a conservative policy that contemplates only use values, the aggregated WTP is defined for a policy involving a given extent of new salt marsh area created (corresponding to the realignment scenarios) and different distances, and with the possibility of access. Given the distance decay found in the analysis, for the aggregation of the WTP, we applied an approach similar to the one used by Bateman et al. (2006). The GIS was used to calculate the distances from each town representing an Essex district to Abbott's Hall (Essex), a well known managed realignment site located in the estuary. Districts and relative distances were categorised in four groups: 8, 15, 23 and 32 miles. WTP at each distance band is calculated by multiplying the population of that area by the mean household WTP for that area for the improvement under consideration. The total WTP for the 'Near' sample (Essex – UK) is obtained by simply summing across areas. Inserting in the policy equations the extent of the new salt marsh area created for each scenario, the aggregated WTP for the PT, DG and EDG scenarios was calculated as reported in Table 6.

A summary of the costs and of the ecosystem benefits and related values used in the CBA for both estuary case studies is reported in Table 7.

				WTP			
Distance to Abbott's Hall	Households population	PT: 81.6 Hectares		DG: 816.5 Hectares		EDG: 2404.1 Hectares	
		use and non-use values	use values only	use and non-use values	use values only	use and non-use values	use values only
miles		Benefits (£/yr)	Benefits (£/yr)	Benefits (£/yr)	Benefits (£/yr)	Benefits (£/yr)	Benefits (£/yr)
8	63706	771	547	930	706	1,005	781
15	349836	4,107	2,875	4,981	3,749	5,392	4,160
23	97974	1,109	764	1,354	1,009	1,469	1,124
32	33185	360	243	443	326	482	365
		6,347	4,429	7,708	5,790	8,348	6,430

Table 6: Aggregated willingness to pay (WTP) for the Blackwater saltmarshes under the Policy Targets (PT), Deep Green (DG) and Extended Deep Green (EDG) scenarios (£ thousand).

Costs and benefits	Humber	Blackwater
	Value at time of reference (2005)*	Value at time of reference (2007)*
Capital costs of realignment[a]	£878,159/km	£929,252/km
Replacement costs[b]	£668,441/km	NA
Maintenance cost of non-realigned defences[c]	£3560/km/yr	£866/km/yr
Maintenance cost of realigned defences[d]	£1780/km/yr	£433/km/yr
Opportunity costs		
Grade 1 and 2 agricultural land[e]	£4790/ha	NA
Grade 3 agricultural land[e]	£5458/ha	£5138/ha
Benefits		
Amenity and recreation[f]	£621/ha/yr	see Table 6
Carbon sequestration benefits	£222; £45; £4/tC	£230; £30; £15 and £7/tC (See Table 3)
Fish nursery benefits	NA	£7.43/ha

NA = denotes aspects of one cost or benefit that were not available for one case study or the other.
** All values are converted to 2005 prices for the Humber estuary and to 2007 prices for the Blackwater estuary using the GDP deflators published by HM treasury (http://www.hm-treasury.gov.uk/).*

[a] Costs based on contemporary realignment schemes (Halcrow, 2000).
[b] Only the costs of replacing unsatisfactory defences (Defra, 2001)not affected by realignment are included.
[c] Maintenance costs are taken from Black and Veatch/Halcrow (2005) for the Humber case study. These are assumed to increase in the future due to the effects of climate change. Following current government guidance (Penning-Rowsell et al., 2005) maintenance costs are increased by a factor of 1.5 for the period between 20 and 50 years into the future and by a factor of 2 for years further into the future. For the Blackwater, values are based on EA Blackwater management strategy (Halcrow, forthcoming) for the Blackwater and Colne estuaries.
[d] Assuming maintenance cost being 50% than for non-realigned defences.
[e] Based on sale prices (Humber – (Defra, 2004); Blackwater, (Defra, 2005) and adjusted downwards for the effects of the single farm payment following (Penning-Rowsell et al., 2005).
[f] For the Humber, benefit transfer values were used. For the Blackwater the WTP values reported in Table 7 were used.

Table 7: Values used to estimate the costs and the benefits of realignment for the Blackwater estuary (2007 base year).

For both case studies the PV of the proposed managed realignment projects have been calculated for a time horizon of 25, 50 and 100 years and with different positive discount rates: a constant rate (3.5%); a declining rate (3.5% for years 1-30, 3% for years 31-75, 2.5% for years 76-125) following current HM treasury guidance for project appraisal (HMT, 2003); and the declining gamma (Weitzman, 2001) discounting method (4% for years 1-5, 3% for years 6-25, 2% for years 26-75, 1% for years 76-300). The results of the analysis showed positive net present values (NPVs) for both estuaries.

As Table 8 shows, in the Humber NPVs are positive for periods of time longer than 25 years – the longer the time horizon, the more economically efficient is the policy. The results of the CBA for the Blackwater estuary are even stronger than those of the Humber. NPVs are positive under any MR scenario examined and for any period of time considered. Table 8 also shows that these results are achieved even when a set of quite conservative assumptions (use values only) are adopted for possible realignment policies in the Blackwater. Evidently, the use of site specific (as opposed to benefit transfer

Scenario	25 yrs Humber	25 yrs Blackwater*	50 yrs Humber	50 yrs Blackwater*	100 yrs Humber	100 yrs Blackwater*
Policy Targets (PT)						
NPV PT	-73.23	68.41	-82.22	152.25	-92.27	307.19
NPV HTL	-70.40	-1.88	-86.01	-3.96	-100.93	-7.81
NPV(PT) - NPV(HTL)	-2.83	70.29	3.79	156.21	8.66	315
Deep Green (DG)						
NPV DG	-97.32	74.83	-101.42	185.35	-107.92	389.58
NPV HTL	-70.40	-1.88	-86.01	-3.96	-100.93	-7.81
NPV(DG) - NPV(HTL)	-26.92	76.71	-15.41	189.31	-6.99	397.39
Extended Deep Green (EDG)						
NPV EDG	-94.30	62.83	-74.48	186.22	-63.83	414.24
NPV HTL	-70.40	-1.88	-86.01	-3.96	-100.93	-7.81
NPV(EDG) - NPV(HTL)	-23.90	64.71	11.53	190.18	37.10	422.05

Table 8: Comparing net present values (NPVs) for the Humber and the Blackwater estuary studies using conservative values (only use values) and a declining discount rate (HMT); (£ million).

data) value estimates derived via choice experiment for the amenity and recreation benefit (composite environmental benefit), which dominates over carbon storage[12] and fisheries benefits, has served to reinforce the positive NPV findings of the Humber study. The overall effect of the new data on C sequestration (Adams et al., forthcoming) only serves to increase the positive NPVs, because the estimated economic value of the carbon sequestration potential per scenario is now higher.

3.3 Non linearities

Closer inspection of Table 8 reveals a possible anomaly in the Blackwater estuary NPVs. We would expect to see the benefits growing from the PT to the EDG scenario as was found in the Humber for any time horizon. However, in the Blackwater it is the DG scenario that has the highest positive value over the 25 years time horizon. Over the other time horizons the difference between the NPV of the two scenarios (DG and EDG) is quite small. A possible explanation relates to the length of defences to be realigned. The EDG scenario has the longest length of defences to be realigned, incurring higher costs of realignment, although most of the areas of realignment were chosen where the elevation of the land would not then require a secondary line of defence. When it is assumed that none of the areas to be realigned in any scenarios requires a secondary line of defences, the anomaly disappears. The results for the two case studies highlight that the values are sensitive to the scale of the realignment scheme and local topography. It means that we cannot deliver a general rule saying that more realignment is always 'better', because the different values depend, among other factors, on the extent of the MR scheme and the specific topography of the region we are looking at.

4. Conclusion

Given the LOICZ methodological approach in terms of the coastal-catchment continuum and its championing of interdisciplinary research, the analysis outlined in this paper indicates its potential to combine sound science with policy relevant analysis and findings. The continuum concept combined with the ecosystem approach 'forces' a more holistic form of analysis. The addition of the ecosystem services notion and decision support system allows for a more policy relevant set of outcomes. While a number of data gaps and methodological challenges still remain, our MR case study has produced reasonably 'reliable' results in a policy and management context where contemporary 'actions' are required if the longer term consequences of climate change and other environmental change effects are to be mitigated. Waiting for 'absolute' precision and data coverage may be a feasible approach when environmental changes are 'simple', not close to thresholds and are slow. It is a luxury society cannot afford in context where environmental change is complex, rapid and possibly 'dangerous'.

[12] Little sensitivity is found also when the figure for the social cost of carbon used by the Stern Review (Stern, 2007) - £230, which is one of the highest figures found in literature – is applied in the analysis.

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LOICZ-Affiliated Activities

Comparative Assessment of Coastal Vulnerability to Sea-Level Rise (COMPASS)

Introduction

COMPASS (Comparative Assessment of Coastal Vulnerability to Sea-Level Rise) is an international project funded by the European Commission under the Marie Curie International Research Staff Exchange Scheme (IRSES) of the 7th Research Framework Programme (FP7). IRSES aims at "strengthening research partnerships through staff exchanges and networking activities between European research organisations and organisations from third countries ..." and to "provide support to research organisations to establish or reinforce long-term research co-operation through a coordinated joint programme of exchange of researcher staff for short periods" (European Commission, 2011).
To promote these aims, COMPASS involves partners from Europe and South America and its focus is the transfer of knowledge between partner institutions on the development and application of the Dynamic and Integrated Vulnerability Assessment (DIVA) tool. The six organisations participating in COMPASS are based in five different countries in Europe and S. America and have significant experience in coastal research. They include the Christian-Albrechts University of Kiel (CAU); the Potsdam Institute of Climate Impact Research (Germany); the University of the Aegean (Greece); the National University of La Plata (Argentina); the University of Para (Brazil); and Codesosur-Sinergias (Chile). COMPASS started in 2009 and is led by CAU. Its duration is 48 months and it is an affiliated LOICZ project.

Project Background, Aims and Objectives

Accelerated sea-level rise (SLR) is expected to have significant effects on coastal ecosystems and societies. Furthermore the increasing concentration of population and resources renders coastal regions highly vulnerable to these effects. Dynamic and consistent assessments of coastal vulnerability across space and time are necessary for developing relevant policies and supporting decision making in order to cope with the increasing exposure of coastal regions. Despite a significant amount of work on coastal vulnerability and impact assessment, the constantly changing and dynamic nature of the coast and the forecasted increase in the magnitude of hazards poses major challenges to societies and decision and policy makers for the forthcoming years. Modelling tools, offering the possibility to assist decision and policy making for coping with the increasing exposure of coastal regions to the above-mentioned hazards, have recently been developed and have been used for assessing coastal vulnerability in an integrated manner.

Figure 1: Punta Rasa wetlands, located on the west margin of the Rio de La Plata estuary (Photo B. Neumann).

Such a model is the DIVA (Dynamic Interactive Vulnerability Assessment) integrated assessment model (Vafeidis et al., 2008; Hinkel and Klein, 2009). Developed within the context of the EU-funded DINAS-COAST project, DIVA is a flexible assessment tool, within which a range of mitigation and adaptation policies can be analysed in terms of coastal vulnerability. DIVA enables its users to produce quantitative data on a range of coastal vulnerability indicators, for different climatic and socio-economic scenarios and adaptation strategies at national, regional and global scales. It includes a global coastal database and a series of impact and adaptation modules. Spatially, DIVA operates on about 12,000 independent linear coastal segments, which have been defined based on longshore variations in natural and socio-economic parameters, as well as administrative boundaries (McFadden et al., 2007; Vafeidis et al., 2008) and form the basis for the regional analysis of impacts and adaptation to sea-level rise.

The European partners participating in COMPASS have been and are currently involved in different aspects of the development of the DIVA model and provide the necessary support for the transfer of knowledge and expertise on DIVA to the partners from Argentina, Brazil and Chile. At the same time, the S. American partner institutions play an important role in the regional application of DIVA for S. America and in the further development of the model, by providing expert local knowledge and information, which will be used for the evaluation of the model performance and the results of this application. For this purpose the scientific exchanges carried out within COMPASS also involve field studies and extensive work on assessing the performance of the model in different coastal environments. Furthermore efforts are made to allow for an improved representation of adaptation for the region by exploring the possibility to implement site-specific adaptation options in the model application. Besides however the transfer of knowledge and the application of DIVA, COMPASS aims to exploit the opportunity of the exchange visits for conducting further research related to different aspects of coastal vulnerability to SLR, especially looking at regional differences in exposure and adaptation. This research is intended to contribute to broadening the scope of DIVA and to further development of the model.

Work accomplished during the first phase of the project

During the first two years of COMPASS, a total of 32 man-months of secondment visits have been completed between the partner institutions. The primary scope of those visits in this first period has been two-fold. First, seconded scientists have introduced the different elements of the DIVA model to members of the S. American organisations that are involved in the COMPASS project. Series of lectures and workshops were carried out for introducing the theoretical background that underpins DIVA and for providing hands-on experience on the application of the model. Secondly, a regional application of DIVA for South America, assessing the long-term impacts of SLR in the region, is currently underway. Preliminary results show particularly high damage costs for specific countries as well as high costs from saltwater intrusion into rivers. These results are currently being evaluated together with local experts from the S. American partner institutions. Final results are expected to provide a complete assessment of SLR impacts for South America at continental scale. These results will be used as the basis for exploring the possibility of conducting more detailed assessments for specific regions.
The exchange visits have also led to further work on coastal vulnerability to SLR, directly related to the expertise of the seconded scientists. Examples of this work include the investigation of salt water intrusion into coastal aquifers in the provinces of Buenos Aires (Carretero and Rapaglia, 2011); the assessment of adaptation of coastal residents at household level (Koerth et al., 2011); and an extensive review of existing coastal adaptation policies in S. American countries. Further examples include the evaluation of the results of the saline intrusion module of DIVA and the development of new modules for DIVA, including a numerical model of saltwater intrusion into groundwater aquifers.

Future work and significance of the project

More than 14 months of exchange visits between all institutions are planned to take place in the next months while the programme of secondments will be intensified in the last year of the project in order to complete the remaining research tasks. These include the completion of the DIVA application for S. America, exploring the possibility of developing regional versions of DIVA and work on the further development of the model through updating the database or developing new modules and improving existing ones.

Last, it is important to note that the IRSES projects do not directly fund research but only research visits and in this context the work conducted in COMPASS has already led to the establishment of long-term research co-operations, both at institutional and at personal level. Through the secondment visits participating scientists have been given the opportunity to combine expertise, knowledge and experience stemming from different backgrounds and geographical regions. We anticipate that this multi-disciplinary exchange will provide substantial added value to the scientific outputs of the project. In this context, the work carried out during the first phase of the project has been highly successful and we anticipate this trend to continue in the final phase of COMPASS.

Contact:
A. Vafeidis
“Coastal Risks and Sea-Level Rise” Research Group
Institute of Geography
Christian-Albrechts University Kiel
Ludewig-Meyn-Str. 14
24098 Kiel, Germany
http://www.crslr.uni-kiel.de/

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RA:dOst
Regionale Anpassungsstrategien für die deutsche Ostseeküste

On 18 and 19 May 2011, the second annual RADOST conference took place in Lübeck-Travemünde. At the forefront of the conference was a science-practice dialogue, in which results of the scientific, engineering and social research conducted as part of RADOST were discussed. Along with scientists from RADOST-participating research institutions, practitioners from business, public administration and non-governmental organisations were among the 75 guests in attendance. The directors of three state agencies participating in RADOST – the State Agency for Agriculture and the Environment of Central Mecklenburg (StALU-MM) as well as the State Agency for Agriculture, Environment and Rural Areas of Schleswig-Holstein (LLUR) and Schleswig Holstein's Government-Owned Company for Coastal Protection, National Parks and Ocean Protection (LKN-SH) – were active participants in the discussions.

They praised the wide array of topics covered in the research being conducted under RADOST and emphasised the importance of coordination and cooperation between governing bodies as well as the support of participative processes in Baltic communities.

Scientific research results concerning the influence of climate change on the Baltic Sea region overall as well as specifically with regard to nutrient inputs, water quality, currents and waves were presented. In the field of social science, results from surveys of community and state-level decision-makers as well as from those in the tourist industry and tourists served as the focus of discussion Overall, it became clear that influences of climate change are emerging and are also being perceived by the public.

One trend that is clearly related to climate change is the retreat of sea ice. Ice cover has a significant effect on the sea waves even in far away sea regions, since it shortens the effective length of wind. A decrease in ice therefore increases the area which is subject to wind above the water, thereby producing more waves.

Other consequences, which are now seen as certain to occur, are the increase in water temperature and the decrease in salt content. Depending on which scenario is used, scientists estimate that the water surface of the western Baltic Sea will be 2 to 3 °C warmer by the end of the twentyfirst century. The salt content of the water of the western Baltic Sea will decrease by 1-2 g/kg, according to calculations. These changes will have an effect on the ecosystems of the Baltic Sea: There will be a shift of habitats to the west, with corresponding changes in species.

Through simulations of the future wind activity over the Baltic Sea, it appears that both moderate as well as extreme wind speeds will only increase minimally by the end of the century, by a maximum of five percent. This will most likely cause only small changes in the overall sea waves. Reliable conclusions however can only be made after all calculations have been conducted. Simulations of local sea waves, however, produce widely varying results, depending on the location. In Rostock-Warnemünde and Westermarkelsdorf (Fehmarn) for instance, calculations of future wave heights showed that small waves will be more rare and moderate and large waves will become more common. This would mean an increase in wave energy, especially toward the end of the twenty-first century. For Lübeck-Travemünde on the other hand, the opposite pattern appears to be taking place: waves of moderate height are expected to occur less frequently, whereas smaller waves will be more common.

There are also areas where other factors play an equally strong role as climate change. For instance, deciding factors for tourism are general economic development and demographic changes. Another example is the development of nutrient inputs from agriculture, which is strongly influenced by the world market as well as political decisions, be it European agricultural policy, incentives for the cultivation of energy corn or requirements for the reduction of nutrient inputs according to the Baltic Sea Action Plan (BSAP) of the Helsinki Commission. From the surveys among stakeholders, it became clear once again that there is a need for comprehensible

Dr. Grit Martinez, RADOST project leader (Ecologic Institute) (photo: Ralph Bodle) information on climate changes themselves as well as on concrete, anticipated effects and appropriate plans of action. Examples of related efforts were presented at the conference, such as the info-pavillion on climate change of the municipality of Schönberg, which is currently being implemented. Two multimedia-events were part of the conference programme: one visualisation show of the Swedish Meteorological and Hydrological Institute (SMHI), which shed light on climate change and the ecology of the Baltic Sea region through projections in a dome tent, and a short film, created at the International Summer School 2010 "Climate Change in the Baltic – From global problems to local adaptation" of the Leibniz Institute for Baltic Sea Research, Warnemünde.

Proof of the ambiguity of communication: the same instructions lead to different patterns. (photo: Ralph Bodle)

Conference documentation:
www.klimzug-radost.de/termine/RADOSTJK2011

Workshops on Regional Availability of Climate Knowledge in the Baltic Sea region at Ecologic Institute in Berlin

In June 2011, two events were held at Ecologic Institute which were carried out as part of the project "Regional Availability of Climate Knowledge in the Baltic Sea region". The project is affiliated with RADOST and funded within the funding programme "Circum Mare Balticum" initiated by the International Bureau of the German Federal Ministry of Education and Research.

A three-day workshop with more than 30 participants was conducted to foster the exchange of ideas between climate scientists (functioning as climate service providers) and users of climate data across various countries of the Baltic Sea region. Central questions of the exchange were to what extent existing information tools meet users' needs and are actually used by them, what improvements could be made, and what benefits can be expected from enhanced international cooperation. At the first part of the workshop, that took place in Berlin, scientists and stakeholders from the administration and politics of various Baltic countries discussed approaches from different scientific institutions in Germany, Sweden or Finland to make available regional climate knowledge to decision-makers and the public. Secondly, the practical use of these climate services was discussed with potential users at a local venue in Timmendorf Beach. There, an inclusive coas-

Field trip to observe coastal defense measures (Scharbeutz) (photo: Josephine Lenk)

tal protection project, as part of an Integrated Coastal Zone Management (ICZM) project, was presented. Subsequently, three guest academics from Poland, Lithuania and Latvia visited Ecologic Institute Berlin. Lana Saksone (Latvia), Gintautas Stankunavicius (Lithuania) und Artur Skowronek (Poland) and academics from Ecologic Institute and the Helmholtz-Centre Geesthacht discussed climate adaptation strategies in the Baltic area.

Starting point for the discussion was an online survey conducted at the beginning of 2011 on the perception of climate change and the implementation of adaptation strategies among political decisionmakers on the German Baltic Sea coast. The survey was intended to identify gaps in communication between climate researchers and decision-makers on the coasts with regard to climate change adaptation behavior. The aim of the working meeting was to prepare a second survey that will be extended to the other Baltic countries. To that end, "first-hand" information was gathered in the workshop on the political management structures and the stakeholders involved in Lithuania, Latvia and Poland. Using detailed descriptions of the political structures in these three countries, it became clear that climate change is thematised there from a global perspective but is not perceived as a significant threat on the national level. Instead, economic issues are seen as more pressing. Thus, decision makers and the general public do not see the need for immediate action concerning climate change; rather, they associate it with positive effects for their respective countries (such as a longer vegetation period). Therefore, special adaptation measures hardly enter public debate. Coastal protection, however, is discussed often but is mostly treated as independent from climate changes. In a summary of the workshop, a consensus was reached: the results of this workshop should lead to ongoing activities on the topic of climate knowledge dissemination. Therefore, further workshops will be held in autumn 2011 in cooperation with universities from Lithuania, Latvia and Poland to discuss the regional availability of climate knowledge with local stakeholders.

INNOVATIVE MANAGEMENT FOR EUROPE´S CHANGING COASTAL RESOURCE

Investing in Opportunities

This project has received European Regional Development Funding through INTERREG IV B.

INTERREG IVB

Developing Local Coastal Adaptation Strategies to Climate Change across North West Europe: How IMCORE is addressing the Challenges

Jeremy Gault, Stefan Gray & Cathal O'Mahony
Coastal & Marine Research Centre (CMRC), Environmental Research Institute, University College Cork, Ireland

Val Cummins
Maritime & Energy Research Cluster & Commercial Campus (MERC3), Cork, Ireland

Anne Marie O'Hagan
Hydraulics & Maritime Research Centre (HMRC), University College Cork, Ireland

Introduction

Coastal environments as locations which are often hubs of intense human activity and settlement (Martínez., 2009) will face a range of impacts and challenges as a result of projected changes in climate (Gibbs, 2007). While much effort has been directed at offsetting these impacts through mitigation at international and national levels, it is recognised that some degree of change is unavoidable and therefore adaptation will be required (Herr and Galland, 2009). Identifying appropriate actions and formulating plans for adaptation will require effort from all segments of society, not least local government, citizens and the scientific community (McGinnis and McGinnis, 2011).

The Intergovernmental Panel on Climate Change (IPCC) has attributed global warming beyond that of normal climatic variation to an accumulation of greenhouse gases in the atmosphere resulting from the burning of fossil fuels and changes in land use. In marine and coastal locations the expected impacts of climate change include changes in-sea temperature and ocean chemistry, weather patterns and wave conditions, precipitation levels and fresh-water run-off, increased atmospheric temperature as well as sea-level rise and increased risk of flooding (IPCC, 2007). These risks have been acknowledged by the European Environment Agency (EEA) which specifically highlighted coastal areas in north-western Europe as being susceptible to major impacts as a result of sea level rise and the increased frequency of severe storm surges coupled with intense winter and spring river flooding (EEA, 2010).

Climate change and our ability to adapt will have serious implications for the future development of coastal resources with regard to key sectors such as land-use planning, fisheries and aquaculture, ports and shipping, marine recreation and coastal defence (Nicholls and Klein, 2005). Society is expected to be impacted through storm and flood damage to the built environment and infrastructure and the environment will suffer with the potential loss of protected habitats. Adaptation is predicted to cost US$ billions per annum (Stern, 2007) but the alternative of delaying adaptation or doing nothing is likely to be more costly - the EEA concluded that timely and proportionate adaptation makes economic, social and environmental sense, and is likely to be far less costly than inaction (EEA, 2010).

In order to deal with these potential ecological, social and economic impacts from climate change, coastal managers need to have a methodology and the institutional capacity to develop local coastal adaptation strategies. IMCORE – Innovative Management for Europe's Changing Coastal Resource, has used a range of flexible techniques and tools to develop local adaptation strategies, thoroughly evaluate these at a range of test sites across north west Europe, and build adaptive capacity at the local level. By detailing all the processes involved and cataloguing the lessons learned, the project has produced a template for effectively developing coastal adaptation strategies which is freely available to all through a dedicated portal. As a result, IMCORE has successfully addressed a very real need of coastal managers and communities as well as producing a 'tried and tested' approach that should be of significant interest to all stakeholders interested in adaptation to climate change in the coastal zone.

Law and policy drivers for adaptation to climate change

While the science of climate change continues to develop, in recent years the climate change debate has become more firmly ensconced in the policy realm. Within this there has also been a shift in emphasis from an almost absolute initial focus on mitigation to a now more concentrated focus on adaptation. The IPCC's Third Assessment Report defines adaptation as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC TAR, 2001). The theory and practice of adaptation is quite recent and, for many in relevant policy communities, confusing in terms of meaning, scale of necessary response, sources of guidance, and relevance to policy agendas (Adger et al., 2007). This makes the IMCORE project timely and appropriate in focus.

The very nature of climate change and the number of impacts it can produce means that negotiation of any law or policy framework on climate change is incredibly complex. Numerous regional conferences in the 1980s called for measures to be taken to reduce the generation of greenhouse gases. These efforts culminated in 1992 with the adoption of a Framework Convention on Climate Change (UNFCCC). In this no common position was taken on a number of topics and opinion varied greatly on how to deal with climate change issues. As a result it is necessary to regard the Convention on Climate Change not as a fully formed, detailed regulatory regime but rather a framework convention that establishes a process through which further agreements and policies relating to climate change can be addressed and progressed.

Article 2 of the UNFCCC states that the objective of the Convention is to "achieve, in accordance with the relevant provisions of the Convention, stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". The article goes on to state that such a level should be achieved "within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner". This wording suggests that some degree of climate change is inevitable and that this can be tolerated provided it happens slowly enough to allow natural adaptation.

Work on adaptation has progressed since the Convention entered into force. At COP10 in 2004 the Buenos Aires Programme of Work on Adaptation and Response Measures was accepted (Decision 1/CP.10 in FCCC/CP/2004/10/Add.1, p.2). This led to the development of a dedicated Work Programme on Impacts, Vulnerability and Adaptation to Climate Change (NWP) at COP12. In Nairobi in 2006, this work plan was completed, renamed and the first phase, of the now called Nairobi Work Programme, began (UNFCCC, 2007). The Bali Action Plan has since recognised that there is a need for enhanced action on adaptation. Within the working group tasked with carrying out the work of the Plan, four areas were identified as important to progress implementation of adaptation. These are: national planning for adaptation; streamlining and scaling up financial and technological support; enhancing knowledge sharing; and institutional arrangements. Adaptation can now be regarded as one of the five key building blocks (along with shared vision, mitigation, technology and financial resources) for a strengthened future response to climate change up to and beyond 2012. Effectively this places the concept of adaptation on an equal footing to mitigation for the first time in the history of the Convention. The Copenhagen Accord, agreed at COP15, further recognised the urgent need for 'enhanced action and international cooperation' on adaptation to ensure the implementation of the Convention (Copenhagen Accord, 18/12/2009).

At the EU level, it has been widely recognised in all recent policy documents that a number of existing European instruments can be used to progress adaptation to climate change at Member State level. An overview of these is provided in a number of associated IMCORE reports (see, for example, IMCORE: O'Hagan, 2010). Primary actions at the EU level were directed at reducing greenhouse gas emissions through the adoption of the European Climate Change Programme (ECCP) in 2000. Since that time the ECCP has evolved to look at adaptation to climate change through the established on a dedicated Working Group on Impacts and Adaptation. The aim of this Group is to explore options to improve Europe's resilience to climate change impacts, to encourage the integration of climate change adaptation into other policy areas at the European, national and regional level and to define the role of EU-wide policies complementing action by Member States (ECCP Working Group II, 2006a).

A White Paper on Adaptation to Climate Change: towards a European framework for action was published on 1 April 2009. The Paper recognises that adaptation is already taking place but in a "piecemeal manner" (COM(2009) 147 final, p.3). This suggests the need for a more strategic approach to adaptation. In recognition of the fact that adaptation measures and strategies are currently the responsibility of individual Member States, the White Paper states that such measures can be supported and strengthened by an integrated and coordinated approach at EU level (op. cit., p.6). The core objective of the EU's Adaptation Framework is to improve the EU's resilience to deal with the impact of climate change. In this regard it proposes a phased approach: the first phase will run from 2009 to 2012 and will lay the foundation for preparing a comprehensive EU adaptation strategy to be implemented post-2012. An Impact and Adaptation Steering Group (IASG) was established by the Commission in September 2009 composed of representatives from various Member States involved in the formulation of national and regional adaptation programmes. Technical thematic groups have also been created to advance work in specific sectoral areas, one of which is oceans and seas. Overall the group will encourage further development of national and regional adaptation strategies with a view to considering mandatory adaptation strategies from 2012.

The above paragraphs indicate that while adaptation is not currently mandatory at Member State level it is likely to become so in the near future. In line with the principle of subsidiarity, the local level is often the most appropriate level for action, hence, the local focus taken in designing adaptation strategies in the IMCORE project.

Partnership Working – the Expert Couplet Node Approach

This collaborative approach, piloted under a previous project (COREPOINT Project - Coastal Research and Policy Integration) was rolled out under IMCORE at nine locations (Figure 1) to facilitate the testing of a range of innovative tools and techniques supporting local adaptation strategy formulation. The 'Expert Couplet Node' (ECN) model of partnership typically entails research centres and local authorities working in close collaboration throughout a process devised to respond to a particular issue(s) (e.g. coastal management, climate change), and marks a departure from the traditional client / provider relationship that tended to exist between research community and administrative bodies (Cooper and Cummins, 2009; O'Mahony et al., 2009). Whilst some of the partners had an existing relationship prior to the project, and IMCORE enabled them to cement their working relationship, for others the project was the catalyst for initiating an ECN; however, in all cases the IMCORE project afforded the opportunity for ECN partners to effectively employ their combined knowledge and skill-sets.

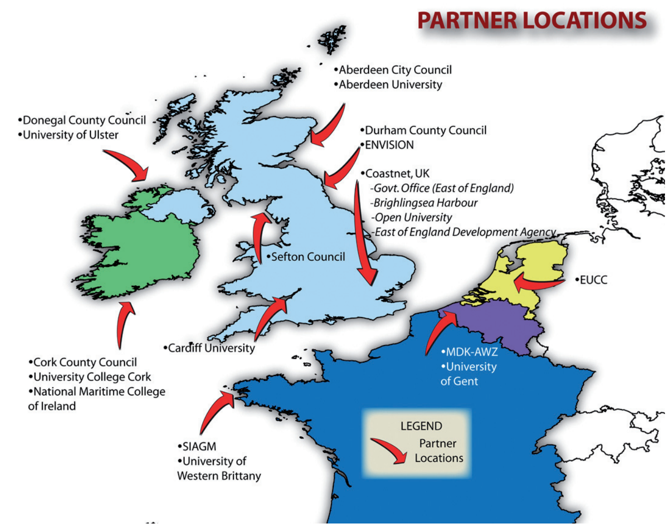

Figure 1: Geographical distribution of the IMCORE Partners and their corresponding ECN

Over the course of the IMCORE project it has become apparent that the ECN concept has the flexibility to:

1) accommodate the cultural differences in working practices that exist in the various participant locations;
2) build capacity within participant institutions;
3) put in place collaborative networks (locally and trans-nationally) that contribute to sustainability; and
4) adapt to changing circumstances and issues as they arise.

As such no ECN is identical with some operating on a formal / semi-formal basis whilst others tend to be much more ad hoc. However, regardless of their operational structure, all have successfully come together to deliver the Local Adaptation Strategies across North West Europe.

Issue Identification

Once established, the nine ECNs worked together to develop stakeholder engagement techniques, culminating in the production of guidelines to assist with stakeholder identification and engagement, and subsequent issue identification by stakeholders. These preliminary steps in the process of developing adaptation strategies, together with lessons learned across, and at each of the ECNs were encapsulated in an online resource (distance learning tool, below).

In addition, significant effort was targeted into scaling down climate change impacts from the various national and regional projections in order to present the potential impacts at the relevant local scale. This enabled the ECN to effectively engage local stakeholders, individually and collectively (e.g. workshops), to ascertain the key issues and sectors that were considered likely to be affected by climate change in their respective locations. Key issues that were raised included sea-level rise, coastal flooding, erosion and changes in meteorological / storm patterns. The associated sectors identified that could be impacted upon by climate change ranged from critical infrastructure, cultural heritage and habitat conservation, shipping and port operations, marine recreation and tourism to fisheries, agriculture and aquaculture; thus, covering the range of sectors associated with coastal locations. The synopsis of the expected impacts on the sectors is shown in Table 1. In most case study areas, the ECN sought to identify one or more headline issues that reflected key local concerns and could thus serve to galvanise local stakeholder interest.

ECN Area	Impacts Identified
Severn Estuary,	Impact on communities
Wales-England, UK	Strain on emergency services
	Development at risk
N.W. England, UK	Loss of habitats/designations
	Change in ground water affecting habitats
	Port and Harbour functioning
	Threat to industrial infrastructure
	Threat to urban areas
	Threat to coastal paths - Marine and Coastal Access Bill
	Coastal squeeze and impact on designations
	Salination of agricultural land
Lough Swilly, Donegal, IRL	Flooding of low lying towns
	Erosion of infrastructure and property
	Changes/loss of biodiversity
	Damage to aquaculture sites
	Safety for water activities
	Reduction of access to piers and harbours
Cork Harbour, Cork, IRL	Threat to tourist attractions/infrastructure
	Threat to existing port facilities/commercial viability
	Damage to ports and vessels
	Closure of harbour to shipping / Access to port delayed
	Potential loss of tourist liner trade/livelihoods
	Loss of housing/commercial property
	Loss of habitats
	Loss of coastal heritage
	Impact on future land-use patterns
E. England, UK	Erosion and pressure on flood defences
	Loss of protected intertidal habitat
	Higher defence costs
Belgium Coast, BEL	Loss of beach/dunes and protected areas
	Loss of employment in flooded area
	Safety/protection of harbours
	Loss of property/infrastructure
	Loss of human lives
	Damage to ports
	Dune erosion
Aberdeen, Scotland, UK	Flooding of low lying towns
	Loss of habitats
	Damage to harbour and shipping infrastructure
	Decreased tourism due to increased rainfall and snowfall
	Inability of drains to cope with excess rainfall

Table 1: Type of Impact identified at each of the Expert Couplet Node Sites

Scenarios and Visualisation

Once a key focal issue (or issues) had been identified (e.g. flooding, threats to tourism through loss of amenities), the ECNs utilised a Futures Approach (e.g. Kannen and Burkhard, 2009) which though increasingly commonplace in industry and policy support agencies (notably Shell and the Rand Corporation respectively), represents an innovative application as a tool for coastal management. In order to develop a range of scenarios each ECN initially considered three defined techniques:

- Predictive – assessing what will happen...
- Exploratory – assessing what can happen...
- Normative - assessing how a specific target be achieved....

Most ECNs worked with stakeholders using an exploratory approach or a combination of exploratory and normative (also known as backcasting) approaches with at least one ECN using a predictive approach over a 20-30 year time horizon. Taking the exploratory approach as an example, an initial PESTLE (Political, Economic, Social, Technological, Legal, and Environmental) analysis was typically conducted with stakeholders (Figure 2) to identify elements (e.g. Political: reform of planning guidelines in coastal locations) under each of these headings that could influence the trajectory of the key issue(s) under consideration.

Figure 2: Photograph of ECN Members conducting a PESTLE analysis

Once the merits of including each element had been thoroughly debated, similar or related elements were combined into groups, which were then plotted on an axis according to: 1) their significance to the issue under consideration; and, 2) against the degree of uncertainty the stakeholders felt regarding the element's future path. The two groups of elements which were considered to be most significant and most uncertain then formed the basis for a second set of axes. Once agreed with stakeholders, this provided a framework for the exploration of how the elements identified could influence potential (differing) futures. This process informed the development of four exploratory scenarios (Figure 3).

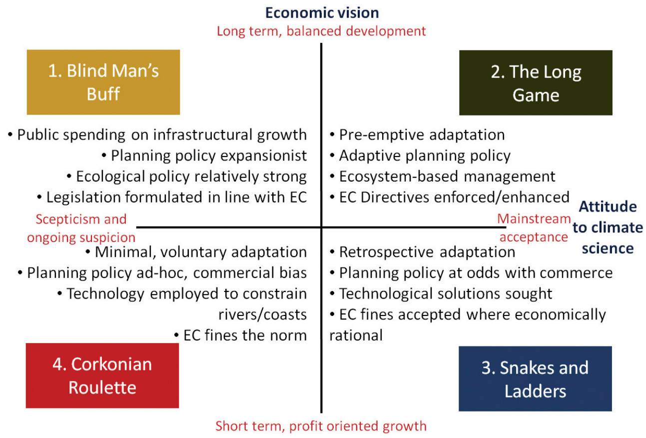

Figure 3: Exploratory Scenarios developed using the Futures Approach (Cork Harbour)

To aid this process visualisations of potential impacts were developed at a number of sites, ranging from traditional mapping and the use of Geographical Information Systems (G.I.S.) through to more advanced computer generated 2D stills and video. These proved particularly effective in conveying the level of potential impacts to stakeholders and were universally well–received by the stakeholders and the ECN facilitators alike.

Figure 4: Scenarios developed under IMCORE for the Golfe du Morbihan, France

Once the exploratory phase was complete, stakeholders were able to directly choose one of the four scenarios that they felt was the "best" for their location, or alternatively to utilise elements of each of the scenarios to create a fifth hybrid scenario or range of scenarios (Figure 4).

Local Adaptation Strategy Development

The final stage in the development of the adaptation strategy involved matching the desired final scenario with the processes required to achieve it, as defined by the stakeholders (Figure 5).

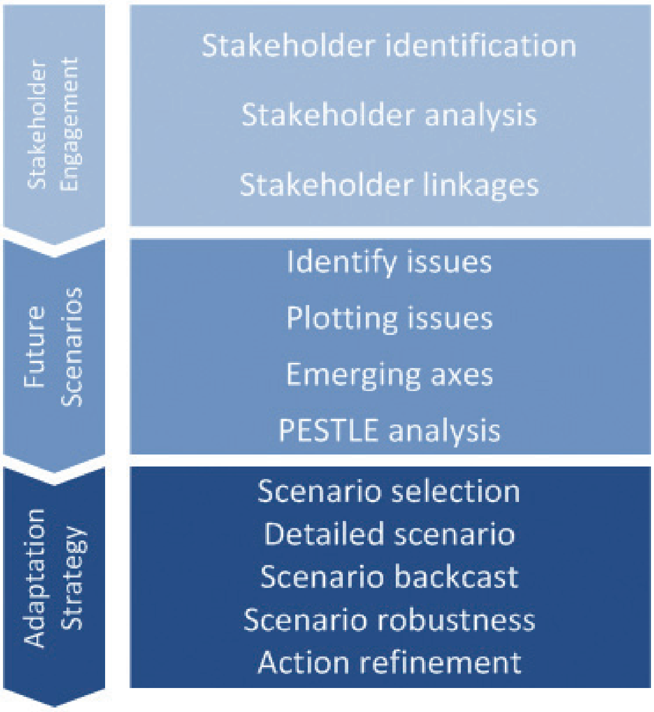

Figure 5: Schematic diagram outlining the development process for an adaptation strategy under IMCORE

To identify these processes usually requires a backcasting exercise – starting from the preferred future and working backwards to the present day to identify how it could be realised, by whom and over what time scale and is typically presented in a tabular format (Table 2, below).

The backcasting component and this output, plus, the methods and results from the stakeholder engagement, issue identification, scenarios and optional visualisation steps form the content of actual adaptation strategies produced for each of the sites (Figure 5).

Building Capacity

In addition to the direct capacity building nurtured under the ECN, the project ran several 'training of trainers' events in order to build local institutional capacity to adapt. These events afforded participants the opportunity to receive face-to-face training in coastal adaptation strategy development and also provided materials and guidance that would enable them to increase capacity within their institutions.

Throughout, the ECN critically assessed the processes and tested a range of tools that were applied in their respective locations recording the lessons learned as they worked through the process of developing local adaptation strategies with stakeholders. As a result the project has been able to produce guidelines on all the aspects of the strategy development from initial ECN set-up and stakeholder engagement, through to conducting issues and scenarios workshops, the use of visualisation and the final output of a strategy.

This material forms the base level of a distance learning tool, CoastalAdaptation.eu, and is combined with an e-learning module to provide an easily accessible didactic resource that supports both experienced and less experienced coastal managers in developing adaptation strategies.

Action	Activities	Delivery period
Political		
1. Initiatives developed by political representatives involve and collaborate closely with NGO's and community organisations.	a) Secure and consistent flow of relevant and appropriate information about coastal issues to elected representatives.	1-2 yr
	b) Political activities increasingly aligned to consensus view on coastal issues and problems.	2-5 yr
2. Policy developments in the North-East closely linked to evidence-base and policies / plans.	a) Regional data hub utilised to support decision-making by various agencies in an accountable manner.	1-2 yr
	b) Decision-making carried out through wide stakeholder consensus so that linked to existing policy plans.	2-5 yr
	c) Decision making is used to influence policy development in a NE constituency forum.	5-10yrs +

Table 2: Example of adaptation strategy actions from Durham Coast, UK

Figure 6: Screenshot of the on-line IMCORE Distance Learning Tool: CoastalAdaption.eu

This on-line portal includes reflections from individual ECN members and provides real-life insights into the problems encountered, and the solutions derived at local level when developing adaptation responses. The on-line content details the tools used and their application at nine sites across North West Europe and includes a layered e-learning system that, whilst simple to use, is under-pinned by comprehensive reference material. Therefore the user can tailor their learning experience depending on the scope they wish to cover and the time they have available.

Summary

Given the predicted scale of impacts of climate change in the coastal zone it is essential that coastal managers are in a position to develop coastal adaptation strategies but until now there has been limited support available. By actually going through the process of developing coastal adaptation strategies, the IMCORE project has succeeded in providing tangible outputs, developed and tested in real locations, which will provide the requisite help and support to allow coastal managers achieve this goal. The IMCORE model is also transferable and not restricted to coastal applications, so it should be of interest to managers from other sectors.

The IMCORE project provides clear evidence that INTERREG funding can provide the transnational framework to bring research centres and local authorities together from across Europe to engage with stakeholders to develop local coastal adaptation strategies, and to influence / inform both local and national policy. By carefully recording the process, conducting capacity building initiatives and ensuring that all the materials are readily accessible on-line the IMCORE project should leave a lasting legacy that is of real benefit to coastal managers and stakeholders alike.

Acknowledgements

IMCORE aimed to promote a transnational, innovative and sustainable approach to reducing the ecological, social and economic impacts of climate change on the coastal resources of North West Europe. Funded under the INTERREG North West Europe IVB programme the project commenced in May 2008, will run until November 2011, and has 17 Partners from Ireland, UK, France, Belgium and The Netherlands.

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SSC News

Tim Carruthers, LOICZ SSC Member from the beginning of 1st January 2010

Tim Carruthers is currently the Marine and Coastal Adviser, within the Island Ecosystems program of the Secretariat of the Pacific Regional Environment Programme (SPREP), based in Apia, Samoa. SPREP has 21 Pacific island member countries and four countries with direct interests in the region. SPREP's core business under the Islands Ecosystems programme is to address the issues of ecosystem conservation, the sustainable management of natural resources and the protection of priority threatened species, from the threats of human-induced impacts, invasive species and living modified organisms.

His research background is sea grass eco-physiology, specifically how sea grass can be used as an indicator of ecosystem condition and to monitor ecosystem change, and he spent 10 years carrying out science synthesis, data reporting and communications with the Integration and Application Network (IAN) at the University of Maryland Center for Environmental Science (UMCES). From working in the temperate Indian Ocean to tropical Pacific, Caribbean and temperate Atlantic Oceans he has developed habitat scale syntheses of major processes, features and threats within multiple coastal systems.

Contact:

Tim Carruthers, PhD
Coastal and Marine Adviser
SPREP (Secretariat of the Pacific Regional Environment Programme)
PO Box 240, Apia, Samoa
Ph: +685 21929 ext 264
email: timc@sprep.org

IPO Notes

Young LOICZ Forum (YLF 2011)

The LOICZ OSC 2011 is integral part of the Young LOICZ Forum. The YLF 2011 takes place from 8-15 September, 2011, in Yantai, China.
The Forum enhances Capacities for Global Change Mitigation in Asia-Pacific Coastal Zones for early-career scientists and managers. This well-targeted training programme offers the opportunity to enhance soft skills as well as to learn about drivers and pressures on coastal systems and thus to better define their future professional role in coastal management. It provides the next generation of scientists and decision makers with knowledge and practical skills that they can apply in their own country and an opportunity to interact and network with their peers.

Jo-Ting Huang, from Taiwan at LOICZ IPO

My name is Jo-Ting Huang and I am from Taiwan. Currently, I am attending a master program at the Graduate Institute of Environmental Education, National Taiwan Normal University. Awarded a "Summer Institute Program" fellowship from the National Science Council (NSC) in Taiwan and the German Academic Exchange Service (DAAD), I am conducting an internship in the LOICZ IPO from July 6th to August 24th. My master thesis focuses on climate change adaptation policy in coastal cities. Under the guidance of my supervisor, Dr. Juergen Weichselgartner, I am focusing on the HafenCity in Hamburg and its climate adaptation measures. This includes collection of basic information and data, analysis of structural and non-structural measures with regard to vulnerability and disaster management, as well as analysis of the transferrable flood mitigation measures and applicable climate change adaptation policies for harbor cities. I find my research stay at Helmholtz-Zentrum Geesthacht very valuable because I have the opportunity to meet outstanding scientists and learn from them. I am gaining important scientific and cultural experience and receiving precious academic training. After my internship period, I will continue my research in University of Twente in the Netherlands while pursuing my master of sciences in environmental and energy management.

LOICZ Open Science Conference 2011 Coastal Systems, Global Change and Sustainability

12-15 September, 2010, in Yantai, China

Coastal Vulnerability in an Earth system change and sustainability context is among the top priorities of future challenges for the interdisciplinary research community world-wide. LOICZ with its historical focus on biogeochemistry and its recent decade of exploring the social-ecological context and human dimensions of coastal change is expected to contribute substantially to meet this challenge now and in future. The goal will be to broaden and improve significantly our knowledge to support adaptation to global change by linking natural and social sciences with knowledge of coastal communities at global regional and local scales.

With the initial draft programme of the LOICZ Open Science Conference you will find below we hope to cover an adequately wide variety of social-ecological issues and ways towards sustainability solutions. We expect a meaningful mix of state of the art sciences addressing the Grand Challenges which derived form the recent global Earth system visioning processes (Observing, Forecasting, Confining, Responding and Innovating). And we also hope to outline at least initial views on solutions and ways to bridge different world views across the multiple science policy public interfaces characterizing global coastal zones. During the opening session we look forward to be introduced to a set of key note presentations providing the plenary with insight from ICSU, from the national scientific community, the LOICZ Chairperson, and from the host of the LOICZ International Project Office.

So we are glad to feature below the initial draft set and organizational structure of the sessions we will expect in Yantai. This programme comes already with a big "Thank You" to all the parties involved in getting this exciting programme off the ground and organized namely the global scientists, supporting agencies and first and foremost the local host at the Yantai Institute of Coastal Zone Research and the LOICZ Regional Node.

Conference website: www.loicz-osc2011.org

Sunday 11 Sep. 2011	Monday 12 Sep. 2011					Tuesday 13 Sep. 2011				
	08:30-9:00 Registration					08:30-12:30 10:20-10:40 Tea break				
						Room A	Room B	Room C	Room D	Room E
	9:00-12:30 Opening Ceremony and Planery Presentations					B3: Observation, Monitoring and Modeling	C4: Bridging the Science-Policy Gap	A4: Small Island Developing States	D2: Case Studies of long term Change or Stability in Coastal Ecosystems	D7: Estuaries and Coastal Seas: Interactions, Fronts and Climatee:
	12:30-13:30 Lunch					12:30-13:30 Lunch				
	13:30-18:30 max 15:20-15:40 Tea break					13:30-18:30 max 15:20-15:40 Tea break				
	Room A	Room B	Room C	Room D	Room E	Room A	Room B	Room C	Room D	Room E
15:40-18:00 max Registration opens	A1: Linking Regional Dynamics in Coastal and Marine Social-ecological Systems to Global Sustainability (LOICZ Synthesis)	B1: Nutrient Accounting in Coastal Waters and Watersheds (LOICZ Synthesis)	C1/A5: Planning and Governance in Coastal and Marine Areas (LOICZ Synthesis)	D3: Coastal eco-environments from a microbial perspective	A3: Changing Land Use in the Coast: Present and Future A2: Arctic Coastal Processes, Peoples and Societies (Physical, Ecological and Socio-Economic	B3: Observation, Monitoring and Modeling	C2: Megacities and Resilience in the Coastal Zone	D4: The Application of Remote Sensing and GIS in Coastal Zone	D2: Case Studies of long term Change or Stability in Coastal Ecosystems D1: Plant Biodiversity in Coastal Area and intensive Utilization	D5: The Application of Isotope to track Pollution Source from Land to Ocean
	18:30-20:30 Welcome Reception: Conference Dinner at YIC					18:30-20:30 Postersession with fingerfood and drinks				

Wednesday 14 Sep. 2011					Thursday 15 Sep. 2011
08:30-12:30 10:20-10:40 Tea break					
Room A	Room B	Room C	Room D	Room E	Room A
C3: Coastal Hazards, Inerability, and Adaptation	B2: Catchment-Estuary – Nature and Human Interaction	B6: Coastal Biogeochemical Cycles and Climate Change	A6: Ecosystem Goods and Services and Environmental Economics	B5: Eutrophication, Hypoxia and Algal Blooms	08:30-10:20 Plenary Rapporteurs of LOICZ Synthesis Sessions 10:20 Rapporteurs of Hot Spots Closure
12:30-13:30 Lunch					12:30-13:30 Lunch
13:30-18:30 max 15:20-15:40 Tea break					Field Trips
Room A	Room B	Room C	Room D	Room E	
C3: Coastal Hazards, Vulnerability, and Adaptation	B2: Catchment-Estuary – Nature and Human Interaction A7: Coastal and Marine Sectors: Managing Change	B6: Coastal Biogeochemical Cycles and Climate Change D6: Climate Extremes and Carbon Biogeochemistry in Large-River Delta	A6: Ecosystem Goods and Services and Environmental Economics	B4: Estuarine and Coastal Ecohydrology	
18:30-20:30 Conference Dinner at Haitian Hotel Award Ceremony (Posters and Young LOICZ Forum)					

Hot Spot Sessions

欢迎来烟台 Welcome in Yantai

»LOICZ OPEN SCIENCE CONFERENCE 2011«

Programme News

GLOBAL IGBP CHANGE International Geosphere-Biosphere Programme

The International Geosphere-Biosphere Programme (IGBP)

New Chair of Scientific Committee Appointed

The International Geosphere-Biosphere Programme is pleased to announce the appointment of Professor James PM Syvitski as the new Chairperson. The IGBP Chair leads the Scientific Committee, IGBP's main decision-making body.

The US academic is Executive Director of the Community Surface Dynamics Modeling System and brings extensive experience directing large national and international research institutes and programmes. He is co-author on more than 150 publications and has been involved in IGBP projects since IGBP's inception in 1987.

"This is an important time to join IGBP," says Professor Syvitski who is based at the University of Colorado, Boulder. "The defining research question of our age is how do we manage the Earth system - the planet's physical, chemical, biological and social components - responsibly, whilst feeding, clothing and protecting a population predicted to grow to nine billion people? IGBP and its partners are at the centre of this research," he adds.

The coastal-zone researcher is widely regarded as a leader in Earth-system science. He specializes in research on rivers, deltas, polar environments, sediment transport and continental margins. Over half the population of the planet live on the coasts, making research in Professor Syvitski's areas of expertise a priority for international research programmes.

In 2009, Professor Syvitski and colleagues published an influential paper revealing that most of the world's major deltas are sinking, largely as a result of human influence including mining, water extraction and damming.

Science communication is clearly important to Professor Syvitski: "IGBP faces a public with limited understanding of the complexities of global-change science. We have a duty and a responsibility to communicate to the widest possible audience the gravity and consequences of the global changes we are revealing."

Professor Syvitski's appointment begins 1 January 2012, and he will succeed Professor Carlos Nobre.

The Brazilian academic says, "I am delighted IGBP's Scientific Committee has appointed James Syvitski as Chair. He will bring a range of expertise and leadership skills to IGBP at this crucial time."

Professor Nobre added, "We are in the midst of a great transition. IGBP Is fully engaged with the International Council for Science's visioning process for the future of Earth System Science."

Since 2005, Professor Nobre has provided two consecutive terms of inspirational leadership to IGBP. Brazilian President Dilma Rousseff has recently appointed Professor Nobre to lead the Secretariat of Policies and Programs in Research and Development under the Ministry of Science and Technology in Brazil. In the wake of the severe floods and landslides affecting Brazil in 2011, Professor Nobre will lead the task team directed to create a disaster risk reduction strategy for the country.

Professor Nobre will be part of the Brazilian team developing the United Nations Rio+20 Summit in 2012. IGBP through the 2012 Planet Under Pressure conference in London will build close links with the Rio+20 Summit.

The appointment of Professor Syvitski as IGBP Chair has been formally endorsed by the International Council for Science.

A note from LOICZ:
From 1999 to 2004 Professor Syvitsky was member of the LOICZ SSC. He still is a key contributor of "lighthouse" science in LOICZ e.g. in the field of global delta vulnerability and changing sediment fluxes from source to sea.

More information
Owen Gaffney
Director of communications
International Geosphere-Biosphere Programme
Email: owen.gaffney@igbp.kva.se
Tel: +46 86739556
Mob: +46 730208418
Skype: owengaffneyigbp
Jim Scott
University of Colorado Boulder news office
Email: Jim.Scott@Colorado.EDU
Tel: +1-303 4923114

New Knowledge Towards Solutions

26-29 March, 2012, London, UK

www.planetunderpressure2012.net

CALL FOR ABSTRACTS

Abstract submission is now open for this major international science conference focusing on solutions to the global sustainability challenge.

This is an open call for participants and for abstracts for presentations and posters to be submitted against the **session topics** described on the conference website under the following outline:

- Day 1: **State of the planet:** the latest knowledge about the pressures on the planet
- Day 2: **Options and opportunities:** exchanging knowledge about ways of reducing the pressures on the planet, promoting transformative changes for a sustainable future and adapting to changes in the global system
- Day 3: **Challenges to progress:** clarifying what is preventing or slowing humanity from implementing potential solutions
- Day 4: **Ways ahead:** a vision for 2050 and beyond, and exploring new partnerships and pathways towards global sustainability

Each day will include relevant aspects of the conference themes:

- **A.** Meeting global needs: food, energy, water and other ecosystem services
- **B.** Transforming our way of living: development pathways under global environmental change
- **C.** Governing across scales: innovative stewardship of the Earth system

The closing date for abstract submission is 19 August 2011. Please note, additional sessions will be advertised over the next few weeks.

Why you should attend

The conference will provide a comprehensive update of the pressure planet Earth is now under. The conference will discuss solutions at all scales to move societies on to a sustainable pathway and will provide scientific leadership towards the 2012 UN Conference on Sustainable Development - Rio+20.
The programme is designed to attract senior policymakers, industry leaders, NGOs, young scientists, the media, health specialists, and academics from many disciplines.

IHDP
International Human Dimensions Programme on Global Environmental Change

IHDP is pleased to announce the publication of its Annual Report for 2010

The Annual Report 2010 provides a comprehensive overview of IHDP's mission and objectives as well as an extensive update on the latest activities and progress of IHDP's global research network, its projects and partners.
One of the most substantial innovations introduced with this report is a summary of key findings and recommendations provided by IHDP projects, addressing a broad range of vital issues such as food security and human health.
In addition, editorials by the newest Scientific Committee members highlight the current challenges and opportunities of human dimensions research on global environmental change.

Download pdf http://www.ihdp.unu.edu/file/get/8808
http://www.ihdp.unu.edu/article/annual-report-

IHDP
International Human Dimensions Programme on Global Environmental Change

2010Workshop Towards Green Economy

IHDP is hosting a workshop to provide an integrated framework on Green Economy that considers social, political, economic and technological changes.
Read more:

http://www.ihdp.unu.edu/article/read/training-workshop-asian-development-pathways

IHDP
International Human Dimensions Programme on Global Environmental Change

"International Seminar on Geospatial and Human Dimensions on Sustainable Natural Resource Management"

The IHDP National Committee in Indonesia is organizing an "International Seminar on Geospatial and Human Dimensions on Sustainable Natural Resource Management" in September in Bogor, Indonesia. The announcement can be found on the IHDP website:

http://www.ihdp.unu.edu/article/read/geo-spatial-and-human-dimension-on-sustainability-natural .

Earth System Governance
People, Places, and the Planet

New major initiative of the Earth System Governance Project related to the upcoming "Rio+20" UN Conference on Sustainable Development.

The **Earth System Governance Project** is also a core project of IHDP and has set up a new online discussion forum on ‚international environmental governance' (the key concept used in UNEP reform debates) and on the ‚institutional framework for sustainable development' (the key concept at the centre of the "Rio+20" Conference).
The project seeks to stimulate debate and shares a wide range of online resources to support current reform processes and research efforts. The forum is open for comments and viewpoints.

http://www.ieg.earthsystemgovernance.org for
general information, and for more detailed information on how to contribute
http://www.ieg.earthsystemgovernance.org/news/2011-05-12/invitation-contribute-and-share-comments-and-texts.

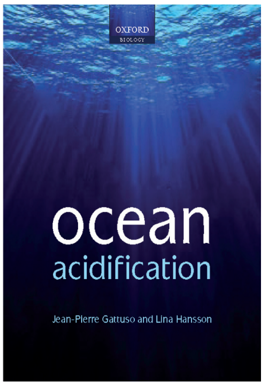
The Earth System Governance Project is also compiling a succinct policy-relevant assessment of the state of knowledge about the institutional framework for sustainable development, which is authored by over thirty international experts. This policy assessment, mandated by the four global change research programmes, will serve as a key input to the Rio+20 process.
The Earth System Governance Project will share a draft version of this policy assessment on their website soon.

More information is at:
http://www.ieg.earthsystemgovernance.org/news/2011-05-12/policy-assessment-institutional-framework-sustainable-development.

Publications

Ocean Acidification

About this book



- Synthesizes the findings of recent national and international research efforts, including those of EPOCA (European Project on Ocean Acidification affiliated to LOICZ), set in a broader global context
- Reviews our current knowledge of the chemical, biological, biogeochemical, and societal implications of ocean acidification, with a particular emphasis on its impact on marine organisms and ecosystems
- Assesses the uncertainties, risks, and thresholds related to ocean acidification at molecular, cellular, organismal, local, and global scales

The ocean helps moderate climate change thanks to its considerable capacity to store CO2, through the combined actions of ocean physics, chemistry, and biology. This storage capacity limits the amount of human-released CO2 remaining in the atmosphere. As CO2 reacts with seawater, it generates dramatic changes in carbonate chemistry, including decreases in pH and carbonate ions and an increase in bicarbonate ions. The consequences of this overall process, known as “ocean acidification”, are raising concerns for the biological, ecological, and biogeochemical health of the world’s oceans, as well as for the potential societal implications. This research level text is the first to synthesize the very latest understanding of the consequences of ocean acidification, with the intention of informing both future research agendas and marine management policy. A prestigious list of authors has been assembled, among them the coordinators of major national and international projects on ocean acidification.
Readership: Suitable for graduate level students as well as professional researchers in oceanography and marine biology. It will also be of relevance and use to a more general audience of marine scientists and managers interested in the effects and potential impacts of ocean acidification.

Ocean Acidification
Edited by Jean-Pierre Gattuso and Lina Hansson
344 pages | 75 illustrations | 246×189 mm
Publication date: September 2011

The book “Ocean Acidification”, to be published by Oxford University
Press in September, can be purchased with a 20% discount:

http://tinyurl.com/OUP-OA-book.

Coastal Snapshot

LOICZ Snapshot is a feature on the LOICZ website and in our newsletter LOICZ INPRINT. LOICZ Snapshot is a non scientific report from people (scientists and non scientist) for the LOICZ community. LOICZ snapshot tries to capture special adventures, experiences and impressions in coastal regions in order to tell about people living or researching in these coastal zones or other interesting aspects of ‘remote’ regions along the world’ s coasts.

Presumably our next article will be published in LOICZ INPRINT 2011/3 about Coastal Hazard Management in Samoa, by
Prof. John E Hay
Affiliations:
Visiting Professor, Ibaraki University, Japan
Adjunct Professor, Lincoln University, New Zealand
Adjunct Professor, The University of the South Pacific, a regional university with the main campus in Fiji

If you also want to become a “LOICZ Snapshot Reporter” please send your “Snapshot article” to: b.goldberg@loicz.org

Further articles of ‘Coastal Snapshots’ can be found here:
http://www.loicz.org/Snapshot/index.html.en

Have you seen?

Integrating **biodiversity** Science
for **human well-being**

DIVERSITAS is pleased to announce the launch of its new website. The new website has new functions, better tools and a new visual design, making it easier for you to find the information you need. A revamped newsletter will soon appear on a regular basis to enable the entire DIVERSITAS community, including national members, to stay informed on activities and publications from the DIVERSITAS community at large. DIVERSITAS welcomes your feedback as they continue to improve this site.

Please note: DIVERSITAS a co-organiser of **Planet Under Pressure 2012** the major international science conference focusing on solutions to the global sustainability challenge; 26-29 March 2012, London, UK.

Call for Abstracts Now Open

The IPY 2012 Conference "From Knowledge to Action" is taking place in Montreal, Canada April 22-27, 2012 and will be one of the largest and most important scientific conferences for polar science and climate change, impacts and adaptation. The Call for Abstracts for oral and poster presentations is now open. Conference organizers invite you to submit abstracts on the latest polar science, as well as the application of polar research findings, policy implications and how to take polar knowledge to action. The Conference program is available at

www.ipy2012montreal.ca

The Call for Abstracts closes September 30, 2011.

NEW Conference Website Launched

A new conference website is up and running and features the latest information on the development of the Conference program, as well as indepth articles and highlights of polar science news from around the world on our Conference Twitter page (IPY2012). Please be sure to update your bookmarks to link to the new site.

IASC Medal Award 2012

IASC Medals are awarded in **recognition of exceptional and sustained contributions to the understanding of the Arctic**. A maximum of one award is made each year, assuming that there is a nominee of appropriate quality. The award of medals will normally be by the President of IASC during the Arctic Science Summit Week (or exceptionally at another major international meeting) following the ratification of the award.

Nominations for the **IASC Medal 2012**, which will be awarded at the **IPY 2012 From Knowledge to Action Conference** in Montreal (22-27 April 2012), can be submitted to the IASC Secretariat until **31 December 2011**. A medal nomination form is available on the IASC website at:

http://iasc.arcticportal.org/index.php/home/iasc/iasc-medal

For more information please contact the IASC Secretariat

Telegrafenberg A43 - 14473 Potsdam - Germany
+49-331-2882214
iasc@iasc.info
www.iasc.info

Exploring linkages between environmental management and value systems – the case of Antarctica

– 25th International Congress for Conservation Biology (ICCB 2011) –

When? 9:00 am – 5:00 pm on 5 December 2011
Where? University of Auckland, Auckland, New Zealand
What? Full-day interdisciplinary workshop
For whom? Scholars of any discipline interested in value systems, environmental management, societal and political responsibilities for and engagement with wilderness areas, Antarctica

This workshop focuses on the connection between the values attributed to a certain environment and its management. Using the case of Antarctica, a continent without an indigenous human population, we will discuss how the human impressions of and engagement with Antarctica inform environmental management decisions. These impressions and opinions might influence decisions that, collectively, can affect entire global systems, primarily through their impacts on climate, natural resources, and international policy.

Media coverage has brought information about the Antarctic to millions of people around the world and has prompted them to consider the benefits that humankind receives from the time, effort, and money invested in Antarctica. As a result, society engages increasingly with Antarctica and has been given reasons to consider the value of Antarctica. So far, policy-making and public opinion, as represented in the media, has reflected a conservationist approach, but it is unclear for how much longer the benefits of conservation will outweigh its costs, including foregone economic profits.

Understanding the nature of the values that humans attribute to Antarctica has large-scale and serious implications. So far, no substantial body of research exists that assesses the range of values placed on Antarctica and their implications for environmental management. This workshop represents one step towards addressing this important gap in the literature and bringing together scholars and practitioners to facilitate an informed discussion on this topic.

We invite a broad spectrum of contributions on topics ranging from value frameworks and the conceptualisation of values to value-based management and conservation with a special focus on the Antarctic. Contributions from scholars of all disciplines are welcome as we want to encourage an interdisciplinary discussion.

Anticipated outcomes of the workshop:

Joint discussion paper with the workshop participants or conference proceedings as an edited volume.

Please email Daniela Liggett (daniela.liggett@canterbury.ac.nz) or Gary Steel (gary.steel@lincoln.ac.nz) if you are interested in participating in this workshop.

Calendar

2011

World Water Week 2011: Responding to Global Changes - Water in an Urbanising World
21 - 27 August 2011; Stockholm, SWEDEN
http://www.worldwaterweek.org/

8th Baltic Sea Science Congress 2011
22 - 26 August 2011; St. Petersburg, RUSSIAN FEDERATION
http://www.bssc2011.org/

Ecocity World Summit
22-26 August, 2011, Montréal, Canada
http://www.ecocity2011.com/accueil/default_e.asp

EMECS 9 – Global Summit on Coastal Seas
28-31 August, 2011, Baltimore, USA
http://conference.ifas.ufl.edu/emecs9/index.html

Marine Resources and Beyond
05 - 07 September 2011; Bremerhaven, GERMANY
http://www.mrb2011.org

CoastGIS
5 - 8 September 2011, Oostende Belgium
http://www.coastgis.info/

Coastal Structures 2011
05 - 09 September 2011; Yokohama, JAPAN
http://www.jsce.or.jp/committee/ocean/coastalstructu-res/

7th IAHR Symposium on River, Coastal, and Estuarine Morphodynamics
06 - 08 September 2011; Beijing, CHINA
http://sklhse.tsinghua.edu.cn/rcem2011/rcem2011.html

YouMaRes 2.0 - "Oceans amidst science, innovation and society"
Datum: 07 - 09 September 2011; Bremerhaven, GERMANY
http://www.youmares.net

Young LOICZ Forum 2011
Enhancing Capacities for Global Change Mitigation in Asia-Pacific Coastal Zones
8-15 September, 2011, Yantai, China
http://www.loicz.org/young_loicz/YLF2011

LOICZ Open Science Conference 2011
Coastal Systems, Global Change and Sustainability
12-15 September, 2011, Yantai, China
http://www.loicz-osc2011.org

Geo Spatial and Human Dimension on Sustainability Natural Resources Management
12-13 September 2011 | IPB International Convention Center, Bogor Indonesia
http://www.ihdp.unu.edu/article/read/geo-spatial-and-human-dimension-on-sustainability-natural

Adapting to Coastal Change: Local Perspective (International Conference)
13 - 14 September 2011; The Hague, NETHERLANDS
http://imcore.eu/TheHagueConference2011/

ICES Annual Science Conference 2011
19 - 23 September 2011; Gdansk, POLAND
http://www.ices.dk/iceswork/asc/2011/index.asp

Special Session on "Integrated Coastal Zone Management (ICZM): from protocols to local communities"
25. - 29. September 2011; Dubrovnik, CROATIA
http://www.dubrovnik2011.sdewes.org/special.php

World Conference on Marine Biodiversity
26 - 30 September 2011; Aberdeen, UNITED KINGDOM
Webseite: http://www.marine-biodiversity.org

HOMER 2011, Ancient coastal settlements and human/environment relationships
27 September - 01 October 2011; Vannes, FRANCE
http://homer2011.univ-rennes1.fr/

Coasts and Ports 2011
28 - 30 September 2011; Perth, AUSTRALIA
http://www.coastsandports2011.com.au/

The Legal and Socio-Economic Problems of Arctic Peoples
29 Sept 2011, North-Eastern Federal University in Yakutsk, Russia

International Symposium on the Ecology of the Wadden Sea
10 - 14 Oktober 2011; Texel, NETHERLANDS
http://projects.nioz.nl/ecologyofthewaddensea

Fachmesse acqua alta 2011
11 - 13. October 2011; Hamburg, GERMANY
http://www.acqua-alta.de

7th International Conference on Asian Marine Geology
11-14 October 2011, Goa - India
http//:icamg7.nio.org

Indian Ocean IODP Workshop
Goa on 17-18 October, 2011
http://www.iodp.org/workshops/

7th International Conference on Asian Marine Geology (ICAMG-7)
Goa, October 11-14
http://icamg7.nio.org/

DISCCRS VI
Interdisciplinary Climate Change Research Symposium
22-29 October, 2011, La Foret Conference and Retreat Center, Colorado Springs, USA
http://disccrs.org/disccrsposter.pdf

EUR-OCEANSCONFERENCE
24-26 October 2011, Mas des Canelles, Toulouse, France
http://www.eur-oceans.net/conf-oxygen

EUR-OCEANS Conference
- Ocean deoxygenation and implications for marine biogeochemical cy-cles and ecosystems
24 - 26 Oktober 2011; Toulouse, FRANCE
http://www.eur-oceans.net

Coastal Management 2011
15 - 16 November 2011
Europa Hotel
Belfast, UK
http://ice-coastalmanagement.com/

2012

Planet Under Pressure: new knowledge towards solutions
26-29 March, 2012, London
www.planetunderpressure2012.net

IPY Conference: From Knowledge to Action
22–27 April, 2012, Montreal, Canada

50th ECSA Conference 2012: Today's science for tomorrow's Management
3-7 June 2012, Venice, Italy
CALL FOR ABSTRACTS! Deadline: 13 January 2012
http://www.estuarinecoastalconference.com/

33rd International Conference on Coastal Engineering- ICCE 2012
Santander-Spain, July 1st to 6th, 2012.
http://www.icce2012.com/

8th International Conference on Tidal Environments (Tidalites 2012)
July 28 – August 5, Caen, Normandy, France
http://www.unicaen.fr/colloques/tidalites2012/index.php

34th International Geological Congress (IGC): AUSTRALIA 2012.
5-10 August, 2012, Brisbane Convention and Exhibition Centre
First Circular: https://mymail.ezemsgs.com/download/files/08781/1261286/34th%20IGC%20First%20Circular.pdf

2015

INQUA Congress (International Union for Quaternary Research)
July 27 to August 2, 2015, Nagoya
Good opportunity to have sessions on deltas and Holocene sea-level

IHDP
International Human Dimensions Programme
on Global Environmental Change

GLOBAL
IGBP
CHANGE
International
Geosphere-Biosphere
Programme

Helmholtz-Zentrum
Geesthacht
Centre for Materials and Coastal Research

Contact:
Helmholtz-Zentrum Geesthacht –
Centre for Materials and Coastal Research,
Institut of Coastal Research, LOICZ IPO
Max-Planck-Str. 1
21502 Geesthacht, Germany
phone: +49 4152 87-2009 · fax: +49 4152 87-2040
e-mail: loicz.ipo@loicz.org · URL: www.loicz.org