Summer School

Delineating the Issues of Climate Change and Impacts to Marine Ecosystems: Bridging the Gap Between Research, Assessment, Policy and Management

4-9 August 2014

East China Normal University

Shanghai, China

Contents

Welcome

On behalf of the East China Normal University, I am very pleased to welcome you to the fourth international IMBER ClimEco summer school on “Delineating the issues of climate change and impacts to marine ecosystems: Bridging the gap between research, assessment, policy and management”.

There is overwhelming evidence that global climate change is a serious threat requiring urgent response. Although the planet has experienced change many times throughout the millennia, this is the first time that humans have been the cause of the change. However, humans are also reliant on the goods and services offered by the marine environment, and consequently, there are very complex interactions and feedbacks between the oceans and human society.

IMBER aims to foster research at the interface of natural and human systems. This summer school brings together lecturers and participants from a variety of different disciplines and different regions of the world to share their perspectives on the challenges that human and marine systems are facing under global change. It provides a wonderful opportunity to consider and predict possible scenarios of these complex issues taking into consideration perspectives like human behaviour, economic constraints and the organisation of society, in addition to the physical, biogeochemical and biological impacts.

I wish you a stimulating and productive week at the IMBER ClimEco4 summer school and an enjoyable stay in Shanghai.

Jing Zhang
Professor of Chemical Oceanography and Cheung Kong Scholar
State Key Laboratory of Estuarine and Coastal Research, ECNU

Organising Committee

Ingrid van Putten (Convener): CSIRO, Hobart, Tasmania, Australia

Stéphane Pesant (Convener): University of Bremen, Bremen, Germany

Lisa Maddison: IMBER International Project Office, Bergen, Norway

Fang Zuo: IMBER Regional Project Office, Shanghai, China

Li Tan: East China Normal University, Shanghai, China

Wei Zheng: East China Normal University, Shanghai, China

Sponsors

Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project

IMBER is an international project that aims to investigate the sensitivity of marine biogeochemical cycles and ecosystems to global change, on time scales ranging from years to decades. IMBER aims to provide a comprehensive understanding of, and accurate predictive capacity for ocean responses to accelerating global change and the consequent effects on the Earth System and human society. IMBER is co-sponsored by the International Geosphere-Biosphere Programme (IGBP), the Scientific Committee on Oceanic Research (SCOR).

Asia-Pacific Network for Global Change Research (APN)

The Asia-Pacific Network for Global Change Research (APN) is a network of 22 Member Country governments that promotes global change research to enable countries in the Asia-Pacific region to successfully address global change challenges through science-based adaptation strategies, effective science and policy linkages, and capacity development.

The APN defines “global change” as natural and human-induced processes in the Earth’s physical, biological and social systems that, when aggregated, are significant at a global scale.

The APN works to enable developing countries in the Asia-Pacific region to participate increasingly in regional cooperative research, and

to benefit fully from such research.

It strives to assure that the research results contribute to the development of science-based adaptation strategies, policy- and decision-making processes, and developing scientific capacity to address these important issues.

Variability and predictability of the ocean-atmosphere system (CLIVAR) project

CLIVAR is the World Climate Research Programme (WCRP) project that addresses Climate Variability and Predictability, with a particular focus on the role of ocean-atmosphere interactions in climate. It works closely with WCRP projects on issues such as the role of the land surface, snow and ice and the role of stratospheric processes in climate.

East China Normal University

ECNU is one of the China's key universities under the Ministry of Education of the People's Republic of China and supported by the national programs on key universities "Project 211" and "Project 985". Currently, the University contents of 21 schools and colleges and five research institutes, with 58 departments offering 70 undergraduate programs, 38 master's programs and 26 doctoral programs of the State Primary Disciplines. The total number of full-time undergraduate students and graduate students is about 15,000 and 12,000, respectively.

Institute of Marine Research (IMR), Norway

IMR is Norway's largest centre of marine science. Its main task is to provide advice to Norwegian authorities on aquaculture and the ecosystems of the Barents Sea, the Norwegian Sea, the North Sea and the Norwegian coastal zone. The aim of research and management advice provided by IMR is to ensure that Norway's marine resources are harvested in a sustainable way.

Korean Institute of Ocean Science and Technology

Korea Institute of Ocean Science & Technology (previously KORDI - Korea Ocean Research & Development Institute), is the only comprehensive ocean research organization in Korea and has led the development of marine science and technology within the nation. Since its establishment in 1973, it has played a pivotal role in improving Korea's focus on the development and promotion of marine knowledge, exploitation of marine resources, and preservation of marine environment, and thus utilize potentials in ocean for the future of Korea.

North Pacific Marine Science Organization (PICES)

PICES is an intergovernmental scientific organisation that aims to promote and coordinate marine research in the northern North Pacific and adjacent seas (particularly northwards of 30°N). It is mandated to advance scientific knowledge about the ocean environment, global weather and climate change, living resources and their ecosystems, and the impacts of human activities. Present members are

Canada, People's Republic of China, Japan, Republic of Korea, Russian Federation, and the United States of America.

Ocean Carbon & Biogeochemistry (OCB)

The Ocean Carbon Biogeochemistry program focuses on the ocean's role as a component of the global Earth system, bringing together research in geochemistry, ocean physics, and ecology that inform on and advance our understanding of ocean biogeochemistry. The overall program goals are to promote, plan, and coordinate collaborative, multidisciplinary research opportunities within the USA research community and with international partners.

The OCB is supported by the NSF, NASA and NOAA in the USA.

Past Global Changes (PAGES) project

The Past Global Changes project (PAGES) is an international effort to coordinate and promote past global change research. Its mission is to improve our understanding of past changes in the Earth System in a quantitative and process-oriented way in order to improve projections of future climate and environment, and inform strategies for sustainability.

PAGES brings together more than 6000 scientists from over 100 countries with an interest in the physical climate system, biogeochemical cycles, ecosystem processes, biodiversity, and human dimensions, on different time scales that reach back centuries to hundred thousands of years.

It is a core project of the International Geosphere-Biosphere

Programme (IGBP) and Future Earth and is funded by the US and Swiss National Science Foundations and the National Oceanic and Atmospheric Administration (NOAA).

To subscribe to PAGES and receive the PAGES Magazine see: www.pages-igbp.org/my-pages/introduction

Scientific Committee on Oceanic Research

Formed by the International Council for Science (ICSU) in 1957, SCOR is an interdisciplinary body whose activities promote international cooperation in planning and conducting oceanographic research, and solving methodological and conceptual problems that hinder research. SCOR provides a mechanism to bring together international scientists and has thus been instrumental in the planning and coordination of several large-scale ocean research projects for long-term, complex activities.

State Key Laboratory of Estuarine and Coastal Research (SKLEC), China

SKLEC is based at the ECNU. It was established by the State Planning Commission of China in 1989 and went into operation in 1995. The research areas in SKLEC are: estuarine evolution and estuarine sediment dynamics, coastal dynamical geomorphology and sediment process, and estuarine and coastal ecology and environment.

Programme

DAY 1 – MONDAY 4 AUGUST 2014	
General introduction to marine climate change and indicators	
09:00-09:45	Welcome address and overview of the course **Prof. Yunxuan Zhou (SKLEC),** **Lisa Maddison, Ingrid van Putten, Stéphane Pesant**
09:45-10:30	Delineating the issues of climate change and impacts to marine ecosystems **Beth Fulton**
10:30-11:00	*Break*
11:00-11:45	Indicator basics – What they are, why we use them and what they can be used for **Alida Bundy**
11:45-12:30	Indicators of climate change and climate impact on marine ecological systems (biophysical perspective) **Scott Large**
12:30-13:30	*Lunch*
State and pressure indicators and modelling basics	
13:30-14:15	Climate change and marine biogeochemistry at different time scales **Eric Galbraith**
14:15-15:15	Socio-economic and governance indicators and climate impact (including ecosystem services approach) **Ingrid van Putten, Rashid Sumaila**
15:15-15:45	*Break*
Working group projects	
15:45-17:00	Introduction to group work, divide into groups **Ingrid van Putten, Beth Fulton (and all other lecturers)**
17:00-19:00	Poster session – Participants present a poster relating to their research (Drinks and snacks will be served) **All lecturers**

DAY 2 – Tuesday 5 AUGUST 2014	
Data and databases	
09:00-10:00	Modelling basics and modelling in the context of indicators **Beth Fulton**
10:00-10:45	General circulation models **Eric Galbraith**
10:45-11:15	*Break*
11:15-12:00	Selecting indicators **Alida Bundy**
12:00-13:00	Access to observational data and indicators **Stéphane Pesant**
13:00-14:00	*Lunch*
Working group projects	
14:00-15:30	Commencement of group work **All lecturers will be present to help with ideas and approaches**
15:30-16:00	*Break*
16:00-17:00	Group work continued **All lecturers**

DAY 3 – Wednesday 6 AUGUST 2014	
Analyses refresher and statistics primer – how to analyse data	
09:00-09:45	Data analysis methods (including methods for data quality control) **Scott Large**
09:45-10:30	Methods for nonlinearity exploration in data: Detecting 'tipping points', developing decision criteria empirically and analytically. **Scott Large**
10:30-11:00	*Break*
11:00-11:45	Applied statistical techniques (PCA and Cluster analysis) **Scott Large, Beth Fulton**
11:45-12:30	Applied statistical techniques (analysis of networks) **Scott Large, Ingrid van Putten**
12:30-13:30	*Lunch*
13:30-15:00	Interactive assessment and discussion of three scientific papers (Fulton et al 2010, Mora et al 2009, Halpern et al 2012) **Rashid Sumaila, Beth Fulton and others**
15:00-15:30	*Break*
Working group projects	
15:00-17:00	Group work continued **All lecturers**

DAY 4 – Thursday 7 AUGUST 2014	
How to use indicators in ecological and socio-economic models	
09:00-10:00	Publishing, discovering and re-using scientific data **Stéphane Pesant**
10:00-11:00	Linking coastal communities and socio-economic indicators to marine ecosystems **Ingrid van Putten**
11:00-11:30	*Break*
11:30-12:30	Using indicators with ecological and socio-economic models **Rashid Sumaila**
12:30-13:30	*Lunch*
13:30-14:30	Performance of indicators **Alida Bundy**
14:30-15:00	*Break*
Working group projects	
15:00-17:00	Group work continued **All lecturers**

DAY 5 – Friday 8 AUGUST 2014	
Using indicators for policy, decision-making and management	
09:00-09:30	Impacts of climate change and fishing on fisheries **Yongsong Qiu**
09:30-10:00	Use of indicators in fisheries management **Jiahua Cheng**
10:00-11:00	Use of indicators in policy and management **Keith Sainsbury**
11:00-11:30	*Break*
11:30-12:30	Use of economic and social indicators in fisheries management and policy **Rashid Sumaila**
12:30-13:30	*Lunch*
13:30-14:30	Communicating indicators to a range of audiences **Keith Sainsbury**
14:30-15:00	*Break*
Working group projects	
15:00-17:00	Preparation for group presentations **All lecturers**
19:30	Summer school dinner at the Shanghai Min Restaurant

DAY 6 – Saturday 9 AUGUST 2014	
Participant presentations	
09:00-11:00	Group presentations of their ecosystem assessment **All lecturers**
11:00-11:30	*Break*
11:30-12:30	Group presentations of their ecosystem assessment **All lecturers**
12:30-13:30	Closing discussion **All lecturers**

Suggested reading and useful links

Alida

Rice, J.C., and Rochet, M.J. 2005. A framework for selecting a suite of indicators for fisheries management. *ICES Journal of Marine Science*, 62: 516-527.

Shin, Y.-J., Shannon, L.J., Bundy, A., Coll, M., Aydin, K., Bez, N., Blanchard, J.L., Borges, M.F., Diallo, I., Diaz, E., Heymans, J.J., Hill, L., Johannesen, E., Jouffre, D., Kifani, S., Labrosse, P., Link, J.S., Mackinson, S., Masski, H., Möllmann, C., Neira, S., Ojaveer, H., Ould Mohammed Abdallahi, K., Perry, I., Thiao, D., Yemane, D., and Cury, P.M. 2010. Using indicators for evaluating, comparing and communicating the ecological status of exploited marine ecosystems. Part 2: Setting the scene. *ICES Journal of Marine Science*, 67: 692-716

Link, J. S., Yemane, D., Shannon, L. J., Coll, M., Shin, Y-J., Hill, L., and Borges, M. F. 2010. Relating marine ecosystem indicators to fishing and environmental drivers: an elucidation of contrasting responses. *ICES Journal of Marine Science*, 67: 787-795.

Bundy, A, Coll M, Shannon L, Shin Y. 2012. Global assessments of the status of marine exploited ecosystems and their management: what more is needed? *Current Opinion in Environmental Sustainability (COSUST*) 4:292-299.

Samhouri J.F, Levin P.S., Harvey C.J. 2009. Quantitative Evaluation of Marine Ecosystem Indicator Performance Using Food Web Models. *Ecosystems* 12:1283-1298.

Samhouri, J. F., P. S. Levin, and C. H. Ainsworth. 2010.Identifying thresholds for ecosystem-based management. *PLoS ONE* 5:e8907.

ICES. 2012. Report of the Working Group on the Ecosystem Effects of Fishing Activities (WGECO), 11-18 April 2012, Copenhagen, Denmark. ICES CM 2012/ACOM:26. 192 pp. (available on the website)

Houle, J. E., Farnsworth, K. D., Rossberg, A. G., and Reid, D. G. 2012. Assessing the sensitivity and specificity of fish community indicators to management action. *Canadian Journal of Fisheries and Aquatic Sciences*, 69(6), 1065-1079.

Shackell N.L., Bundy A., Nye J.A., Link, J.S. 2012. Common Large-scale Responses to Climate and Fishing across Northwest Atlantic Ecosystems. *ICES J. Mar. Sci.* 69(2): 151-162.

Eric

Jaccard, S. L. and E. D. Galbraith. 2012. Large climate-driven changes of oceanic oxygen concentrations during the last deglaciation. *Nature Geoscience* 5: 151-156.

Bopp, L., L. Resplandy, J.C. Orr, S.C. Doney, J.P. Dunne, M. Gehlen, P. Halloran, C. Heinze, T. Ilyina, R. Seferian, J. Tjuputra and M. Vichi. 2013. Multiple stressors of ocean ecosystems in the 21st century: projections with CMIP5 models. *Biogeosciences* 10: 6225-6245.

Ingrid

Ostrom 2009. A General Framework for Analyzing Sustainability of Social-Ecological Systems. *Science* 325: 419-422

Allison *et al* 2009. Vulnerability of national economies to the impacts of climate change on fisheries. *Fish and Fisheries* 10: 173-196

Sumaila *et al* 2011. Climate change impacts on the biophysics and economics of world fisheries. *Nature Climate Change* 1: 449-456.

Perry *et al* 2011. Marine social–ecological responses to environmental change and the impacts of globalization. *Fish and Fisheries* 12: 427-450

Poloczanska *et al. 2013.* Global imprint of climate change on marine life. *Nature Climate Change* 3: 919-925

Scott

Zuur, A. F., E. N. Ieno, and C. S. Elphick. 2010. A protocol for data exploration to avoid common statistical problems. *Methods in Ecology and Evolution* 1:3-14.

Stéphane

Commission staff working document, accompanying the document: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions. Innovation in the Blue Economy realising the potential of our seas and oceans for jobs and growth. European Commission, DG-MARE 08-05-2014

The Ocean Data Interoperability Platform (ODIP; http://www.odip.org/) project aims to establish a coordination platform (EU/USA/Australia/IOC-IODE) to achieve interoperability of ocean and marine data infrastructures.

The COOPEUS (http://www.coopeus.eu/) project aims for global integration of existing data infrastructures by bringing together scientists and users from EU and US environmental research infrastructure projects.

The European Marine Observation and Data Network (EMODnet; http://www.emodnet.eu/) is a consortium of organisations within Europe that assembles marine data, data products and metadata from diverse sources in a uniform way.

Australia's Integrated Marine Observing System (IMOS; http://www.imos.org.au/) is designed to be a fully-integrated, national system, observing at ocean-basin and regional scales, and covering physical, chemical and biological variables.
The U.S. Integrated Ocean Observing System (U.S. IOOS: http://www.ioos.noaa.gov/) is a vital tool for tracking, predicting, managing, and adapting to changes in our ocean, coastal and Great Lakes environment. U.S. IOOS delivers the data and information needed, so that decision-makers can take action to improve safety, enhance the economy, and protect the environment.

MyOcean (http://www.myocean.eu/) is a European marine core service. Its objective is to provide users with the best generic information available on the state of the ocean. MyOcean is committed to develop and run a European service based on a worldwide capacity for ocean monitoring and forecasting, using observations data, modelling and assimilation systems.

Eurostat is (http://epp.eurostat.ec.europa.eu/) the statistical office of the European Union situated in Luxembourg. Its task is to provide the European Union with statistics at European level that enable comparisons between countries and regions.

The IndiSeas project (http://www.indiseas.org/) is a multi-institutes collaborative effort. One or two scientific experts from each ecosystem represented have calculated the necessary indicators and provided background information and overview of the status of their ecosystem. Indicator series currently extend to 2010, but the database will be updated on a regular basis.

Lecturers' biographies

Alida Bundy is a Research Scientist with Fisheries and Oceans, Canada, based at the Bedford Institute of Oceanography, Halifax, Nova Scotia. Her main research concern is the preservation of the biodiversity of the oceans and the benefits that they provide. To this end, her research interests include the impact of fishing on marine ecosystems, the structure and functioning of ecosystems, ecosystem-based management and ecosystem-based indicators of fishing impacts and interdisciplinary approaches to fisheries science. Alida has led various projects on these themes within Fisheries and Oceans Canada. Internationally she is Vice-Chair of the IMBER Scientific Steering Committee, founder and co-Chair of the IMBER Human Dimension Working Group, co-Chair of IndiSeas (Indicators for the Seas) and co-Chair of the IndiSeas Human Dimension Working Group.

Jiahua Cheng has PhD from the Ocean University of China, Qingdao. He is a professor and researcher based at the East China Sea Fisheries Research Institute in Shanghai, China. His main research interests include marine fisheries resources management and enhancement, fish ecology and fishery information technology. He spent time as a visiting scholar at the University of British Columbia Fisheries Centre, Canada where he worked on fisheries ecological modelling. Specific research activities that he has been involved in include: assessment of fishery resources and the condition of fishing grounds, fisheries management, fish biology, the ecology of fish populations and the fishery ecological system. With regard to the enhancement of fishery resources, his research has included seed production, the evaluation of artificial releasing and ecological rehabilitation.

Beth Fulton has a PhD in ecomathematics from the University of Tasmania and is a leading marine ecosystem modeller with a background in marine ecology, mathematics and scientific programming. She has been leading the CSIRO ecosystem modelling efforts for the past 15 years. Her science focus is on marine natural resource management, conservation and ecosystems.

Beth's team focuses on the development of whole of system marine ecosystem models (e.g. Atlantis, InVitro and CORSA) that give equal attention to biophysical and human components of marine ecosystems. These models allow users to explore the impacts and management of the myriad pressures on marine and coastal environments. The approach underpins CSIRO's research into managing potentially competing uses of Australia's marine environments and adaptation to global change and is currently used up by researchers and management bodies in 26 countries around the world. Dr Fulton's work has been recognised with numerous awards including the Science Minister's Prize for Life Scientist of the Year (2007), a Pew Marine Conservation fellowship (2010) and an ESA Sustainability Science Award (2011).

Eric Galbraith is an Earth System scientist with a doctorate in oceanography from University of British Columbia, Canada. He is currently Assistant Professor in the Department of Earth and Planetary Sciences at McGill University in Montreal. His research uses observations of the modern ocean, computer simulations of ocean biogeochemistry, and sedimentary records of past climate change to examine the connections between climate and marine ecosystems.

Scott Large is an ecologist with a doctorate in marine biology. He is currently a Postdoctoral Researcher with NOAA-Fisheries at the Northeast Fisheries Science Center in Woods Hole, USA. He has a strong background in chemical and behavioural ecology and in ecosystem-based fisheries management. He is particularly interested in applying empirical and quantitative approaches to ecological and fisheries-related questions. He is currently working on identifying thresholds in pressure-response relationships between ecological indicators, fishing, and the environment.

Stéphane Pesant is a biological oceanographer. His PhD at Laval University, Québec was on plankton food webs and their associated biogeochemical carbon fluxes. He is based at the Center for Marine Environmental Sciences at the University of Bremen and is involved in the integration of scientific data for several European, national and international projects, through his work with PANGAEA - Data Publisher for Earth & Environmental Science.

Yongsong Qiu is a research scientist and chief of the Fishery Resources Division at the South China Sea Fisheries Research Institute. He organised several offshore surveys on fishery stocks and Indo-Pacific humpback dolphins and conducted stock assessments for both the management of the fishery and the environmental impact assessment. In 2005, he was appointed as head of the China-Vietnam Fisheries Resources Specialist Team for the Tonkin Gulf and led a China-Vietnam joint monitoring survey on fisheries resources in the Tonkin Gulf. The program monitors trawl survey catch rates and stock parameters for major commercial fishes. In recent years, he has investigated the influences of fishing pressure and climate variability on fish production in China’s seas. His current interest is the investigation of the effects of natural iron and macronutrient fertilization on fish

productivity.

Keith Sainsbury´s background in fishery and marine management, has combined marine science with executive and Board experience in both government and private organisations.

His science experience as a marine ecologist and mathematical modeller, focused on the assessment, ecology, economics, exploitation and conservation of marine resources and ecosystems. His research ranged from abalone to tuna, and from Sub-Antarctic toothfish to tropical snappers, and on the development of assessment and risk management strategies for fisheries. He led research programs to support sustainable management of human activities in the economically critical North West Shelf region (i.e. petrochemical industries, aquaculture, tourism, conservation, fisheries and human communities) and the iconic Ningaloo Reef ecosystem (i.e. tourism, fisheries and conservation) in Western Australia. He provided several key inputs during development of Australia's Oceans Policy to address integrated oceans management, and subsequently led the main research team that supported practical implementation of the policy - including identification of Marine Protected Areas.

His executive and Board experience includes the Australian Fisheries Management Authority, the statutory Total Allowable Catch Committee for the Australian state of New South Wales, the Australian Fisheries Research and Development Corporation, and the Board of the Marine Stewardship Council.

Rashid Sumaila is Professor of Economics at the University of British Columbia, (UBC) in Canada and Director of the Fisheries Economics Research Unit at the UBC Fisheries Centre. He specialises in bioeconomics, marine ecosystem valuation and the analysis of global issues such as fisheries subsidies, IUU (illegal, unreported and unregulated) fishing and the economics of high and deep seas fisheries. Rashid has worked in fisheries and natural resource projects in Norway, Canada and the North Atlantic region, Ghana and other parts of West Africa, Namibia and other southern African regions, Hong Kong and the South China Sea

Ingrid van Putten is a human behaviour modeller with the ecosystems modelling team at the CSIRO Centre for Marine and Atmospheric research, in Hobart, Australia. Her research focuses on the social and economic behaviour modelling of interaction with the biophysical marine environment and understanding coupled social-ecological systems. Because complexity in the bio-physical sphere is mirrored in social and economic systems, she focuses on the tools that effectively model social and economic data. Ingrid has used network analysis to model lease quota trade systems and Bayesian models to investigate non-economic drivers in indigenous fisheries. She has also applied qualitative models to investigate the drivers of participation in marine sectors in the context of climate change.

Poster abstracts

Study of potential impacts of climate change on fisheries sector and adaptation options in Malaysia

Lubna Alam[1], Mazlin Mokhtar, Goh Ta and Lee Ern

[1] Institute for Environment and Development (LESTARI), National University of Malaysia, Bangi, 43600, Selangor, Malaysia.

Abstract
Climate change has attracted much scientific and public attention over the last few years and is expected to influence marine ecosystems throughout the world influencing fish, fisheries, and aquaculture programmes. The ecosystem productivity, fish vital rates (growth, recruitment, and mortality), fish distribution and migration patterns, species composition, biodiversity, phenology, and input costs are the sector predicted to be influenced by climate change. Thus, climate change poses new challenges to the sustainability of fisheries and aquaculture systems, with serious implications for the 520 million people who depend on them for their livelihoods, and the nearly 3 billion people for whom fish is an important source of animal protein. However, in case of Malaysia, the fisheries sector is considered as an important sub-sector in playing significant role in the national economy. Apart from contributing to the national Gross Domestic Product (GDP), it is also a source of employment, foreign exchange and a source of protein supply for the population in the country. The fisheries sector of Malaysia is not free from the threat of climate change as this country is considered as one of the highly vulnerable countries due to climatic changes. But unfortunately, research on this promising issue is still lacking in Malaysia. Therefore our future plan is to assess the vulnerability of fisheries sector due to changing climate and to propose possible adaptation options for Malaysian fisheries. This empirical study will use both primary and secondary data. Primary data will be collected through structured questionnaire interviews, interviews with community leaders and field observations at the fisherman community. Subjects of focus for the questions will be included: (i) the fisher's experiences of fishing; (ii) the fisher's perception on management regimes; (iii) the fisher's perception of climate change and its impact on the fisheries; and (iv) the fisher's perception of and ideas for adaptation. The integrated fisheries risk analysis method for ecosystems model (IFRAME) will be utilized to form an ecosystem approach to assess the impact of climate change on fisheries. The adaptation strategies will be investigated based on the assessed impact of climate change on

fisheries and the focused sectors will be: adaptation to impacts of climate change on fishery habitat, adaptation to direct impacts of climate change on fishery stocks, adaptation to impacts on the harvesting sector and adaptation to impacts on fishing communities. The decision tools like benefit-cost analysis, cost effectiveness analysis and multi-criteria analysis will be utilized to assist decision-makers in choosing between, or prioritizing, alternative adaptation measures.

Surface ocean pCO_2 variability and sensitivity in the southwestern Atlantic Ocean

Ricardo Arruda[1] and Paulo Calil

[1] Universidade Federal do Rio Grande, FURG, Rio Grande, Brazil

Abstract

Surface Ocean pCO_2 is the parameter that ultimately controls the ocean-atmosphere flux of CO_2. pCO_2 variability is driven by temperature (T), salinity (S), inorganic dissolved carbon (DIC) and alkalinity (ALK). Ocean pCO_2 in the Southwestern Atlantic Ocean was assessed through climatological runs of a coupled physical-biogeochemical model, with the hydrodynamical model ROMS and a NPZD-Carbon model. Results were compared to available observations from SOCAT. The pCO_2 sensitivity to each of its main drivers (T, S, DIC, ALK) was estimated through anomalies and applying small perturbations to the pCO_2 equation. A spatial analysis was made throughout the continental shelf (15° S to 55°S), and a temporal analysis was made dividing the shelf into three areas, the South Brazilian, the Southeast Brazilian and the Patagonian continental shelf. The modeled pCO_2 ranged between 200 and 500 µatm, with the highest pCO_2 in the inner continental shelves and in the low latitudes. Spatial analysis of sensitivity showed that DIC and temperature are the main drivers of pCO_2 variability. With temperature representing the most important driver in the Southernmost and Northernmost regions, being responsible for changes up to 100 µatm in pCO_2. DIC contributes to a cross shelf gradient of pCO_2, from the continental shelf break to a nearshore maxima. Salinity and alkalinity play less important roles in regulating pCO_2 in this region. The temporal analysis of the sensitivity showed that the most expressive anomalies of pCO_2 occur in the South Brazilian and in the Patagonian shelves. In the South Brazilian continental shelf the anomalies are mainly driven by changes in temperature, whilst in the Patagonian shelf both temperature and DIC are important drivers to these anomalies. The Southeast Brazilian continental shelf is less variable, with DIC, ALK and temperature affecting the pCO_2 with the same magnitude. Overall,

when comparing with the few SOCAT data available for this area, the modeled pCO_2 represents the seasonal pattern, although in some months the model underestimates pCO_2 by 20 µatm to 40 µatm. As this area of the Atlantic Ocean has few observations available, numerical modeling becomes an important tool for the investigation of pCO_2 dynamics and variability. Our results could be used as baseline for planning future studies about climate change and processes affecting surface ocean pCO_2. Overall, the variability of biogeochemical variables is represented by the model. Temperature and DIC are the main drivers of pCO_2 variability, but their importance varies in different regions and in different seasons.

Modelling the Processes of Intertidal Seagrass in Ria de Aveiro (Portugal)

Ana Azevedo[1], Ana Isabel Lillebø, João Lencart e Silva and João Miguel Dias

[1] University of Aveiro, Aveiro, Portugal

Abstract

Seagrasses are rooted flowering plants, growing in marine and estuarine environments. They may form extensive and productive meadows that provide several goods and services to coastal populations. Nevertheless, these habitats are declining at a worldwide scale, as a result of human driving forces such as the coastal development and climate change, with additional impact effects for the species depending on them.

Since they are important ecological quality indicators of the coastal zone, increasing the knowledge of these systems is essential for management strategies to preserve and improve the health and environmental quality. To achieve that, modelling approaches arise as useful supportive tools that will be adopted, together with the construction and evaluation of multiple stressor scenarios (e.g. storm surges, heat waves). This way, and considering the context of global climate change, the resilience of the system to multiple stressors could be assessed. Attending the Summer School ClimECO4, it is expected to learn more about the linking between scientific knowledge and management or policy, as well as understand how climate change impacts and the potential alterations on the providing services and ecological functions could be linked to indices for socio-economic and policy information in relation to climate-ecosystem interactions. Finally, it is expectable to learn best-practices on providing useful and understandable information to coastal managers, for a better comprehension and using planning of coastal areas, particularly those in the vicinity of very dynamic and sensitive habitats such as seagrass meadows.

3D Multidisciplinary numerical model of polychlorinated biphenyl dynamics on the Black Sea north-western shelf

Andrii Bagaiev

Marine Hydrophysical Institute of National Academy of Sciences of Ukraine

An original 3D model of PolyChlorinated Biphenyls (PCB) dynamics in the Black Sea has been developed to provide a robust predictive tool in case of accidental spill at sea. PCBs are eco-toxicants, highly resistant to degradation, hence are capable of long-range transport, bioaccumulation in human and animal tissue. Being lipophilic, PCBs demonstrate the distinguishing sorption/desorption activity on the organic matter particles and in sediment. The model consists of one-way coupled sub-systems as follows: an operational ocean circulation model, a module of transport and transformation of suspended particulate matter, and a PCB dynamics module. Production of suspended particulate matter and gravitational settling, first-order decomposition rate and the water-sediment exchange are taken into account. PCB module includes its concentration in solution, concentration on suspended particulate matter and concentration in the upper layer of sediment. Adsorption and desorption as well as the reversible PCB fluxes at the bottom are parameterized explicitly while PCB cross-boundary fluxes are taken into account implicitly in the generalized form. The model is validated on the historical interdisciplinary data sets by means of over 200 spin-ups. The model is upgraded to evaluate efficiency of deployment of the artificial active sorbent as a countermeasure in PCB spill response. The approach developed is promising with respect to risk assessment problem and development of decision support system. The model allows generalization to any of the environmental pollutants and Hazardous and Noxious Substances (HNS).

Using high-resolution sampling along CLIVAR transects to investigate ocean changing biogeochemical cycling of trace elements

Pamela Barrett[1], Joseph Resing, Nathan Buck, William Landing, Rachel Shelley and Peter Morton

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Abstract

Trace elements in the ocean can function as essential micronutrients that modulate primary productivity and ocean CO_2 uptake (e.g., Fe, Zn) or as potential toxins (e.g., Cu, As). Incorporation of trace element cycling into global ocean biogeochemical models will be important to understand the state of future ocean carbon cycling, ecosystem health, and global climate feedbacks. A dedicated trace-element sampling program has been carried out on 11 U.S. CLIVAR-CO_2 Repeat Hydrography cruises since 2003, transecting the major ocean basins. This work has produced high-resolution sections of the distribution of selected trace elements in the upper 1000 m of the global ocean which have been used to identify and characterize sources, sinks, and processes that control the internal cycling of trace elements in the upper ocean. Repeat observations of trace element distributions in the North Atlantic have been made along CLIVAR section A16N, occupied in 2003 and 2013. Tracers for aerosol dust deposition on the surface ocean (Al, Ti), a major pathway for delivery of Fe to the ocean, were found at higher concentrations in the upper ocean in 2013, indicating increased aerosol dust Fe delivery to the North Atlantic over the last decade. In contrast, ocean inventories of trace metal species originating primarily from anthropogenic aerosol sources (e.g., Cu, Ni) declined in 2013. Repeat observations of trace element distributions will better constrain oceanic budgets, improve model parameterizations, and allow predictions about the impact of changing trace element distributions due to natural and anthropogenic forcing on future climate.

The effect of Milankovich cycles on the emergent of a marine ecosystem

Hadar Berman

The Hebrew University of Jerusalem

Abstract
We study the effect of changes in photosynthetically active radiation (PAR) due to Milankovich cycles on the marine ecological system. This is done using MITgcm Darwin 1D model. We conduct a series of experiments to test the sensitivity of the ecosystem structure to long term variations in solar insolation.

Early warning system for monitoring harmful algal blooms in the Sorsogon-Maqueda-Sapian Triangle (SMS-Tri) using satellite ocean color imagery

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Abstract
Remotely-sensed, satellite ocean color images from 2002-2012 were analyzed to device an early warning system for monitoring harmful algal blooms (HABs) in the Sorsogon-Maqueda-Sapian Triangle (SMS-Tri). The MODIS Aqua dataset for chlorophyll a concentration (4 km resolution) was compared against local declarations of shellfish bans which, in this study, is used as a proxy for blooms of PSP toxin producing dinoflagellates. The data used for the analysis is from July 4, 2002 to Jan 9, 2012 for a total of 439 weekly composites which were analyzed and compared to the local shellfish ban declarations from 2002 to 2010. When the chla anomaly (difference between that week's chla concentration and the average concentration) goes beyond a certain threshold, this indicates a potential harmful algal bloom (HAB). Average concentration was calculated in 2 ways - seasonal concentration (monthly average over data for all the years) or running average (average value for two months prior to the week being analyzed). The threshold MODIS chla concentration was found to be 0.01 mg/m^3 chla, above which monitoring is recommended to verify the presence of a HAB in that locality. Using this threshold, it was found that the 4 km resolution of MODIS can show potential blooms at the bay level.

As an early warning for HABs, this tool is useful in aiding shellfish management and public health in responding to rapidly developing HABs in a timely, efficient manner. There is still a chance that this tool might not be able to detect a bloom if its signal is not detected by the satellite – a subsurface bloom, a bloom that is too small, or simply due to the presence of clouds. There is also a chance that a potential bloom that this tool will detect is not harmful if the high concentration of chla is due to non-harmful algae. The actual threshold limits should also be calibrated if applied to localities beyond the SMS-Tri or for other species of blooms.

The behavior of dissolved inorganic selenium in the Changjiang Estuary

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Abstract
To thoroughly investigate the behaviors of inorganic selenium species in Changjiang Estuary, samples were taken in summer (July 2011) and winter (March 2012). The dissolved inorganic selenium (DISe) averaged 1.79 nmol/L in summer and 1.24 nmol/L in winter, the selenite to selenate ratio (Se(IV)/Se(VI)) was 0.42 in summer and 0.61 in winter. The data showed Se(IV) and Se(VI) behave strictly conservatively in winter while non-conservatively in summer in the estuary due to the adsorption by suspended particulate matter and the assimilation by the phytoplankton. The distribution of selenium in Changjiang Estuary was controlled by Changjiang riverine input, Taiwan Warm Current and Yellow Sea Coastal Current with specific Se(IV)/Se(VI) ratio 'signature' which could remain in winter while be altered in summer. The Se(IV) concentration was related to the nitrate, silicate and phosphate concentration in the estuary. The DISe and Se(IV) concentration was comparable with other coastal regions and estuaries which was in the natural levels.

Prediction of silver hake distribution on the Northeast U.S. shelf based on Gulf Stream path index and autoregressive models

Xujing Jia Davis, Terrence M. Joyce and Young-Oh Kwon

Abstract
Over the past ~40 years, the distribution of silver hake (SH) on the Northeast U.S. shelf is found to be closely related to changes in the latitude of the Gulf Stream (GS) path. The correlation coefficient between the fall GS position and the center of biomass (COB) of spring SH reaches 0.75 when the GS leads the SH for 0.5 year. Based on this lead-lag relationship and low-frequency variability of GS position with a dominant period of ~9-10 years, the GS path index is used as a predictor for the COB of SH in linear autoregressive (AR) models. The goal of this study is then to optimize the AR model for the prediction of SH based on the observed changes in GS position. Fall GS position is first predicted out to 5 years using a 5^{th} order AR model and the observed GS position in preceding years. We propose an optimization process to choose best AR coefficients based on a new combined skill parameter. We then use this predicted GS position to further predict the COB of SH in subsequent spring. Three different AR models are compared for the SH prediction. The predicted SH time series can explain as much as 69% of the variance of the observation for the 1^{st} year prediction and 41 % for the 5^{th} year prediction. Our results indicate that including GS as a predictor produces better prediction skills of SH COB than the AR model prediction solely based on the observed SH time series

Development of cyberinfrastructure to facilitate collaboration and knowledge sharing for marine Integrated Ecosystem Assessments

Massimo Di Stefano, Linyun Fu, Patrick West, Xiaogang Ma, Stace Beaulieu and Peter A. Fox

Abstract
Here we present an approach to help scientists collaborate in multi-disciplinary research, providing a wide spectrum of software tools for data science and enabling the reproducibility of their research outputs. The main tool is based on the extensive use of a web application, the IPython Notebook, that gives the scientists the ability to work on very diverse and heterogeneous data and information sources, providing an effective way to share the source code used to generate data products and associated metadata as well as save and track the workflow provenance. A key feature in IPython (Interactive Python) is that metadata, embedded in the Notebook,

can be generated during the access and processing of data. We are presently developing functionalities to collect the provenance generated at each run of the workflow and store this metadata in the JSON-LD (JSON for Linking Data) standard format. In this way it is possible to record the provenance for derived data products, to trace back to their original sources and the processing conducted to generate them.

Seasonal variations of the Java Upwelling System and its biogeochemical responses in the southeastern Indian Ocean

Yongliang Duan, Weidong Yu, Lin Liu, and Huiwu Wang

Abstract
In the monsoonal Indian Ocean, Eastern Indian Ocean Upwelling (EIOU), driven by the southeastern monsoon, exhibits more profound impacts at regional and global climate through its intensive interaction with the atmosphere, i.e., the Indian Ocean Dipole (IOD). EIOU is very unique not only because it is driven by boreal summer monsoon wind but also it has the porous eastern boundary with several straits to pass the information from Pacific Ocean. The seasonal monsoon-driven Java Upwelling System, together with the circulation convergence and water mass mixing by Indonesian Throughflow (ITF), South Java Current, South Equatorial Counter Current, makes the region between south Indonesia and northwest Australia one unique area of high importance for the fishery. However, the ecosystem response to upwelling is poorly sampled and multidiscipline research is highly desired. Here we use the high-revolution satellite remote data and advanced cruising data to illustrate the seasonal variations of the Java Upwelling System and its detail biogeochemical responses in the southeastern Indian Ocean. The results show that the Java Upwelling System, driven dominantly by the southeastern monsoon, occurs in Jun.-Oct. And it favors the high sea surface chlorophyll-a concentration and supplies high ecosystem concentrations in the coastal region south of Java. The advanced VPR technology permits to sample further offshore, to connect ITF, eddies, tuna spawning area to coastal upwelling.

Impact of climate change on Indian marine fisheries biodiversity

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Abstract

In Indian marine fisheries biodiversity changes in interspecific relationships, in turn, can drive important local-scale changes in community dynamics, fisheries biodiversity, and ecosystem functioning, and can potentially alter large-scale patterns of distribution and abundance. Marine fisheries biodiversity in India encompasses all levels of complexity of life in the sea, from within species to across ecosystems. At all levels, marine fisheries biodiversity has naturally exhibited a general, slow trajectory of increase, punctuated by mass extinctions at the evolutionary scale and by disturbances at the ecological scale. In these current times, a synergy of human threats, including overfishing, global warming, biological introductions, and pollution, has caused a rapid decline in Indian marine fisheries biodiversity, as measured by species extinctions, population depletions, and community homogenization. In many cases, the importance of indirect effects of warming, mediated by changing species interactions, will be greater and less well understood—than direct effects in determining the community- and ecosystem-level outcomes of Indian climate change. The consequences of Indian fisheries biodiversity loss include changes in ecosystem function and a reduction in the provision of ecosystem services. Indian fisheries biodiversity loss will continue and likely accelerate in the future, with potentially more frequent ecological collapses and community-wide shifts. However, the timing and magnitude of these catastrophic events are probably unpredictable. A better understanding of potential climate change impacts (scenarios) at both regional and local levels, the development of improved methods to quantify the uncertainty of climate change projections, the construction of usable climate change indicators, and an improvement of the interface between science and policy formulation in terms of risk assessment will be essential to formulate and inform better adaptive strategies to address the inevitable consequences of climate change. The paper illustrates how qualitative scenario planning provides opportunities to address the challenges of marine fisheries biodiversity conservation in a changing environment

Effect of climate variability on fish supply in West Africa: the case of small pelagics in West Africa

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Abstract
The paper presents an analysis over the last 30 years of the changes in fish supply of small pelagics in Senegal due to climate variability. It highlights how climate changes affect fish supply and therefore the nutritional patterns of coastal communities that rely on fish for animal proteins.

Impacts of climate and land-use changes on the fate of nitrogen in the Chesapeake Bay

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[1] Virginia Institute of Marine Sciences, College of William and Mary, Gloucester Point, VA, USA

Abstract
Anthropogenic activities have produced unprecedented impacts on coastal regions over the past century. Together, climate and land-use changes have caused nutrient-enriched riverine flows to significantly impact estuarine biogeochemical cycles. In this study, we apply a land-ocean-ecosystem modeling system (DLEM-ROMS) to the Chesapeake Bay, the largest and most productive estuary in the U.S. By comparing model output with contemporary in situ and satellite-derived data, we demonstrate that our model successfully reproduces the hydrodynamic and biogeochemical fields in the Bay. In order to determine the effects of changing riverine inputs on the estuary, nitrogen budgets were compared for two DLEM river scenarios, including the contemporary scenario from 2001-2005 and the past century scenario from 1901-1905. This study will help quantify the impacts that changes in riverine inputs are having on estuarine and coastal environments.

Individual based modelling of red coral (*Corallium rubrum*) growth in response to environmental factors

Giovanni Galli, Lorenzo Bramanti, Cristina Priori, Georgios Tsounis, Sergio Rossi, Giovanni Santangelo and Cosimo Solidoro

Abstract

Corals are regarded as sensitive to climate change because they have narrow temperature tolerance ranges and, due to their carbonate skeletons, might be impaired by acidification; furthermore, being sessile, they cannot migrate quickly to more favorable places.

Yet the understanding of cause and effect relationships underlining coral response to the environment is still fragmentary. Suitable tools to derive reliable projection of ecological responses and impacts under expected environmental conditions are currently lacking. These issues were seldom addressed from a modelling perspective.

Mediterranean octocoral *Corallium rubrum* (or red coral) is an important constituent of coralligenous communities as well as an economically valuable species, it was subject to massive mortalities during summery heat waves and its sensitivity to acidification has been demonstrated in lab experiments.

In this study we developed a bioenergetic individual based model for Mediterranean red coral. The model simulates colony growth as a result of single polyps energy budget, is forced with food availability, flow conditions and seawater temperature and can be used to explore the organism functional response under current and future climate scenarios.

Impact of climate change on coral reef ecosystem of Andaman Islands

Grinson George[1], Rekha J. Nair[1] and Somy Kuriakose[1]

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Abstract

Coral reef ecosystems are vulnerable due to increase in Sea Surface Temperature (SST) and extreme events such as cyclones and El Niño. There are several instances of massive coral reef bleaching in Andaman and Nicobar group of Islands (ANI). SST during night time is an important parameter for assessment of the thermal conditions inducing the bleaching. The estimation of monthly maximum mean using night time SST climatology retrieved using NOAA, AVHRR is used for generating reef health advisories to eliminate the effect of solar glare and reduce the variation in SST caused by the heating during day time. Threshold hotspot (HS) and daily heating week (DHW) values for a region are calculated. The occurrence of mass bleaching (1998 and 2010), mild bleaching (2002 and 2005) and non-bleaching (2011 and 2012) events in the coral reef regions around the Andaman Islands is examined seeking their relationship with NOAA AVHRR satellite derived SST to find out the relationship between the mass bleaching events and El Niño. Both Niño 3.4 and 3 indices are examined and correlated with SST anomalies in the Andaman Sea. The rising temperatures are causing frequent cyclones in the Bay of Bengal (BoB). During 13–17 March 2011, the reefs in ANI suffered severe damage following a tropical cyclone in the BoB off Myanmar coast. The investigation exposed the vulnerability of the reefs to oceanographic features which generally remain unnoticed unless they directly affect the life or the property of coastal inhabitants. The wind tracks of cyclone were generated using weather research and forecasting (WRF) models which clearly indicated the passage of cyclone where reefs suffered damage. Recently, we have undertaken a survey on the major reef dwelling groupers, which are commercially in demand, to see the difference in their abundance due to reef bleaching. Earlier records point to the presence of 31 species of groupers (Family Serranidae) in Andaman waters. The present short study points to the presence of only 16 species from these waters indicating a change in the community structure of reef dwellers.

Monitoring of demersal fishes in the Azores (North-East Atlantic): a case study for addressing the issue of climate change?

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Abstract

Fishing activities are of great importance to the economy of the archipelago of the Azores, accounting for 2% of the regional gross value added. The Azorean fisheries are mostly small scale and artisanal, multi-species and multi-gear, using hook and line gears and no trawl gear. In terms of economic value, demersal fishes account for more than 50% of the total annual ex-vessel price landed in the region. Most of demersal and deep-water fisheries are conducted on seamount-like features. Despite the artisanal nature of the fishery, exploitation rates are much intense and local severe depletion of demersal species have already been detected around some of the Azorean islands. The occurrence of multi-gear and multi-species fisheries and the geographically dispersed fishing grounds make the assessment of Azorean fisheries challenging, and in need of knowledge-based management.

With the aim of collecting data on demersal and deep water fishes, a monitoring survey has been established since 1995, consisting in an annual cruise throughout the Azores archipelago, and some cruises to other areas in the North-East Atlantic (as Madeira archipelago and seamounts off the Azores Exclusive Economic Zone). The standardized surveys use a long-line gear similar to that mostly in use by the local demersal fishing fleet, and provide data on fishing effort, depth, catches by species and some biological variables (as length, weight, sex, gonadal maturation stage). More recently, with the general aim of improving our understanding on seamounts and the quality of advice for management, a seamount in the central group of Azores has been declared as an area specifically earmarked for scientific research. Condor seamount is currently a protected area with the aim of providing, among other things, data on changes in fish community after cessation of intense bottom fishing for demersal and deep-water fish species.

Data obtained from monitoring cruises are useful to assess the ecological status of demersal fishes, evaluating changes in abundances, body size and other indicators over almost two decades of fishing. Moreover, exploring patterns of data such as distributional depth range, body size, sex-ratio along a longitudinal (i.e. western vs eastern group of Azorean islands) and latitudinal (i.e. Azores vs Madeira) gradient may shed light into their relationship with environmental variables (such as temperature). Inputs obtained from these analyses, in addition to specific

information from Condor seamount (i.e. on fish recovery rates, food webs) may provide useful insights for addressing the issue of climate change.

Bacterial Biogeography along Stratified Water Columns in the Western Arctic Ocean

Dukki Han, Yoo Kyung Lee, and Hor-Gil Hur

Abstract

The Arctic Ocean is hydrographically complex and considered to be a double estuary with Pacific water entering through the Bering Strait and Atlantic water entering through the Fram Strait. A northward Pacific-origin current enters through the Bering Strait into the Chukchi Sea and intermixes with the northern Atlantic water that enters through the Fram Strait. However, the mixed currents are distinctive along depths of water column by their own water masses. Of the stratified structure of the Arctic water columns, surface mixed layer water (0-10 m) is strongly affected by melting sea-ice and river discharge during summer. Beneath the mixed layer which strongly affected by wind, the influx of Pacific water is significant, and the highest and the lowest temperatures indicate Pacific summer water and winter water, respectively. Atlantic water flows below Pacific winter water. An expedition of the IBRV ARAON took place in the Arctic Ocean during the summer of 2010. To investigate the hydrographic features of the bacterial variations in water columns, we categorized 16 collected water samples from the Arctic Ocean into distinctive water masses. Bacterial diversity, relative abundance, and community composition were determined based on a pyrosequencing approach, and then compared to water mass properties. Alphaproteobacteria (43.2%), Gammaproteobacteria (16.7%), Flavobacteria (13.7%), and Deltaproteobacteria (12.0%) were the most dominant classes of bacteria in all of the samples, and the relative abundance of these major populations represented the population dynamics of the bacterial communities in different water masses (from the euphotic to the sub-euphotic zone) in the Arctic Ocean. Furthermore, the relative abundance of Alphaproteobacteria and its subgroup, SAR11 group I, were significantly related to a depth change, suggesting that depth or environmental heterogeneity caused by depth change may play an important role in their population dynamics of this bacterium. Bacterial communities in the Arctic Ocean exhibit biogeographic patterns according to water mass types. The halocline layer between the Pacific winter water and Atlantic water exhibits the variation of bacterial community compositions, which may be influenced by the diapycnal mixing between Pacific winter water and Atlantic water.

Selection of indicators for monitoring within the Inuvialuit Settlement Region of the Beaufort Sea and Tarium Niryutait MPA

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[1] Fisheries and Oceans Canada, Winnipeg, Canada

Abstract

This project combines indicators from different studies and scales in order to select useful indicators for (1) monitoring the coastal region of the Inuvialuit Settlement Region (ISR), and (2) satisfying the conservation objectives of the Tarium Niryutait Marine Protected Area (TN MPA). Management objectives for resources within the greater ISR include protecting and preserving Arctic wildlife, the environment and biological productivity. The TN MPA is made up of a series of three small coastal areas within the ISR. The MPA was established in 2010 primarily to protect the rights of local communities to harvest beluga and provide a hunting area free from oil and gas development including the prevention of future development). The conservation objective for the TN MPA is to conserve and protect beluga whales and other marine species (anadromous fish, waterfowl and seabirds), their habitats, and their supporting ecosystem. In order to meet the conservation objective of the TN MPA, some 82 indicators have been proposed for monitoring within six categories: ecosystem structure, ecosystem function, population structure of key species, heath of key species, physical and chemical environment, and noise and other physical stressors. This proposed list of indicators represents a complete ideal list for monitoring that has been deemed too large a task, both logistically and financially. For this reason, we are using the guidance of the management and conservation objectives, to select a subset of indicators to be evaluated using data from three separate research projects within the ISR study area. Each project attempts to address the objectives using a different approach to indicator assessment (ecosystem model indicators, regional stable isotopic analysis, and local observation) in order to address the variety of management questions within the ISR.

Crises for the Sundarbans mangrove ecosystem in Bangladesh: Threats, stressors and responses

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Abstract

Using a case study approach this study will explore how different threats and stressors affect natural, social and governing systems of the Sundarbans mangrove ecosystem in Bangladesh and on the contrary, what are the roles of these systems in maintaining the sustainability of the fisheries resources of the Sundarbans. The result shows that natural systems of the Sundarbans have been subjected to conspicuous changes due to repeated exposure to climatic extreme events, reduction of freshwater supply due to upstream damming, climate variability induced-prolonged drought and intensive cold etc. On the other hand, over-exploitation of mother and undersized species, particularly indiscriminate collection of the post larvae of shrimp and prawns cause recruitment overfishing in the Sundarbans. A number of threats and stressors in social systems also affect the sustainability of the fisheries resources and contributed to overfishing. Widespread poverty, high illiteracy, very heavy debt bondage with money lenders with high interest rates, vulnerability to different risks and shocks particularly sudden loss of life by tiger attacks and attacks by unlawful elements, to mention a few problems in social system. In particular the prevalence of money lenders cum traders who adopt monopolistic practices is blamed for over-exploitation of fisheries resources by many fishers interviewed. Governance failure is another driver that contributed to the over-exploitation of fisheries resources. For example rampant corruption of forest official in the exploitation process cause market failure and insist over-exploitation by illegal means. Insufficient budget, limited manpower, lack of incentives to the employees, poor organizational capacity, and top-down bureaucracy practice in decision making are perceived as main threats for the good governance of the Sundarbans. Finally this study submits that over-exploitation of fisheries resources of the Sundarbans is subjected to a complex set of natural, social and governance drivers, hence responses are required at multiple levels and scales.

Increased productivity and sea surface temperature results in better recruitment and spread of Indian oil sardine in Northern Indian Ocean

Rekha J Nair[1], Somy Kuriakose[1], Grinson George[1], P.U Zacharia[1] and A. Gopalakrishnan[1]

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Abstract

Primary productivity (PP) and average sea surface temperature (SST) in Northern Indian Ocean increased during the last decade. The enhanced productivity had impacts on the Indian oil sardine (*Sardinella longiceps*) fishery in this region. During 1986, oil sardine from the southwest coast of India contributed to 7.8% of the total fish landings and 99 % of the oil sardine landings of India whereas, northwest coast comprising of Maharashtra and Gujarat contributed a mere 1.5 % to the total oil sardine landings of India. Averaged annual SST increased by 0.8°C along the southwest coast of India during the last 100 years. Slow decadal changes were noticed in the sardine fishery with contribution from the northwest increasing to 2% in 2005 and further to 4.6 % in 2012. Landings of oil sardine in the northwest region increased by over 31,548 tonnes during the period 1985-2012. This however did not cause any decrease in the landings in the southwest coast where landings increased from 1,20,575 tonnes in 1985 to 5,19,404 tonnes in 2012. Similarly, landings along the southeast coast comprising of the states of Tamilnadu and Andhra Pradesh accounted for only 3.7 % of the landings of oil sardine during 1985; this increased to 8.6% in 2005 and further to 16 % in 2012. SST showed an increase by 0.5^{o}C during the last 50 years along this coast. Landings of oil sardine during the period 1985-2012 increased by over 1, 11,078 t. Similarly landings of oil sardine which was a meagre 1 tonne in 1985 in West Bengal which has risen to 85 tonnes in 2012. Congenial productivity and temperature conditions resulted in the enhanced potential and recruitment success of Indian oil sardine population in the area thereby increasing the production. Along this coast, SST showed an increase of 0.78^{o}C during the last 50 years. The increase in production of oil sardine all along the Indian coastline from 1,20,587 t in 1985 to 7,20,270 t in 2012 is a pointer to the beneficial effects of increase in PP and SST of small pelagics such as oil sardine.

OceanTuneIn –Oceanic Tunas as Indicators of Ecosystem Health

Maria-José Juan-Jordá, Hilario Murua, Haritz Arrizabalaga, Andy Cooper and Nick Dulvy

Abstract
Understanding to what extent human activities have altered marine biodiversity is an increasingly urgent societal challenge and of considerable scientific and policy concern. Our ignorance of the pressures upon and fate of marine biodiversity is, in part, because there are few synoptic global indicators to measure changes in marine biodiversity – particularly for exploited organisms in oceanic ecosystems. In my postdoctoral work I aim (1) to develop new indicators for measuring biodiversity change in oceanic marine ecosystems for the Atlantic, Pacific and Indian Ocean, using tunas, billfishes and sharks as sentinels of ocean health and (2) to develop management guidelines to determine how these indicators can be effectively used for improving management and conservation of oceanic ecosystems. This project will provide the tuna Regional Fisheries Management Organizations with a set of new products – a set of pressure, ecological state and threat indicators and a set of specific management guidelines, to assist them in the incorporation of ecosystem considerations in the management and conservation of tuna and tuna-like species. The new knowledge, tools, training, and collaborations generated in this project have the potential to support national and international policy commitments in light of the European Commission Marine Strategy Framework Directive and the 2020 Convention on Biological Diversity Aichi Targets.

Has fish harvesting altered biogeochemical cycling?

Lucas Kavanagh and Eric Galbraith

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Abstract
Fish removal was the earliest major human influence on the marine environment and global fishing effort has increased by orders of magnitude since its ancient origins, depleting predatory fish biomass by as much as 90%. The full effects of this massive endeavour are poorly known, largely due to the lack of a constrained baseline. What did the ecological and biogeochemical dynamics of a pre-fishing ocean look like and how have they changed as a result of anthropogenic fish removal?

A severe depletion of upper trophic levels may result in a top-down ecological regime shift, manifesting in the form of trophic cascades and alterations to nutrient cycling and carbon export. Changes of this nature can be recorded in the sedimentary record through proxies such as fish remains, total organic carbon, 15N, and microfossil assemblages. This project searches for these biogeochemical effects of fish harvesting by compiling paleoceanographic data and comparing it to historical and archaeological records of fish harvesting. Hypotheses of potential effects and methods of analysis will be discussed and preliminary results from the Peruvian Upwelling Ecosystem will be presented.
Exploring the effects that fish can have on biogeochemical cycles will help quantify the full impact of anthropogenic fisheries. This will aid in establishing pre-human baselines for ecosystem-based management and in the parameterization of upper trophic levels in ocean biogeochemical models.

Approaching model cross-validation against data from mesocosm experiments

Shubham Krishna and Markus Schartau

Abstract
The burning of fossil fuels is responsible for the observed increase of carbon dioxide (CO_2) in the atmosphere. This continuous increase enhances the net CO_2 flux from the atmosphere to the sea, thereby altering ocean biochemistry and likely affecting marine life. This CO_2-influx gradually decreases seawater pH, a process termed ocean acidification (OA). A continuous drop in pH and changes of the oceans' chemical state are expected in the future. Consequences of OA for marine flora and fauna are subject to ongoing research and are currently discussed. Investigations of OA effects on plankton were conducted with mesocosm, where enclosed water volumes were exposed to different CO_2 concentrations, e.g. Pelagic Ecosystem CO_2-Enrichment Studies. The central idea of our study is to use these mesocosm observations for systematic data-model syntheses. Our main objective is to assess whether ecosystem models can explain observed responses in plankton to variations in pH/CO_2 and temperature.
In our study we also wish to identify benefits and drawbacks of some recent approaches to marine ecosystem modeling. This will be achieved by systematic data-model comparisons and model parameter optimization. Markov chain Monte Carlo (MCMC) algorithms are used to estimate optimal model parameters such that misfit between model results and data are minimized. While comparing models, it is important to take in account model sensitivity to parameter change and induced

uncertainty with the higher complexity. Number of parameters in a model increases exponentially with the number of model components. More complex the model, higher the number of model components and better the ability to reproduce observations, resolving more individual biogeochemical processes. But as it is said, “there are two sides to every coin”, therefore inclusion of complexity in a ecosystem model should be dealt carefully. If there is no data to constrain extra model component then it always leads to uncertainty. Hence, it is not sufficient to assess model performance on the basis of its ability to reproduce data, there should be a balance between added complexity and induced parameter uncertainty. Our primary technical task is to setup a mesocosm model environment in R. For this a wrapper function has been devised that allows us to make model calls from any R-script. Concurrently, we organized data from three mesocosm experiments, PeECE I, II, and III respectively. For our model environment we also prepared forcing files for single mesocosms.
On our poster first technical achievements and preliminary scientific results are presented. We show results from a model cross-validation against PeECE experimental data. Simulation results are evaluated with respect to different parameterization of calcification. Also, our results reveal the feasibility of a single set of parameter values, apart from initial values, to show mesocosm differences within one experiment and between experiments. We also show model sensitivity to 2-D parameter change on our poster.

Effects of climate changes at multiple timescales on the fishing conditions of Grey Mullet (*Mugil cephalus* L.) in the Taiwan Strait

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Abstract
Grey mullet (*Mugil cephalus* L.) is one of the most important commercial species of fish in the coastal fisheries of Taiwan. Since 1958, the catch of grey mullet has greatly fluctuated, exhibiting peaks of 2.54 million fish in 1980 and at bottom of 0.2 million fish in 2000–2004 in the coastal fisheries of Taiwan. It has been speculated that climate variability and rising SSTs caused by global warming have crucial impacts on the migration and catch rates of grey mullet; however, direct

comparisons of long-term data on the migration numbers of grey mullet and climate change are scarce. In this study, we analyzed the long-term (1967–2009) records of grey mullet catch per unit effort (CPUE) in the Taiwan Strait (TS) to investigate the influences of climatic indices on the annual catch of grey mullet at multiple timescales. A wavelet analysis revealed that variations in climatic indices, namely the Pacific Decadal Oscillation (PDO), the Oceanic Niño Index, and sea surface temperatures (SSTs) might have affected the abundance and migration behavior of grey mullet in the TS in winter. The CPUE of grey mullet showed significant high correspondence with the annual PDO index ($R2 = 0.82$, $p < 0.01$). The results suggested that the PDO affects the migration of grey mullet, but that increases in SSTs are a more important influence on the decreased catches of grey mullet after 1980. Mean SSTs increased 1.01°C at the Chang-Yuen Rise in the TS from 1984 to 2009. The 20°C isotherms in the TS in the winter also shifted from 23–24°N in 1958–1978 to north of 25°N after 1998. The fishing grounds of grey mullet also shifted to the north following changes in the 20°C isotherm in the TS.

Decomposing the dynamics of an ETM in an energetic estuary.

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Abstract

Located in the Pacific Northwest of the United States, the Columbia River estuary features at least two estuarine turbidity maxima (ETM), or regions characterized by high concentrations of sediments. These ETM constitute important biogeochemical “hotspots” that contribute to many of the ecosystem services of the estuary. As part of a broader effort to model biogeochemical processes, we present the results of a numerical sediment model calibrated to the Columbia River estuary to study sediment dynamics. In particular, we investigate the physical processes leading to the generation of the Columbia River ETM including influence of density driven circulation, tidal asymmetries, lateral bays, intertidal flats, and the settling and resuspension of particles. We estimate the importance of each process by comparing the magnitude and timing of ETM events in each numerical simulation against those from a baseline run in realistic 3D domains. In agreement with previous idealized studies, preliminary results suggest that the Columbia River ETM requires the trapping processes of density driven circulation, tidal asymmetry of velocity and stratification, and particle resuspension due to erosion. However, the

intertidal flats provide substantial source material for the ETM and have a large impact on the magnitude of the suspended sediments trapped in the ETM. Similarly, the presence of a source of resuspendable material is required to create the ETM, but contributes substantially to the magnitude and size distribution of suspended particles trapped in the ETM. These results contribute to our understanding of precise processes governing sediment dynamics in the Columbia River estuary and constitute a small, but important step in the development of a biogeochemical model.

Coral Traits: Indicators of Bleaching Susceptibility & Range Expansion Potential in a warming ocean

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Abstract

Warm, tropical waters are home to hundreds of coral species. Sea surface temperatures at these low latitudes have increased globally and are projected to continue warming over the coming decades. Susceptibility to this thermal stress varies by species but survival through these changing conditions may be facilitated by species' characteristics that promote persistence as waters warm over the long term and also through immediate stressors like bleaching events. To understand how different species may be able to cope with the temperature increase on different time scales, I evaluated characteristics of coral species using the Coral Traits Database (coraltraits.org). Species' traits, which have often been applied in plant ecology studies, are used as surrogates for understanding relationships within communities or ecosystems. In particular, I examined the relationships between coral traits that infer resilience to bleaching and/or those that may facilitate changes in distributions.

As an immediate response to thermal extremes, corals may bleach (expel their symbiotic algae), some species more severely than others. Any degree of bleaching can impact coral health, potentially lead to death and may devastate coral reef ecosystems overall. Species-specific post-bleaching coral surveys that measured categorical responses to bleaching events (normal, pale, bleached, dead) were modeled as a function of coral traits hypothesized to influence bleaching susceptibility. The best predictors of the degree of bleaching include coral growth form; species' corallite size (the hard skeleton of a single polyp); phylogeny of the symbiotic algae; and mode of algal symbiont transmission (in larvae or not). This

suggests that corals with specific combinations of these traits are more likely to withstand extreme temperatures in the short term.
Over longer time periods, species capable of distribution shifts may be more likely to persist through significant environmental change. One obstacle to a pole-ward shift into cooler water is the ability of species to settle and survive in habitats beyond reef growth. I evaluated differences in species' traits for corals that live both on and beyond reef throughout the Indo-Pacific in comparison to those that are found only on reefs. Those species found pole-ward of reef growth generally shared a common set of traits including: large depth range, tolerance to turbid water and certain growth forms, especially encrusting and massive.
These results suggest that evaluating various coral traits (reproductive, morphological, phylogenetic, etc.) can support our understanding of species-specific responses to warming waters on different time scales. Given that coral traits are becoming readily available, this trait-based approach provides enormous potential to predict responses to impacts of a variety of major threats coral reef ecosystem health globally, identifying which characteristics may allow certain species to cope – or not – with changing conditions.

Impact of stratification on timing and magnitude of phytoplankton bloom in southwestern the East/Japan Sea: Application of 1D GOTM-ERSEM to the Ulleung Basin

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Abstract
Ulleung basin (UB) located in southwestern part of East Sea (Japan Sea) is considered having a high primary productivity due to nutrient supplements such as wind-driven upwelling, current transport, eddy-induced upwelling. We applied a vertically one-dimensional biological model (1D GOTM-ERSEM) to Ulleung basin focusing on timing and magnitude of phytoplankton bloom. To investigate impact of stratification on timing and intensity of phytoplankton bloom in the Ulleung basin, three different temperature and salinity dataset were assimilated in GOTM. When MLD in winter is relatively shallow, spring bloom tends to occur earlier (in Feb.) by two months, compare with observations. The magnitude is smaller than the observations. In contrast when MLD in winter is relatively deep, timing of spring bloom and intensity become more realistic. This represents the stratification

contributes to determining timing of spring bloom and magnitude of spring bloom in the Ulleung Basin.

Seasonal sinking fluxes of trace elements in a coastal system in Western Cantabrian Sea (Bay of Biscay)

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Abstract
It is widely known that estuaries are natural traps for trace elements, however, dynamics of those entrapment process still have to be studied and understood. In this study, vertical fluxes of particulate metals (Al, Cd, Co, Cr, Cu, Fe, Ni, Pb, and V) were studied in the Ria of Barqueiro (Galicia, NW Iberian Peninsula). Sampling was carried out from Jan. 2008 to Jan. 2009 at the middle ria (20 m depth), by means of a multitrap collector system anchored to the sea-bottom during a 24 h period. Additionally, physicochemical variables of the water column, chlorophyll and primary production were measured. Seasonal description was done following the oceanographic periods previously defined for the Ria of Barqueiro according to its thermohaline properties, nutrient concentration and phytoplankton biomass: spring (Apr, May, Jun), summer (Jul, Aug, Sep), autumn (Oct, Nov), winter (Dec, Jan, Feb, Mar). The suspended particulate matter revealed a seasonal decreasing in the sedimentation, with the highest values during winter (56 $g \cdot m^{-2} \cdot d^{-1}$) and the lowest during autumn (4.6 $g \cdot m^{-2} \cdot d^{-1}$). Sinking fluxes were 0.56±0.90 $gAl \cdot m^{-2} \cdot d^{-1}$, 2.04±1.49 $\mu gCd \cdot m^{-2} \cdot d^{-1}$, 0.11±0.14 $mgCo \cdot m^{-2} \cdot d^{-1}$, 2.87±4.97 $mgCr \cdot m^{-2} \cdot d^{-1}$, 1.79±1.08 $mgCu \cdot m^{-2} \cdot d^{-1}$, 0.48±0.55 $gFe \cdot m^{-2} \cdot d^{-1}$, 1.57±2.74 $mgNi \cdot m^{-2} \cdot d^{-1}$,1.27±1.41 $mgPb \cdot m^{-2} \cdot d^{-1}$, and 0.75±0.91 $mgV \cdot m^{-2} \cdot d^{-1}$. A high variability was observed in the seasonal behaviour of the studied metals, with the highest values during winter for Al, Cu, Ni and V, during spring for Co, Fe, and Pb and during autumn for Cd and Cr. Lithogenic particle fluxes (Al, V) were higher during winter, associated to the increase of sedimentation due to the rainy season.

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Monitoring anthropogenic threat to mangroves along Central West Coast of India: a holistic approach

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Abstract

Kundalika and Vasishthi are two major estuaries draining the central west coast of Maharashtra, a highly developed state in India. Both estuaries house luxuriant mangroves. Unfortunately, these estuaries have also been means for discharging industrial effluents, ever since the establishment of important industrial development corporations in their vicinities. Serious concerns have been raised by NGOs and local population over dwindling fish resources in both the estuaries, rendering the fishing profession defunct. Whilst authorities refrain from assigning the environmental status of these estuaries despite timely water quality monitoring, the present work documents evidences for deterioration in the environment, due to rampant human intervention.

The dense, sanctuary-like mangroves of the Kundalika estuary are the only ones in the State ear-marked by the government for conservation. However, subsequent field visits reveal rampant suction-sand mining in the channel of the estuary in its middle and upper reaches. Over a kilometre long stretch of the mangrove mudflats in the upper reaches of the estuary have been dredged and reclaimed and are being used for stacking and loading illegally mined sand and as landing/parking of suction sand dredges. This is detrimental and causes irreversible damage to the fertile breeding grounds of this estuary, which is the major cause of collapse of the fish catch in the estuary. However, these postulations are being verified using downcore foraminiferal signatures to understand impact of human-climate interaction in the estuary over the past few centuries.

Proliferation of foraminiferal and diatom species tolerant to heavy metal toxicity in the Vasishthi estuary suggests heavy metal toxicity in the environment. The geo-accumulation index and enrichment factors are suggestive of significant Cu enrichment and strong pollution thereby in the estuary. Though each of the remaining heavy metals, viz. Mn, Co, Ni, Cr, Zn, Pb and Cd show moderate levels of contamination, their combined degree of contamination is indicative of extremely strong levels of toxicity in the estuarine environment. The geo-accumulation index is suggestive of non-anthropogenic sources of pollution. High heavy metal concentrations in the estuary could also be the cause of proliferation of oyster species, *Saccostrea cucullata*. Field observations suggest physiological impairment of mangroves due to biofouling, due to which their capacity to accrue sediments is being lost. Thus, biofouling by *S. cucullata* is not only a major threat to the mangrove

forests in the Vasishthi estuary, but also to the tidal flats which are a haven for diverse benthic community, organic carbon sinks and natural adsorbents of pollutants.
Extensive biofouling on mangroves in the Vasishthi estuary and sand-mining in the Kundalika are the major reasons for destruction of these mangroves. A holistic approach exhibits how different trophic levels in these estuaries have been impaired and demand management and restoration.

The ugly face of flood events

Ravindra Rattan

Abstract
Climate change has contributed to a rise in extreme weather events. Its effects are higher temperatures, changes in precipitation patterns, rising sea level, increase weather volatility and more frequent weather-related hazards, thence, pose risks for agriculture, food, and water supplies. Extreme natural disasters and an increase in global temperature will severely reduce the food production and will have severe impact on livelihood in Pacific islands and called for urgent measures to adapt to expected losses. Pacific Island countries are spread over a vast area of the Pacific Ocean, occupying an area over 30 million km^2. Smallness, remoteness and vulnerability are the major problems affecting the Pacific Island Countries. The heterogeneous Pacific Island countries are particularly vulnerable to the effects of climate change and thus are exposed to more frequent natural hazards, such as tropical cyclones, flash floods, and droughts. The impacts of climate change on food and livelihood security is not uniformed because of the characteristics of PICT's, which spans many different ecological, geographic, and meteorological zones. In Social Science ideas about vulnerability to natural disasters have emerged in the past three decades. To adjust, adapt to cope or if necessary to recover from adverse events is a big challenge in Pacific Island countries like Fiji Islands. Maintaining the sustainable livelihood pattern for every households, albeit being poor or rich is one most commonly advocated sustainability strategies in response to extreme flood events in Nadi area, Fiji. A tourist and agriculture town with an area of 8 km^2 and having approximately 70000 people (10000 households), Nadi has been prone to flooding over the last fifteen years and it has been hit by 9 severe flooding from 1999. The nation was jolted in motion in 2012 when it was hit by two consecutive floods that was January and March flooding. Therefore, to understand and address this problem, one developed a framework which combined the sustainable livelihood framework and food security dimension framework. To understand one

particular extreme event in the PICT´s, therefore, a case study was conducted focusing on the extreme flood events of January, 2012 and March, 2012 flooding and its impacts on food and livelihood security in Nadi. We use the combined sustainable livelihood and food security framework to prove that livelihood and food in-security does exists in Nadi, Fiji islands, even for a short time (transitory) during the flood until it is nigh to recovery.

Exploring spatial variability in the controls on the spring phyotoplankton bloom.

Tyler Rohr

Abstract

Oceanic uptake of anthropogenic CO_2 is a predominant factor in mitigating a dangerous rise in atmospheric CO_2 levels, and the Southern Ocean accounts for a disproportionately large fraction (~1/3) of total oceanic uptake. Faced with a changing climate, understanding the controls on phytoplankton ecosystem dynamics in this region is critical to better understanding the biological pump, the air/sea CO_2 flux, and long term variability in CO_2 storage. 900 years of high temporal resolution model output from the Community Earth Systems Model are used in tandem with historical observational satellite data to study and quantify the spatial variability in the controlling mechanisms on the spring phytoplankton bloom in the Southern Ocean. Qualitative and quantitative discrepancies between population specific growth rates and cell specific division rates are studied in relation to bloom size and phenology to provide insight into which biological, trophic or physical controlling mechanisms dominate regionally. Moving pole-ward, results indicate a substantial increase in bloom magnitude and significant delay in bloom phenology. Further, results suggest the possible existence of a spatial transition from the dominance of a 'Top-Down' to 'Bottom-Up' control on bloom dynamics. Spatial variability in the relevant physical processes (sea ice, mixed layer depth, etc.) appears to play a critical role in mediating this transition. As climate driven alterations moderate these physical processes understanding the spatial variability in their role controlling bloom dynamics will help provide predictive insight to global oceanic carbon storage.

Modeling mercury cycle dynamics in a temperate lagoon (Marano-Grado, Italy)

Donata Melaku Canu, Ginevra Rosati and Cosimo Solidoro

Abstract

The Marano-Grado lagoon (Northern Adriatic Sea, Italy) is one of the best preserved wetland environments in the Mediterranean area. It offers shelter to many bird species and provides significant ecosystem services which sustain several economic activities. The lagoon was subjected to long term mercury loadings mainly coming from two anthropogenic sources: a cinnabar mine and a chlor-alkali plant. Although these activities ceased years ago, the lagoon, as well as the nearby Gulf of Trieste, still exhibits high mercury concentrations in water, sediment and biota due to environmental persistence of mercury. In aquatic environment mercury undergoes several transformations and can be found primarily in three chemical species present in a variety of both inorganic and organic complexes: elemental Hg (Hg^0); divalent ionic Hg (HgII), and methylated Hg (MeHg). The latter is the more bioavailable species and tends to bioaccumulate and biomagnificate through trophic nets.

Understanding the relative importance of transport, transformation and bioaccumulation processes is crucial for the ecosystem based management of the lagoon. With this aim, an integrated modeling approach has been adopted to estimate fluxes of mercury species in the lagoon and between the lagoon and its surrounding systems (Adriatic Sea, atmosphere, deepest sediments and watershed). Two mercury models developed by US EPA and publicly available have been implemented to complement the experimental knowledge and to perform mass balance and scenario analysis. Data characterising the biogeochemical cycle of mercury in the Marano-Grado lagoon have been gathered and the lagoon has been represented as a six box system, interacting with its boundaries. Model parameters have been derived from site specific data, when available, or from parameters related to similar environments, as reported in literature.

The SERAFM model was implemented describing the lagoon at steady state. Given HgT concentrations in sediment, the model computes concentrations of mercury species in different environmental compartment, biota included, driven by hydrological characteristics, other environmental data, and mercury process parameterization. The model also allows the user to estimate wildlife and human risk related to MeHg bioaccumulation. The WASP model was implemented representing the lagoon as a dynamic six connected box system. Time variable water fluxes between the six boxes and with the Adriatic Sea have been introduced, based on a high resolution hydrodynamic model results. Variable river discharge and mercury concentration and at the boundary systems are taken into account. This model does not consider the living compartment but it can represent mercury

species dynamics and seasonal trends. Models results have been compared to a small validation data set.
Our results point out that the Gulf of Trieste gives currently the main contribution to Hg concentration in surface water and that sediment represents a secondary source of Hg and MeHg contamination. Rivers and atmospheric deposition loads do not have remarkable effect on concentration of HgT, although atmospheric deposition affect Hg^0 content. MeHg on average, account for the 0.77% of THg in water and the 0.09% in surface sediment. Hazard analysis indicates that children and piscivorous wildlife could be at risk.

Impacts of coastal ocean acidification in the Baltic Sea region: Zombie forams and biomarkers

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Abstract
Since the industrial revolution about half of the emitted anthropogenic CO_2 has been absorbed by the world oceans. This has caused a shift in the ocean carbonate chemistry and a decrease in seawater pH, a process referred to as ocean acidification. The effects of ocean acidification are, however, not uniform. Due to the higher solubility of CO_2 in colder water, it is predicted that the impact of ocean acidification on marine life is larger at higher latitudes. Furthermore, in coastal oceans additional environmental stressors can play a large role, such as salinity variations, deoxygenation as a result of eutrophication, higher run-off due to increased erosion and consequential higher nutrient load and changes in circulation patterns. These processes will contribute to a lowering of pH and a lowering of the carbonate saturation state. The consequences of the combination of these environmental stressors on coastal micro-organism communities are, however, not yet known, but are expected to cause major changes in biogeochemical cycling and ecosystem dynamics.
To gain a better understanding of how the benthic ecosystem is responding to changes in pH in a coastal area, the DISCO (Drivers and Impacts of Coastal Ocean Acidification) project integrates results from benthic foraminiferal communities with high-resolution biomarker records as well as hydrographic data from nine sites sampled along the Swedish coasts. In the Baltic Sea region the seawater pH is low enough to dissolve calcium carbonate and to affect shell preservation of calcifying

organisms. Our preliminary results reveal substantial dissolution of benthic foraminifera. Furthermore, from two sites we found living foraminifera of which their shells were completely dissolved. How long these so-called zombie foraminifera can survive under these circumstances remains uncertain.
To further study the separate effects of the various environmental stressors, we also focus on the distribution and stable carbon isotope patterns of certain biomarker lipids. Biomarkers are fossil chemical compounds, which have a biological origin and can be related to a specific group of organisms or to their metabolic pathways. We will target specific marine and terrestrial biomarker lipids derived from different sources (i.e. organic matter from higher plants, marine algae, bacteria, and archaea), which will provide us information on the spatial and temporal climate variations in the Baltic Sea region for the last ~200 years. By comparing the results obtained from the benthic foraminifera with that of the biomarker records from the same sites we will be able to assess the different responses within the micro-organism community. This is of paramount importance, because many micro-organisms are important players within the global carbon cycle and stand at the basis of the marine food web. A change in the biogeochemical cycling due to coastal ocean acidification may therefore have dire consequences for the entire ecosystem, such as lower biodiversity and, in turn, threaten seafood resources.

Redistribution of anchovy *Engraulis japonicus* wintering stock under climate change scenarios in the Yellow Sea

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Abstract
With the increasing effects of climate change and human activities on marine ecosystem, the dynamics offishery resources are greatly changed. As the key species in food web of the Yellow Sea, anchovy *Engraulis japonicus* plays a critical role in fishery community, as well as to marine ecosystem. In the present study, based on the fishery survey data in the central and southern Yellow Sea, the redistribution of anchovy was evaluated using a modified dynamic bioclimate envelope model under climate change scenarios. A habitant suitable function, consisting of SST and sea surface salinity (SSS), was used to demonstrate the impacts of environment factors on the wintering anchovy stock; four climate change scenarios were analyzed, including RCP2.6, RCP4.5, RCP6 and RCP8.5, these

came from Geophysical Fluid Dynamics Laboratory (GFDL) CM2.0, and represented the low, relative low, modest and the highest emission scenarios; the resource barycenter was used to evaluate the reaction of wintering anchovy to different climate change scenarios. The wintering anchovy stock showed the obvious northward trend, reached as much as to 2.5-2.7°in the next 30 years. The average speed of shift to northward could be 0.09°per year. There were no significant differences (P>0.05) among the four climate change scenarios. In the sensitivity analysis, the scale constant k was not sensitive to the redistribution of anchovy stock, while the intrinsic rate of population increase r was closely related to its redistribution.

Ocean warming and acidification scenarios in the northern Bay of Bengal, Bangladesh

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Abstract

Historical sea-surface temperature (SST) and seawater pH data, which were obtained from the National Oceanographic Data Center, were analyzed using ocean data view and ArcGIS tools to determine the state of warming and acidification of marine ecosystem Bangladesh in the northern Bay of Bengal. The temporal trends indicate that SST has gone up during the past few decades, i.e. an average increase is recorded from 28.39^{o}C (1970-1979) to 28.86^{o}C, 29.31 and 29.39^{o}C over the years of 1980-1989, 1990-1999 and 2000-2010, respectively. In case of pH, the average value has been found to be declining, i.e. a decrease is noted from 7.8 (1970-1979) to 7.6 and 7.3 over the years of 1980-1989 and 1990-1999, respectively. Incidentally, the rising temperatures and lowering pH of ocean can have adverse effects on marine life (i.e. declining fisheries resources), and ecosystem processes and services. This would directly affect the livelihoods of millions of coastal poor people. However, most of these issues are poorly understood and virtually nothing has been studied in Bangladesh regarding climate change impacts across marine systems. Therefore, an improved monitoring programme is essential to recognize the current and future costs of ocean warming and acidification in Bangladesh.

For establishing a model of evaluation the ecosystem services of open oceans

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Abstract

Evaluation of the economic value of ecosystem services (ES) has being widely applied to understand the multiple benefits provided by ecosystems. As an important component of global ecosystem, open oceans are facing more and more challenges today not only on fisheries, but also on implementations of geoengineering for mitigating climate change and exploitations of ocean floor resources. However, studies regarding evaluation of open oceans' ES are few and almost all of them evaluating the ES of open oceans by "replacement cost methods (CM)". As a shortcoming of CM method, non-use (including legacy, existence & altruism) value cannot be revealed, and this hence causes a defective valuation results. In order to get the comprehensive value of open oceans, "conjoint analysis (CA)" method could be employed. However, as a necessary condition for using the CA method, amount of each ES by regions must be known. At present, although the total amount range of most ES are known, its accuracy is not sufficient to apply regional ecosystem-based management. The other research groups, in research project titled "The New Ocean Paradigm on its Biogeochemistry, Ecosystem, and Sustainable Use (NEOPS)", is collecting kinds of natural scientific data in the North Pacific. The ultimate goal of this study is to use these collected data to establish a model of evaluating the ecosystem services based on CA method.

As the first step before we get the total data from the natural science group. We conducted pre-tests research by using conjoint analysis to obtain the "willingness to pay (WTP)" of general Japanese citizen. In the questionnaire survey, the respondents were told that an assumed geoengineering project (Fe fertilization) will be conducted in the open oceans. Through this project three main services of open oceans (CO_2 absorption, food production, and water purification) will be improved. After collecting the answers, we analyze the raw data with the "choice-based conjoint analysis" based on logit model.

Through the first survey, we elicited Japanese respondents' marginal WTP (MWTP) for three main ES of open oceans. Furthermore, we found variation across different prefecture in WTP trends for the three OPES, implying the influence of traditional food culture, mass media and natural hazards. Differences in WTP trends were also found to depend on income level and gender. Due to the second survey, we detected the relation between WTP and the respondents' educational level. Furthermore, we

calculated the discount rate of WTP for the ES of open oceans between present and future, which should be considered into decision-making process.

Preliminary multiproxy surface air temperature field reconstruction for China over the past millennium

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Abstract

We present the first millennial-length gridded field reconstruction of annual temperature for China, and analyze the reconstruction for spatiotemporal changes and associated uncertainties, based on a network of 415 well-distributed and accurately dated climatic proxy series. The new reconstruction method is a modified form of the point-by-point regression (PPR) approach. The main difference is the incorporation of the “composite plus scale” (CPS) and “Regularized errors-in-variables” (EIV) algorithms to allow for the assimilation of various types of the proxy data. Furthermore, the search radius is restricted to a grid size; this restriction helps effectively exclude proxy data possibly correlated with temperature but belonging to a different climate region. The results indicate that: 1) the past temperature record in China is spatially heterogenic, with variable correlations between cells in time; 2) the late 20th century warming in China probably exceeds mean temperature levels at any period of the past 1000 years, but the temperature anomalies of some grids in eastern China during the Medieval climate anomaly period are warmer than during the modern warming; 3) the climatic variability in the eastern and western regions of China was not synchronous during much of the last millennium, probably due to the influence of the Tibetan Plateau. Our temperature reconstruction may serve as a reference to test simulation results over the past millennium, and help to finely analyze the spatial characteristics and the driving mechanism of the past temperature variability. However, the lower reconstruction skill scores for some grid points underline that the present set of available proxy data series is not yet sufficient to accurately reconstruct the heterogeneous climate of China in all regions, and that there is the need for more highly resolved temperature proxies, particularly in the Tibetan Plateau.

Potential effects of climate change-induced alterations to trophodynamics along the western Antarctic Peninsula

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Abstract

In the present study we predicted changes that may occur to the western Antarctic Peninsula's marine ecosystem according to predicted alterations in water circulation changes from predicted westerly wind intensification, nutrient upwelling, circumpolar deep water upwelling, and decreased sea-ice extent as it effects primary productivity, as well as ocean acidification-related reductions in thecosome pteropod productivity, individually and together, using a series of linear forcing function scenarios in an Ecopath with Ecosim model to anticipate their effects to the marine ecosystem over the next 40 years. We focused on predicting changes in primary and secondary production, because these trophic levels are likely to cause significant alterations to the entire western Antarctic Peninsula's marine ecosystem; in particular changes in biomass, ecosystem biodiversity and/or mean trophic level through positive or antagonistic interaction effects. Biomass was observed to decrease more severely in co-occurring primary production and thecosome productivity forcing-functions scenarios, than would have been predicted based on individual scenario outputs. This would indicate the possibility of synergistic dynamics in the ecosystem. Organismal groups in the model that emerged as losers or winners in the climate change scenarios corresponded to predicted ecosystem shifts. For example, the model indicated that with a decline in the biomass of krill biomass, salp biomass would increase. Pteropods, historically included in aggregated planktonic groups within other Ecopath with Ecosim models, when considered as individual species in the present study, demonstrated significant influences to the marine ecosystem, particularly in environmental forcing functions that considered ocean acidification's effects to their productivity.

Modelling interaction of physical and ecological processes in Lake St. Lucia with respect to conservation and management of the system

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Abstract

Lake St. Lucia is one of Africa's largest estuarine lakes and is part of the iSimangaliso Wetland Park, a UNESCO World Heritage site. The system is an important source of biodiversity and plays an important role as a nursery ground for fish and prawn which are sustained by a diverse and productive planktonic and benthic food-web. Lake St. Lucia is a large and shallow system where wind driven currents and waves are the key processes for the exchange of water between individual lake basins and for the resuspension and transport of sediment and organic material. These physical processes influence biological processes such as primary production, benthic-pelagic coupling and dispersion of organisms. We study the interaction of ecological and physical processes with the help of mathematical models. We simulate wind driven currents and waves with a hydrodynamic spatially explicit model of Lake St. Lucia which is coupled with a model of microalgal dynamics and their grazers using the model environment Mike21 (Danish Hydraulic Institute). Using such a coupled spatially explicit approach allows for an integrated physical, chemical and biological description and modelling of the St. Lucia Lake system, providing an excellent basis for predictions on its behaviour under certain environmental conditions and management scenarios. In particular, we study the effects of resuspension on ecological dynamics at different scales in Lake St. Lucia and possible re-colonisation patterns of the lakes following extreme conditions. Results of our research will provide important information for conservation and management practitioners and will help to sustain the ecosystem goods and services of the St. Lucia lake system.

The influence of biomass on the habitat preference of three small pelagic fish species in the southern Benguela

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Abstract

Environmental factors that govern habitat preference and impact on fisheries resources can be determined by linking prevailing environmental conditions to the abundance and distribution of individual species. Spatially-explicit estimates of the abundance of anchovy (*Engraulis encrasicolus*), sardine (*Sardinops sagax*) and round herring (*Etrumeus whiteheadi*) during the adults life history stage were combined with oceanographic data to reveal the habitats utilized by these three species at different biomass levels in the southern Benguela upwelling ecosystem. These species are of great socio-economic and ecological importance to the region and are vulnerable to population fluctuations in response to environmental variability. To understand the preferred environmental envelop of each species and how habitat usage is affected by biomass, a single parameter quotient (SPQ) method with randomization was used. The analysis was conducted using three subsets of fish density data; firstly including data from a period when the total combined biomass of small pelagic fish was high, secondly using data from a period of average biomass and thirdly using only data from a period when the combined biomass was low. Results indicated variable habitat use by these small pelagic species across gradients of environmental variables. During low and high biomass levels anchovy preferred slightly different bottom temperatures ranging between 16.0-19.0°C and 15.0-18.5°C, respectively. Sardine on the other hand preferred a broad range of warmer temperatures (15.5-20.0°C) at high biomass levels and a narrower range of cool temperatures (15.5-18.5°C) during the low biomass period. Compared to sardine, anchovy occurred over a broader range of depths (15 to 65 m) at high biomass levels. This basic biological information is an essential step towards understanding habitat partitioning and population responses, and hence the role that environmental change may play in regulating the distribution, abundance and hence management of these species.

Tracing the composition of dissolved organic matter by fluorescence analysis in mesocosms of Sanggou Bay, North China

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Abstract
Aquacultural activity has developed rapidly, especially in China. The potential contribution of aquaculture to the global carbon cycle is not well understood. Sanggou Bay, which is dominated by aquaculture systems, was chosen as the site for this study characterizing the composition and abundance of dissolved organic matter (DOM) and its potential link to CO_2 dynamics. Field incubation experiments of eight mesocosms containing various aquaculture species were carried out (6 days) in July 2013 to explore the impact of aquaculture species on DOM composition. The dissolved organic carbon (DOC) and chromophoric dissolved organic matter (CDOM) showed increasing trends, suggesting the release of DOM by plankton and aquaculture species. Parallel factor analysis (PARAFAC) was applied to identify the independent components of the excitation–emission matrix spectra (EEMs), and four components were identified: two humic-like components (C1, C4) and two protein-like components (C2, C3). The correlation between the aquaculture species present and the concentrations of humic-like components indicated that seaweeds and bivalves play important roles in the production of humic-like matter. The variation in the protein-like components and chlorophyll a demonstrated that plankton contributed to the variation in the protein-like CDOM in this study. The significant increase in protein-like matter suggested that it is likely that the carbon sink flux in the Sanggou Bay aquaculture systems has been overestimated.

Verification of flood risk areas based on climatic and geomorphological conditions in central highlands and coastal lowlands of Sri Lanka

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Abstract

Flood is one of the common natural hazards that is experiencing specially in central highlands and coastal lowlands of Sri Lanka. Floods have been creating a significant influence on environmental as well as socioeconomic like damage and loss of properties, loss of lives, degradation of cultivated lands, etc. The intense rainfall is the key factor influence on floods. However, some other factors like geomorphological features, siltation, landuse pattern and some human activities are also contribute to create floods. According to geomorphological and the landscape setting of Sri Lanka, many rivers like Mahaweli, Kalu, Kelani, Walawe and Gin rivers start from the central highland and flow through the coastal lowland and fall into sea in different places. Many occasions in the past, these rivers affected by coastal floods, river floods and flash urban floods during Southwest and Northeast monsoon periods from May to August and December to January. Other than getting an intense rainfall, siltation on river beds due to soil erosion, deforestation, chena cultivation, alteration of flood plains by natural and human activities also contribute to record many number of floods in the country. These factors were concerned for the preparation of initial flood risk zonation maps for the study area. Thematic maps were produced using satellite imageries, climatic data, landuse data, geomorphological data, etc. Geographical Information Systems (GIS) techniques and Multi Criteria Decision Analysis methods were applied to analyze and to demarcate the flood risk buffer zones within central highlands and coastal lowlands.

Primary productivity and its interannual variability in the East Sea, 1998-2007

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Abstract

We investigated the interannual variability of primary production in the East Sea for the 10-year period from January 1998 to December 2007. Primary production was calculated from satellite ocean color data using a local primary production algorithm for the East Sea. To identify the spatio-temporal patterns of primary production, empirical orthogonal function analysis was applied. Based on this, the East Sea was classified into several sub-regions using K-means clustering method. The primary productivity of each sub-region showed characteristic seasonal and interannual variability. The time series of primary productivity of each sub-region were compared with physical factors (wind stress, mixed layer depth, photosynthetic available radiation and volume transport of the Tsushima Warm Current) and climate indices, such as the Multivariate ENSO Index, the Siberian High Index and the East Asian Winter Monsoon Index. The seasonal and annual primary productivity in each sub-region show different relationships with physical forcing and climate indices. Here we discuss how the variability of primary production in the East Sea is linked to local and non-local forcing.

Statistical relationships of water temperature and atmospheric circulation indices derived from mechanism studies for different regions in the Yellow Sea

Chengyi Yuan[1], Hao Wei, Youyu Lu, Xiaofan Luo and Zhihua Zhang

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Abstract

Both in-situ and satellite observations of temperature showed significant inter-annual variations and long-term trend in the Yellow Sea (YS), which are important to the modification of ecosystems referred to ocean primary production and fishery. The seeking of statistical relationships between the water temperature and large-scale atmospheric conditions were motivated by the prediction of water temperature. Statistical relationships have been built on the cause and effect relationships derived from mechanism studies based on hindcast simulator for 1958-2007 using a two-way nested global - Northwest Pacific model.

In winter, temperatures in coastal regions of the YS are primarily controlled by variations in latent and sensible heat fluxes at surface due to the East Asian Winter Monsoon, which can be further related to variations of large-scale Arctic Oscillation (AO) index in the Northern Hemisphere. The statistical model of water temperature base on AO index has been established and proved to able to capture the main inter-annual variations. In the Yellow Sea Trough, inter-annual variations of temperature are distinctly different from the surrounding shallow regions, since the influence of lateral heat transport by the Yellow Sea Warm current (YSWC) is significant. Wind stress and deviation of the pathway of the YSWC are both responsible for inter-annual variations of winter mean temperature, which are suggested by applying Empirical Orthogonal Function analysis and correlation analysis to winter mean temperature, northward velocity of YSWC and curl of wind stress in the central YS. The statistical model for winter temperature in the YSWC region has been built on AO index and leading Principle Component of curl of wind stress, which represented the strength of wind stress and the lateral heat transport influenced by the west/east-ward deviation of the pathway of YSWC to its mean location, respectively.

And in recent studies, wintertime AO can be forecasted for the lead times exceeding 2 months with the state-of-the-art dynamical ensemble prediction systems. Hence, statistical relationships based on atmospheric circulation indices are potentially useful to the temperature prediction in the YS.

Seasonal distribution of dissolved iron in surface water of Sanggou Bay, a typical aquaculture area in China

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Abstract

Sanggou Bay is one of the largest aquaculture bases in China. In this study, seasonal distribution of dissolved iron (dFe) in the surface water of Sanggou Bay as well as its surrounding rivers and groundwater were investigated during four seasons from April 2013 to January 2014. The average of dFe concentration in surface water of Sanggou Bay in four seasons were 12.01±6.29, 4.72±3.04, 1.83±0.42 and 3.36±2.06 nM, respectively. Different sources contributed dFe into Sanggou Bay following the descending order of atmospheric deposition, rivers and groundwater input. Utilization by the cultivated species of seaweed, scallop and Oyster was the main sink of dFe in Sanggou Bay, which account for over 90% of the dFe removal. The calculation results of Fe* suggested that dFe was sufficient to support the biological utilization of nutrients (DIP) in spring and summer, while iron might be a potential limiting factor for primary production in autumn. High positive correlation between dFe and chlorophyll-a in summer verified the effect of iron on promoting chlorophyll synthesis.

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Practical information

Venue

Multi-function Hall, 3rd floor, Yifu Lou Guest House.

East China Normal University (North Zhongshan Road Campus)
3663 Zhongshan Road North
Shanghai 200062, China

Posters

Please put up your poster before 16:30 on 4 August 2014.

Poster presentations

17:00 – 18:00 Participants whose last name begins with A-K
18:00 - 19:00 Participants whose last name begins with L-Z
Please stand near your poster during these times to present your poster or answer questions

The posters be displayed for the duration of the meeting.

Social events

Reception (with drinks and snacks) during the poster session on Monday evening.

You are invited to attend the ClimEco4 dinner at the Shanghai Min Restaurant, 4th floor of Zhaofeng Plaza, 999 Changning Road, Changning District, Shanghai on Friday evening.

Buses will leave from the Yifu Lou Guest House at 18:30.

Please let Lisa know by Wednesday whether or not you plan to attend.

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