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COMMENTARY

Global environmental changes: setting priorities for Latin American coastal habitats

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Abstract

As the effects of the Global Climate Changes on the costal regions of Central and South Americas advance, there is proportionally little research being made to understand such impacts. This commentary puts forward a series of propositions of strategies to improve performance of Central and South American science and policy making in order to cope with the future impacts of the Global Climate Changes in their coastal habitats.

Keywords: benthic ecology, climate impacts, habitat mapping, long-term monitoring, marine biodiversity

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The need for a science-policy agenda in Central and South America

The Intergovernmental Panel for Climate Change (IPCC) reports that Global Environmental Changes (GEC) are occurring quicker than at any other time over the last 25 million years and impacting upon marine environments (Bellard *et al.*, 2012). There is overwhelming evidence showing that GEC are affecting both the quality and quantity of the goods and services provided by a wide range of marine ecosystems.

To discuss regional preparedness for global environmental changes, a workshop was held in Ilhabela, Brazil (22–26 April 2012) entitled 'Evaluating the Sensitivity of Central and South American Benthic Communities to Global Environmental Changes' that drew together scientists from ten Latin American and three European countries. Our analysis revealed critical knowledge gaps that hinder policy-making and assessments for the forthcoming IPCC Report (AR5, 2013–2014). We developed key recommendations on how to foster the development of a regional science-policy agenda to meet urgent demand for sound scientific advice in the face of rapid changes to marine coastal ecosystems in Latin America.

Threats to ecologically and socio-economically important coastal habitats in Latin America

Central and South America is the home of 1/3 of the world's most biodiverse countries, and is one of the most urbanized regions in the world (Unep, 2011). Besides regional heterogeneity, and significant variation in size and economic development, the 33 countries of the region have relatively young democracies that face a number of common political, social-economic, environmental, and science-policy issues. The marine habitats are of fundamental importance for the approximately 610 million coastal residents, but the need to develop sustainable coastal management occurs at a time of rapidly changing climate coupled with social upheaval such as uncontrolled urbanization and social inequality.

Latin America marine realms include a wide range of benthic ecosystems, many of which are unique and constitute hotspots of biodiversity (Miloslavich *et al.*, 2011). These include the kelp forests on the Cape Horn Biosphere Reserve (Fig. 1; Rozzi *et al.*, 2012), the huge rhodolith beds along the Tropical Southwestern Atlantic coast (Berchez *et al.*, 2009; Amado-Filho *et al.*, 2012), the large blue carbon ecosystems, formed by tropical mangroves and seagrass beds (Copertino, 2011) and the highly biodiverse coral reefs of the Tropical Atlantic, with their large number of endemic species (Leão *et al.*, 2003). Therefore, major efforts to protect these marine habitats are essential. Fundamental regional economic activities, such as fisheries, with the world's highest average annual growth in the period 1970–2008 (21.1% as reported by Salas *et al.*, 2011), and tourism, with an 8.6–13.9% total contribution to gross domestic product (Wttc, 2012), depend on marine environmental quality.

Multiple human impacts endanger Latin America coastal habitats. Changes in the composition and distribution of sensitive habitats are already occurring (Martins *et al.*, 2012), with highly impacted sites in the Eastern Caribbean, and medium to highly impacted zones around almost the entire continent (Halpern *et al.*, 2008). Without timely action the situation will steadily deteriorate. Bleaching and diseases in coral reefs (Fig. 2), both linked to ocean warming, are becoming an increasing problem (Wilkinson & Souter, 2008). Kelp forests have proven to be highly susceptible to temperature and current changes (Wernberg *et al.*, 2011) and ocean acidification not only threatens to degrade the world's largest rhodolith beds along the Brazilian coast (Amado-Filho *et al.*, 2012) but also to seriously reduce the ability of edible shellfish, such as mussels and oysters, to produce shells, thereby threatening local aquaculture activities and food security. Extreme events, such as cyclones, are occurring with greater frequency (Emanuel, 2005), thereby impacting coastal habitats, with particular severity in the SE Atlantic coast. Moreover, harmful algal blooms, partially related to temperature increase, have negative impacts on the quality of coastal areas as a whole.

Fig. 1 A kelp forest in the Cape Horn Biosphere Reserve, Chile. This habitat is extremely important as a CO_2 sink and for fisheries. Centolla crab *Lithodes santolla* growing on *Macrocystis pyrifera* at the Capitan Aracena Island, Magallanes (Photo: Mathias Hüne).

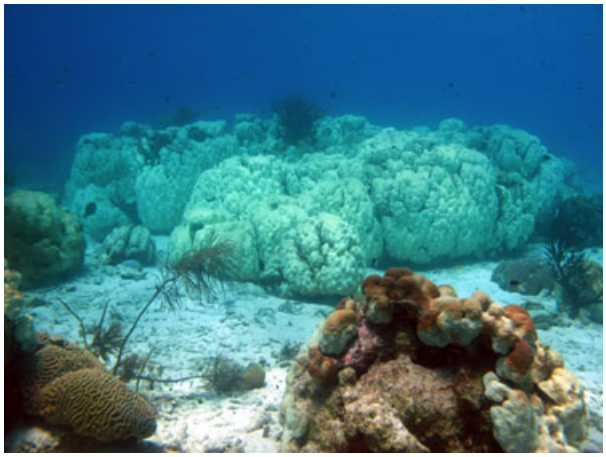

Fig. 2 A coral bleaching event. Bleaching events in the Caribbean Sea are becoming more frequent and severe (Photo: Aldo Croquer).

Gaps in scientific knowledge

Concerted efforts to understand the effects of GEC on Latin America coastal habitats lag behind other regions worldwide, leaving society ill-prepared to cope with future changes. The paucity of time-series data in the southern hemisphere is especially acute in developing countries (Rosenzweig *et al*., 2008). Less than 5% of the participants in the Second International Symposium on the Effects of Climate Change on the World's Oceans (Korea, May 2012) were from C&SA, exemplifying the low priority afforded to the issue in the regional scientific agenda. In short, baseline, monitoring and detailed forecast studies are insufficient for a specific understanding of detrimental GEC effects in the region. This has arisen due to a lack of scientific incentives and a dearth of efforts at the science-policy interface across the entire Latin America region.

Baselines

Integrated baseline studies are required to assess seabed-habitat distribution and quality, as well as human threats and risks associated with local and regional climate change scenarios. National support, within a multinational strategy, will be essential for systematic habitat mapping that should include geomorphological and ecological features at different spatial scales, using standardized approaches, to facilitate spatial and temporal comparisons, as well as the organization and dissemination of information. This will allow identification of biodiversity hot-spots, habitats of high value in terms of ecosystem services, and areas most vulnerable and less resilient to local anthropogenic impacts and GEC. It is imperative to take into account the potential synergies deriving from the interaction of multistressors, as the effects of GEC will differ according to the different combinations of threats. This information would also be important as a base for marine spatial planning strategies. For this issue, efforts should be targeted to the less studied ecosystems and regions, such as the Cape Horn Biosphere Reserve and the Brazilian rhodolith beds.

Monitoring

A strategic array of physical and biological monitoring stations is an urgent requirement in C&SA, to fill critical knowledge-gaps, and provide an early warning system of GEC on coastal communities. The systematic application of monitoring protocols to each habitat, scale, and level of organization, as well as to the various oceanographic conditions, is essential for documenting habitat degradation, carbon sinks, the reduction of primary and secondary production, and habitat destruction, fragmentation or loss, as well as biological invasion, and regime shifts. Thus, support for long-term time-series data collection through national and international networks is required using rigorous standardized protocols. The Monitoring Network for Coastal Benthic Habitats (*ReBentos*), to date one of the main extensive networks implemented in Latin America for monitoring marine habitats, groups together around 100 researchers starting to apply standardized protocols to both soft and hard substrata, viz., rocky shores, coral reefs, rhodolith beds, mangroves, salt marshes, estuaries, and sandy beaches, at stations distributed all along the Brazilian Coast. The South American Research Group for Coastal Ecosystems (SARCE), comprising 108 sampling localities, is another example. Efforts should be made to spread these tried and tested schemes to other countries in the region, through combining procedures and efforts with local projects already under way, and building an open access data-base to provide information for local, regional, and global habitat health evaluation and forecasts, this including the Regular Process of the United Nations for Global Reporting and Assessment of the State of the Marine Environment. Initial efforts should be centered on locations already undergoing immediate damaging pressures, such as the Caribbean Coral Reefs, the SE Atlantic rocky shores, or the southernmost kelp forests.

Forecasts

The absence of baseline studies seriously compromises reliable forecasting in Latin America. There is an urgent need to refining regional and local scenarios of threats related to GEC, to assess the uncertainties, risks, and

thresholds at organism and ecosystem levels. Not only the identification and quantification of carbon sinks and cycling processes but also experimental and modeling approaches, are key challenges to forecasting future changes.

A scientific-support policy

The challenges are so great that collaborative efforts among institutions at national and international levels are essential. Most of the present initiatives in Latin America are national, for example, Brazilian Network for Global Climate Changes (Rede CLIMA), or bilateral, for example, the CNPq–CONICET Brazil & Argentina funding support. Efforts should be centered on networking the knowledge-base across disciplines and among all Latin American countries. Besides strengthening the support of national science funding agencies to studies focused on GEC, multilateral international agreements are also required. The incentive of capacity-building efforts at undergraduate and graduate levels, and of habitat mapping and the evaluation of GEC effects, is mandatory, as is stimulation of the formation and recruitment of interdisciplinary capacities in marine and human sciences, and technology, at a continental level. There is also a need to stimulate a better and wider communication of GEC to society as a whole, through innovative educational approaches and efficient scientific-outreach efforts, with focus on the Latin American marine environments, which, by leading to greater public involvement, could thus increase political interest.

Political and governance issues

Urgency requires the immediate establishment of a collaborative framework, to so induce a systematic and integrated spatial planning process for the sustainable use of marine biodiversity and other resources in C&SA. This would include joint efforts to identify and give precedence to the most pressing issues related to GEC and coastal habitats. There is the need for a more pro-active engagement of Latin American governments and sector-ministries, as well as the recruitment of socio-economic stakeholders, in a co-management effort regarding GEC and sustainable development, with a more evident focus on the sea. The delimitation of marine protected areas to reach the 10% goals established during the COP-10 – Convention of Biological Diversity - is a priority. Even in Brazil, the most protected country of the region (Halpern *et al.*, 2012), only 1.5% of the exclusive economic zone is protected and nearly 9% of priority areas for marine conservation have already been ceded to oil companies for offshore exploitation (Scarano *et al.*, 2012). The establishment of national councils, such as the Brazilian Inter-ministry Commission for Marine Resources, or processes, such as the National Science, Technology and Innovation Conferences in Brazil, could be considered as models to be followed. Initiatives should emerge as political efforts, under the responsibility of those countries already undertaking successful experiences, or those in better economic conditions, such as Argentina, Brazil, Chile, and Mexico. International articulation efforts should be reinforced by establishing formal mandates and securing resources for leadership institutions and initiatives, such as the Intergovernmental Oceanographic Commission at UNESCO, to consolidate South-to-North, and significantly increase South-to-South collaboration, thereby also benefiting other areas, such as Africa, India, and Southeast Asia.

Science and policy-making under an integrated perspective

Nations should improve communication between policy makers and scientists, to the point that new policies can be based on the best available evidence, and scientific studies widened to include the most policy-relevant questions. The UN Regular Process, IPCC, IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services), and the Future Earth initiatives should be considered as opportunities for the international integration of this agenda. Finally, once both IPBES and IPCC undertake the regular and timely assessment of knowledge, thereby identifying and giving precedence to the key scientific information needed for policymakers, priority on issues regarding climate change in the IPBES agenda, and those on marine habitats, biodiversity, and ecosystem services in the IPCC, becomes mandatory.

Operational agenda for the near future

As it is impossible to address all the issues simultaneously, multicriteria analysis becomes necessary. This would include the survey and analysis of existing data, to thus facilitate the identification of priorities for urgent action. Our main recommendations include sensitivity analysis on an eco-regional scale, thence addressing vulnerability to GEC on a habitat basis. This would include ecological (e.g., geographical distribution and associated biodiversity) and socio-economic (e.g., the economic evaluation of ecosystem goods and services) aspects. Local forecasting, based on the downscaling of available GEC scenarios, geographical distribution, conservation status, and the likely response of different habitats in different eco-regions, as well as the

evaluation of potential ecological and socio-economic impacts should be a first step. Once having established the geographical scope of priority issues, both scientists and policy-makers should work together, by searching for the most effective governance setting to design and implement adaptation and/or mitigation schedules, either at international, national, or local levels.

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