PANAMJAS
Pan-American Journal of Aquatic Sciences

# F O R E W O R D

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The Intergovernmental Panel on Climate Change (IPCC) projections for this century would certainly result in a suite of biophysical and socio-economic impacts on the Brazilian coastal zone that would ultimately affect several sectors, including natural ecosystems, fisheries, transportation, tourism and recreation, infrastructure and local communities.

Global climate change will affect coastal zones where approximately 40% of world's population lives within 100 km of the coastline. The anticipated climate-related changes include an accelerated sea level rise, a further increase in sea surface temperature, an intensification of tropical and extra-tropical cyclones, large extreme waves and storms, alterations in the precipitation and run-off rates, ocean acidification, among others. These phenomena will vary from place to place at different time scales, but their impacts are most certainly to be negative on coastal societies.

Coastal zones will face socio-economic and environmental problems, especially in low-lying areas, which can be severely affected by seawater intrusion and local wave climate changes. For instance, the IPCC expects that, globally, mean sea level may rise as much as 88 cm by the end of the 21st century. One clear message that emerged from the last IPCC report is the urgent need to understand the impacts and assess the vulnerability of coastal zones to climate changes around the world.

Although there has been a considerable increase in the understanding of the impacts of climate changing on coastal zones and their ecosystems, there are still substantial knowledge gaps. The vulnerability to climate change is highly variable, depending on the region and ecosystems under investigation. The capacity of adaptation of marine and coastal ecosystem will vary among species, communities, geographical regions and levels of system health and degradation. Rising in sea level and increase in both frequency and intensity of storms would amplify the impacts on the detected areas under risk. Coastlines under stress from human activities are particularly susceptible to global warming impacts and their vulnerabilities have to be urgently assessed. In highly urbanized areas floods rather than coastal erosion can cause strong impacts. Even worse, the historic drainage problem in certain coastal cities can be magnified due to intense flooding causing a serious public health problem with groundwater contamination, mosquito proliferation, and associated spread of diseases.

**The Brazilian Climate Change Research Programs: Rede CLIMA and INCT for Climate Change**

In late 2007, the Brazilian Ministry of Science and Technology (MCT) created the Brazilian Research Network on Climate Change (Rede CLIMA) with the following objectives: (a) generate and disseminate knowledge and technology for Brazil to meet the challenges represented by the causes and effects of global climate change; (b) gather data and information necessary to support Brazilian diplomacy in negotiations on the international regime for climate change; (c) develop studies on the impacts of global and regional climate change in Brazil, with emphasis on the country's vulnerability to climate change; (d) consider alternatives for the adaptation of Brazil's social, economic and natural systems; (e) investigate the effects of changes in land use, and in Brazil's social, economic and natural systems to the country's emissions that contribute to global climate change, and (f) contribute to the formulation and monitoring of public policies on global climate change within the Brazilian territory, g) contribute to the conception and

implementation of a Brazilian climate-related disaster monitoring and alert system, h) carry out studies regarding Brazilian greenhouse gas emissions in support to the periodic national greenhouse gas inventories stipulated by the Presidential Decree n.º 7.390 of September 9th 2010. One of the first products of Rede CLIMA will be to produce regular analysis of Brazil's climate and predicted climate change, with better precision for South America than the models developed in other countries that are available nowadays, and with more specific analysis in certain strategic areas, among them Coastal Zones, for the formulation of national policies.

From the scientific point of view, Rede CLIMA interacts closely with the National Institute of Science and Technology for Climate Change (INCT for Climate Change), which began in 2008, and with the São Paulo State Research Funding Agency (FAPESP) Research Program on Global Climate Change also established in 2008. The INCT for Climate Change is funded by Brazil's National Council for Scientific and Technological Development (CNPq) and by FAPESP. It brings together the largest and most far-reaching interdisciplinary network of environmental research institutions in Brazil, involving over 90 research groups from 65 institutions and universities from Brazil and abroad, with over 400 participants. The main goal of the INCT for Climate Change is to provide high quality and relevant scientific information needed to (a) understand climate functioning, variability and change, and (b) inform adaptation and mitigation at local, national and international levels. The INCT for Climate Change is structured in three scientific and one technological axes: scientific basis for global environmental change; research on impacts, adaptation and vulnerability; mitigation; and technological developments and products. FAPESP Research Program on Global Climate Change has objectives that are similar to those of the INCT for Climate Change and of Rede CLIMA, with a particular emphasis in the development of new technologies to mitigate and adapt to climate change.

**The Coastal Zone Network**

With about 8.500 km, the large Brazilian coastal zone presents a variety of climates and coastal morphologies, including several ecosystems such as sandy beaches and dunes, rock shores, coral reefs, estuaries, mangroves, salt marshes and seagrass meadows. The Brazilian's coastal zone is a significant national environmental benefit that is also fundamentally important to our lifestyle and economy. About 20-30% of the Brazilian population lives by the coast, where several pressures already exist such as sea reclamation, flooding, erosion and extreme weather events.

Climate change will certainly affect in different ways the various coastal cities and coastal ecosystems in Brazil. Due to its complexity, the Brazilian coastal zone cannot be investigated under the perspective of small projects addressing only few scientific questions. Dense population occupies the region at sea-land interface with complex infrastructure in certain areas, added to a mosaic of different ecosystems, which are exposed to anthropogenic and natural impacts.

Therefore, a coordinated research team was needed to investigate vulnerability, impacts and adaptation of the Brazilian coastal zone to climate change. To address this need, the Coastal Zone network was created within the context of Rede CLIMA and INCT for Climate Change. The first and major effort was made towards establishing a multidisciplinary research team, comprising both regional and institutional representativeness, aiming at achieving national and international scientific impact. Coordinated by the Institute of Oceanography at the Federal University of Rio Grande (IO-FURG), Coastal Zone is formed by more than fifty researchers from 23 institutes, covering about 11 Brazilian coastal states. Taking into account that the analysis of the impacts of climate change on the Brazilian coastal zones is limited by a number of deficiencies, especially by basic knowledge about the physical, geological and ecological dynamics of these environments, the main CZ goals are: 1) to evaluate the state of knowledge and identify the gaps; 2) to recommend future studies; 3) to establish protocols and 4) to coordinate/integrate projects that investigate the vulnerability and the effects of climate change in coastal areas of Brazil in order to propose adaptive actions with the organized sectors of society. The CZ researchers focused first on making a preliminary assessment of the studies, including reviews, analysis of past data and vulnerability assessment of ecosystems and regions to climate.

**I Brazilian Workshop on Climate Change and Coastal Zones**

The Coastal Zone netwport has planned workshops to run on biennial basis, to better integrate the finds. The "First Brazilian Workshop on Climate Change and Coastal Zones", one of the first CZ achievements, was held from September 14th to 16th 2009 at the IO/FURG. The Workshop aimed the

divulgation of Coastal Zone preliminary results, consolidating the research group, stimulating the integration of its members and discussing methodological protocols and future research. The Workshop covered topics within the areas of geology, geography, physical, geological and biological oceanography, ecology, fisheries, socio-economics, scientific divulgation and education. The event was attended by 200 people, including scientists and students, from several national institutions. The Workshop successfully achieved its goals, and its results were highlighted by the national scientific community and by the media and society in general. By bringing together different research areas and institutions, new collaborations were established. Moreover, the Workshop established scientific basis, new and promising collaborations and leaded the future of climate change research in Brazil.

The Workshop also resulted in this Special Issue of the *Pan-American Journal of Aquatic Sciences* (PanamJAS), which includes 15 peer-reviewed scientific articles covering several physical, biological and social aspects of the Brazilian coast. The Issue is the first of several steps toward a detailed assessment of the impacts and vulnerability of the Brazilian coastal zone to climate change.

Based on Workshop discussions, we released the *Rio Grande Declaration*, an open letter signed by Coastal Zone members and meeting participants. Forwarded to the main national media groups and public sectors, and also published in this volume, *Rio Grande Declaration* is a manifest from the scientific community present or represented during the Workshop, warning about climate change impacts, particularly those affecting the coast. The letter highlights a series of scientific goals that still needs to be reached to adequately assess and monitor the effects of climate change on coastal ecosystems in Brazil. The successful implementation of the recommendations depends on political will and decisions, which must be long-term committed to the theme of Climate Change.

We hope that this Special Issue will heighten the interest of the scientific community, managers and policy-makers, because a wide range of climate changes impacts are expected to influence the Brazilian coastal zones. Human response and our scientific capacity will play a major role in determining the success of the adaptation of the Brazilian coastal zone to climate change.