Vulnerability to sea level rise in the Metropolitan Region of Rio de Janeiro through 3D modeling

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• The cities located along the coast are particularly vulnerable to climate change, and more especially to the rise in mean sea level.

• Rio de Janeiro has a densely populated metropolitan region, almost completely located in coastal lowlands, with the exception of coastal massifs (Tijuca, Pedra Branca, etc..) and the escarpment of the Serra do Mar to the north.

• What would be the effects of the rising sea level projected by the IPCC in the coastal zone Rio de Janeiro’s Metropolitan Region (RJMR)? Complex projection, influenced by many variables. This work indicates the most vulnerable areas, environmentally and socially.
Vulnerability: social and environmental variable, which is based in the perspective of probability of occurrence of environmental impacts to a particular geographical area, but also to the responses of the society's there located to these impacts.

Objective: Identification of the most vulnerable areas as from the redefinition of the coastline of the city of Río and all the shoreline of the Guanabara Bay, considering three different scenarios of mean sea level rise (0.5, 1 or 1.5m).

How? 3D - Digital Elevation Models (DEMs).
Methodology

• Main difficulty faced: finding cartographic databases on a scale compatible with the objectives presented and that covered the entire study area.

• Databases used for the digital elevation models (DEMs), developed in ArcGIS software:
  – cartography of the city of Rio de Janeiro, scale of 1:2,000 (Pereira Passos Institute, 1997 and 2000);
  – cartography of part of the RJMR developed by CIDE (State level foundation), in the scale of 1:10,000 (CIDE, 1996);
  – Contours, elevation points and quoted shoreline were the available features used to generate the DEMs.
Current Scenario of the shoreline in Rio de Janeiro Metropolitan Region

• Relative stability in historical time -> occasional episodes of surf, sometimes associated with spring tide.
  – coastal erosion, overwash of structures built on the waterfront and "drowning" of stormwater galleries (flooding in low lying areas such as occurred in April 2010).

• Oceanic beaches are the most vulnerable and don´t have adaptative capability by downgrading to a new condition of mean sea level due to the urbanization of the backshore.

• Mangrove ecosystems and coastal lagoons -> already suffering from the impacts of environmental pollution and are especially vulnerable to a rising mean sea level, mainly due to the urbanization of its surroundings.
Most vulnerable areas to sea level rise in the city of Rio
Most vulnerable areas to sea level rise in the city of Rio

Biological Reserve of Guaratiba, protected area dominated by mangroves, that may have its dynamic completely altered by the sea level rise. There are occupied areas around that stop it from adapting and are also vulnerable.
Jacarepaguá Lowlands and its Lagoon System is the region for the most important Olympic Venues for Rio 2016 Games. The lagoon system is directly connected to the sea and may have its water mirror expanded throughout its margins if nothing is done.
Most vulnerable areas to sea level rise in the Metropolitan Region of Rio de Janeiro
Rate of populational growth in the Rio de Janeiro Metropolitan Region - 1991-2010
Rate of populational growth in the Administrative Regions of Rio de Janeiro - 1991-2010
Main impacts predicted for the city of Rio

Final considerations

- Urban ocean beaches - stopped from adjusting by means retrogradation, will suffer loss of sand and impacts on structures built along the shore;

- Non-urban ocean beaches - adjustment through erosion and transposition, in a amplitude of retreat the order of a few tens of meters, if there is space for it;

- Urban drainage – Elevation of the groundwater level, flooding of low lying areas and block of drainage canals and lowland rivers, causing floods more often;

- Economic loss - negative impacts on the world famous beaches of the city can bring serious damage to economic activity in the city, especially in the tourism sector.

- This work was an initial approach on the issue, with the intention of rising this subject throughout the municipality administration and, from there, develop another studies and mitigation, adaption and/or resilience actions.
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