

RIVERS, DELTAS, AND CLIMATE VULNERABILITY: IMPACTS OF ENVIRONMENTAL CHANGE ON RIVER SYSTEMS AND COASTAL ZONES

P. Michael Link, Jürgen Scheffran

Forschungsgruppe Klimawandel und Sicherheit (CLISEC), Institut für Geographie, Centrum für Erdsystemforschung und Nachhaltigkeit, Universität Hamburg

michael.link@zmaw.de
juergen.scheffran@zmaw.de



Introduction

Rivers and coastal regions are the economic and social lifelines of many countries. They are the areas in which population densities are traditionally highest and along which economic activities are concentrated. However, these regions are also particularly vulnerable to changes in environmental conditions brought about by climate change. Coastal zones are particularly heavily used by humans. In the near future, more than half of the world's population will live along coasts. While life along the border between the land and the sea takes advantage of many natural features of the coastal zones, an overuse of the given resources can have long-term adverse impacts on coastal societies. Intensive economic use and groundwater removal can cause subsidence, which locally and regionally worsens the expected impacts of a rising sea level. This requires adaptation and coastal protection of the considerable human values in such coastal zones against extreme storm surges and inundation. The success of response mechanisms depends on the participation of local agents and the agreement on common strategies.

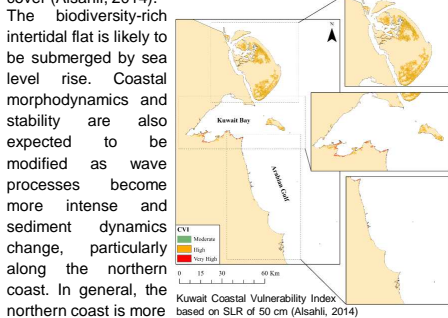


The vulnerability of key estuaries to the consequences of climate change (IPCC, 2007)

These important issues were discussed in two sessions at the 2014 annual conference of the Association of American Geographers in Tampa, FL. Key examples highlight the diversity of problems faced by the communities in these sensitive areas if environmental conditions change.

Impacts of sea level rise on the coasts of Kuwait

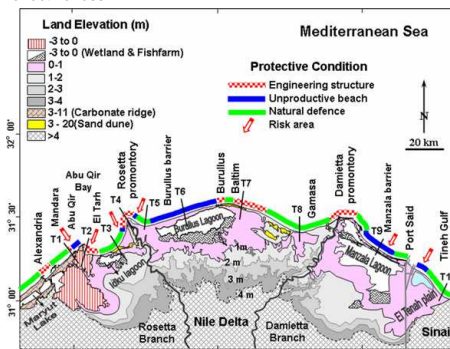
The Kuwaitian coasts are productive environments of approximately 350 km length. They host the most vital areas in the country including urban, commercial, and industrial sectors. The potential impacts of future sea level rise on the coastal zones of Kuwait are assessed using a GIS analysis leading to an index of coastal vulnerability that is based on elevation, coastal slope, population density, and land use-land cover (Alsahli, 2014).



The biodiversity-rich intertidal flat is likely to be submerged by sea level rise. Coastal morphodynamics and stability are also expected to be modified as wave processes become more intense and sediment dynamics change, particularly along the northern coast. In general, the northern coast is more sensitive to sea level rise than the southern coast. Inundation will also influence future coastal zone development, particularly along the northern coast, where the Kuwait Government is currently planning large development projects.

Vulnerability of the Nile Delta to sea level rise

The downstream areas of the Nile River in Egypt face multiple challenges from the consequences of climate change. As the population grows and the economy continues to develop, the demand for water from the Nile is increasing drastically in the downstream countries, increasing tensions between Egypt and its neighbors (Link et al., 2012). In addition, the Egyptian coasts and especially the Nile Delta, which is of particular importance to the Egyptian economy as it is the prime agricultural area of the country, are vulnerable to SLR and need particular protection (Link et al., 2013). However, so far efforts to protect the Egyptian coasts have been rather uncoordinated and local in extent, creating a wide array of protective measures that often have limited effectiveness.

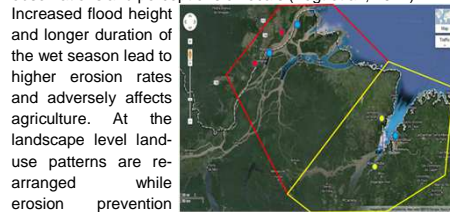


Types of coastal protection in the Nile Delta region (Fritly & El-Sayed, 2013)

An effective protection of the Nile Delta requires additional investments and the development of a coherent strategy that involves all administrative levels and also a distinct increase in public awareness. However, following the Arab Spring other issues have been the focus of the political agenda while coastal protection still receives very limited attention.

Extreme flood events in the Amazon estuary

Sea level changes also affect the estuary of the Amazon River. Experts of the traditional local population (Caboclos) report changes in timing, frequency, and duration of lançantes (extreme floods) across the Amazon estuary. However, there is little knowledge on how this translates into concrete challenges to the local population. As there are no long-term data sets of tides, assessments need to be based on observations and perceptions of locals (Vogt et al., 2014).



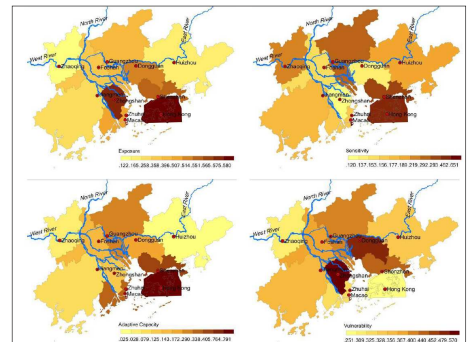
The study area in the Amazon estuary (Vogt et al., 2014)

Increased flood height and longer duration of the wet season lead to higher erosion rates and adversely affects agriculture. At the landscape level land-use patterns are rearranged while erosion prevention measures and refuges are the main adaptation measures at the communal level. This indicates that the Caboclos of the Amazon estuary are not passive and should not be regarded as "climate or environmental victims" but adept at adaptation to reduce impacts of events that are uncertain and hard to predict. Knowledge of how to adapt to climate change is often generated individually but shared communally.

Responses to flooding in the Pearl River Delta, China

The Pearl River Delta is a rapidly developing and largely urbanized coastal area in southeast China. Changing environmental conditions and continued urbanization of flood-prone areas are expected to lead to increased flood frequency and an aggravation of scale and degree of flooding in the delta area. A vulnerability estimate has been conducted for 11 cities in that region (Yang et al., 2014).

The exposure and sensitivity of the central cities, e.g. Hong Kong, is very high because of the large populations and considerable assets in low-lying areas. However, the adaptive capacity is also quite high, which reduces the actual risk to the affected areas as there are substantial flood-control measures.

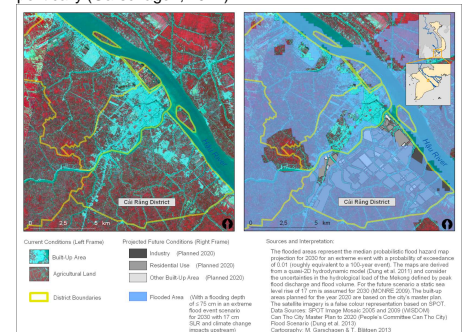


The relative flood vulnerability of major cities in the Pearl River Delta (Yang et al., 2014)

On the basis of this vulnerability assessment a flood response framework is proposed that can identify vulnerable links and optimize response strategies for different phases of a flood event. It is based on an integration of a climate response strategy, early warning and action guidance, flood-related information, and information of online social network analysis.

Urban disaster risk governance in the Mekong Delta

Vietnam and the Mekong Delta are expected hotspots of climate change impacts and are also undergoing a comprehensive transformation process. However, the dynamic impacts of transformation on risk, vulnerability, and adaptation remain poorly understood scientifically and underemphasized politically (Garschagen, 2014).



An assessment of governance structures indicates that shifts in risk are not mainly produced by climate change, despite the predominant narrative on climate risk. Also, the transformation process has not led to a vulnerability reduction for all social groups. Finally, the adaptation of the physical infrastructure is currently insufficient and the institutional setup of risk and adaptation governance as such needs to be more adaptive.