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GUEST EDITORIAL

# Journal of Coastal Conservation special issue "Coast and society"

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The coastal zone is the area where geosphere, hydrosphere, atmosphere, ecosphere and anthroposphere meet. Since prehistoric times the coast has provided people with habitat, food, trade ways, and facilitated socio-economic networking. However, coasts are also recognized as areas that are threatened, where rising sea level, floods, storms, tsunamis, erosion and silting endanger livelihoods. These threats have become even more visible in recent times in the face of climate change and related oceanographic processes.

Geologists, oceanographers, engineers, modelers and socio-economists met at the 35th International Geological Congress, Cape Town, South Africa in August 2016 and discussed at the symposium "Coast and Society" how natural processes and anthropogenic driving forces jointly shape the development of coastal zones and how the threats because of climate change and increasing exploitation of coastal zones resources can be mitigated. Some selected papers of the presentations from Cape Town 2016 have been brought together in this special issue in order to exemplify general principles at the interference of natural processes and human activities. Figure 1 shows the complicated interrelations in this large and extremely complicated system.

The change in the shape of coastlines is probably the most easily observable modification of the coastal zone. A closer look reveals that the climate variability strongly effects ecosystems in near coast areas. All three spheres interacting – climate, geo-, and ecosystem – strongly influence the human population living in coastal environments since the last glacial period. Before the change from hunting/fishing and gathering to farming societies (Neolithic Revolution), socio-economic systems were dependent on relative sea-level change, requiring migration according to the shift direction of the coastlines.

After the establishment of farming societies the sensitivity changed to climate-ruled atmospheric parameters such as temperature and precipitation influencing agriculture. Another historical modification stems from the impact of the socio-economic system onto the climate-, geo- and ecosystem. Before the Neolithic Revolution societies reacted passively by adjustment of socio-economic parameters to climate variation or changes in the geo- and ecosystem. However, economic and technical development in the course of the Neolithic Revolution enabled the society to influence actively and directly the ecosystem by deforestration and agricultural activities.

With the major technological development in the relatively recent past, people began to influence the geosystem actively (by port constructions, the erection of shoreline protection measures, land reclamation etc.). Direct anthropogenic impact on climate system was remarkably forced by the industrial revolution and the explosively increased emission of greenhouse gases. At the moment we are experiencing a period of transition from more or less random (locally planned) anthropogenic impacts on climate, geo- and ecosystem framework to regionally planned sustainable development of coastal zones.

The papers published in this special issue can be assigned to three main research topics:

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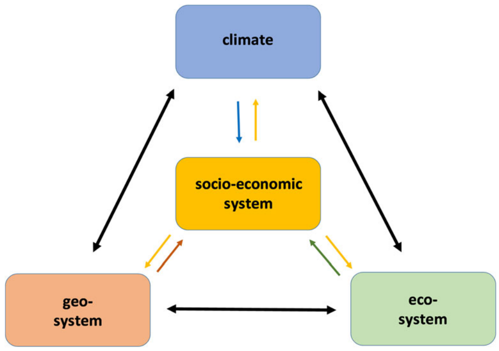


**Fig. 1** Cause-effect relationship of factors influencing coastal development (modified from Harff et al. 2007)

## Modeling and reconstruction of coastal landscapes' formation

Deng et al. (2019) developed a methodological framework to reconstruct the delta front morphology by integrating the information from historical shorelines, spatial distribution of depositional environments, relative sea-level changes and a modern Digital Elevation Model (DEM). A key process is the spatial connection between mud basin morphology, the subaerial DEM and the historical shoreline. In addition, the authors used available sedimentation data at the delta front to reflect the complex morphological formation processes. For the Macquarie Rivulet delta within Lake Illawarra, Australia, used as an example, the authors generated the historical delta morphogenesis since 1892. The reconstructed morphologies provide basic information about delta evolution including the mass balancing needed to deploy the method for coastal zone management.

In their paper, Ryabchuk et al. (2019) present the first results of geological and geoarchaeological multi-proxy studies in the northern part of Narva-Luga Klint Bay (between the Kurgalov and Kurovitski Plateaus) in the Eastern Gulf of Finland, Baltic Sea. The detailed study using ground-penetrating radar (GPR), drilling, outcrop description and sampling revealed a postglacial coastal morphogenesis in an area that is determined by a complex behavior of vertical crustal displacement close to the fomer Fennoscandian ice shield. The archaeological investigation proved that the area was populated after the “Littorina Transgression” (ca. 8 kyr BP) connected with a shift of the fresh water to brackish marine environment, and that prehistoric settlers used both coastal and forest resources for their advantage in subsistence living.

Galili and Zviely (2019) investigated geoarchaeologically a quite different climate zone during the Holocene on the Mediterranean coast of Israel. The Sharon Coastal Ridge was formed during the Late Pleistocene (about 70,000 to 10,000 yr BP). Since about 7,500 yr BP, when due to the raising plostglacial sea level, the coast line reached the western edge of the present coastal ridge, the cliff has been continuously eroded and retreated eastward by natural processes, as well as due to anthropogenic impact. The sea level reached its present level at about 4,000 yr BP (Middle Bronze Age) and has not changed significantly since. Human activity and sea level rise during the last 100 years have significantly accelerated coastal erosion and cliff retreat.

## Description of natural and man-made coastal hazardous processes

Climate driven sea-level rise is one of the most common reasons for coastal hazards. Evadzi et al. (2019) characterize the large-scale climate forcing that drives mean sea-level (MSL) variability on the West African coast and its offshore waters in the observation period (1993–2013). For this purpose, the authors performed statistically analyses on several available data sets: sea-level data from tide gauges, satellite altimetry, gridded sea-level reconstruction, meteorological reanalysis, high resolution ocean model simulation driven by this meteorological reanalysis, and observational oceanographic data sets. The authors combined different sea-level records, and constructed a regionally representative sea-level curve for Ghana (1929–1981).

In order to find appropriate remedies, Bitan and Zviely (2019) calculated the economic losses from public bathing beaches, due to the potential threat of sea-level rise (SLR) based on an economic analysis. The authors selected for the study three of the main Mediterranean public bathing beaches of Israel. To calculate the morphological impact of SLR, the authors used a modification of the Bruun Rule. By using a benefits-transfer approach, consumer surpluses from other areas were adjusted to the Israeli beaches. For future projection of sea-level rise the authors referred to the latest report of the Fifth Intergovernmental Panel on Climate Change (IPCC). Based on these data the value loss for each beach was calculated for SLR from 0.2 m to 1.0 m at 0.2 m intervals. It is likely that Dado beach (Haifa) will be severely damaged or even lost by 0.4 m SLR, while Tel Aviv Promenade and Ashdod beaches would be severely affected by 1.0 m SLR. The overall of the annual losses of public benefits is estimated to be NIS 122 million ($31 million) and NIS 416 million ($104 million) for values of 0.2 m and 1.0 m SLR respectively.

Bagdanavičiūtė et al. (2019) focus on the more complex effects of sea-level rise combined with meteorological events on sandy beaches. Their study aims to quantify coastal risks associated with erosion and inundation accelerated by sea-level rise and extreme storms events for the specific conditions of the eastern Baltic Sea coast as an example of a micro-tidal semi-enclosed seas. The authors make an attempt to develop a measure that characterises climate-related external hazards, the exposure (of people and assets at risk of being damaged) and vulnerability of human and natural systems. About 11% of the study area is under very high risk. The largest risk values occur close to tourist and industrial centers near Klaipėda, around the Palanga pier and north of Šventoji.

Completely event-related are deposits due to the effect of storms and tsunamis. Schneider et al. (2019) present new data of accurate determination of geometric parameters for a holistic understanding the formation of storm and tsunami deposits and for modelling wave magnitudes responsible for the displacement of large boulders along the coast of Oman. The reconstruction of boulder movements along coastlines is a new approach that can be generalized for a better understanding of storm and tsunami dynamics. An important technology to estimate the change of coastlines in order to study cause and effect relations in the marine coastal environment is provided by the analyses of remote sensing data.

Jia et al. (2019) analysed the coastlines of sand-barrier lagoons that are the locations of coastal economic development along the eastern coast of Hainan Island in southern China. Here, increased human activities have remarkably destabilized and damaged the coastal ecosystems. The authors used innovative technology to classify and evaluate six phases of overlapping coastlines in Li'an and Xincun Lagoons in Lingshui County in southeastern Hainan Island between 1987 and 2013. The method applied combines the analysis of remote sensing images with ocean dynamics and bathymetric surveys.

Comparable results have been achieved by Li et al. (2019) who have investigated morphological change in the Qinzhou Bay (QZB), southwest China, using bathymetric charts and remote sensing data. Summarizing the results, the bathymetry and coastline of QZB have changed dramatically in recent decades. Land reclamation caused a decrease of subaqueous area of about 8% over the last 50 years while the average growth rate of the coastline was 2.07 km/yr between 1978 and 2013. Hereby it has to be considered that the natural curvy shape of the coastlines is being replaced by straighter artificial coasts. During the period from 1960s to 1990s, the evolution of QZB was mainly governed by natural factors with slight deposition or erosion in the deep troughs. From 1990s to 2010s, intensive large-scale human activities, such as port building, channel dredging and artificial island construction became the main causes affecting morphological changes in the QZB. The authors claim that only sustainably integrated coastal zone management can maintain the balance between economic development and ecological health.

But it is not only the morphodynamic environment that has to be considered when investigating hazardeous effect of human activities in coastal areas. The geochemical environment has to be taken into consideration as well. Modern salt lakes belong to a growing class of natural systems undergoing compositional change due to increased human activity along their shores. To understand the full consequence of anthropogenic-driven changes, detailed geological and geochemical study of such salt lake systems is required. Kotov et al. (2019) have investigated changes recorded in the peloids (lake muds) in Crimean salt lake systems and compared them with the similar systems in the Dead Sea region. In addition to natural reasons for differences in the geochemical peloid facies, the impact of human activities influences the salt, granulometric and microelemental compositions of peloids. A complete lack of halite in the Lake Kuchuk-Adzhigol mud is most likely related to intensive anthropogenic desalination, as well as to the input of drainage and waste water. The coarsest muds were found in Lake Saky, which reflects changes in the hydrochemical regime of the lake. Ferrous sediments of the Cimmerian stage are widespread in the East of Crimea. Until recently, these deposits were exploited through open pit mining (e.g., the iron ore mine Kamish-Burun), which could amplify Fe-Ti-Cr-K-V-Pb-Y-Mn-As-Co associations in the Lake Tobechik muds.

## Towards spatial planning of the coastal zone

A clear demand for marine spatial planning is expressed by Liu et al. (2019) in their paper. The authors study the Jiangsu coast, with the unique feature of expanding tidal flats along the west border of the South Yellow Sea. Using a comprehensive analysis of the historical documents and historical maps as well as remote sensing images, the authors reviewed the development and conservation of the tidal flats of the Jiangsu coast that have a long history of more than two thousand years. Salt production was the earliest economic purpose of the tidal flat development, before the tidal flat use changed from salt production to farming in the late nineteenth century. Large-scale land reclamation began in the early 1910s. The authors are convinced that politics related decision-making plays an important role in the conflicts between coastal wetland conservation and development in Jiangsu Province. The authors claim that coastal development policy and decision-making has to be improved in the future.

Zhao and Jia (2019) report about the positive effects of multi-planning integration (MPI) for the coastal zone examplified by the Island of Haina. The establishment of MPI and an orderly spatial planning system has been identified as one of the most important issues in China. According to the authors, since 2014, as many as 28 counties and cities have been selected as typical examples in China to launch MPI pilots systems. The Hainan Island MPI pilot system is the only one that comprises coastal waters, which makes it particularly valuable to coastal zone management research. In their paper, the authors present a qualitative study of the Hainan Island MPI pilot system in order to get insights into the effectivenes for integrated coastal zone management. The results were derived from a comparison with previous coastal spatial management scenarios, interviews of MPI-related government officials and technically realized in a GIS approach. According to the results of the study, the MPI advanced coastal management using several reform measures, including an overarching planning system to resolve previous planning conflicts forming a blueprint for optimizing coastal land and sea conservation and development activites. The authors explain in detail the needed relation of Legislative and Executive for an effective spatial planning system. The authors demand an integrated land and marine spatial planning framework to mitigate the conflicts in sectoral management to achieve a balance between protection and the economic use of coastal resources and environments.

In **summary** it is concluded that at the moment, human population of the world's coastal areas experience increasingly threads caused by natural and anthopogenically accelerated change of climate and near-coast environments. Many sections of the surf zone receive almost continuously so much wave energy that it serves as the fourth most energetic region in the world after locations where earthquakes, volcano eruptions or asteroid impacts occur. In addition, we realize that coastal protection measures well-intentioned by local stakeholders very often do more harm than good. By recognizing this situation, national authorities are endeavoring to find local planning systems that offset headings in the need to protect the coasts and interests in the exploitation of coastal resources. But what is really needed that is a cross-border planning and management system that is adapted to the spatial extent of natural coastal units in order to balance the use and protection of coastal resources. This demand requires international cooperation of geoscientists, climatologists, coastal engineers and planning authorities.

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