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Editorial: Climate Services for Adaptation to Sea-Level Rise

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Editorial on the Research Topic:

Climate Services for Adaptation to Sea-Level Rise

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INTRODUCTION

We are committed to sea-level rise of at least 4mm/year over the coming century, contributing to increases in extreme flooding, coastal erosion and shoreline changes, as well as the salinization of estuaries, soils and coastal aquifers. Adaptation will be required to manage these hazards and their consequences for human activities, coastal infrastructure and ecosystems.

The latest report of the Intergovernmental Panel on Climate Change (IPCC) shows that adaptation to sea-level rise can be supported efficiently by tailored climate services (Cooley et al., 2022). Climate services can be defined as the operationalization of climate and climate impacts science, in order to support the diverse adaptation needs in the public and private sectors. Within this broad area, climate services supporting coastal adaptation to sea-level rise are developing in a distinctive manner: besides large authoritative services such as Copernicus in Europe (Melet et al.; Legais et al.), many activities that do not identify themselves as climate services, are in fact supporting coastal adaptation and contribute to the uptake of coastal climate services (Le Cozannet et al., 2017; Lawrence et al.).

This Research Topic contributes to better understanding of the status of climate services for coastal adaptation. It builds upon a workshop organized by the Regional Sea-level Change and Coastal Impacts Grand Challenge of the World Climate Research Programme in Orléans in November 2019, where scientists working with coastal adaptation practitioners around the world shared their views about current developments and needs for information and services to support adaptation to sea-level rise. The 16 resulting papers provide evidence of progress in this area.

MEAN AND EXTREME SEA-LEVEL CHANGES

A most obvious need is sea-level projections that are applicable locally. Regional sea-level projections presented in IPCC reports since AR5 are available for scientists and practitioners (Oppenheimer et al., 2019; Fox-Kemper et al., 2021; https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool). Yet, they do not resolve two important regional and local components: (1) vertical ground motions, and (2) the meso-scale oceanic processes at the coast. In this Research Topic, Su et al. examined enhanced SROCC projections using local data such as precise national-wide land-rise and subsidence information in Denmark. Similarly, Kim et al. provide new evidence that high resolution oceanic models resolving currents, eddies, and tides, and considering the influence of the bathymetry, can modify broad scale sea-level scenarios by more than 15 cm. On the practical side, the slight increases in sea-level rise projections since AR5 mean that protection standards need to be revised upwards, as shown in Danish municipalities by Su et al. More generally, both papers highlight how regional sea-level scenarios can be taken forward to inform adaptation strategies in specific countries and regions.

Extreme sea levels are changing consistently with mean sea-level rise, including small changes in storminess, surges and waves at each location. Using a regional frequency analysis of tide gauge records, Sweet et al. re-assess risks of flooding in the Pacific. This technique uses many tide gauge records in the region in order to improve the sampling of rare events. This leads to 100-year extreme sea-levels that are revised upwards by 0.15m (median). Furthermore, damaging floods whose return periods are currently 20 to 25 years are projected to occur annually by the mid-21st century in that region.

Where no tide gauge observations are available, the only possible approach to evaluate flood risks is modeling. For example, in low-lying atoll settings such as the Maldives, swell is a major driver of flooding, but information is lacking to assess risks ahead of development projects. Amores et al. model regional waves along the oceanward Maldivian coastlines with a spatial resolution down to 500 m, which can be used to assess local flood risks as illustrated in the case of a new airport on an atoll island. Luque et al. assess future flooding and beach losses in the Balearic islands due to sea-level rise and extreme events. They show that the resulting recreational services could represent up to 7% of the 2019 Gross Domestic Product by 2100. Flood modeling can also be used to evaluate adaptation strategies, such as the implementation of dikes to protect cities in areas where softer shoreline management strategies are being implemented (Louisor et al.). Such studies can help support the identification, planning and sequencing of adaptation options over time.

MANAGING AND COMMUNICATING COMPLEXITY

Future coastal risks assessments often come with large uncertainties resulting from different climate scenarios that cascade across the chain of coastal models from regional to local scales. Toimil et al. present an approach to decompose and visualize uncertainties in future coastal erosion. They show that climate variability can have substantial effects on coastal erosion prediction, and that ignoring their impact may lead to poor decision making. More generally, Simm et al. argue that more attention should be given to the form in which climate services are provided. In this context, official institutions have the challenge to deliver consistent and transparent guidance on climate information and its use.

The Research Topic demonstrates that climate services supporting coastal adaptation to sea-level rise are addressing increasingly complex management issues. For example, Mitchell et al. assess the challenges related to the maintenance and installation of septic systems affected by ongoing and future sea-level rise in low-lying rural areas of coastal Virginia (USA). Yet, systematic guidance is lacking to define climate service requirements. Similarly, Nicholls et al. assess how the large legacy of coastal landfills can be managed as they are increasingly threatened by sea-level rise across Europe and the United States. Yet, financial resources to manage such issues are limited. This raises the need for initial screening services, assessing the scale and characteristics of the problems, and then assessing management options and priorities with careful consideration of acceptance and legal aspects.

Climate services are generally addressing local to regional issues and therefore require consideration of local land use and attitudes toward risks (Durand et al.). However, there are also other adaptation decisions that consider bigger scales up to global (Bisaro et al.). This includes, for example, large private companies assessing the vulnerability of their supply chains, of their geographical presence in multiple countries or governments negotiating greenhouse gas emission targets and their impacts for adaptation aid. Bisaro et al. provide a typology of such adaptation decisions that require climate services addressing larger to global scales.

ADDRESSING RESEARCH GAPS

This Research Topic shows that sea-level adaptation science is progressing rapidly. Yet, there remain key unknowns such as the rate of ice-sheet melting in Greenland and Antarctica over the coming decades and centuries (Durand et al.). A key challenge of climate services is to deliver information that recognizes the committed impacts and adaptation needs on the short term, as well as the deep uncertainties on the long term (Lawrence et al., 2021; Durand et al.).

A regional or national research strategy supporting coastal adaptation can bring substantial benefits to countries exposed to sea-level rise and where research gaps are identified. Melville-Rea et al. proposes such a strategy, with the aim to improve the use of climate and sea-level science in the United Arab Emirates. The strategy considers science and policy coordination, data collection and sharing and funding aspects.

As climate services for coastal adaptation are being developed, people, the institutional frameworks and the environment are changing. Lawrence et al. invite us to rethink how current or projected climate services fit within the evolving decision making, policy and governance contexts. Together with Durand et al., they show that co-production efforts involving scientists, decision makers and communities can enable the transformation of climate services into benefits for society.

The Copernicus services using satellite altimetry monitor global and regional mean sea-level changes with increasing accuracy (Legeais et al.). Early detection of accelerating signals is identified as a potential benefit of this service for adaptation. The wider services of Copernicus cover information on mean and extreme sea level observations and projections, of exposure and vulnerability, notably using digital elevation models and the ground motion service (Melet et al.). In the coming decades, a challenge will be to better connect these authoritative services with the flourishing diversity of activities supporting coastal adaptation on the ground.

We hope that the papers in this Research Topic contribute to the discussion on climate services and indicate the wide range of problems encountered in the development of adaptation strategies to reduce risk caused by sea-level rise.

AUTHOR CONTRIBUTIONS

GC, RN, RW, MS and JL contributed to the ideas development and writing. All authors contributed to the article and approved the submitted version.

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