Anthropogenic-estuarine interactions cause disproportionate greenhouse gas production: A review of the evidence base

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Tweetable abstract

Anthropogenic-estuarine interactions cause disproportionate greenhouse gas production promoted by urban wastewater, low oxygen and amplified by estuary typology. This undermines the assumption that discharge into estuaries is flushed away without environmental repercussions.

Abstract

Biologically productive regions such as estuaries and coastal areas, though only covering a small percentage of the world's oceans, contribute significantly to methane and nitrous oxide emissions. This paper synthesises greenhouse gas data measured in UK estuary studies, highlighting that urban wastewater loading is significantly correlated with both methane ($P<0.001$) and nitrous oxide ($P<0.005$) production. Further, we demonstrate that specific estuary typologies render them more sensitive to anthropogenic influences on greenhouse gas production, particularly estuaries that experience low oxygen levels due to reduced mixing and stratification or high sediment oxygen demand. Significantly, we find that estuaries with high urban wastewater loading may be a significant hidden source of greenhouse gases globally. Synthesising available information, a conceptual model for greenhouse gas concentrations in estuaries with different morphologies and mixing regimes is presented. Applications of this model should help identification of estuaries susceptible to anthropogenic impacts and potential hotspots for greenhouse gas emissions.

Acknowledgements

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Dynamic Coast 2: Anticipating coastal change in Scotland as sea levels rise

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Twitter:

@DynamicCoasts @UofGGES

Research by @DynamicCoasts shows that more of Scotland's Coast is expected to be eroding, and more rapidly over the coming decades. We must be #SeaLevelWise.

Some amount of sea level rise is now an inevitable consequence of our warming climate, even under low future greenhouse gas (GHG) emission scenarios. We are currently on course for over 1 m of sea level rise in Scotland unless emissions can be brought under control globally towards Net Zero GHG emissions. Scotland's coasts are already known to be eroding (Dynamic Coast 1, 2017), and both the extent of eroding coast and the rate of erosion has increased during the 20th century. Dynamic Coast 2 (2021) accounts for an updated record of past coastal change and anticipated future change based on scenarios of sea level rise. This anticipates more of Scotland's coast to erode in the coming decades, and at quickening rates due to sea level rise, even under low GHG scenarios, since the oceans will continue to respond to past and current emissions. Some £1.2 billion worth of assets are anticipated to be at risk near the coast, yet achieving a low emissions scenario could save at least £400 million by 2050. In the meantime, we need to become sea level wise, and adapt to make space for coastal change in our warming world.

A review of the mechanisms by which climate change affects seabirds within the North-East Atlantic

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We carried out a literature review to understand the mechanisms by which climate change affects seabirds breeding within the EU funded INTERREG VA region. The review identified indirect and direct effects of climate change on species in the region. @MarPAMM_project @_BTO #MASTSasm2021

The full abstract should be submitted to masts@st-andrews.ac.uk, in an editable format, by 16:00 Monday 23rd August 2021.

Main abstract

Many seabird populations are sensitive to climate change, both indirectly through effects on prey and directly via effects on fitness. As part of the Marine Protected Areas Management and Monitoring Project (MarPAMM), we performed a literature review to identify the main climate change mechanisms which may affect seabird demography. Using the North-East Atlantic as a case study, we found the most strongly-supported long-term mechanism was indirect, through temperature-mediated changes in prey populations. Although responses to climate varied between species/colonies, our results suggest that the best options for seabird climate change adaptation may focus around the management of prey stocks and colony protection from storm events. There was considerable spatial variation in the strength of the available evidence, and we highlight where current knowledge may be applied to these understudied regions. This project has been supported by the EU's INTERREG VA Programme, managed by the Special EU Programmes Body.

Understanding the United Nations Framework Convention on Climate Change's role in managing and mitigating the climate change-induced existential threats faced by Small Island Developing States.

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Tweetable abstract: SIDS face unique climate change-induced threats. This study explores the degree to which the UNFCCC is acting as a vector for SIDS' needs; understanding how it is voicing existential threats and whether it's providing the vital resources required. #MASTSasm2021

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Abstract

Small Island Developing States (SIDS) are a group of countries which have unique social, economic, and environmental vulnerabilities. Low-lying SIDS face existential threats caused by climate change-induced sea level rise and extreme weather events, with future predictions suggesting that some states might end up completely submerged and uninhabitable. SIDS have contributed negligible greenhouse gas (GHG) emissions, and yet they are facing some of the most sudden and extreme effects of climate change, placing them at the forefront of many international climate justice discussions (Thomas *et al.*, 2020). The United Nations Framework Convention on Climate Change (UNFCCC) is a multilateral treaty which aims to combat dangerous anthropogenic interface with the climate system and it is in charge of major financial mechanisms which support vulnerable developing countries, including "small island countries" (UN, 1992). This study aims to understand the UNFCCC's role in safeguarding SIDS which risk complete inundation by studying how it has handled the situation in the past, its limitations, and what SIDS want from the Convention in the near and distant future. To achieve this, an in-depth discourse analysis of texts associated with the UNFCCC and expert interviews were conducted to gain a breath of knowledge about the situation. The results revealed that the UNFCCC has provided an important platform for SIDS to voice their concerns and needs, however, it struggles to deliver the acknowledged mitigation targets and SIDS' capacity-building needs. The study uncovers several limitations which hinders the UNFCCC and exacerbates SIDS' vulnerability to climate change. It reveals that SIDS need the UNFCCC to provide the security required to protect their islands from complete inundation by pushing for stronger mitigation ambition, allowing for equitable support, and ensuring that the power dynamics within the treaty represent its global initiative to combat climate change. SIDS' unique circumstances presented a unique opportunity to detangle the injustice they face from wider socio-economic concerns, allowing the study to assess how UNFCCC mechanisms are functioning in the context of a clearly understood, and relatively simple situation. However, this study also offers a detailed examination of the UNFCCC in general, as well as its ability to safeguard communities (not just SIDS) which are particularly vulnerable to climate change.

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A tool for predicting sea temperature rise to aid in site selection and development planning for Scottish salmon farming

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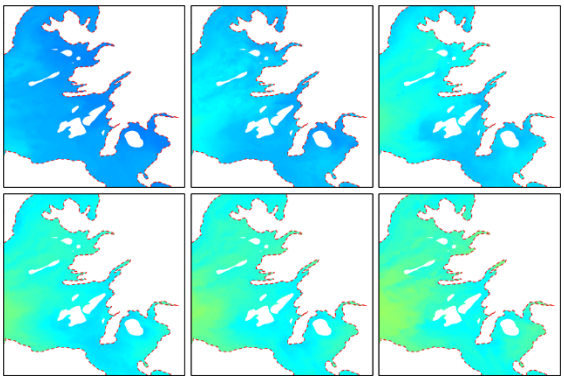
Tweetable Abstract:

BMT is presenting at #MASTSasm2021 a *tool developed using TUFLOW for Scottish waters to predict sea surface temperatures decades into the future. These predictions can aid site selection for salmon farms, mitigating the threat to the industry from rising sea temperatures.*



Thermal tolerances for Atlantic salmon (*Salmo salar*) are within the range ~6-18ºC. While this makes Scottish coastal waters an ideal habitat for both wild and farmed populations, the UK is close to the southern limit of the species range in European waters. The threat of climate change is likely to have significant impacts on the productivity and viability of salmon aquaculture in Scotland. Scottish summer sea temperatures are predicted to consistently exceed 18ºC by 2050 under some emissions scenarios; impeded growth rates and increased incidence of pathogen and parasite infestations are among the possible consequences (Genner *et al*. 2017). The continued viability of salmon farming is likely to depend upon making informed strategic decisions today, to plan for and mitigate against deleterious impacts of climate change in the future.

A tool has been developed to map projected sea surface temperatures under climate change. Sea surface temperatures for Scotland's coastal and ocean waters are simulated using TUFLOW FV (https://www.tuflow.com/products/tuflow-fv/), a 3D flexible mesh hydrodynamic model. The model is simulated using meteorological and open boundary climate change data predicting projected changes in sea temperatures over a range of emissions scenarios. The model mesh resolution can be adjusted to focus on regions or sites of interest along the Scottish coast, providing accurate predictions of sea temperature changes at a high resolution. This tool can subsequently aid in appropriate site selection of salmon farms within Scottish waters and plan for climate change risk assessments.

We present a proof-of-concept of the above, including some initial results of the predictive modelling, mapping indicative areas along the Scottish coast that are at risk of becoming unsuitable for salmon farming, as well as for commercial and recreational fisheries. The results of this modelling are presented as a risk matrix for each area of interest to include estimated time to increased risk, as well as the likelihood of reaching unsuitable conditions for growth based on ensemble model outputs. The tool was originally developed for investment risk analysis and can be adapted to support salmon farmers and management bodies to make informed decisions on mitigation steps for existing farms as well as future planning and site suitability for new regions under expansion planning.

Acknowledgements

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