

# End of project popular science description

## Introduction

Gulf of Guinea large marine ecosystem is a hotspot of multiple stressors. The threats include both organic and solid waste from domestic and industrial sources, and hazardous substances originating from mining and oil exploration, which, together with the effects of climate change and overexploitation of aquatic resources, put an intense pressure on the environment of the Gulf of Guinea and threaten the societies that depend on healthy seafood for their daily income and nutrition. The main objective of HOTSPOT was to identify the sources and effects of maritime pollutants in the coastal waters of Ghana, and to evaluate their importance compared to land-based sources, which is essential information to develop management plans for the marine ecosystem. The maritime pollutants include oil, heavy metals, sewage and plastic originating from oil exploration and shipping.

The specific aims of HOTSPOT-1 were 1) to provide new knowledge on the cumulative effects of pollutants in the changing marine ecosystem, 2) to develop research capacity in the partner institutions, both in terms of laboratory and sampling facilities and in training of students and young researchers, 3) to communicate the research results to the local and national policy-makers and 4) to develop a research-based management plan for the coastal waters of Ghana.

## Results

*Research:* The research in HOTSPOT focused on the sources, concentrations and effects of maritime pollutants, particularly regarding cumulative effects of different contaminants and their interaction with climate change. The field measurements documented elevated concentrations of several heavy metals and measurable concentrations of diverse PAH compounds in coastal waters, as well as high concentrations of plastic on the beaches. Heavy metals were also shown to bioaccumulate and biomagnify in plankton, suggesting that the concentrations in fish could be high and potentially harmful for human consumption. The laboratory experiments demonstrated additional harmful effects of heavy metals (Ni and Cd) and oil compounds (pyrene and crude oil) on the feeding and reproduction and/or growth of diverse phytoplankton and zooplankton species, and indicated that a higher temperature reduces the tolerance of organisms to contaminants. In contrast, microplastic did not appear to have direct negative effects on zooplankton feeding or reproduction. Experiments where the responses of whole communities were tested (so-called mesocosm experiments) confirmed the patterns observed in experiments with selected organisms. In summary, HOTSPOT demonstrated that heavy metals and oil compounds are present in the coastal waters of Ghana, and can have negative effects both on the productivity of the ecosystem and on the contaminant concentrations in the seafood.

*Capacity built:* HOTSPOT contributed to both building of the infrastructure and human capacity, and also included a campaign of citizen science. HOTSPOT established laboratory facilities to work with the ecological effects of maritime pollutants, including cultures of algae and zooplankton, temperature-controlled rooms, field sampling equipment (CTD, plankton nets), fluorometer, microscopes, plankton wheel and diverse containers and aquaria. The human capacity was increased by training of students mainly in the University of Cape Coast, but also in DTU, and by training of young professionals both within and outside the university. HOTSPOT campaigns always had an ample participation of students, and resulted in several master and bachelor thesis. In addition, HOTSPOT training course on maritime pollution, and the seminars and workshops organized by the project were well-attended by students and staff, both within and outside the

university. HOTSPOT also extended its network to cover the University of Aarhus and the Finnish Environmental Institute, who provided the group with their specific expertise on microbial communities and plastic, respectively. One of the highlights of HOTSPOT was an investigation on beach littering where students from DTU and UCC executed a quantification of coastal littering together. Besides illustrating the extent of plastics pollution in the coast of Ghana, it demonstrated how Citizen Science can gain public awareness to reduce marine littering. The final HOTSPOT stakeholder workshop was organized as a webinar in December 2020, and attracted > 30 researchers, students and managers to discuss the findings of the project.

## **Conclusions**

HOTSPOT results suggest that different types of pollutants have different effects in the ecosystem, so that oil compounds are most likely to decrease the productivity of the ecosystem through lethal and sub-lethal effects on organisms, whereas heavy metals are likely to bioaccumulate in the food web. Microplastic might not be particularly toxic to aquatic organisms, but the huge quantities of plastic pollution along the coast can result in microplastic concentrations that are so high that effects on organisms might occur. The cumulative effects of these diverse contaminants are likely to be further strengthened by climate change, and together with over-fishing, they pose a serious threat to marine ecosystem in the coast of Ghana – and therefore for the coastal communities that rely on fisheries. This information has been disseminated to diverse policy makers and management authorities in Ghana. The ambition of HOTSPOT2 is to elaborate and synthesize these results (including building of ecosystem models and predictive models), to identify and prioritize most problematic pollutants, sensitive areas and seasons, which can be used to build management plans for the marine ecosystems in Ghana. Our experience in HOTSPOT showed that training of university students is a very efficient way for capacity building, and that UCC with its position as an African Centre of Excellency is perfectly placed to facilitate and profit from such training. Also, the network of authorities and policy-makers that is established by UCC is essential for the dissemination of the project results, if the research is to have influence on the policy development.

## **Recommendations**

It is clear that the coastal waters of Ghana suffer from multiple stressors, some of which are local (such as pollution and over-exploitation of fish stocks) whereas others are global (such as climate change) and outside the reach of the local authorities. However, it would be highly advisable that the pollution in the coastal waters is reduced and that the pressure on the fading fish stocks is decreased. This can only be reached by a combination of management actions that regulate fisheries and discharges, technological aid such as sewage cleaning plans and increased awareness of public at large to reduce discharge of litter. This in turn needs intensive collaboration between researchers, authorities, managers, industry and public, as well as long-term plans for raising of public awareness, developing the knowledge and skills on marine environmental management and research and investing in infrastructure.