

# MULTI-HAZARD ASSESSMENT OF NATURAL AND ANTHROPOGENIC STRESSORS IN MARINE AREAS: THE CASE STUDY OF THE ADRIATIC SEA

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## Abstract

Europe's seas are facing increasing threats and degradation induced by a wide range of human activities as well as climate change. In order to assess the environmental impacts posed by climate drivers in combination with local to regional anthropogenic pressures (e.g. temperature and salinity variation, sands extraction, trawling fishing) a spatially explicit risk approach was developed, allowing a quick scan and ranking of marine targets at risk. The methodology was tested in the Adriatic sea for the scenario 2000-2015, producing a range of GIS-based maps and indicators for selected marine receptors (e.g. seagrasses, aquacultures) useful to identify marine areas where management actions and adaptation strategies would be best targeted.

*Keywords: Geohazards, Gis, Global change, North Adriatic Sea*

## Introduction

In the last few decades the health of marine ecosystems has been progressively threatened by the anthropogenic presence as well as by climate change effects triggering alteration on biological, chemical and physical processes ([1], [2]). An environmental risk-based approach should be developed in order to identify marine areas that are more likely to be at risk of not achieving the Good Environmental Status (GES) [3] due to multiple threats posed by climate and anthropogenic stressors. By integrating a wide array of indicators related to hazard, exposure and vulnerability with Multi Criteria Decision Analysis (MCDA) and Geographic Information Systems (GIS), the assessment lead to develop, for the scenario 2000-2015, a set of spatial maps and statistics representing key risk metrics useful to evaluate progress toward the implementation of the Marine Strategy Framework Directive [3] and identify marine areas where management actions would be best targeted.

## Risk-based approach for multi-hazard assessment and management in marine areas

In order to evaluate the environmental impacts produced by human-made pressures in combination with climate-related hazards, a risk-based approach was developed and applied in the Adriatic Sea (Figure 1).

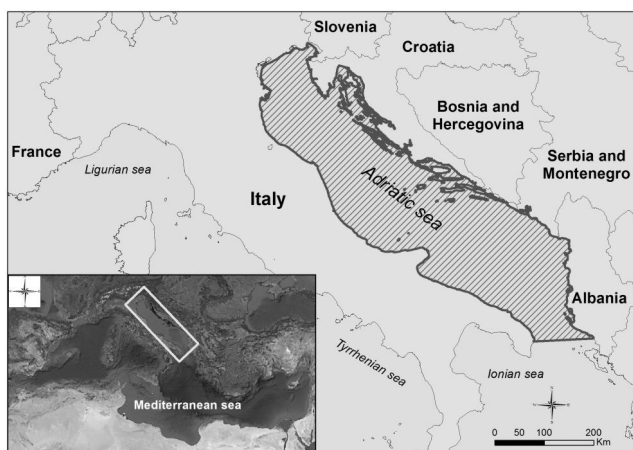


Fig. 1. Adriatic sea case study area

The approach is based upon the three main pillars of risk defined by UNISDR [4] and IPCC [5] and, accordingly, is composed of four consecutive steps. The first phase consists in the hazard assessment which aggregates metrics and scenarios of climate, ocean, bio-geochemical and anthropic pressures (e.g. chlorophyll concentration, temperature and salinity variation, bottom stress) for determining potentially affected marine areas. The exposure assessment selects and localizes key receptors that could be subject to potential losses (adverse consequences) in marine areas (e.g. seagrasses, coral and maërl beds,

aquacultures). Subsequently, the vulnerability assessment aims at evaluating the degree to which the receptors could be adversely affected by the considered hazards, based on their specific physical and environmental features (e.g. sensitive habitat extent and typology, biodiversity indexes, seabed typology). Finally, the relative risk assessment combines the information about the considered hazards, exposure and vulnerabilities, in order to identify marine areas and targets at higher risk from multiple pressures.

Results obtained for the Adriatic sea include GIS-based hazard, exposure, vulnerability and risk maps, as well as key risk indicators calculated for the selected marine receptors (e.g. extent of seagrasses and coral habitat potentially affected by human activities, alterations of physical and chemical parameters). The assessment showed that higher hazard scores are linked to climate stressors (i.e. sea surface temperature and salinity variation) while the lower ones resulted from anthropogenic and more localized pressures (e.g. abrasion, input of organic matter). Relatively very high scores were observed for vulnerability over the whole case study for almost all the considered pressures, showing seagrasses meadows, maërl and coral beds as the most vulnerable targets.

These output can be used as decision support tools for planners and local authorities, providing guidance and information on the current state and the main risks in the marine area of concern, thus setting the scene for the design and implementation of targeted management actions that consider spatially relevant issues and are consistent with the objectives of the MSFD [3].

## Conclusions

Integrating climate pattern with socio-economic and environmental information of the considered marine area, the proposed multi-hazard methodology supports a semi-quantitative evaluation and relative ranking of areas and targets potentially affected by multiple stressors in the considered marine region. The approach is flexible to be applied in different geographical regions and scenarios, supporting to evaluate both the progress toward the achievement of GES [3] and the potential effects of long-term climate change.

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