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Multi-risk assessment for sustainable marine management: the case study of the Adriatic Sea

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Assessing and managing cumulative impacts produced by interactive anthropogenic and natural drivers on the marine environment still remains a major challenge to sustainable development. The complexity inherent to marine ecosystems and the uncertainty linked to future changing scenarios represent major obstacles for understanding how multiple pressures will affect marine ecosystems and, as a consequence, selecting suitable management stratetegies for the sustainable use of marine space and resources. Enhancing our capacity to model and assess the combined effects of interactive stressors (e.g. temperature variation, shipping traffic, aquaculture, ports and harbors activities), in decisional contexts where data are limited and uncertainty is high, is a key component to aid the future planning and management of our seas.
In this study, a multidisciplinary risk-based approach, integrating GIS techniques with Multi-criteria Decision Analiysis and Bayesian Belief Networks, was developed with the main aim of evaluating the relationships between interactive climate and anthropogenic pressures (e.g. chronic and acute chemical pollution due to nutrients input and oil- spill, sea temperature variation, seabed abrasion), the environmental vulnerability of marine targets (e.g. seagrasses, maërl and coral beds, marine protected areas) and the resulting probability of cumulative impacts. The approach, by integrating different metrics and scenarios of climate, ocean, bio-geochemical and human-made pressures, was tested in the Adriatic Sea case study producing a set of future impacts scenarios for the timeframe 2035-2050, to be compared with the reference scenario 2000-2015.
Results, including GIS-based maps and statistics, showed low and moderate cumulative impact scores in the reference scenario, value which tends to increase in the future time window due to the effect of potential rising sea temperature. Mostly affected areas can be detected in the Nord Adriatic Sea in both timeframe scenarios, especially around the Po delta river and the ports of Trieste and Venice due to the intense shipping traffic and ports activities as well as the high nutrient input in the area. The proposed multi-risk model, and the resulting output from its application at the case study level, represent valuable decision support tools to inform maritime spatial planning and related decision-making processes, focusing efforts on marine areas and vulnerable targets where management actions and adaptation strategies would be best targeted.