Bridging the Gap between Climate Change and Maritime Security: Towards a Comprehensive Framework for Planning

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Abstract

For the past two decades, the need to shield strategic maritime interests, to tackle criminality and terrorism at or from the sea and to conserve valuable marine resources has been recognized at the highest political level. Acknowledging and accounting for the interplay between climate change, the vulnerability of coastal populations and the occurrence of maritime criminality should be part of any ocean governance process. Still, given the complex interactions between climate change and socio-economic components of the marine realm, it has become urgent to establish a solid methodological framework, which could lead to sound and effective decisions. We propose that any such framework should not be built from scratch. The adaptation of well tested, existing uncertainty-management tools, such as Cumulative Effect Assessments, could serve as a solid basis to account for the magnitude and directionality of the dependencies between the impacts of climate change and the occurrence of maritime criminality, offering spatial explicit risk evaluations. Multi-Criteria Decision Making could then be employed to better and faster inform decision-makers. These mechanisms could provide a framework for comparison of alternative mitigation and adaptation actions and are essential in assessing responses to tackle maritime crime in the context of climate change.

Keywords: global environmental change, maritime security, cumulative risk assessment, method standardization

1. Environmental and social complexities in marine and coastal systems

Coastal and marine systems provide critical environmental and social values, supporting the maintenance of human health and welfare (Costanza et al. 1997; Martínez et al. 2007). Still, coastal zones and the marine sites out to the continental shelf break are listed within the most heavily used and vulnerable systems of the planet, with climate change recognized as a major threat (Grebmeier 2011; Harley et al. 2006; Wise et al. 2014). Ample evidence is now available demonstrating that climate change alters ecosystem functionality and structure, biotic community composition and fisheries (Cheung et al. 2010; Hoegh-Guldberg and Bruno 2010; Pinsky et al. 2013). At the same time, it is acknowledged that the response mechanisms of natural and social systems could be eroded by the magnitude of global climate change, threatening societal stability and even triggering violent conflicts and criminal behaviors at national, regional and global scales (Barnett 2003; Gemenne et al. 2014; Gleditsch 2012; Hsiang and Burke 2014; Scheffran et al. 2012).

Security issues (e.g. illegal fishing, piracy, drug and arms smuggling, illegal immigration and human trafficking) in the sensitive maritime domain have recently received considerable attention at higher political levels (Bueger 2015; Germond 2015). Still, the magnitude and directionality of the links and dependencies between maritime criminality and alternative stressors, such as the impacts of climate change on marine ecosystems and down the line on human systems, have not yet systematically been analyzed. Consequently, the methodological framework that could offer the basis for a systematic management and spatial mitigation planning is missing even though this need has somewhat been recognized by states and supranational actors (e.g. Council of the EU 2014; HM Government 2014).

Social vulnerabilities, criminality and environmental components are linked through multiple pathways altering safety and good governance within the maritime domain (Cochrane et al. 2009; Pomeroy et al. 2016). A critical step for effective long-term planning and adaptive management of coastal and marine systems is to incorporate this complexity into decision-making processes and governance mechanisms (Stelzenmüller et al. 2018). Still, the successful application of any assessment method would require reliable information on the distribution of security components and on the expected impacts from multiple sources/activities, which is not always available. An additional challenge consists in finding how to incorporate impacts which are not easily predictable (e.g. stochastic extreme weather events) and/or could emerge as a complex network of relationships (e.g. extreme weather events that impact upon poverty or food security), whose magnitude and directionality are still uncertain (Jones et al. 2016; Judd et al. 2015; Scheffran et al. 2012). For example, direct evaluations of the links between climate change and violent conflicts or criminal activities are often complicated due to uncertainties in the quantitative data used to establish the associations (Gleditsch 2012). Similarly, methodological difficulties in distinguishing whether identified impacts are related to climate or to short term weather fluctuations, or the ability to delineate various other variables that can explain the occurrence of violence, highlight the uncertainties associated with this field of research (Baldwin 2014; Barnett 2003; Barnett and Adger 2007; Gemenne et al. 2014; Gleditsch 2012).

What is currently lacking is the science that integrates the multiple links between climate change and the occurrence of maritime criminality, while considering the assumptions underlying the role, estimation, quantification and sensitivity of background factors structuring these links (Scheffran et al. 2012). In this paper, we suggest that the means to conceptualize, quantify and evaluate the magnitude and directionality of the links and dependencies between climate change and the occurrence of maritime criminality can be found in well-established cross-disciplinary research achievements. As a first step toward building an adequate framework for analysis and planning, we propose to adapt existing and comprehensive methodologies and tools commonly used for evaluating environmental risks. These tools are widely used for informing conservation planning and guiding management decisions; we propose that they could also be used to inform how maritime security as a social risk could interact with, and be exacerbated by, climate change at local, national, regional and global scales.

2. Climate change dimensions in maritime security

Climate change alters maritime security without causing violent conflicts and threatening the integrity of states directly. Floods, changes in the ocean biophysical conditions, expansion of invasive species, changes in production of marine fish and shellfish species are all linked to climate change causing serious degradations of the functionality, structure and services of coastal and marine systems (Cheung et al. 2009; Hoegh-Guldberg and Bruno 2010; McGranahan et al. 2007). Shipping hazards and damage to maritime infrastructure as outcomes of extreme weather events, fish stock reduction and the redistribution of marine biodiversity could negatively impact livelihoods, incomes and health, leading to social, political and economic collapse. Eventually, such conditions could create incentives to engage in various forms of criminal behavior.

Poor management strategies and loose surveillance are often attributed to poverty, economic collapse and environmental degradation, which coexist with climate risks (Allison et al. 2009; Cinner et al. 2012). Ineffective management sets the stage for cascading effects such as overexploitation of marine resources, food scarcity or water pollution by domestic and industrial wastes. Climate-driven changes in people's living and working environments, could also influence displacement and migration patterns, increase health risk, strengthen competition for resources and alter geopolitical stability (McMichael et al. 2012). In turn, these dimensions of social instability activate factors of maritime insecurity such as illegal fishing, piracy, drug trafficking and arms smuggling, as well as illegal immigration and human trafficking. For example, Jasparro and Taylor (2008) have highlighted the link between climate change, degradation of fisheries and socio-economic conditions, and the occurrence of piracy in South-East Asia. The importance of socio-economic components, in addition to physical and ecological ones, towards assessing the complex impacts of climate change upon fishery has also been acknowledged (Cochrane et al. 2009). Similarly, the need to put in relation climate change impacts and bad governance has been highlighted to explain the occurrence or strengthening of illegal practices regarding fishery (Allison and Kelling 2009).

Crucially, the dependencies between climate change and maritime security are not unidirectional (Fig. 1). Indeed, the sustainable development of coastal communities may be undermined by illegal activities performed at or from the sea (Malcolm 2017), feeding back the loop. For example, maritime crime threatens marine ecosystem integrity through illegal fishing (Agnew et al. 2009) or jeopardize conservation efforts through piracy or redirection of financial aid (Mazaris 2017; Mazaris et al. 2016). Illegal fishing activities result from pressures likely to increasingly originate in climate change (such as scarcity of fish resources) and then in turn affect fisheries resources (Pomeroy et al. 2016). Ultimately, further such pressures on sensitive ecosystems and challenges to the blue economy (i.e. sustainability and economic development in the marine and maritime sectors) can in turn trigger additional motivations to engage in maritime crime. This is a synergistic process, which results in an exponential loop of environmental issues, structural pressures on the social, political and economic systems, and maritime crimes.

In sum, the magnitude of social and economic sectors relying upon the marine realm contributes to a complex array of receptors but also constitutes an additional source of pressures for the sensitive marine ecosystems (Atkins et al. 2011). Overexploitation of marine resources, illegal migration and human trafficking, are all vectors of instability which could be intensified under social, political or economic unrest (McMichael et al. 2012). An inadequate consideration of the interactions, the underlying drivers and the cumulative impacts of pressures and activities, along with the multidimensional impacts of climate change, could downgrade the efficiency of policy measures targeting a sustainable use of the oceans.

3. Promoting standardized planning tools

The question of how to identify the magnitude and directionality of various factors and processes, and also how to quantify and evaluate their cumulative, incompatible or multiplicative effects upon various receptors, is not novel (Borja et al. 2016; Korpinen and Andersen 2016). This is also the case for the complex role of the continuous and dynamic threat of climate change (Costanza et al. 1997). Understanding how climate change triggers responses and poses alterations to natural and socio-economic systems and how this could accelerate, interact and feed upon existing pressures represents a major scientific challenge (Barnett and Adger 2007; Gemenne et al. 2014).

Methodologies endorsed within the wider context of Cumulative Effect Assessment (CEA) allow identifying causalities of multiple pressures operating at various temporal and spatial scales, offering the means for systematic, spatially explicit action planning (Borja et al. 2016; Crain et al. 2008). The basic aim of CEAs is to cover the wide vector of anthropogenic pressures and estimate their additive, multiplicative, synergistic and antagonistic impacts upon selected ecosystem components (e.g. habitats, populations). Depending on the scope of the assessment and action planning (e.g. reserve selection, evaluation of environmental status, prioritization of management and mitigation measures), CEAs could be applied at local, national, regional are even continental scales (Judd et al 2015). Even if initiated from a scientific, political or legal perspective, the basic rationale behind CEA is to spatially overlay multiple pressures and assess their impact on ecosystem components (e.g. species, communities, ecosystem functions). The impact of a pressure upon the target ecosystem's features is assessed either through numeric evidence (e.g. spatial extent of degradation, species population reduction) or categorically as the outputs of expert consultations (Korpinen and Andersen 2016). Under this context, once the impacts of climate change and interactions with other pressures are conceptualized, they become part of the assessment process (Therivel and Ross 2007).

Drawing from the theory behind CEAs, we could distill a set of opportunities offered to address challenges in managing maritime security risks in the context of climate change. A major challenge in assessing risks within complex systems consists in the limited quantitative evidence on the combination or interaction between social, economic and environmental stressors; one way that CEAs could overcome this limitation is by applying impact weighting factors for any combination between specific pressure and ecosystem component (Korpinen and Andersen 2016). This weighting scheme reflects "vulnerabilities" to pressures and could be fed by expert opinion, while multiple interactions (i.e. weighting schemes) could be applied and progressively analyzed. Under the context of CEA, an analysis of maritime security could be done once a series of environmental or social components, which reflect the concern of stakeholders, have been selected so as to capture a holistic picture of the phenomena under evaluation. For example, when there is a need to prioritize actions towards mitigating and managing regional maritime insecurity issues, weighting indicators of selected components could serve as a first step to assess the relative effects of these potential actions (Mitchell and Parkins 2011). In this case one could ask how climate change might alter well-functioning governance (i.e. social component) by considering and weighting a set of alternative indicators (e.g. quality of the civil service, cultural support, control of corruption); similarly, expansion of criminal activities could be reflected by a set of economic and social indicators (e.g. altered conditions of the business environment, increased access to some technologies, etc.).

Often, quantitative evidence to support a direct link between climate change and the extent of a security issue (e.g. initiation of violent conflict) are not available (Baldwin, 2014; Barnett

2003; Barnett and Adger 2007). An additional principle that is often adopted by marine CEAs towards informing conservation and management planning is the validation of applied impact scores, which can even operate under a lack of information on links and dependencies between different drivers, components or actors. For example, the objective of a regional study might be to inform decision-makers and generate a spatially explicit risk assessment on activities against mariners and shipping by considering multiple stressors including climate change. In this case, uncertainty analyses could be run in order to generate sets of results under alternative assumptions of the type of interactions and data inputs; similarly, simulation-based sensitivity analyses could determine the relative importance of each stressor, including climate change, upon overall assessment (Stock and Micheli 2016). Uncertainty and sensitivity analyses would allow delineating which are the most critical stressors (e.g. food scarcity) and how they could be accelerated by the secondary impacts of climate change (e.g. pressure upon population health). At the same time, they could exemplify the information gaps and bridge them to generate a spatially explicit assessment output.

Once CEA has allowed better grasping the way climate change and maritime criminality variables interact, then multi-criteria decision making (MCDM) frameworks represent reasonable variety of approaches to assess the interactions of physical, biological and human systems, and address the consequences of actions and decisions upon policies and planning (Huang et al. 2011; McGranahan et al. 2007; McMichael et al. 2012). Similar to the case of maritime security issues, the intensity and reciprocity of the interactions inherent to decisions on many environmental and energy issues are not always straightforward and thus subroutines must be developed to account for the uncertainty of the inputs and the variation in sensitivity of the outputs. For example, in order to tackle maritime crime at a national scale, key vulnerable groups should be identified and the basis for cooperation (e.g. though financial support, small-scale infrastructure) could be recognized.

The same concerns apply to climate change, which, considered as a major driver of change and/or as a source of uncertainty in decision-making, is incorporated into multi-criteria, integrative assessments aiming to guide effective management (Bell et al. 2003; Pinsky et al. 2013). Decision-makers operating in the field of maritime security and risk mitigation could benefit from MCDM tools towards setting an action plan while accounting for social and behavioral patterns, legislation, governance and risk factors, irreversible impacts, as well as prevention and adaptation costs. For instance, decisions based on series of available options could be informed by the need to maximize the adequacy of international financial investments to support safety, health and economic development of communities that are considered at risk from the point of view of the interaction between climate change and maritime security. Similarly, under conditions of severe maritime crime, a prioritization should be made on whether irreversible impacts for the community would be driven by the exposure to extreme weather events or any other factors such as illegal fishing.

4. Building consensus and capacity

The outputs of any risk assessment and thus of any decision-making processes should be accompanied by a detailed description of the methodological choices and their potential limitations (Judd et al. 2015). Tools based upon the concept of CEA could offer the means to spatially define risk *hotspots* in respect to selected and predictable indicators that are relevant to policy level developments. On the other hand, MCDM contributes to a better management of the risks by improving decision-making. The two tools could further complement each other, as CEAs could generate spatially explicit assessments recognizing critical locations or components for intervention (e.g. spotting communities that are under higher pressure due to criminality) while MCDM could build upon such background to devise optimal decisions on actions over a set of alternatives.

To further add clarity, the improvement of data quality, the application of standardized monitoring schemes and the careful interpretation of the outputs are critical steps for the success of any assessment. Apart from enhancing parameterization of uncertainty-management tools, the identification of simple pathways over complex networks of interacting drivers (e.g. human activities, societal attitudes) could help to translate outputs into prioritization of governance initiatives and policies (Martínez et al. 2007). Often, a first step to standardize assessment processes is to achieve a consensus on the terminology commonly employed to describe components, indicators and impacts (Judd et al. 2015; Stelzenmüller et al. 2018).

The mitigation of the effects of climate change on natural and human marine systems requires interactive decision-making and management processes, grouping various state and non-state stakeholders and spanning across multiple dimensions and scales. Therefore, making the outputs of the maritime security assessment tools useful for governance requires a science-policy dialogue towards co-designing questions, inputs and indicators. Once the alignment between available scientific information and policy-makers' needs is achieved, regulations, policies, strategies and commitments need to be formed.

Acknowledging the uncertainty inherent to any decision-making process, centers for integrated research where background information, existing tools and datasets could be synthesized, can provide answers and technical solutions. We urge scholars, research institutions and think tanks to start building the foundations for such integrated centers of excellence as the only way to offer ground solutions for an increasingly challenging issue.

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Figure 1: The multidirectional dependencies between climate change and maritime security proceed from the complex interplay between the effects of climate change on natural and human systems and actors' responses to impacts. In turn, these responses, including criminal behaviors, feed the loop back, since actors are both objects and agents of impacts. Cumulative Effect Assessments (CEA) and Multicriteria Decision Making (MCDM) could be adopted to better inform actors and gradually drive mitigation, adaptation and management planning.