



Manifestation of maritime piracy as an additional challenge for global conservation



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ABSTRACT

Hostile acts against ships and mariners remain a global social and political phenomenon which usually reflects a high degree of socioeconomic vulnerability. The identification of the causes and driving factors behind the deteriorating maritime security has received considerable attention. However, their potential impact upon biodiversity conservation initiatives remains poorly evaluated. In the present study the spatial overlap between biodiversity hotspots and hotspots of hostile maritime acts are explored. The majority of such hostile acts occur in economically vulnerable countries, with the operation of their Marine Protected Areas largely depending on the revenue generated by visitors. Given that hostile maritime acts could cause financial losses and increase social and political instability, they could significantly alter conservation efficiency. Thus, it is critical to consider the way of incorporating maritime security risks into conservation agendas.

1. Introduction

The world now faces a global biodiversity crisis [1]. At the same time, the increase of violent acts against humanity is the leading challenge for modern communities [2,3]. The amplification and substantiality of conservation efforts in a given area depend on the sociopolitical conditions detected at national or regional scales [4]. Political unrest and unstable socioeconomic context could have multi-dimensional implications for conservation [5]. Under increased national security risks and/or societal and economic collapses, a profound redirection of the national priorities and of the financial targets towards humanitarian needs is needed. Similarly, international funds, which often reflect the only viable way for the establishment of basic conservation plans and for the development of green infrastructure at given areas of our planet, should be redirected towards the maintenance of peace, social stability and economic recovery.

Financial constraints, lack of enforcement of national and international treaties and commitments, and gaps in scientific knowledge are currently listed among the main conservation barriers [1,6,7]. While the synergies and interactions among these factors are clear, violent acts (i.e. act of terrorism, warfare, or other forms of violence or social disturbance) could further pose an additional obstacle to conservation efforts. For example the level of security could impede scientific research and international communications [7,8], while could significantly reduce income generated by tourism which is often critical for the operation of Protected Areas [9].

The ability to reduce the risk of biodiversity loss and the collapse of

conservation infrastructure, requires both an understating of the implications of violent acts and a spatially explicit framework that could allow translating the implication of such acts to conservation needs and gaps. In the last decade, an increasing number of studies have listed the direct impacts of warfare, military operations and civil conflicts upon habitats, species and ecosystems (for reviews [10,11]). Similarly, few global studies have attempted to demonstrate the extent of ecological risk associated with violent acts, by overlaying major warfare events and biodiversity hotspots [12] or by linking the distribution of Marine Protected Areas (MPAs) and metrics of national security including the risk of terrorism [9]. The above-mentioned studies have contributed much to our understanding on how violent acts could be transformed from a societal challenge to a major biodiversity threat, but questions about the extent of the risks and the global impacts remain.

In this paper, an attempt is made to contribute to this discussion by analyzing spatially explicit information of hostile acts (i.e. hijacking, piracy and armed robbery) against ships and mariners, as an additional type of violence which has been overlooked from any previous assessment. The armed, hostile activities against the ships and mariners, does not necessarily occur in belligerent countries, and thus their impacts upon conservation initiatives could be underestimated by studies focusing on warfare implications. Still, the existence of any such action that threaten maritime trade and security, premises a destruction or collapse of main societal infrastructure (e.g. law enforcement system) at such a degree that protection of marine resources is often non-existent [13,14].

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This study explores the spatial patterns of hostile acts against ships and mariners and delineates any potential relationship of the spatial configuration of these activities with the coverage of MPAs. The economic status of the countries that faces limited maritime security is explored. An additional objective of this study is to examine whether hostile activities occur within marine areas of high biodiversity value, and thus are likely to pose additional barriers to conservation initiatives.

2. Methods

Data on anti-shipping activities were obtained from the National Geospatial Intelligence Office (<https://www.nga.mil>). The dataset consists of more than 7000 records on location and specific details of hostile acts against ships and mariners. For the present analyses, a total of 2767 reports on threats of piracy, hijacking, robberies or incidents of suspicious activities, from 2010 until the present were utilized. Data regarding the classification of countries into groups of economic wealth were derived from World Bank. Specifically, based on the most recent (i.e. 2015) economic data, countries were grouped into four categories on the basis Gross National Income (GNI) per capita; low income economies: GNI per capita \$1025 or less in 2015; lower middle-income economies: GNI per capita between \$1026 and \$4035; upper middle-income economies: GNI per capita between \$4036 and \$12,475; high-income economies: GNI per capita of \$12,476 or more.

A spatial database of maritime Exclusive Economic Zones (EEZs), derived from Marine Regions [15], was used to determine number of hostile activities across territorial waters. A map of protected areas was obtained from World Database of Protected Areas [16]. To calculate the actual maritime surface which is under protection, the terrestrial sites were removed by clipping out surfaces from protected areas within the coastal boundaries of a full resolution level 1 (global coastline) dataset derived from the Global Self-consistent, Hierarchical, High-resolution Geography (GSHHS) database [17]. The number of MPAs was then calculated as the distinct polygons of protected seascape maintained. The percentage of national maritime EEZ under protection was then calculated.

To test whether countries where hostile acts take place, have a significantly lower coverage of MPAs, a Mann-Whitney test was employed. Acknowledging that a limited number of hostile activities might be reported in a given country, without actually reflecting an existing threat of maritime security, the upper 90th percentile of the countries subjected to an extended threat of anti-shipping activities ($n=27$; > 14 reported incidents per country over the study period) were considered.

Richness maps of threatened marine mammals, corals and fish were produced by using spatial datasets derived by the International Union for the Conservation of Nature (IUCN; <http://www.iucnredlist.org>; downloaded 8/8/2016).

Kernel density estimations (KDE) were calculated by using Home Range Tools version 2.0.20 [18] extension for ArcGIS (version 10.3, ESRI, Redlands, California, U.S.A.) to objectively assessing space expansion of anti-shipping activities. A least squares cross validation method was applied to determine bandwidth of KDE. Contours representing 50%, 90%, and 95% estimates of area use were generated based the volume of the KDE distributions and were compared with global hotspots of threatened marine biodiversity.

3. Results

The vast majority of hostile acts against ships and shippers occurred at western Indian Ocean, eastern Indian Ocean and western Pacific Ocean, east central Atlantic Ocean, and Caribbean Sea (Fig. 1a and b). About one fifth (~20) of the activities took place in international waters, at the western Indian ocean. Since 2010 hostile activities were reported in 82 countries, with only 26 of them hosting the vast majority

(> 90%) of these actions (see Appendix A). Only two of the 25 countries, Oman and Seychelles where listed as highest income economies, six as upper middle income countries, 12 as lower middle income and six were defined as lower income countries.

The higher number of incidents were reported in the territorial waters of Indonesia ($n=595$), Nigeria ($n=233$), Yemen ($n=216$) and Malaysia ($n=120$). Of these countries Indonesia and Malaysia host a large number of MPAs ($n=295$; $n=166$ respectively) while Nigeria and Yemen have only limited MPAs (1 and 3 respectively). The 26 countries subjected to hostile anti-shipping activities, host less than 5% ($n=532$) of global MPAs. Still, no significant difference was detected in the proportion of the territorial water being protected in these countries in comparison to others that are free of hostile maritime activities ($p > 0.05$).

Antishipping activities occur in tropical and subtropical regions of the planet which support the largest proportion of threatened coral species (Fig. 1c) and provide habitat for several threatened marine mammals (Fig. 1d). In the South China Sea, east Indian Ocean, which was identified as a hotspot of anti-shipping activities, the waters of Indonesia and Malaysia hosts more than 75% of the coral species threatened globally. The same region provides habitat for many threatened marine mammals. This is also the case for the Gulf of Guinea, east Atlantic Ocean, with high density of hostile anti-shipping activities overlapping with one of the richest areas of the planet for threatened marine mammals.

4. Discussion

Identifying the linkages between national security risks and biodiversity conservation is critical for designing appropriate management plans [12]. The results of this study show that hostile activities against ships and mariners are distributed across specific regions of the planet which have a high marine biodiversity value. The countries which are subjected to a higher degree of anti-shipping incidents could be grouped into two main categories: those that host a large amount of MPAs and those that are far behind in officially protecting marine environment though the establishment of MPAs. As the vast majority of these countries are weaker economies, it is likely that anti-shipping activities could have a significant impact upon conservation efforts regardless of the numbers of MPAs listed.

Although different dimensions of maritime security has been increasingly addressed in the scientific literature over the last decades [19,20], the majority of these studies deal with the geopolitical dimensions of hostile actions [19], the impacts upon fisheries [21,22] and the influence on patterns and decisions of maritime traffic [23] but largely ignore the direct and indirect influences to marine conservation. Security status drives tourism demand and determines destination selection [24]. Given that the revenue generated from visitors of protected areas covers various costs of the operation of MPAs [25], any action that could increase the perception of insecurity could act as an additional obstacle against conservation targets. While the world-wide costs for the operation and support of the global network of MPAs could range from \$5 to \$19 billion annually [26], the annual costs of maritime piracy to global economic range from \$7 to \$12 billion annually [27]. Piracy and detour costs are projected to increase up to \$30billions annually, if no actions to mitigate the threats will be taken [28].

Investments that are critical for societal peace, security and development (e.g. on naval deployments, embarked guards, vessel hardening, rerouting, prosecutions and imprisonment) [29], could potentially limit financial resources, effort, personnel and infrastructure development towards protecting the global services generated by marine biodiversity. For example only in 2009, piracy has cost to Yemen \$150 million in security expenses while the costs due to losses of fishing and relevant revenue was estimated to \$200 million [30]. In Yemen, a country with estimated Global Domestic Product per capita

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