Navigating spaces for implementing raptor research and conservation under varying levels of violence and governance in the Global South

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Abstract

The Global South harbors a large share of imperiled biodiversity. Effective research and conservation in the Global South are negatively affected by weak or turbulent socio-political contexts, such as poor governance and/or high violence levels. There is a need to understand how priorities for research and conservation relate to different levels of violence and governance, in order to highlight opportunities and challenges for biodiversity conservation. We explore the spatial overlap between density of violence and raptor research and conservation priorities, and unveil the effect of considering governance and violence when prioritizing areas for raptor research and conservation. Raptors are a group of species potentially highly affected by violence that may lead to proliferation of firearms and uncontrolled wildlife resource extraction. We found low spatial correlation between raptor research and conservation priorities and violence in the Global South. Exceptions are represented by distinct areas of high or increasing violence and that are important for raptors, such as the central African Rift Valley and west Yemen. We also highlight emerging potential opportunities, such as coastal West Africa, where violence is decreasing. Overall, while we show that governance and violence only marginally affected the distribution of raptor priority areas, results also highlight spatio-temporal dynamics in violence and governance that should be considered when navigating the research-implementation space in the Global South. In these regions it is crucial to focus on societal issues to reduce social and economic inequalities, stabilize unsafe regions and promote community-led initiatives that would mutually benefit people and wildlife.

Short running title: Raptor conservation under violence and governance in the Global South
Key words: Armed conflicts; birds of prey; geopolitics; war; biodiversity; research-implementation space

1. Introduction

Biodiversity is being lost worldwide at accelerating rates (Butchart et al. 2010; Ceballos et al. 2015). Averting the collapse of biodiversity and the associated ecosystem services it supports may still be possible, but increased efforts are required (Ceballos et al. 2015; McCarthy et al. 2012). Conservation efforts can only be effective if adequate knowledge of threats and conservation actions to avert such threats are available (Sutherland et al. 2004). However, detailed knowledge of threats to biodiversity, as well as of the responses of species and ecosystems to the drivers of threats, is still very limited (Joppa et al. 2016). Navigating the space to implement conservation and increase knowledge is thus crucial, because the window of opportunity to avert the global biodiversity crisis is rapidly closing (Ceballos et al. 2015; Wilson et al. 2016). This is particularly so for the tropical areas of the world, where most of the hotspots of threatened biodiversity occur (Allan et al. 2019), and where resource and capacity limitations, as well as socio-political factors, hinder conservation efforts (Buechley et al. 2019; Wilson et al. 2016; Zuidema et al. 2013).

Effective research and conservation are typically challenging under weak or turbulent socio-political contexts (Brito et al. 2018; Hanson et al. 2009). Recurring events that result in violence against humans, hereafter broadly referred to as violent events, such as, but not limited to, armed conflicts, can hinder the acquisition of conservation funds, the implementation of actions, and the conduction of research that provides the evidence-base for effective action (Brito et al. 2018; Dudley et al. 2002). Furthermore, violent events have been linked with unsustainable harvesting of wildlife (Brito et al. 2018; Daskin and Pringle 2018; Gaynor et al. 2016). Conflicts may also imperil protected area staff, researchers, and tourists (Hamilton et al. 2000). Similarly, conflicts may act as a strong deterrent for conducting monitoring and other ecological and applied research (Brito et al. 2014; Gaynor et al. 2016), as well as create barriers for the effective engagement of local communities in conservation initiatives (Madden and McQuinn 2014). However, in some cases, conflicts may also benefit biodiversity by hindering encroachment and development (McNeely 2003).

Several tools have been identified for implementing effective conservation in areas of high incidence of violent events (Brito et al. 2018). Moreover, conservation and natural resource management initiatives have been used to mitigate the drivers of human conflict (Roe 2015). Among those, community-based wildlife or natural resource management, as well as protected areas, may represent effective long term conservation tools (Brito et al. 2018). In addition to violence, another important factor influencing the effectiveness of conservation is governance (Amano et al. 2017; Baynham-Herd et al. 2018). Poor governance has been reported to negatively affect conservation efforts and also to reduce international aid for biodiversity (Miller et al. 2013). Therefore, governance can play an important role in driving the allocation of conservation efforts globally (Eklund et al. 2011). Overall, conflicts and governance may act in synergy, with deleterious effects for conservation as they may limit resources for conducting research and implementing actions, and limiting effective use of resources where these are available.

There is a need to understand how priorities for research and conservation relate to violence and governance, in order to highlight opportunities and challenges for biodiversity conservation. To this end, the Strategic Goal E of the Aichi Biodiversity targets of the Convention on Biological Diversity (CBD) specifically calls for enhancing the implementation of biodiversity conservation measures through knowledge management and capacity building by 2020 (www.cbd.int/sp/targets/). While the
deadline to achieve such targets is fast approaching, we still lack a systematic, large-scale understanding of the role that factors such as governance and violence may have while navigating the biodiversity research and implementation space. This is particularly important for species, such as avian predators and obligate scavengers, occurring in tropical areas (Buechley et al. 2019). Such species play disproportionately important roles in the ecosystem, and their loss may disrupt ecosystem functions and services (Buechley and Şekercioğlu 2016; O’Bryan et al. 2018), thereby negatively impacting human societies (Markandya et al. 2008; O’Bryan et al. 2018; Santangeli et al. 2019).

The vast majority of studies addressing the connection between conflict and wildlife have focused on large mammals (Gaynor et al. 2016). However, birds are illegally shot in large numbers across several conflict regions, such as areas bordering the Mediterranean and in the Middle East (Brochet et al. 2016). Hunting is one of the main threats to raptors worldwide, and these species are declining at a rate much higher than most other taxa (Butchart et al. 2004; McClure et al. 2018). As large and relatively obvious targets, raptors may be particularly threatened in areas where conflicts and violence lead to the proliferation of weapons and create conditions of poor law enforcement, potentially facilitating illegal activities. In these areas, the taking of raptors to fill a growing demand for specimens, body parts, or as bushmeat may be widespread (Buij et al. 2016; McClure et al. 2018; Williams et al. 2014). A recent study highlighted major gaps in global raptor research and conservation in the Global South (Buechley et al. 2019). At the same time, the Global South includes areas most afflicted by violence and poor governance (Gaynor et al. 2016). Research and conservation efforts may be often hindered by violence and poor governance (Amano et al. 2017; Gaynor et al. 2016). However, many critical areas for biodiversity conservation occur under high violence and poor governance, highlighting the relevance of implementing efforts in these areas, for the mutual benefit of people and nature (Brito et al. 2018).

Here we aim to explore the spatial relationship between violence and raptor research and conservation priorities (i.e. areas that are important for the conservation of threatened raptors that have been least covered by scientific research), and to unveil the effect of considering governance and violence when prioritizing areas for raptor research and conservation efforts. We use the raptor research and conservation priority index, hereafter RCPI (Buechley et al. 2019) that, compared to a simple species richness metric, ranks species by their scientific coverage (i.e. how many publications on that species are available in the field of ecology and conservation) and also by their conservation priority (i.e. their IUCN Red List status). This index allows to identify areas holding under-researched and threatened species, thus in need of immediate conservation attention. Specifically, we map the co-occurrence between recent violent events and priority areas for raptor research and conservation across Africa, Asia and the Middle East. Second, we map the co-occurrence between a nine year trend in violence in Africa and current priority areas for raptor research and conservation. Third, we use a conservation planning tool to explore the possibility of finding efficient conservation solutions while accounting for governance and violence. We propose that if priority areas for raptor research and conservation largely occur where violence is high and governance poor, avoiding those areas would reduce the efficiency in achieving raptor research and conservation objectives in the Global South. Understanding the spatial co-occurrence of raptor research and conservation priorities with varying levels of governance and violence is important in order to describe the context that defines the research-implementation space. Only by understanding and defining the social context it will be possible to efficiently and effectively navigate the research and implementation space (Toomey et al. 2017).

2. Methods

2.1 Violence data
Data on violence were obtained from the Armed Conflict Location and Event Dataset (ACLED; Raleigh et al. 2010). This data source was also recently used to investigate how armed conflicts may affect the selection of protected areas for conserving biodiversity (Hammill et al. 2016). ACLED data is the best available dataset for this analysis, having higher precision and more reported events than other similar databases, for example the UCDP Georeferenced Event Dataset (Sundberg and Melander 2013). From the ACLED database, we downloaded violent events (i.e. battles, violence against civilians, remote violence), from across all regions where data were available. Data from Africa, the Middle East, and South and South-East Asia were available for the period 2016-2018, whereas a longer time period (1997-2018) was only available for Africa. Only data with available coordinates, the vast majority of the data (i.e. 96% of the data from across the whole region in 2016-18 and 99% from Africa for the period 1997-2018), were used.

To obtain a snapshot of recent violence across the entire study region, all violent events from 2016-18 years were pooled. A kernel density map (Diggle 1985) was then derived from these points, resulting in a raster layer with a resolution of 10km x 10km and depicting current density of violent events (see Figure A1). A kernel density map is deemed most appropriate in this case because violent events are typically assumed to cause displacement of civilians and movements of military forces. Therefore, the effects of violent events may spill over to surrounding areas. This fact justifies the use of a kernel approach whereby the effect of violence gradually decreases with the distance from the event point (O'Loughlin et al. 2010). Also, allowing a wide spatial effect of violence beyond the incident point is most appropriate for this study where violence is not only related to conservation, but also to research allocation. Researchers may avoid altogether regions where the density of violent events is high in a wide area, such as a country, or part of a country (Pettorelli et al. 2019).

We then used the violent events from Africa from 2010-2018 to build kernel density maps for each year at the resolution of 10km x 10km. The nine resulting density maps were used to derive pixel-level trends in violence. To do so, we ran pixel level linear regression using the curve fit tool in ArcGIS 10.1 (©ESRI), considering violent events (the kernel surfaces) from across the nine year time period. This time period was chosen because the number of conflicts in several regions of Africa, such as the Sahara-Sahel, has significantly escalated since 2010 (Brito et al. 2018; Brito et al. 2014). This time period is also more likely to better represent recent trends in violence. In the following analyses (see below), we used the pixel (10km x 10km) level regression coefficient depicting the violence trend from 2010-2018. We repeated the above analyses using data from 1997-2018, deriving the trend in violence for the same 21-year period, in order to compare timelines (both periods of violence trends are shown in Figure A2).

2.2 Governance data

We obtained country level governance information from the World Bank (https://datacatalog.worldbank.org/dataset/worldwide-governance-indicators), whereby six measures of governance are provided: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption. All measures are scaled equally. We calculated the average from across all six indicators per country for the year 2016, the most recent year with a complete set of all six governance measures for the study region (Baynham-Herd et al. 2018). This national level governance indicator was then converted into a raster of the same resolution as the above layers (i.e. 10km x 10km pixel size; shown in Figure A3) and used in the spatial conservation planning analyses.

2.3 Raptor research and conservation data

We used a recently published raptor research and conservation priority index (Buechley et al. 2019) to indicate priorities across the study region. The species-specific index is based on a combination of
scientific coverage of the target species (i.e. how many scientific publications focus on each species) and IUCN threat status (Buechley et al. 2019). The index ranges from 0.1 to 1, where 0.1 depicts a species of low priority (e.g. least threatened and with a high number of scientific publications), and 1 depicts a species of highest priority for research and conservation (e.g. highly threatened and least covered by scientific publications). The index has been recently used to highlight areas in the world that are important for raptor research and conservation (Buechley et al. 2019). We here focus on all 241 extant raptor species that occur within the study region (Supplementary Table A1; Buechley et al. 2019). We also conducted separate analyses on widely-recognized raptor groups: hawks and eagles (hereafter hawks), falcons, owls, and vultures. This was deemed worthwhile, due to the different spatial patterns emerging from the research and conservation priorities of these different groups (Buechley et al. 2019). We present results for these four separate groups in supplementary materials.

2.4 Spatial analyses

Spatial association between violence and raptor priorities

To compare spatial patterns of raptor research and conservation priority with violence, we calculated and mapped the local Lee’s L bivariate spatial association using the package “spdep” in R (Lee 2001). As original layers we used the kernel layer depicting density of violence, and the layer depicting ranked priorities for raptor research and conservation (all at the 10km x 10km pixel resolution). Lee’s statistics represents a measure for the pixel level correlation between two spatial layers while accounting for the spatial autocorrelation of each variable. Specifically Lee’s metric combines Pearson's R with a bivariate Moran's I into a single statistic that simultaneously considers correlation and autocorrelation. Lee's L metric is computed in each cell using all the pixels around the focal pixel (10km x 10km). We centered the Lee's L metric to zero and constrained its range between -1 and 1 (Mateo et al. 2016), thus allowing easier interpretation of the spatial correlation values. A positive Lee's L indicates that clusters match for the two variables (i.e. high violence and high priority for raptors, or vice versa, essentially the two factors go hand in hand), whereas a negative value indicates that the clusters have an opposite spatial distribution. A value around zero indicates that the spatial structure of the two variables considered is not correlated (i.e. they are largely independent of each other). We thus calculated and mapped Lee’s L statistics between violence (for the period 2016-2018) and raptor research and conservation priorities from across the whole study region, and between violence trend (using in turn the trend for period 1997-2018 and 2010-2018) and raptor research and conservation priorities from across Africa. To ease interpretation, all results from the above analyses are shown only for the top 30% most important global priority areas (Buechley et al. 2019) for raptor research and conservation in the study region. This is done to limit interpretation of the results and restrict the focus on areas that are of primary importance for advancing raptor research and conservation.

Spatial prioritization accounting for species complementarity, violence, and governance

We used the spatial conservation planning software Zonation (version 4.0; Moilanen et al. 2014) to identify priority areas for raptor research and conservation, while accounting for governance and violence. Zonation prioritizes landscape units (e.g. raster cells) by iteratively ranking them by their conservation value, while accounting for species complementarity. We used the additive benefit function that promotes representation of all the features (e.g. species distributions, violence or governance; Moilanen et al. 2014). The overall aim of this conservation planning exercise was to explore the independent and combined effect of governance and violence when prioritizing for raptor research and conservation. Essentially, we asked whether hypothetically avoiding areas of high violence and poor governance could impact the efficiency (i.e. amount of landscape required to protect
priority areas) in protecting priority areas for raptor research and conservation. Therefore, we set up separate zonation runs each representing a scenario: a) only raptors; b) raptors and violence; c) raptors and governance, d) raptors, violence, and governance. We then compared the results from these different scenarios. To prioritize areas of high importance for raptor research and conservation across each run, we assigned a weight to each raptor species according to the raptor research and conservation priority index (Buechley et al. 2019). This species-specific weight was associated to each species distribution range (BirdLife International and NatureServe 2015). This resulted in higher weight given to species that are highly threatened and under-researched. Next, we assigned weights for each group of features, raptors (in this case intended as one group), violence and governance, so that the aggregate weights of all the raptors as a group would equal that of the other layers summed, that is the weights of governance and/or violence together, following (Santangeli et al. 2019). Essentially, the weight given to all raptors together always equaled the summed weight of any other feature or features. This weight assignment is deemed to yield a balanced solution whereby priorities are identified based on equal importance for raptors and for the other factors. From each zonation run we mapped the priorities and also extracted the performance curves to derive figures showing the increase in average raptor species range coverage with the hypothetical increased in landscape protection, from 0-100% of the landscape being protected. The resulting performance curves inform about the efficiency in protecting landscapes under each scenario. Efficiency here is intended as the proportion of landscape that needs to be protected to achieve a set target of percentage coverage for the ranges of the species considered; the larger the amount of landscape required to cover a set percentage of species range, the less efficient is the solution. When compared across the four scenarios, the performance curves could thus reveal the relative impact of considering governance and violence when prioritizing for important areas for raptor research and conservation.

3. Results

3.1 Spatial association between violence and raptor priorities

Across the study region (Africa, South and South-East Asia, and the Middle East), violence is largely concentrated in equatorial Africa, the eastern Mediterranean basin, and South Asia (Fig. A1). Overall, the spatial correlation between raptor research and conservation priorities and violence is very low (Fig. 1), that is, they broadly do not co-occur in space. However, the correlation analysis highlighted a few hotspots whereby raptor research and conservation priorities are positively correlated (Fig. 1). Several such areas represent unsafe regions of high raptor priority. These are located in the southwestern Arabian Peninsula, central African Rift Valley, and the Philippines. The above results seem broadly consistent when considering all raptors, as well as each of the four subgroups, such as falcons, hawks and eagles, owls and vultures (Fig. A4).
Across Africa, we found few distinct regions that are of high priority for raptor research and conservation and where violence has been increasing (Fig. 2). These increasingly unsafe areas are principally located in central Africa (Chad, Nigeria, and Cameroon) and in the central African Rift Valley (Burundi, Democratic Republic of Congo, and Rwanda; Fig. 2). These analyses also reveal a
distinct coastal region in West Africa (particularly Guinea and Sierra Leone; blue area in Fig. 2) where decreasing violence may open up opportunities for raptor research and conservation. The above patterns are broadly consistent when considering all raptors, as well as each of the four raptor subgroups, and also when violence trends refer to the period 1997-2018 or 2010-2018 only (Fig. A5).

Fig. 2. Spatial relationship between raptor research and conservation priorities and violence trends in Africa. A) Spatial correlation patterns as derived from the local Lee’s L bivariate spatial association analysis between global priorities for raptor research and conservation (shown in panel B; data derived from (Buechley et al. 2019) and violence trend over the period 2010-2018 (shown in panel C; data from Raleigh et al. 2010; positive values depict increasing violence). Positive correlation in A) is indicated by warm colours. Correlations are only shown for areas representing the 30% most important global priority areas for raptor research and conservation (Buechley et al. 2019) in the study region (grey areas).

3.2 Spatial prioritization accounting for species complementarity, violence, and governance

Priority areas for raptor research and conservation are largely unaffected when accounting for factors such as governance and violence (Fig. 3). Consequently, the spatial variance in governance and violence levels has very little impact on the efficiency in protecting important areas for raptor research and conservation. This is clearly shown by the very similar performance curves depicting efficiency in protecting important areas for raptors alone, as well as when areas of high violence and/or poor governance are given low importance in the prioritization (Fig. 4). Nevertheless, there was some species-specific variation in the efficiency in which the different raptors can be protected when governance and violence are considered. For example, species such as *Circaetus beaudouini* and *Glaucidium sjostedi* appear as largely unprotected, whereas several species, such as *Otus thilohoffmanni* and *Otus pauliani* appear as largely protected, when hypothetically assuming that a total amount of 10 to 30% of landscape is protected (Table A1).

Overall, this result indicates that areas important for raptor research and conservation largely persist in the same regions, and that these cannot be replaced with other areas, even if accounting for governance and violence levels.
Fig. 3. Priority areas for raptor research and conservation identified through spatial conservation prioritization across Africa, the Middle East, South and South-East Asia. Priorities are identified based on different scenarios: A scenario whereby only areas important for raptor research and conservation are prioritized (raptors only); a scenario whereby priorities are sought for important raptor areas, as above, but away from areas of high violence (raptors and violence); a scenario whereby priorities are sought for important raptor areas, but away from areas of poor governance (raptors and governance); a holistic scenario whereby priorities are sought for important raptor areas, but away from areas of poor governance and high violence (raptors, violence and governance; warmer colours indicate higher level of priority). Terrestrial areas beyond the study region (where violence data were not available) are shown in grey.
4. Discussion

We found a generally low spatial correlation between raptor research and conservation priorities and violence across Africa, South and South-East Asia and the Middle East. Exceptions to this are represented by a few distinct regions where priorities for raptors occur in highly unsafe areas, such as the southwestern Arabian Peninsula, the central African Rift Valley, and the Philippines. Across Africa, violence trends are weakly correlated with priority areas for raptor research and conservation, with the exception of few distinct areas of high importance for raptors and where violence has been increasing, e.g. in central Africa and the central Rift Valley, as well as areas where violence has been declining, e.g. in coastal West Africa. Consequently, governance and violence have marginal effects on the efficiency of spatial conservation planning considering the distribution of raptor priority areas.

Challenges for raptor research and conservation in the Global South

For the first time, we assess the spatial link between raptor research and conservation priority areas with violence and governance. Among the few identified areas that are important for raptors and are
associated with high insecurity, perhaps the most critical region is western Yemen, which is afflicted by an ongoing civil war (Themnér and Wallensteen 2014). The area also represents a critical bottleneck along the Red Sea-Rift Valley flyway for many soaring birds, including raptors, migrating from their breeding grounds in the Palearctic to their wintering areas in Africa and vice versa (Newton 2008). Raptors are particularly vulnerable to shooting when crossing migration bottlenecks, such as the one in Yemen. The proliferation of weapons and lack of law enforcement in those areas may facilitate widespread and uncontrolled illegal activities, including raptor persecution. However, the extent and magnitude of such persecution remains largely unquantified. This is unfortunately common for high-biodiversity-value areas located in unsafe regions. Lack of knowledge in such regions prevents designing effective conservation actions, whereas insecurity prevents implementation and monitoring in a spiral that may ultimately might result in the extirpation of wildlife populations from conflict areas (Brito et al. 2018). Given that Yemen lies on a major migratory bottleneck, this conflict could impact as many as 35 raptor species across three continents (Buechley et al. 2018). Two other areas where raptor research and conservation is challenged by high violence were identified in the Central African Rift Valley, and in the Philippines. These two areas likely present similar challenges for research and conservation: they are areas where poverty is widespread (Kummu et al. 2018), where a large share of imperiled species that are affected by one or multiple drivers of threat occur (Allan et al. 2019), and where unsustainable wildlife harvesting is prevalent (Di Minin et al. 2019).

Distinct regions of high importance for raptor research and conservation where violence has been rising were also identified in central Africa and in the central African Rift Valley. Conflicts and insecurity in these areas have been linked to declines in populations of large mammals (Brito et al. 2018), with this pattern also affecting wildlife within protected areas (Craigie et al. 2010; Daskin and Pringle 2018). Similar threats as those identified for large mammals may also afflict the local raptor populations, but monitoring data for assessing this connection are scarce or non-existent (Di Vittorio et al. 2018). The only scattered data available seem to confirm the broad declining pattern in raptors (Ogada et al. 2016; Thiollay 2006), consistent with declines of other taxa (Brito et al. 2018).

Our results also highlight an isolated coastal region in West Africa (e.g. Guinea and Sierra Leone) where violence has been decreasing. This area represents a stronghold for many endangered African raptors, such as several Endangered and Critically endangered vultures (Henriques et al. 2018). The increasing safety of this region may further facilitate raptor research and conservation. However, enhanced safety may also represent a threat in the same area owing to facilitated development and encroachment during the post-conflict times, as shown in many tropical areas (McNeely 2003). Irrespective of the consequences of increased safety on wildlife, this area in coastal West Africa warrants in depth locally-led research to meet its potential for research and conservation (Cresswell 2018), with benefits going beyond raptors and wildlife.

A recent study reported that conservation interventions in conflict areas can be effective (Daskin and Pringle 2018), but for them to succeed, adequate funding is paramount. Unfortunately, many of the identified important areas for raptors where violence is rising fall within the most highly underfunded countries for biodiversity conservation (Waldron et al. 2013). Moreover, previous research has shown that international funders are likely to favor stable countries with good governance (Miller et al. 2013). Even if funds would be available to address conservation and research challenges, they may not suffice for preserving biodiversity in the Global South. Building capacity and empowering local people in conservation is paramount in these contexts (Loucks et al. 2009). There is an urgent need to understand and navigate the conservation research-implementation space whereby society occupies a central place (Toomey et al. 2017). This may be particularly important in the critical areas identified in this study where research and implementation are challenged by high insecurity and poor governance. In such areas it will be crucial to give voice, engage and empower local communities, researchers, conservation practitioners, organisations, and all relevant stakeholders, to foster community-led
initiatives and actions, ultimately placing science in a direct position to serve society and the environment (Toomey et al. 2017). This approach would also help filling knowledge gaps in biodiversity trends among local protected area managers in the Global South (Pyhälä et al. 2019). This process would also enable and empower local conservation leaders to coordinate research efforts, such as species monitoring and threat identification, and to inform the implementation of conservation initiatives (see e.g. Dolrenry et al 2016). A successful example of how this could be achieved is provided by the vulture conservation task force coordinated by a local Maasai conservation officer in Southern Kenya (https://www.birdlife.org/worldwide/news/100-vulture-deaths-prevented-rapid-response-poisoning). The task force includes locally recruited “vulture guardians” who are part of the communities, promote environmentally sustainable behaviours (e.g. advice on effective ways to mitigate human-wildlife conflict) via education campaigns, and are ready to intervene to minimise impacts of poisoning incidents, among others. Poisoning is particularly devastating to vultures, as poisons are often used to eliminate livestock predators, they may unintentionally kill large numbers of vultures (Santangeli et al. 2016). Examples of similar community-based initiatives, such as the community-based natural resource management programs, have shown a high degree of success in engaging and enhancing local people and their livelihoods while ensuring the preservation of the wildlife and other environmental resources of the land they live in (e.g. Lee 2018, Naidoo et al. 2016). The success of such bottom-up approaches to conservation lies on the delicate balance that needs to be sought between people’s needs, values, perceptions and attitudes, and other components of the system, such as institutions, organizations, conservation practitioners and scientists.

Raptors are among the most imperiled group of vertebrates (McClure et al. 2018). Efforts towards raptor research and monitoring have been large and widespread in many countries of the Northern Hemisphere, where several conservation success examples exist (Margalida and Ogada 2018). The situation is much different in the Global South, where conservation of raptors, as well as that of other biodiversity components, has been long hampered by underfunding, lack of research and monitoring, as well as poor research capacity (Buechley et al. 2019; Waldron et al. 2013; Wilson et al. 2016). Overall, our results, specifically those from the conservation planning analyses, suggest that the distribution of raptor research and conservation priority areas are broadly unaffected by varying levels of violence and governance in the Global South. While this suggests that there are opportunities to address raptor research and conservation in areas of relative security and good governance, regions suffering from violence and poor governance must not be neglected by the community of conservation scientists. We contend that efforts should still be allocated, and existing ones continued, in challenging areas with high violence and poor governance, as they often support a large diversity of imperiled biodiversity (Hanson et al. 2009; Myers et al. 2000).

Finally, this study was conducted at the regional to continental scale, and the outcomes are deemed useful in pinpointing broad scale patterns of co-occurrence between raptor research and conservation priority, and governance and violence. The results may help directing further high resolution local studies towards critical areas. Moreover, the choice of the relative weights given to each group of features used (raptors, governance and violence) in the conservation planning exercise, while balanced, is somewhat arbitrary. Changing the weighting scheme may affect the results (Eklund et al. 2011). However, to date empirical evidence on the impact of violence and poor governance on raptor research and conservation is lacking. In that light, any alternative weighting scheme from the one used would yield results associated with high uncertainty. While we broadly refer in this study to the Global South, Latin America was not considered here due to lack of the conflict data. As such, it is challenging to infer patterns in that region based on our study. This is because the socio-ecological context of that region may differ from that of the area focus of this study. As more and wide scale data will become available in the near future, this will allow filling the above gaps in knowledge for regions beyond the one considered here.
Implications for conservation science and practice

Understanding the factors defining and affecting the research-implementation space is important, because the relevant boundaries and components of such spaces may vary in time, and may depend on local and regional contexts. To this end, we show that in the Global South governance and violence play a marginal role when navigating the research-implementation space for raptors. However, we also show how dynamic this research-implementation space can be, with temporal variations in violence opening up new potential opportunities in areas of decreased threat of violence. On the other hand, we also highlight challenging areas where violence and governance occur in areas that are important for raptor research and conservation. While the challenges for research and conservation under high violence and poor governance conditions are substantial, effective tools and solutions have been developed, and there is evidence suggesting that conservation efforts, even in difficult areas, can succeed (Daskin and Pringle 2018; Stalmans et al. 2019). Ultimately, for boosting conservation and research in the Global South, there is a need to reduce social and economic inequalities and stabilize unsafe regions (Brito et al. 2018), as well as building human capacity (knowledge and technology transfer) by supporting conservation practitioners and protected area managers (Loucks et al. 2009; Pyhälä et al. 2019). Such bottom-up approaches could lead to the emergence of community-led initiatives that would be mutually beneficial to people (e.g. increase social cohesion, reduce drivers of conflict) and to the environment as a whole (Brito et al. 2018).

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