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POLICY PERSPECTIVE

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Armed conflicts and wildlife decline: Challenges and recommendations for effective conservation policy in the Sahara-Sahel

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Abstract

Increasing conflicts and social insecurity are expected to accelerate biodiversity decline and escalate illegal wildlife killing. Sahara-Sahel megafauna has experienced recent continuous decline due to unsustainable hunting pressure. Here, we provide the best available data on distribution and population trends of threatened, large vertebrates, to illustrate how escalating regional conflict (565% growth since 2011) is hastening population decline in areas that were formerly refugia for megafauna. Without conservation action, the unique and iconic biodiversity of Earth's largest desert will be forever lost. We recommend: (1) establishing strong commitments for change in global attitude toward nature; (2) engraining a culture of environmental responsibility among all stakeholders; (3) fostering environmental awareness to drive societal change; (4) reinforcing regional security and firearms control; and (5) implementing local research and wildlife monitoring schemes. We identify relevant international partners needed to tackle these challenges and to make strong policy change for biodiversity conservation and regional stability.

KEYWORDS
accessibility, biodiversity loss, conservation actions, human development, illegal wildlife killing, megafauna, natural resources extraction, political instability, population decline, threat mapping

1 | INTRODUCTION

Conflict and social insecurity are known to accelerate biodiversity decline globally and escalate illegal killing of wildlife (Douglas & Alie, 2014; Gaynor et al., 2016). The recent increase in global conflicts (IEP, 2016) stresses the need for the identification of wildlife-declining areas and the development of effective policies to reduce the impacts of conflict on biodiversity (Brashares et al., 2014).

The Sahara-Sahel region of North Africa provides a case study on how wildlife killing may be boosted by the interactions of conflict with illegal activities, infrastructure development, and resource extraction activities. For millennia, the remoteness and harsh climatic conditions of this region have supported subsistence-hunting systems, deeply rooted in traditional cultures (OECD-SWAC, 2014). During the last century, the increased accessibility of previously remote areas (more roads and desert-capable vehicles) and firearms have dramatically amplified the impact of hunting activities (Brito et al., 2014; Newby, Wacher, Durant, Pettorelli, & Gilbert, 2016; Text S1). Growing global demands for natural resources have prompted regional mineral exploitation, which in turn has further contributed to greater accessibility and illegal wildlife hunting (Duncan, Kretz, Wegmann, Rabeil, & Pettorelli, 2014). As such, 12 large-sized vertebrates (out of 14 assessed in Durant et al., 2014) have been listed as *Extinct in the Wild* or are globally threatened with extinction. Exacerbating this scenario, there is now an unprecedented growth in regional instability, characterized by extremist groups carrying out attacks, kidnapping, enslaving, and smuggling arms and drugs to finance their activities (OECD-SWAC, 2014). In Mali, the combination of Al-Qaeda in the Islamic Maghreb (AQIM) activities with local autodetermination claims (National Movement for the Liberation of Azawad) is promoting regional conflict with recurrent attacks (Weiss, 2016). In southern Niger, northern Cameroon, west-central Chad, and northern Nigeria, Boko-Haram performed over 800 attacks between 2009 and 2013, with thousands of lives lost in the past 10 years (Akinola, 2015; OECD-SWAC, 2014). In Libya, the fall of the Gaddafi regime in 2011 and the subsequent war have fragmented the country, which is now controlled by distinct groups imposing their own agendas (Beauchamp, 2014). Political instability in Tunisia and Egypt following social movements have also contributed to regional insecurity. Human migration movements from Libya to Mali/Niger or toward Europe (15% of all Libyans migrated in early 2011; OECD-SWAC, 2014) have been associated with social unrest. Accordingly, insecurity now spans across almost all the Sahara-Sahel (Brito et al., 2014; OECD-SWAC, 2014).

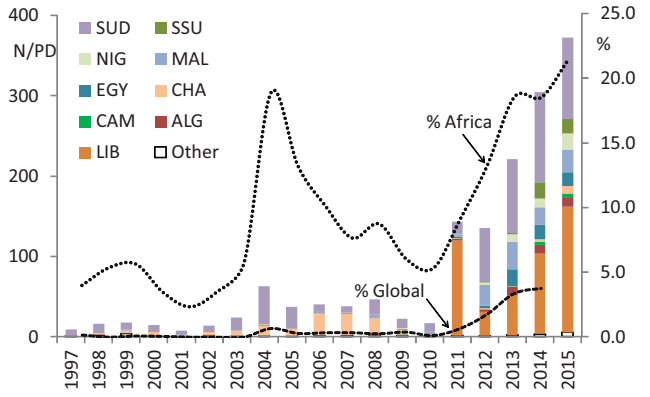

FIGURE 1 Number of conflict events (attacks/battles and violence against civilians) within the Sahara-Sahel range countries since 1997 weighted by human population density of each country (N/PD), and percentage (%) of conflict events in Sahara-Sahel in relation to Africa (%Africa; Raleigh, Linke, Hegre, & Karlsen, 2010) and the world (%Global; START, 2015)

Note: SUD – Sudan, SSU – South Sudan, NIG – Nigeria, LIB – Libya, EGY – Egypt, CAM – Cameroon, ALG – Algeria, MAL – Mali, Other – Other Sahara-Sahel countries.

Although a quantitative assessment of biodiversity threats across the Sahara-Sahel is problematic in these circumstances, there is increasing evidence of an ongoing wildlife massacre resulting from growing instability (Figure S1; Christy, 2015; Smith, 2015; Zedany & Al-Kich, 2013). Here, we aim to map the spatial and temporal occurrence of conflicts and other threatening factors in the Sahara-Sahel, including natural resource exploitation activities and implicit accessibility. Next, we contrast these threat factors with the distribution of 10 threatened large vertebrates. We support our analysis with three case studies where there is sufficient information on population trends to explore underlying relationships between conflict and wildlife decline in more detail. Finally, we identify the key policy players needed to effectively reduce wildlife-related conflicts and make recommendations for conservation practitioners.

2 | METHODS

Georeferenced data on attacks/battles (armed assaults, bombing/explosions, facility/infrastructure attacks) and violence against civilians (hostage taking and assassination) were extracted from global and African databases (data sources in Table S1) to quantify temporal trends in the occurrence of conflicts.

Georeferenced data on conflict events, smuggling and human migration routes, paved roads and tracks, human populated places, sandy areas (representing less accessible zones), and natural resource exploitation were used to map conflicts and extinction risk correlates (Table S1). Maps were contrasted with the distributions of 10 extant Sahara-Sahel large vertebrates. Most species are regional endemics and all have suffered vast range and population declines during the past century (Durant et al., 2014). The threat assessment was further complemented by data compiled from multiple bibliographic sources (Table S1) and direct field observations made by authors (Table S2). Taken together, data were used to review current population status and identify extinction risks in the Sahara-Sahel region. Species distributions were intersected with protected areas (PAs) distribution to quantify their regional representation in PAs.

Local population trend data were available for the addax (*Addax nasomaculatus*), while data on illegal off-take were available for dorcas gazelle (*Gazella dorcas*) and African savannah elephant (*Loxodonta africana*; details in Text S2). Estimates of population size from the last known wild addax population surviving in the Termit & Tin-Toumma National Nature Reserve (TTNNR) in Niger were available in the period 1966-2000 and yearly after 2001. The number of dorcas gazelle illegally killed in Libya was estimated from data obtained through questionnaires to 40 international experts and from interviews made in September 2015 to c. 200 Libyan residents (Text S2). The number of elephants illegally killed in the Gourma region (Mali) between January 2012 and January 2016 was quantified using a community-based vigilance network living throughout the range of the northernmost and isolated elephant population (Text S2).

3 | RESULTS

The absolute number of conflict events has grown within the Sahara-Sahel range countries over the last 19 years, escalating after 2011 (565% growth; Figure 1). Currently, it represents about 20% of total African conflicts and almost 5% of global conflicts. The portions of Sudan/South Sudan included in the Sahara-Sahel account for the largest proportion of conflict events (48%) within the time period, particularly during the Darfur crisis (2003-2006). After 2011, conflict events increased dramatically in Libya and Mali and became widespread, forming multiple clusters (Figures 2 and S2). Numerous smuggling and human migration routes cross the Sahara-Sahel. The distribution of human population centres and major roads and tracks suggests that peripheral Sahara-Sahel areas are widely accessible and that only a few patches covered mostly by sand dunes remain less accessible. Clusters of natural resource exploitation activities are found in Algeria, Libya, Niger, and Egypt. Range fragmentation and population extirpation are common for the 10 species assessed here (Table 1; Figures 2 and S1). Illegal killing associated with increased accessibility and human activities (including mining, grazing, and infrastructure building) within the Sahara-Sahel are the most common pressures associated with wildlife

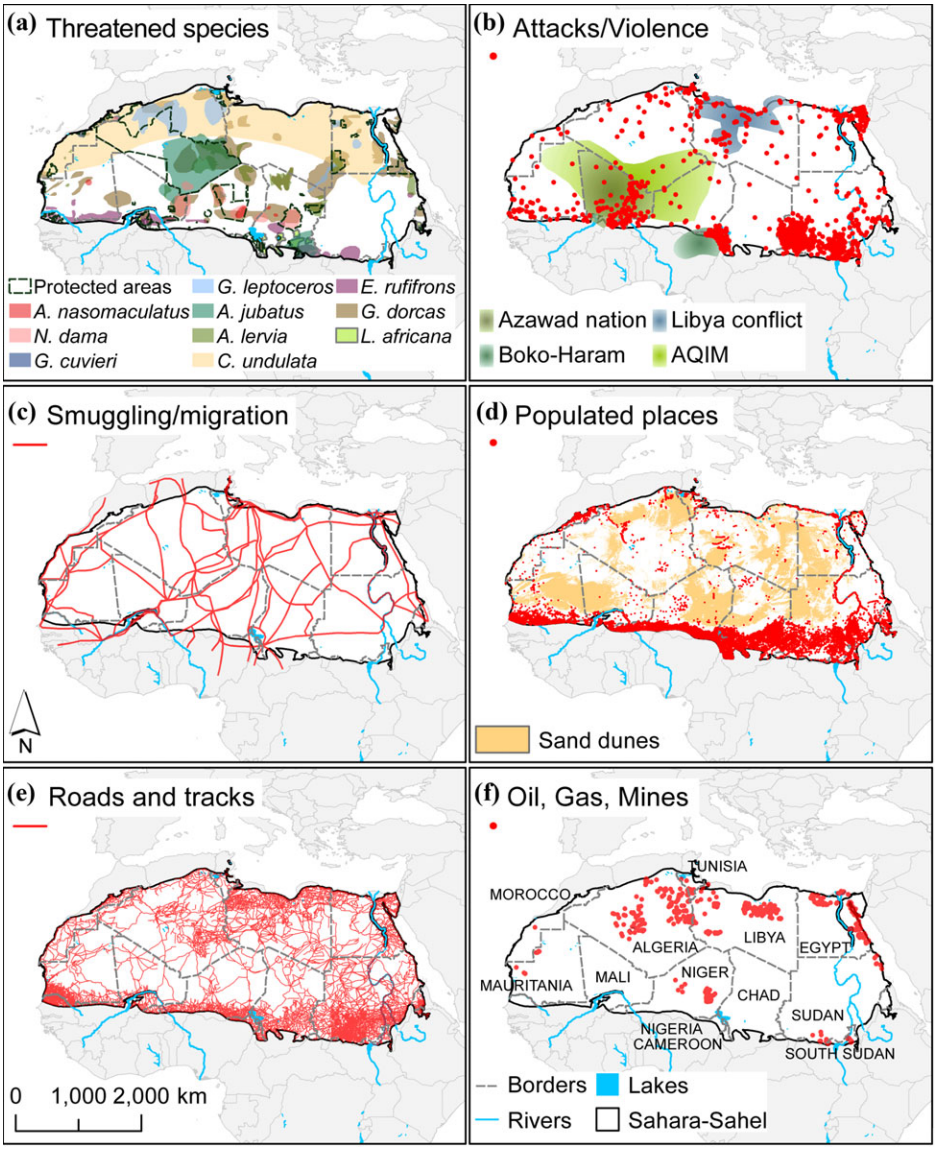

FIGURE 2 Distribution of 10 threatened vertebrates and of PAs in the Sahara-Sahel (a) and distribution of extinction risk factors (b) attacks/battles and events of violence against civilians (including hostage taking and assassination) after 2011, of areas claimed as Azawad nation, under influence of AQIM and Boko-Haram, and affected by the Libya conflict (c) current major smuggling/migration routes (d) populated places and sand dunes (representing less accessible zones) (e) major roads and tracks (f) oil, gas, and other mining facilities

Note: See Table S1 for data sources and Table 1 for species names. Common legend items to all figures are displayed in (f).

population decline (Table 1). Importantly, six of the examined species have less than 40% of their distribution represented in PAs (Table 1).

Addax populations have experienced a marked population decline in Niger since 1997, as the region became affected by conflict, which escalated after 2015 (Figure 3). After 2009, coinciding with the beginning of oil exploration activities, populations reached critically low numbers. Oil activities largely overlap the range of the extant addax population, which occurs in largely unpopulated areas. Similarly, the number of reported dorcas gazelles illegally killed in Libya increased after 2012, about 2 years after the start of the regional conflict, with killing events widespread across the country (Figure 3). The reported number of elephants killed in Mali increased in the beginning of 2015 (Figure 3), 3 years after an increase in conflict and following violent attempts to derail the imminent peace process (Text S3). The current range of the surviving elephant population excludes the most densely human populated places (Figure 2).

4 | DISCUSSION

Analyses of three Sahara-Sahel species clearly show an association between population loss with increased conflict (dorcas gazelle and elephant) and oil exploitation (addax). These

TABLE 1 Overview of conservation status and extinction risk of 10 threatened large-size vertebrates in the Sahara-Sahel region

Species	Scientific name	IUCN	%S-S	%PA	Conservation status and exposure to extinction risk threats
Addax	*Addax nasomaculatus* (de Blainville, 1816)	CR	100.0	60.3	Restricted to 1-4 wild populations. Population in Niger currently undergoing major collapse and likely to go extinct due to illegal killing associated with natural resources exploitation activities and human migration routes. Recently rediscovered in Chad (15-30 individuals in Eguey dunes and a larger population in bordering areas with Niger). Unknown status in Mauritania. Suffered extreme range loss in the Sahara (99%)
Dama gazelle	*Nanger dama* (Pallas, 1766)	CR	100.0	27.3	250 individuals or less known from three disconnected areas in Niger and Chad. Unknown status in Mali. One subspecies Extinct in the Wild (*N. dama mhorr*). Suffered extreme range loss in the Sahara (99%). Illegal killing in Niger forced range shifts to inaccessible and low-productivity habitats where survival is uncertain
Cuvier's gazelle	*Gazella cuvieri* (Ogilby, 1841)	EN	27.7	47.7	Wild fragmented populations forced to live in remote and less productive habitats. Loss of habitat due to continuous expansion of pastureland for livestock and deforestation appears to be the main threat
Slender-horned gazelle	*Gazella leptoceros* (Cuvier, 1842)	EN	100.0	18.3	Patchy distribution restricted to sandy areas. Current population size in Egypt, Libya, and Algeria is unknown but there is population decline due to illegal killing. Suffered extensive range loss in the Sahara (86%)
Saharan cheetah	*Acinonyx jubatus hecki* (Schreber, 1775)	VU	88.6	75.3	Restricted to three populations in the Sahara-Sahel, most numbering only a handful of individuals. The largest population occurs in southern Algeria/eastern Mali, with extremely low density and less than 200 individuals. There is a further population in Chad, but there is no indication if it is the Saharan *hecki* subspecies. This subspecies has suffered extreme range loss in the Sahara (90%)
Barbary sheep	*Ammotragus lervia* (Pallas, 1777)	VU	89.6	46.8	Isolated in remote mountain areas. Suffered strong decline due to illegal killing (Figure S1) and competition from domestic stock. Population status is unclear. Low numbers are reported from Algeria, Chad, Mauritania, Mali, and southern Morocco, and population decline is documented in Niger. Status is unknown in Libya, Egypt, and Sudan
Houbara bustard	*Chlamydotis undulata* (Jacquin, 1784)	VU	94.5	15.6	Widely distributed in northern Sahara, but range and population are declining because of strong legal and illegal hunting pressure. Captive breeding and releasing programs are aimed at maintaining hunting activities
Red-fronted gazelle	*Eudorcas rufifrons* (Gray, 1846)	VU	67.5	19.5	Elusive species with poorly known status in the area. Most of the original range has been affected by human development activities. In Senegal, it is known from small scattered populations (Djoudj N.P., Ferlo Nord Fauna Reserve, Boundou reserve). Extinct from northern Burkina-Faso

(Continues)

TABLE 1 (Continued)

Species	Scientific name	IUCN	%S-S	%PA	Conservation status and exposure to extinction risk threats
Dorcas gazelle	*Gazella dorcas* (Linnaeus, 1758)	VU	97.6	31.1	Suffered the most extensive and intensive massacres, providing the most frequent example of illegal killing (Figure S1). It has been extirpated from large areas across Morocco and Mauritania. Conservation status is likely to change to Endangered if current illegal killing levels maintain. Suffered extensive range loss in the Sahara (86%). The largest densities in the Sahara are found in the TTNNR in Niger and the Ouadi Rimé–Ouadi Achim Game Reserve in Chad
African savannah elephant	*Loxodonta africana* (Blumenbach, 1797)	VU	4.5	30.3	Restricted to scattered small populations in Chad's Soudano-Sahelian zone and to two transboundary populations. Most of the year is spent in Mali (Gourma) and Eritrea (Gash-Setit), crossing into Burkina-Faso and Ethiopia, respectively, during the wet season. The Gourma population was estimated by aerial census in 253 plus 51 individuals. Human encroachment was the biggest threat but since 2012 that insecurity emboldens poachers and traffickers. Waterholes surrounded by thicket forests are the preferred habitat of both elephants and poachers. The Eritrean population has never been formally assessed due to local conflict, but an informed guess numbers them at 100-120. Chad's heavily poached Sahelian elephants number around 150 (although greater numbers are found in the south of the country)

Note: For each species, we report the IUCN Red List status (CR – critically endangered; EN – endangered; VU – vulnerable), the percentage of the global range included inside the Sahara-Sahel (%S-S), and the percentage of the Sahara-Sahel range included inside PAs (%PA). Distributions are mapped in Figure 2. Data compiled from nonacademic publications, published works (see Table S1), and direct field observations.

patterns are likely to be representative of the wider catastrophic wildlife decline occurring in the region (Figure S1). Specifically, the data collected here suggest that illegal killings accelerated around 2 to 3 years after armed conflicts ignited in Libya and Mali. It is difficult to know whether this time frame is significant but conflict and especially terrorism, human trafficking, and organized crime have all previously been related to the occurrence of illegal wildlife killing (Brashares et al., 2014; Christy, 2015; Douglas & Alie, 2014). In the Sahara-Sahel, megafauna have been almost extirpated from the southern regions, where armed conflict endured the longest and where the highest regional densities of roads and human population are found. Furthermore, the rush of extremist groups and traffickers to control remote areas promotes human presence in places that previously were only occasionally crossed by nomads. The current conflict thus adds to disturbances already caused by other human activities (mining, grazing, agriculture, and urbanization), accelerating population decline and local extinction, and leaving large-sized vertebrates with nowhere to go; a global trend observable in megafauna (Ripple et al., 2016).

4.1 | Challenges to biodiversity conservation in the Sahara-Sahel

All Sahara-Sahel range countries are developing nations and most of them are ranked as Low Human Development (Chad, Mali, Mauritania, Niger, and Sudan; UNDP, 2016); several are among the 40 most highly underfunded countries for biodiversity conservation (Algeria, Mauritania, Morocco, and Sudan; Waldron et al., 2013). These countries currently lack the resources and capacities, and in some cases the commitment, to make the strong structural changes needed to reverse the reported extinction trend. The assistance to relieve human pressures that could be provided by NGOs is not present (https://www.ngoaidmap.org/) and, when existing, it is largely underfunded (Development Initiatives, 2016). The combined low income, lack of perspectives on social development, and poor human rights enforcement stimulate human migration (OECD-SWAC, 2014). Algeria, Mauritania, and Chad are among the top five countries unable to retain top talents and brain drain deprives them from the human resources needed to drive and implement change (WEF, 2014). Poor governance and high corruption levels

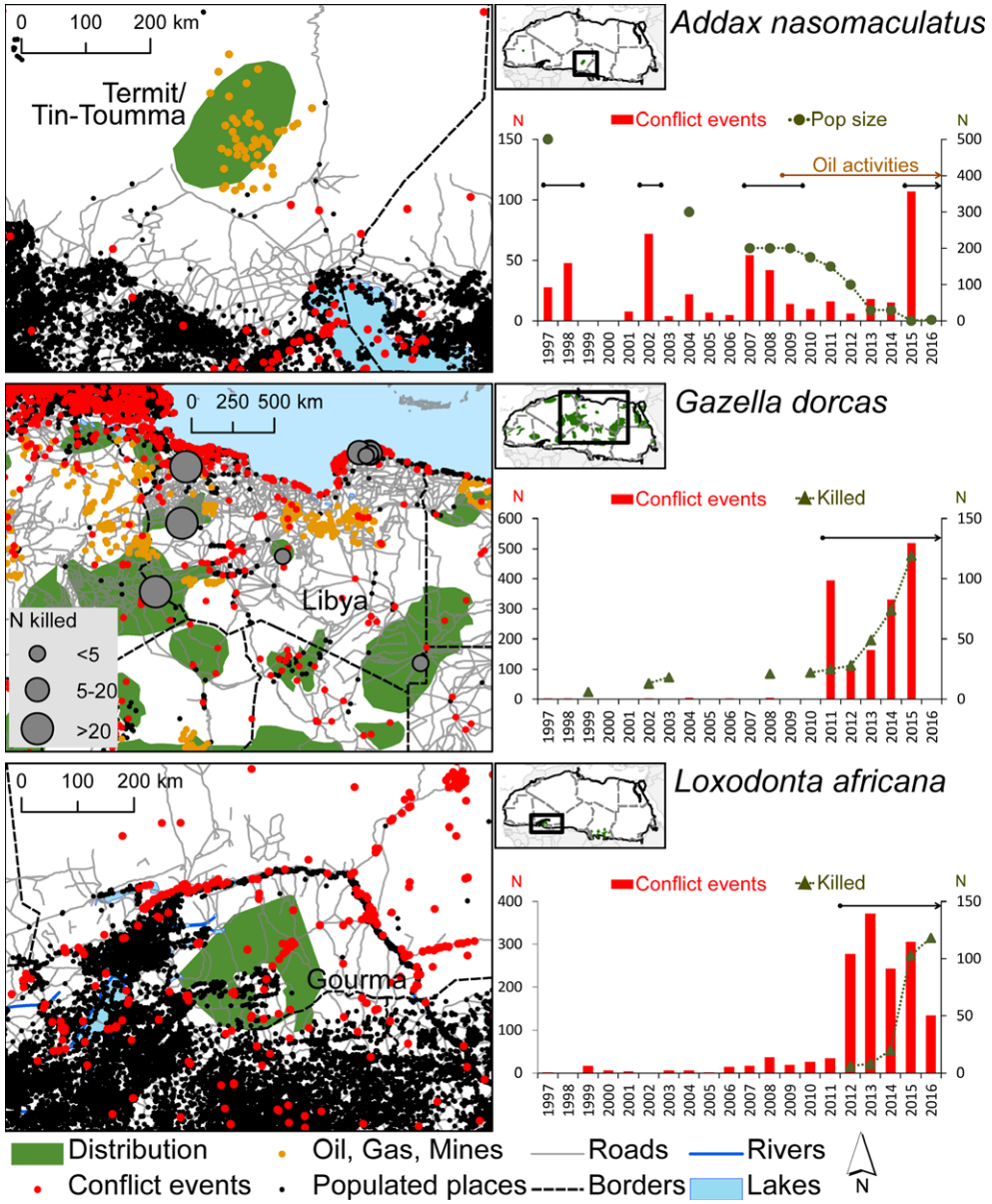

FIGURE 3 Distribution of extinction risk factors and demographic trends in three threatened vertebrates from the Sahara-Sahel. Left column: local distributions of *A. nasomaculatus* in Niger (Termit/Tin-Toumma), *Gazella dorcas* in Libya, and *Loxodonta africana* in Mali (Gourma), of conflict events (including attacks/battles and violence against civilians) after 2011, and of major roads, oil, gas, populated places, and mining facilities. Right column: temporal evolution of population size of *A. nasomaculatus* in Termit/Tin-Toumma and of cumulative number of *G. dorcas* and of *L. africana* illegally killed in Libya and Gourma, respectively, and number of conflict events in each country. Black horizontal lines represent periods of increased conflict

Note: See Table S1 for data sources.

are systemic to Sahara-Sahel countries (all are ranked as Highly Corrupt; Transparency International, 2017), which contribute to environmental destruction and lack of societal accountability. For instance, the oil exploitation prospection phase in Niger caused a significant decline in addax because the restrictions imposed by the health, security, and environment regulations were not respected by oil companies and subcontractors, including the army in charge of securing activities (Rabeil, 2016); this represents an environmental crime that was left unpunished (INTERPOL-UN Environment, 2016). The uncontrolled circulation of firearms in the Sahara-Sahel also underpins the escalating level of conflict and arms trade thriving in the region. For example, between 2005 and 2014, EU member states granted licenses for arm exports to the Middle East and North Africa (including five Sahara-Sahel countries) worth over €82bn (Akkerman, 2016). The largest arm trade companies are also the key winners of EU border security contracts (building fences,

providing equipment for border guards, and establishing surveillance systems) aimed at controlling human migration into Europe (Akkerman, 2016). The situation is likely to worsen as the military industry is currently shaping European border security policy and persuading the EU research and technology policy to start funding military-related research (https://www.ies.be/files/Milestone_or_Maelstrom_Report_HQ.pdf). The EU/US action in the Libyan conflict also demonstrated that third-party interferences often lack the proper consideration for the long-term risks and consequences of military operations. In a region subjected to stochastic drought (Brito et al., 2014), future climate-related adversities are also likely to boost regional conflict and further biodiversity loss given the fast-growing human population rates (United Nations, 2015) and the ethnically fractionalized societies that characterize Sahara-Sahel countries (Schleussner, Donges, Donner, & Schellnhuber, 2016).

4.2 | Short-term initiatives to immediately halt wildlife decline

There are a number of available tools to predict conflicts potentially affecting wildlife and to integrate broad-scale environmental protection into peace strategies, including web-based resources that allow tracking conflict-related movements and human trafficking routes, and combating criminal networks for trafficking wildlife products (Table 2). Evidence-based examples from Chad, Mali, and Niger provide encouraging lessons. Still, conservation efforts are likely to increase in expense, or even fail, if conflicts continue to escalate. The disarmament of civilians, militias, and extremist groups via peace-keeping campaigns is urgently needed in combination with firearms and ammunition embargos to non-governmental buyers from countries under conflict. This can be achieved through the implementation of the United Nations Arms Trade Treaty (ATT; Table 2). West African countries have already ratified the ATT and now need to fully integrate it into their national security systems (ATT Monitor, 2016). Resource mobilization is needed from the United Nations, European Union Force, United States Africa Command, and African-Led International Support Mission to Mali, as well as a better coordination with range countries (Olsen, 2014).

We urgently need accountable and visionary governments and businesses that work in the best interest of societies and promote sustainable and equitable uses of natural resources, while fostering the recovery of threatened species. The EU and Chinese companies exploiting natural resources in Africa need to engage in corporate social responsibility (CSR; Table 2) in the Sahara-Sahel, where economic growth, social progress, and environmental protection are all considered (Cheng & Liang, 2011). Together with the wildlife authorities of range countries, exploiting companies need to design a code of conduct to eradicate illegal hunting. This is critical, particularly for the survival of the last remaining wild addax and dama gazelle; while resources and enforcement is required to prevent elephant poaching for ivory. Together with global and regional conservation organizations, companies exploiting local resources need to support the management of PAs and effective capacity building of the wildlife services. Governments should foster trust between people and their armed forces by ensuring that discipline is maintained, and by responding swiftly to any reported abuse (https://unama.unmissions.org/sites/default/files/wps-sg_report_crsv_-march_2015_0.pdf). Armed forces should set an example of biodiversity conservation to local communities and penalties on harvesting wildlife should be strictly enforced (INTERPOL-UN Environment, 2016; Table 2).

4.3 | Long-term measures for building resilient societies

Conservation scientists need to increase collaboration with politicians and researchers focused on conflict and the military to find innovative ways of dealing with the multitude of challenges in conflict areas (Canney, 2007). Community-based wildlife management and community-based natural resource management allow building awareness of the environment and the cultural, economic, and ecological importance of biodiversity and ecosystem services (www.un.org/africarenewal/magazine/august-november-2017/new-face-sahel), and developing a deeper understanding of the local contexts. Both are required for designing management approaches that successfully preserve the remaining biodiversity in conflict areas (Berkes, 2004; Table 2). The formation of extremist groups is often fuelled by the need to belong to a cause (Bjørgo, 2011). Natural heritage can provide a constructive and positive identity to be proud of, especially through inspiring young future "green activists" (Canney & Ganame, 2014). Increased societal valuation of the local natural capital can also help reduce illegal killing to sustainable levels (Duffy, St. John, Büscher, & Brockington, 2015), especially as a large proportion of the killing documented here (Figure S1) is for sport/leisure reasons. Innovative approaches are needed to build environmental awareness. For instance, faith groups have the potential to mobilize mass support for biodiversity conservation and poverty alleviation (Bhagwat, Dudley, & Harrop, 2011). In the Sahara-Sahel, Islamic religious authorities in particular have the credibility to reshape ethical attitudes toward biodiversity and promote environmental-friendly thinking and lifestyles.

PAs together with local community engagement in conservation are key tools in securing the survival of Sahara-Sahel megafauna, and in sustainably developing the economy, and regional peace and stability (Table 2). At the local level, responsible/sustainable ecotourism-based industry may contribute to alternative livelihoods and to improve

TABLE 2 Tools for biodiversity conservation in conflict hotspots under political insecurity

Tools	Description	Example	Outcome	Timing
Data mapping				
• Mapping conflict hotspots	Web-based resources that allow tracking movements of human populations and conflict sites, providing policy makers with precise, verified information required to understand weapon transfers in detail and, thereby, develop effective, evidence-based weapon management and control. May be used as an independent monitor for the implementation of international arms control agreements, including the UN Programme of Action and the Arms Trade Treaty, and to aid national arms export control agencies in identifying diversion risks prior to export	Armed Conflict Location and Event Data Project (www.acleddata.com); Global Terrorism Database (www.start.umd.edu/gtd); iTrace (www.conflictarm.com/itrace)	Detailed up-to-date mapping of geographical spread of different categories of political conflict and terrorism that can be used to inform conservation interventions	Short-term
• Mapping human trafficking routes	Web-based resources that allow monitoring the flowing of human migrants and map migration routes	International Organization for Migration (www.iom.int/world-migration); Lucify (www.lucify.com/the-flow-towards-europe); The Refugee Project (www.therefugeeproject.org/#/2015)	Detailed up-to-date mapping of human migration routes that can be used to prioritize wildlife surveillance and protection interventions	Short-term
• Remote sensing monitoring	Satellite imagery can be used to monitor conflict-related human movements. These require expensive imagery (e.g., QuickBird, GeoEye-1) and technical capacities but both could be made available from private/military partnerships	Oil exploitation activities in Niger (Duncan et al., 2014); Satellite Sentinel Project (www.satsentinel.org/imagery/imagery-troops-demilitarized-zone-confirmation-violations-sudan-and-south-sudan)	Detailed up-to-date mapping of habitat and land-use change	Short-term
Site-based conservation when at risk from conflict				
• Corporate social responsibility	Companies exploiting natural resources can engage in CSR and work together with wildlife authorities of range countries to align strategies and operations with universal principles on human rights, labor, environment, and anticorruption	United Nations Global Compact (www.unglobalcompact.org); Environmental Justice Atlas (https://ejatlas.org)	Code of conduct for companies that eliminates illegal wildlife hunting practices associated with exploiting operations	Short-term

(Continues)

TABLE 2 (Continued)

Tools	Description	Example	Outcome	Timing
• Community-based wildlife management	Engagement of local people in wildlife management, in vigilance and monitoring to combat illegal wildlife hunting resulting from conflict. Good governance, transparency, and accountability are essential to community-based natural resource monitoring efforts	Savannah elephant conservation in Mali (Canney & Ganame, 2014)	Empowered communities that implement local protection systems to safeguard biodiversity and to ensure sustainable use of natural resources	Long-term
• Community-based natural resource management	Local communities benefiting from sustainable natural resource management programs integrated with biodiversity conservation	International Fund for Agricultural Development (www.ifad.org/documents/10180/91e476ea-679a-46f0-9e0f-5240e0bf1acb)	Increased quantity and quality of available resources, thereby improved livelihoods and increased environmental and societal resilience	Long-term
• PAs	PAs, including transboundary areas, together with local community engagement in conservation planning, are a key tool in securing the survival of megafauna	Peace Parks Movement (www.peaceparks.org); Peace and Biodiversity Dialogue Initiative (www.cbd.int/peace)	PAs that support sustainable economic development, the conservation of biodiversity, and regional peace and stability	Long-term
• Alternative livelihoods	At the local level, responsible/sustainable ecotourism-based industry may help to contribute to alternative livelihoods	UN World Tourism Organization (https://www2.unwto.org/publication/tourism-and-biodiversity-achieving-common-goals-towards-sustainability)	Improved socioeconomic welfare of populations and building of peaceful societies	Long-term
International mechanisms				
• International treaties	The ATT can be used specifically as a framework to assess and mitigate illegal wildlife killing, including the evaluation of the risk that arms transfers will be used to commit genocide, crimes against humanity, or wildlife crimes	Arms Trade Treaty (https://unoda-web.s3.amazonaws.com/wp-content/uploads/2013/06/English7.pdf); Control Arms (https://controlarms.org/en/wp-content/uploads/sites/2/2016/10/Wildlife-Crime-Paper-REVISED-Email.pdf)	Strengthened environmental laws, control arms diversion, monitor trafficking networks, and building local awareness for security and environmental protection	Short-term
• Combating crime networks for trafficking wildlife products	The environmental security programme of the INTERPOL and the International Consortium on Combating Wildlife Crime of CITES, in partnership with the relevant law enforcement agencies, can be used to fight wildlife crime as serious and organized crime	INTERPOL-UN Environment (2016); International Consortium on Combating Wildlife Crime of CITES (https://cites.org/eng/prog/iccwc.php)	Enforcement of environmental laws, strengthened local criminal justice systems, and coordinated national-, regional-, and international-level combat of wildlife crime	Short-term
• Ex situ conservation	Ex situ conservation efforts for the reintroduction of wildlife that have been reduced or extinct in the wild	Reintroduction of the extinct in the wild scimitar-horned oryx (*Oryx dammah*, Cretzschmar, 1826) in Chad (Newby et al., 2016)	Recovered wildlife and ecosystems composition	Long-term
• Societal change for biodiversity conservation	Embracing human economy principles for fundamental change	Oxfam (2017); Seidman (2017)	Resilient peace strategies that integrate environmental protection and societal development	Long-term

Note: Examples of applications and outcomes and putative implementation timing. Short-term indicates actions that can be implemented immediately, while long-term indicates actions that will likely require several years to implement.

socioeconomic welfare of populations, and ultimately to conserve traditional activities, cultural and natural heritage, and to promote peace (https://www2.unwto.org/publication/tourism-and-biodiversity-achieving-common-goals-towards-sustainability).

Research and monitoring activities need adequate financing and should be undertaken swiftly in critical cases, such as the potential addax population reported from Mauritania (Newby et al., 2016). Reintroduction is an option in regions where security is assured (Ripple et al., 2016; Table 2). Such operations, however, require detailed decision processes (McGowan, Traylor-Holzer, & Leus, 2017) and are costly, lengthy, and logistically difficult, magnifying the need to avoid whenever possible local extinction in the first place.

Countries producing arms and ammunition need to change their present attitude toward the revenues generated from the military industry and acknowledge the negative relationships between international efforts to protect biodiversity and arm trades. Building civic consciousness is urgently needed among citizens from arms manufacturing countries (www.photographersagainstwildlifecrime.com), for clear understanding of the vicious circle established between arms trade, conflict, migration, and biodiversity decline to build up societal pressure for change. NGOs can play a critical role in exposing these links (e.g., https://www.tni.org; https://www.transparency.org; https://controlarms.org/en; https://www.sipri.org/).

Globally rising economic inequalities have been identified as major threat to social stability (Oxfam, 2017). Reversing the current wildlife extinction trend is a problem embedded in a larger and much more complex web of global societal challenges. Tackling current biodiversity loss requires the equitable and sustainable use of natural resources, which should be regulated by good governance (including transparency and accountability over natural resource use), and to improve the socioeconomic welfare and access to education for local human populations. While there is no doubt that support is needed to effect major societal and policy change, including from organizations such as the World Bank/GEF, United Nations Convention to Combat Desertification, European Development Fund, Economic Community of West African States, or African Union, we still need to understand how to better integrate environmental conservation with equitable socioeconomic development into efficient peace strategies (Table 2). Embracing human economy values where governments work for the 99% and cooperate (not just compete), where leadership comes with moral authority, and where companies work with social responsibility and contribute to end the extreme concentration of wealth and end extreme poverty, is increasingly advocated as a needed fundamental global change (Oxfam, 2017; Seidman, 2017; https://sustainabledevelopment.un.org/sdgs). Well-targeted international assistance has the potential to reduce biodiversity decline and alleviate poverty (Waldron et al., 2013).

5 | CONCLUSION

Appropriate policy instruments that incentivize conservation and sustainable use of natural resources are urgently needed along with raising awareness and pride within communities of the value and uniqueness of the Sahara-Sahel wildlife. Financial penalties on extractive industries that do not respect conservation guidelines need to be enforced. Such steps need to be taken now, before the unique and iconic biodiversity of the world's largest desert is lost.

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

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