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A framework for application of the landscape approach to forest conservation and restoration in Sierra Leone

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Sierra Leone has made some progress in creating protected areas for wildlife and biodiversity conservation. Yet deforestation and habitat loss remain pervasive, driven largely by unregulated exploitation and poor land use practices. With over 50% of the country (~36,000 km^2) having climate that is favorable for tropical forest vegetation, there is considerable opportunity to advance the landscape approach for forest conservation. We propose a framework to address this need for the globally threatened Upper Guinea rainforest, which has its westernmost extent in Sierra Leone. The framework considers forest and tree cover in the following categories: old growth, disturbed old growth, secondary growth, and managed. We discuss how this typology can foster application of the landscape approach to forest conservation and restoration, including policy options to enhance protection of forests, increase tree cover in production systems, and incentivize innovative land use practices by local communities.

KEYWORDS

ecosystem services, landscape connectivity, landscape approach, Upper Guinea forest ecosystem, wildlife conservation

Introduction

Tropical rainforests are amongst the biologically richest terrestrial ecosystems and play a vital role in biophysical processes that sustain life on earth. For this reason, regions and countries with the most extensive and intact cover have a vital role in safeguarding these forests (Watson et al., 2018). However, in regions where the forests exist in a highly fragmented state, countries are often faced with the challenge of balancing protection with other land uses that underpin livelihoods and wellbeing of local communities (Díaz et al., 2019). In such regions, the importance of "ecological and social forest transitions" (Meyfroidt and Lambin, 2011) has been suggested as basis for advancing the landscape approach to reconcile agriculture, conservation, and other competing land uses (Sayer et al., 2013; Reed et al., 2017).

In the West Africa region, evidence from climatic studies suggests that forests were once extensive, particularly during the interglacial period (Miller and Gosling, 2014). Today, what is known as the Guinean Forests Biodiversity Hotspot (Myers et al., 2000) is considered one of the world's most threatened ecosystems (Luiselli et al., 2019; Luiselli and Fa, 2019). Based on its location and political boundaries, Sierra Leone lies on the westernmost extent of this hotspot in the Upper Guinea forest ecosystem, a biologically distinct ecoregion (Olson et al., 2001; **Figure 1**).

The actual status and origin of forests in Sierra Leone has remained a subject of much debate (Fairhead and Leach, 1998; Munro and van der Horst, 2015), and all of what is considered today as forest is restricted to areas that were demarcated and mapped as far back as the 1950s (Wadsworth and Lebbie, 2019). Diverse land cover types with trees and tree-based systems outside of those demarcated areas are seldom considered. With over 50% of the country (~36,000 km^2) having climate that is favorable for tropical forest vegetation (Davies, 1987; Harcourt, 1992), there is considerable potential to increase forest cover for wildlife and ecosystem services that underpin local livelihoods.

The growing call for tropical forest countries to strengthen efforts toward tackling loss of biodiversity (Giam, 2017), protection of threatened trees (BGCI, 2021), restoration of tree cover (Bastin et al., 2019), and forest landscape restoration (Brancalion et al., 2019; Hansen et al., 2020) presents a timely opportunity for advancing the landscape approach (Sayer et al., 2013; Reed et al., 2016, 2020). As defined by Reed et al. (2016), the landscape approach is "a framework to integrate policy and practice for multiple competing land uses through the implementation of adaptive and integrated management systems." In this context, we consider the landscape as a defined geographical area "with structure and function composed primarily of patches in a matrix" (Forman and Godron, 1981). In relation to tropical forests, it has been suggested that while the integrated management of competing land uses does not expand protected areas *per se*, the landscape approach can promote practices that are compatible with biodiversity conservation goals (Laurence et al., 2012; Sayer et al., 2013; Arts et al., 2017). Furthermore, the approach provides concepts and tools to better manage potential tradeoffs in safeguarding forests and provision of ecosystems services (Hodder et al., 2014; Acheampong et al., 2020). Application of the landscape approach, however, can be constrained by sectoral divides (e.g., Reed et al., 2020), underrepresentation of impact domains (Carmenta et al., 2020), or insufficient engagement with and of diverse stakeholder groups, *inter alia*.

Building on existing literature on state of forests and biodiversity conservation in Sierra Leone, we propose a framework to advance the landscape approach, focusing specifically on the Upper Guinean forest ecosystem. We discuss how existing policies for forest and natural resource management can be harnessed to create enabling conditions for application of the approach. By advancing the landscape approach, Sierra Leone stands to gain immensely from policy options that will improve conservation of this globally important, highly threatened and fragmented ecosystem. The approach will promote practices for reducing deforestation and habitat loss, restoration of degraded forest landscapes, and increasing tree cover in production systems. This in turn will lead to increased landscape connectivity for wildlife and generate multiple ecosystem services and livelihood benefits for local communities.

Rationale and context for the landscape approach

State of forest conservation in Sierra Leone

Since the early 1900s, tropical forests in Sierra Leone have been viewed from two main perspectives in the formulation of policies: protection of flora and fauna, and commercial exploitation for timber. Both perspectives emphasize centralized control over the major forest blocks designated as "reserves" for protection and exploitation (Munro and Hiemstra-van der Horst, 2011), but exclude all other forest fragments that are mostly under control of traditional landowners and local communities. This includes forest fragments considered by communities as "Sacred Groves"–patches of forest that are set aside solely for traditional or religious purposes and protected from all forms of encroachment (Lebbie and Guries, 1995; Martín et al., 2011). In a country where large expanses of intact forest no longer exist, the remaining fragments are becoming increasingly isolated as the surrounding matrix get progressively transformed and degraded from anthropogenic uses. By focusing solely on forests historically demarcated for protection and exploitation, the prospects of achieving connectivity in the landscapes (Correa Ayram et al., 2016) will be constrained, making it difficult to safeguard viable populations of many forest-dependent wildlife species.

Over the last four decades, the Sierra Leone Government has taken important steps to secure most of the remaining forest blocks identified as priorities for safeguarding globally important wildlife species (**Figure 1C**). The prioritization is attributed to a succession of nation-wide surveys (e.g., Lowes, 1970; Wilkinson, 1974; Phillipson, 1978) and site-specific studies (e.g., Cole, 1980; Merz, 1986; Davies, 1987; Allport et al., 1989; Thompson, 1993) that contributed scientific knowledge and understanding on status of wildlife species and their habitats. As knowledge of the status of some globally important taxa in these areas have continued to increase, the urgency to scale up conservation in the face of growing anthropogenic threats has become more apparent.

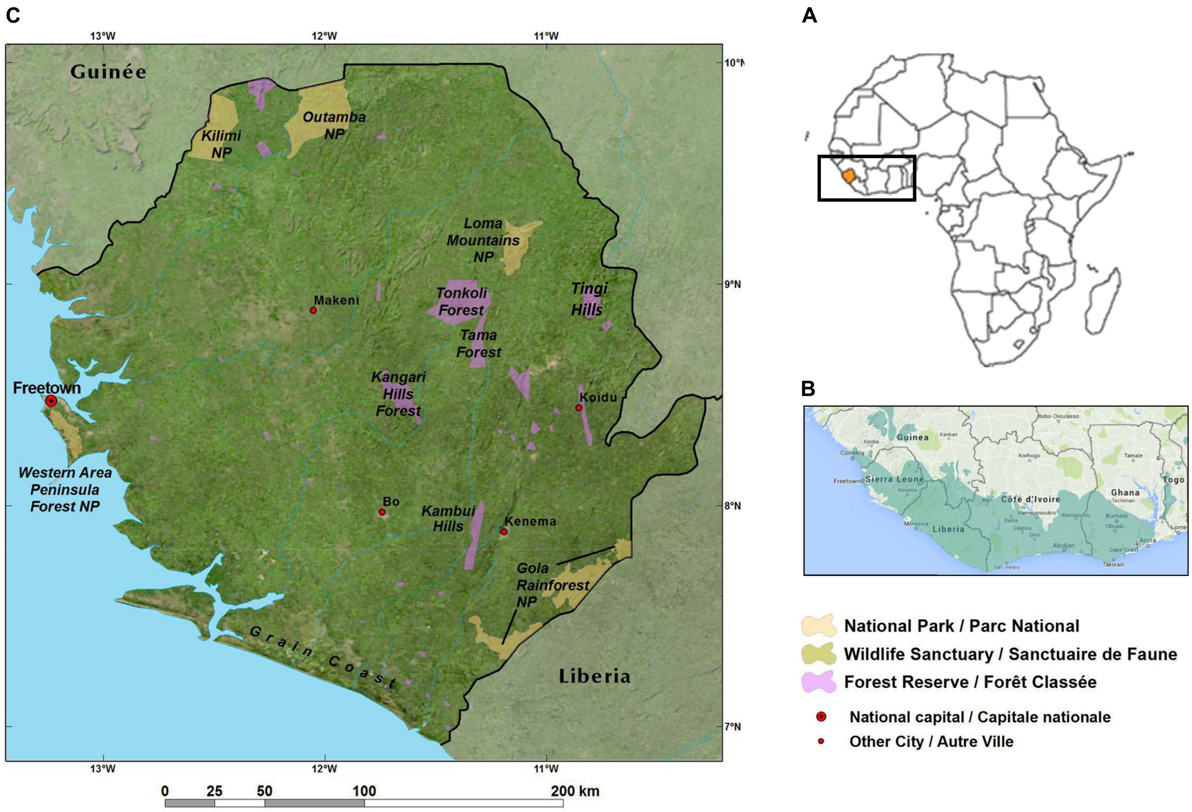

FIGURE 1
(A) Location of Sierra Leone (colored) in West Africa; **(B)** Extent of the Upper Guinea forest in West Africa (area shaded in green); and **(C)** Map of Sierra Leone showing National Parks and Forest Reserves [Sources of maps: **(A)** Mapsland, https://www.mapsland.com; **(B)** Global Forest Watch, https://www.globalforestwatch.org; **(C)** U.S. Geological Survey, https://eros.usgs.gov/westafrica].

According to the World Conservation Monitoring Center, Sierra Leone has 6,825 km^2 (9.39%) of its total land area of 72,709 km^2 under some form of protection (UNEP-WCMC, 2020). The National Protected Area Authority (NPAA)[1] has targeted an estimated 490,000 hectares (6.8% of the total land area) in 15 sites for formal gazettement as National Parks. They include all the major blocks of Upper Guinea forest previously recommended for conservation from the nationwide surveys (Lowes, 1970; Wilkinson, 1974; Phillipson, 1978). Four of the targets have already been declared as National Parks, and include Outamba and Kilimi (1995), Gola Rainforest (2010), Loma Mountains (2013), and Western Area Peninsula Forest (2013) (**Figure 1C**). In addition, Tiwai Island located on the western edge of the Gola Rainforest National Park, was declared a Game Sanctuary in 1987 following a request by Chiefdom authorities (Oates, 1999). Efforts to protect all forest reserves have been useful in reinforcing Sierra Leone's commitment to safeguarding the Upper Guinea forest ecosystem. As noted by Burgess et al. (2007), forest reserves have a legally defined role in biodiversity conservation and as such could contribute toward a comprehensive protected area network.

Existing data on distribution and status of species have been used to confirm the global importance of remnant forests as Key Biodiversity Areas (KBAs; Eken et al., 2004) for conservation of the Upper Guinea ecosystem in Sierra Leone (Kouame et al., 2012). These remaining forest blocks are particularly vital for supporting populations of forest-dependent species in an otherwise fragmented ecosystem. Among such forest-dependent species are the white-breasted guineafowl, *Agelastes meleagrides*; white-necked rockfowl, *Picathartes gymnocephalus*; pygmy hippopotamus, *Choeropsis liberiensis*; and western chimpanzee, *Pan troglodytes verus*. Because of their global appeal and threatened status, we consider these four species as important "flagships" (Bowen-Jones and Entwistle, 2002) for conservation of the Upper Guinea ecosystem in Sierra Leone.

Although the occurrence of all four species in the existing protected forest areas is well documented, the long-term viability and survival of their populations cannot depend solely on these areas because of pervasive threats and increasing isolation. There is a high risk that anthropogenic pressure from expansion of agricultural land, demand for biomass energy,

1 http://www.npaa-sl.org/

and wood extraction (Geist and Lambin, 2002), will continue and increase, further reducing and degrading the remaining forest fragments. The white-breasted guineafowl is endemic to the Upper Guinea rainforest and has a restricted distribution in Sierra Leone, occurring mainly in the Gola forests and on Tiwai Island, but also occasionally in cocoa plantations located adjacent to those forests (Burgess et al., 2017). The white-necked rockfowl, pygmy hippopotamus, and western chimpanzee have also been recorded in forest fragments and gallery forests outside of the existing protected areas (Thompson et al., 2004). To safeguard populations of these species, there is an urgent need to expand the coverage of the protected areas and integrate their management with other land uses. We propose the landscape approach as a promising framework to address the multiple challenges related to land use and types, including the opportunity to harness existing policies than can help promote land use practices for increasing forest and tree cover and improving landscape connectivity (Newmark, 2008).

Forests in environmental and natural resource policies

Forests and forest resources feature prominently in most of the country's national policies and legislation related to environment and natural resource management (**Table 1**). Collectively, the various Acts and policies include relevant provisions to foster a sound enabling environment for conservation of forest and biodiversity. In addition to provisions imposing restrictions on resource exploitation and environmental degradation, some Acts and policies also mandate creation of appropriate institutional frameworks to support law enforcement, monitoring, and resource mobilization. Unfortunately, the characterization of what constitutes forest is not consistent across the various Acts and policies.

The Forestry Act of 1988 is the primary legislation governance, conservation, and other utilization of forests. The Act contains provisions for afforestation, concession agreements, land acquisition, control of timber yields, designation of forest areas and tree species for protection, and penalties for violators. The Act identifies several categories of forest to which the various provisions apply but does not explicitly define what is considered as "forest." The categories are grouped into (a) *classified forests,* which include national production forests, community forests, and protected forests (reserves), and (b) *unclassified forests*, which include all other forests. These categories do not give due consideration to the relative importance of forests for wildlife and biodiversity conservation.

A new Forestry Policy was formally adopted in 2004 and updated in 2010 but has not been made operational through legislation. The policy focuses on sustainable exploitation and use of forest resources for the material, cultural, and aesthetic benefit of people. It outlines priorities for management of state, community and private forests, and reinforces the role of the Forestry Division as the government agency responsible for overseeing forests and wildlife. The policy identifies 48 Forest Reserves in the country, totaling 284,591 hectares. A particularly useful innovation in the 2010 policy is the explicit link of forest management to other sectoral priorities, including protection of catchments, development of urban areas, ecotourism, and social forestry. Although forest is not clearly defined, these cross-sector linkages offer a good foundation for advancing the landscape approach to conservation for biodiversity and wildlife.

Forest land is generally subject to a tenure system that governs land classification in Sierra Leone, and forests can be owned by the state or private parties or fall within chieftaincy land. The Forestry Act of 1988 empowers the Minister of Agriculture and Forestry to declare any forest as a protected area for conservation of wildlife and biodiversity. While all officially designated forest reserves and protected areas are on land that is centrally owned by the government, forest fragments and tree cover on land that is owned and managed by communities can play an important role in advancing the landscape approach.

In addition to national policies, Sierra Leone has also adopted and ratified most global multilateral environmental agreements dealing with biodiversity, wildlife, land degradation, and climate change, signaling its commitment toward global efforts to safeguard the planet. Although the government has established no explicit target, delivering on commitments to multilateral environmental agreements will benefit greatly from a landscape approach to forest management. This will ensure that both natural forests and tree-based systems such as agroforestry can be integrated as options for reducing emissions from deforestation and forest degradation or "REDD+" (Minang et al., 2014).

Characterizing forest cover in landscapes

Despite the fragmented nature of forest in the country, Sierra Leone has continued to demonstrate commitment toward safeguarding wildlife and biodiversity. However, efforts to reduce deforestation and forest degradation are not consistently aligned with others focused on restoration of degraded lands and increasing tree cover in production landscapes. Furthermore, a consistent characterization of what constitutes forests is lacking, and as noted by Wadsworth and Lebbie (2019), international definitions and standards are seldom appropriate to the Sierra Leonean context.

The widely used Food and Agricultural Organization (FAO) definition of forest as "*land spanning more than 0.5 hectares with trees higher than 5 m and a canopy cover of more than 10 percent,*" imposes thresholds that make it difficult

TABLE 1 National policies and legislation related to conservation of forest and tree-based systems.

National policy or legislation	Year enacted	Relevance for forest and tree-based systems
The Wildlife Conservation Act	1972	This Act is the principal legislation guiding the establishment, management and regulation of wildlife and protected areas. It also empowers officers and employees of the Government's Forestry Division and Wildlife Conservation Branch to "enter, demarcate, and survey any land" for establishing such land as a protected area. It further stipulates the prohibition of residing, hunting, killing, or capture of wildlife in protected areas except where a written permission is provided by the Chief Conservator of Forest. Finally, the Act also makes provision for a Wildlife Conservation Officer to arrest without a warrant any person suspected of committing an offense under this Act.
The Forestry Act	1988	This is the primary legislation guiding the conservation and exploitation of forests in Sierra Leone, and categorizes forests into classified (i.e., production, protection, or community) and non-classified forests. It contains special protection provisions under which the Minister is empowered to declare any area to be a "protected area for purpose of conservation of soil, water, flora, and fauna." The legislation also includes provisions for community forests, and on restriction for cutting, burning, uprooting or destroying trees that are in protected areas or trees that have been declared as protected. It also empowers the Chief Conservator/Director of Forest to issue license or concession for harvesting and extraction of a protected tree.
The Development of Tourism Act	1990	This Act promotes the development of Tourism in Sierra Leone. The Act makes provision for the protection of National Tourism Development Assets. Wildlife and protected areas are critical part of these assets.
The National Environmental Policy	1990 and 1994	The Policy aims at achieving sustainable development in Sierra Leone, through sound environmental and natural resources management. It has a specific objective to conserve and use the environment and natural resources; restore, maintain, and enhance the ecosystems and ecological processes essential for the functioning of the biosphere; to preserve biological diversity, and uphold the principle of optimum sustainable yield in the use of living natural resources and ecosystems. The NEP also contain among others sector policies on land tenure, land use and soil conservation; forests and wildlife; biological diversity and cultural heritage; mining and mineral resources; coastal and marine resources; settlements, recreational space and greenbelts and public participation.
The Mines and Minerals Act	1994	This Act among other things ensures the introduction of measures to reduce the harmful effects of mining activities on the environment. This includes empowering the Minister to consider protection of natural resources in or on the land to be mined when granting mineral right, requiring license-holders to undertake an Environmental Impact Assessment (EIA) as prescribed by the Environmental Protection Agency Act (see below), and requiring the rehabilitation and restoration of damaged areas that may have been affected by exploration or mining operations.
National Land Policy and Land Commission Act	2004	The land policy is aimed at ensuring "the judicious use of the nation's land and its natural resources by all sections of the Sierra Leone Society." The policymakes explicit reference to forests as natural assets, including issues related to management and protection. The policy also provides the framework to "ensure equal opportunity of access to land and security to tenure to maintain a stable environment for the country's sustainable, social and economic development." The land policy if effectively implemented will ensure sustainable land use and enhance land capacity and conservation.
The Environment Protection Agency Act	2008	This Act established the Environment Protection Agency (EPA) "to provide for the effective protection of the environment and for other related matters." The Act makes provision for the requirement of EIA license for projects whose activities may impact forests. This includes projects that involve substantial changes in renewable resource use, substantial changes in farming and fisheries practices, exploitation of hydraulic resources, infrastructure, industrial activities, extractive industries, waste management and disposal, housing construction, and development schemes.
The National Protected Area Authority and Conservation Trust Fund Act	2012	This Act established the National Protected Area Authority (NPAA) and Conservation Trust Fund, "to promote biodiversity conservation, wildlife management, research, to provide for the sale of ecosystems services in the National Protected Areas and to provide for other related matters." The Act makes a specific provision for the NPAA to collaborate with other stakeholders on reduced emissions from deforestation and forest degradation (REDD+) as a source of sustainable financing for Protected Area Management. A particularly important function relating to forests is the focus on "promoting policies for enabling by local forest edge communities to participate and co-manage national resources inside and outside National Protected Areas." It also highlights awareness raising and community engagement on environmental management issues, including forestry best practices and forest management.
National Land Policy	2015	The new National Land Policy includes an explicit statement on commitment by the government to "adopt an integrated and comprehensive approach to management of land based natural resources." The overarching objective of the NLP is to "promote and enforce sound land use, regulation and management." The document specifically noted that "the land administration system, particularly its authority in the Western Area is fragmented and experiencing a bureaucratic impasse resulting in inadequate planning and oversight and strewn with uncoordinated activities facing the potential of inefficient use of assets and donor aid".

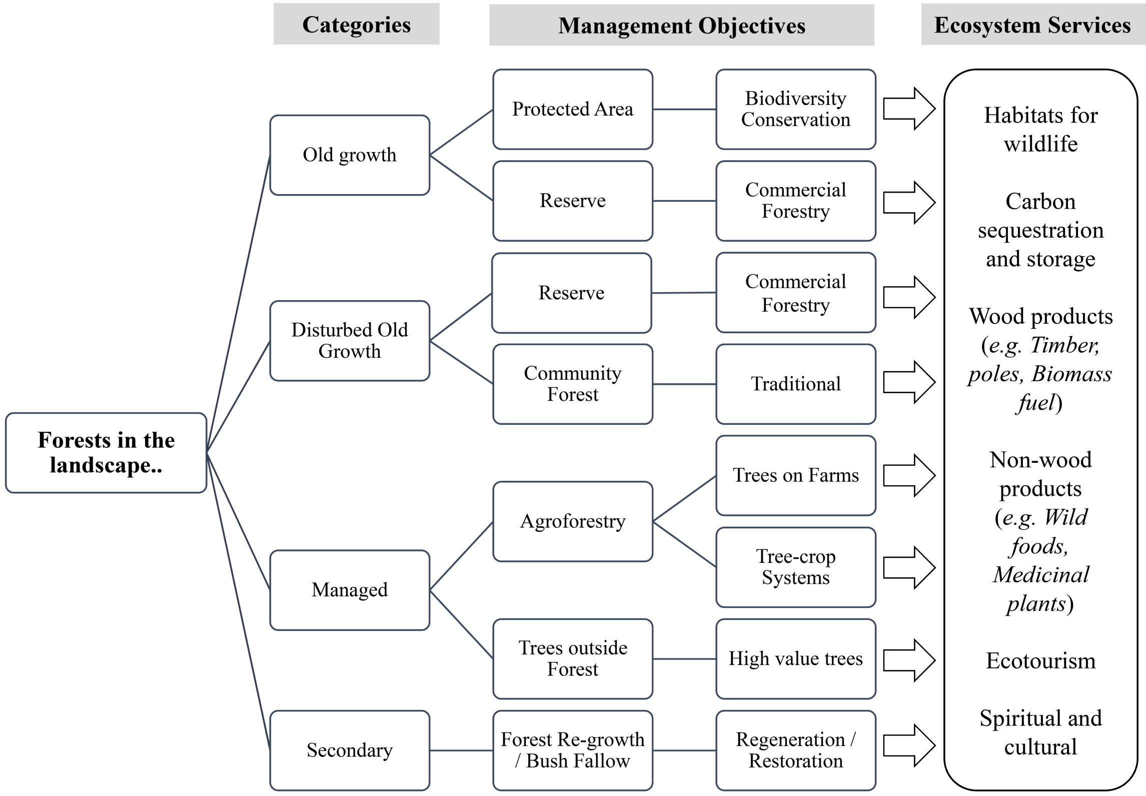

FIGURE 2
Proposed framework for characterization of forests landscapes.

to apply in a country with such highly fragmented forest ecosystem. As noted by Chazdon et al. (2016), this threshold means that "small, isolated forest patches, riparian forest strips, live fences, agroforests, and remnant trees standing within a matrix of non-forest land uses" are often excluded from assessments of forest cover. Global Forest Watch estimates that in 2000, Sierra Leone had 5.62 million hectares of tree cover, of which about 276,000 (4.9%) was considered "primary forest." Although tree cover is defined as "areas with >30% canopy," there is no clear description of what constitutes "primary forest." These discrepancies can only be addressed by characterizing forest cover relative to the national context, which will create opportunities for advancing the landscape approach to conservation.

The tropical forest landscape in Sierra Leone is highly fragmented, with land cover that ranges from relatively intact and undisturbed forests to degraded and unproductive crop lands. Moreover, the occurrence of "primary forest" (Mackey et al., 2015) in Sierra Leone is still very much contested (e.g., Munro and van der Horst, 2015). Hence from a wider landscape perspective, we propose a framework that characterizes existing forest and tree cover in Sierra Leone in four categories (**Figure 2**): *old growth, disturbed old growth, managed*, and *secondary*.

- ***Old growth forests*** include natural forests in the later stages of stand development with no evidence of recent anthropogenic disturbance. Such forests would be characterized by trees typical of the Upper Guinea ecosystem, such as *Lophira alata, Heritiera utilis, Klainedoxa gabonensis, Uapaca guineensis, Oldfieldia africana, Erythrophleum ivorensis, Brachystegia leonensis and Piptadeniastrum africanum, Daniellia thurifera, Terminalia ivorensis, Terminalia superba, Parkia bicolor, Anthonotha fragrans, Parinari excelsa, Bridelia grandis, Treculia africana*, and *Pycnanthus angolensis* (Savill and Fox, 1967; Davies, 1987). The major blocks of forests designated as reserves or declared as protected areas and numerous smaller fragments dotting the countryside are typified by this composition of tree species.
- ***Disturbed old growth forests*** are those that have lost their defining compositional (species) and structural (ecosystem) attributes due to anthropogenic forces, such as logging and harvesting of non-timber forest products, wildlife hunting, and slow-moving low intensity understory fires that kill small trees and shorten the life expectancies of large ones (Putz and Redford, 2010).
- ***Secondary forests*** include vegetation or bush fallows in various stages of regeneration following recent

deforestation of land that was previously under old growth forest (Corlett, 1994; Chokkalingam and De Jong, 2001). Although tree species diversity in these forests is initially low and dominated by early pioneer species, secondary forests can over time transition to old growth forest in the absence of further anthropogenic disturbance (Wadsworth and Lebbie, 2019).

- ***Managed forests*** include tree-based systems in agricultural landscapes and those used for production of timber and non-timber forest products (Birdsey and Panw, 2015). Sierra Leone has a long history with the "Taungya System," an agroforestry system (Nair, 1985) where farmers are incentivized by the government to integrate high value timber trees such as *T. ivorensis*, and *Cassia siamea* on their farms (Savill and Fox, 1967). Although dominated by use of fast-growing exotics such as *Tectona grandis* and *Gmelina aborea*, the system still has potential for management of high value forest species especially along roadsides (Davies, 1987). In this regard, the concept of "Trees outside Forests" (de Foresta et al., 2013; Zomer et al., 2016) is also relevant in the Sierra Leone context because it includes scattered trees in agricultural landscapes that can serve as biological legacies to support species dispersal, and as "keystone structures" for the multiple ecological functions they perform (Manning et al., 2006; Skole et al., 2021).

The forest categories vary in their importance for ecosystem goods and services, such as habitats for wildlife, timber production, carbon storage, and as source of non-wood products for local communities. As described by Chazdon et al. (2016), the flow of ecosystem goods and services depend on the management objectives of forests and tree cover in the landscape. In the Sierra Leone context, such management objectives for the four categories can be described as follows:

- ***Old growth forests*** as those natural undisturbed fragments designated (a) for conservation as protected areas and managed to protect biodiversity, and as a result, contribute to securing carbon stocks and other ecosystem services; and (b) as reserves primarily for commercial exploitation (i.e., extraction of timber);
- ***Disturbed old growth forests*** as those in reserves and under community/traditional use that have or are being exploited for wood or non-wood (e.g., herbal medicine, wild foods) products, but with potential for maintaining native biodiversity, wildlife populations, and securing carbon stocks other ecosystem services;
- ***Secondary forest*** as those in various stages of re-growth or regeneration, contributing to carbon sequestration, habitat improvement for wildlife, and providing access to wood and non-wood products for local communities; and
- ***Managed tree-based systems*** such as *agroforestry* with multi-purpose trees on farms for products (biomass energy, herbal medicine, fodder) and for improving soil health, or in tree-crop systems for biodiversity, shade, timber, and products; and *trees outside forests* contributing to carbon stocks, biodiversity conservation, and access to wood and non-wood products.

Through the landscape approach, the management of forest and tree cover by government agencies, local communities, and civil society organizations can be spatially integrated to improve protection, sustainable use, and restoration of the Upper Guinea ecosystem in Sierra Leone. The approach will also enable the land users to harness existing policies for improving forest conservation, tackling drivers of forest loss, and incentivizing practices that maintain or increase forest and tree cover. As a result, the country will be better positioned to deliver on its commitment under various multi-lateral agreements, such as safeguarding wildlife and biodiversity, securing carbon stocks and reducing greenhouse gas emissions from land use change and forests, and restoring degraded forest landscapes. In the next section, we discuss how these efforts can contribute toward promoting the landscape approach to forest and wildlife conservation in the country.

Advancing the landscape approach–Options and opportunities

The importance of protected areas for conservation of African rainforests is well documented (e.g., Naughton-Treves et al., 2005; Struhsaker et al., 2005; Beresford et al., 2013; Tranquilli et al., 2014). However, human pressure on protected areas has continued to increase globally (Jones et al., 2018), and the loss of forests is exacerbating extinction risks for many species (Betts et al., 2017). Furthermore, most countries are falling short of the Aichi targets for achieving comprehensive coverage (Butchart et al., 2016; Stokstad, 2020) or meeting the costs needed for effective management (Coad et al., 2019), while others are confronted with the problem of downgrading, downsizing and de-gazettement of protected areas (Golden Kroner et al., 2019). These developments highlight the need for tropical forest countries like Sierra Leone where local livelihoods are tightly linked to natural resources, to scale-up conservation by integrating the management of protected areas with human-modified landscapes (Chazdon et al., 2009). This approach will enable countries to target forest remnants and tree cover outside of protected areas, and as a result harness their critical role for wildlife conservation and ecosystem services (Díaz et al., 2018). This is consistent with the multi-pronged strategy proposed by Newmark (2008) for tackling the increasing risk of isolation facing African protected areas.

Despite commitments made by the government of Sierra Leone to increase protected area coverage, the growing demand for land and natural resources will continue to exacerbate threats to wildlife and biodiversity. While increased financing and management effectiveness of the established protected areas remains an urgent priority, there is also a clear need to integrate their management with other land uses across the wider landscapes. Such integration will help to align and scale-up conservation of forest landscapes by recognizing the importance of forest and tree cover in the human-modified landscapes. This will facilitate engagement of diverse stakeholders, including local communities and smallholder farmers, in efforts to safeguard the entire ecosystem. As has been demonstrated in other biodiversity hotspots, stakeholder engagement is key to ensuring that potential trade-offs in balancing conservation with other competing land uses are identified and addressed (Segan et al., 2012).

In the following paragraphs, we describe how the country can advance the landscape approach by promoting policy options that reduce deforestation and habitat loss, increase tree cover in production systems, and promote restoration of degraded lands.

Reducing forest loss

Like all other tropical forest countries, a core priority for Sierra Leone is to safeguard all existing natural forests for biodiversity conservation and carbon stocks, and more generally, for provision of ecosystem services. Although the extent of forest cover in Sierra Leone remains contested, the threat from agricultural land use, urban expansion, overexploitation of forest resources (wood and non-wood), and extraction of minerals is still very pervasive throughout the country. Efforts to tackle these drivers can be greatly enhanced by integrating management of forest and tree cover across landscapes. A comprehensive assessment of forest and tree cover is needed to set targets for wildlife conservation and ecosystems services, as well as inform policies and solutions to reduce deforestation and forest degradation. By recognizing their value and importance, remnant old growth forests can be protected as anchors for increasing connectivity across human-dominated landscapes (Turner and Corlett, 1996).

Local communities value forests for diverse purposes ranging from access to wood and non-wood products to traditional and cultural practices, and typically maintain old growth forests to meet these needs. Forest remnants maintained as sacred groves for socio-cultural purposes have been found to also contain important habitats for wildlife and native biodiversity (Lebbie and Guries, 1995; Decher, 1997; Martín et al., 2011). Although generally too small to be recorded from satellite imagery or remote sensing surveys, these "community forests" can contribute significantly to conservation in landscapes that have been largely transformed by agriculture land use (Porter-Bolland et al., 2012). Integrating them into a landscape approach will, however, require policy options that empower communities as key stakeholders, such as increasing tenure security and rights over forests and trees. This will enable the communities to align their socio-cultural values and practices with priorities for wildlife and biodiversity conservation (Michon et al., 2007).

The integrated management of forest remnants through the landscape approach could also play an important role in understanding and preventing zoonotic spillovers (Laporta, 2014). For example, Rulli et al. (2017) analyzed land cover change data in conjunction with outbreak records of Ebola Virus Disease (EVD) in West and Central Africa, and found that the index cases in humans (i.e., spillover from wildlife reservoirs) occurred mostly in hotspots of forest fragmentation. Olivero et al. (2017) showed that probability of an EVD outbreak occurring in a site is linked to recent deforestation events, and that preventing the loss of forests could reduce the likelihood of future outbreaks. Elsewhere in Africa, studies have shown that the combination of forest landscape fragmentation and human behavior can increase the likelihood of contact events between humans and non-human primates (Bloomfield et al., 2020). By advancing a landscape approach to forest conservation, these dynamics can be better assessed and documented to inform policy options.

Finally, knowledge of the extent of old growth forests will play a critical role in mobilizing investments for REDD+ initiatives (Malhi et al., 2013). From studies conducted in the Gola forests, such forests remain important for carbon sequestration and storage (Lindsell and Klop, 2012). Extending the assessment of carbon stocks and sequestration potential to all forest categories as defined in this paper, will create opportunities to engage local communities and other land users in REDD+ initiatives. This will then create incentives for communities to protect forest remnants and, as a result, increase the potential to create corridors that benefit wildlife (Bakarr and Prabhu, 2006), or generate biodiversity and carbon benefits (Jantz et al., 2014). Promoting such incentive-based options should include commitment to pathways that generate revenue for local communities (Leach and Scoones, 2013).

Managing tree cover in production landscapes

The Upper Guinea ecosystem in Sierra Leone is characterized by a mosaic of forest fragments in a matrix of production systems. Accommodating this agriculture-forest mosaic in conservation is important because of the multiple biodiversity and ecosystem service benefits (Brandon et al., 2008; Norris et al., 2010). Beyond the old growth forests inside and outside of protected areas, trees are a dominant feature of production landscapes and play an important role in slash-and-burn agriculture (Nyerges, 1994), which is still to-date the most common form of land use in the rainforest region (Gboku et al., 2015). In a study of how remnant tree presence affects forest recovery after slash-and-burn agriculture, Cuni-Sanchez and Lindsell (2016) showed that above-ground carbon stocks, stem density, basal area, species richness, and tree diversity increased significantly with fallow age. This makes trees invaluable for integration in production landscapes where they can contribute multiple ecosystem service benefits.

Most trees in production landscapes are typically maintained by farmers because of their importance as sources of wood, biomass fuel, edible products (fruits and leaves), and traditional medicine. The most common large trees in these landscapes include species belonging to the following genera: *Amphimas, Bombax, Bridelia, Ceiba, Chlorophora, Fagara, Klainedoxa, Nauclea, Pycnanthus*, and *Terminalia* (Savill and Fox, 1967). In landscapes where cocoa and coffee are the dominant production system, tree cover is often maintained as shade for the crops, and mainly with tree species such as *Alstonia boonei, Cola nitida, Entandrophragma angolense, Funtumia africana, P. angolensis, T. ivorensis, T. superba,* and *Xylopia aethiopica,* that also provide many other benefits for the communities. These agroforestry systems hold considerable potential for integration into a landscape approach to conservation.

Relative to other crop production practices, cocoa and coffee agroforestry systems have been found to increase biodiversity and functions that underpin ecosystem services in production landscapes (e.g., Schroth and Harvey, 2007; Clough et al., 2011; Abdulai et al., 2018; Barrios et al., 2018; Asigbaase et al., 2019). Because the systems already incorporate a diversity of native tree species, they also represent an attractive option for safeguarding wildlife and biodiversity in landscapes surrounding protected areas (Schroth et al., 2004; Bhagwat et al., 2008; Gardner et al., 2009; Asase and Tetteh, 2010). Studies have shown that forest-dependent species can utilize shade-cocoa and coffee farms adjacent to old growth forests (e.g., Davies, 1987; Allport et al., 1989; Barnett et al., 2000). In production landscapes around the Gola Rainforest National Park, BirdLife International in partnership with several stakeholders is implementing a Landscape Accelerator program to support the scaling up rainforest-friendly cocoa production.[2] These efforts highlight potential opportunities to incentivize and empower communities for scaling-up practices that deliver ecosystem services and livelihood benefits.

Promoting restoration of degraded landscapes

Agricultural production occupies more than 60% of the population in Sierra Leone and the country has an estimated 5.3 million hectares of arable land, representing 74.1% of its total land area (Gboku et al., 2015). The dominant form of agriculture is slash-and-burn farming or shifting agriculture, which is widespread and pervasive across the Upper Guinea forest countries (Ickowitz, 2006). The practice has resulted in a mosaic of "bush fallows"—vegetation in various stages of regrowth or regeneration—across much of the country. When allowed to develop long enough after farming (10–15 years), bush fallows can generate valuable ecosystem services for rural communities, including provision of construction poles and biomass fuel, and medicinal plants. By allowing bush fallows to naturally regenerate, they could transition from secondary forests into old growth forest and contribute directly to recovery of biodiversity and ecosystem services (Chazdon, 2008).

The practice of harvesting trees for fuelwood and charcoal is pervasive throughout the country (Munro et al., 2017; Fayiah et al., 2019), and among the favored tree species are *Lophira lanceolata, Dialium guineensis, Pterocarpus erinaceus, Parinari excelsa, Terminalia albida, Gmelina arborea*, and *Anisophyllea laurina* (Cline-Cole, 1987; Munro et al., 2017). However, the growing demand for these products increases pressure on the vegetation and undermines the prospects of transitioning into old growth forest. This exacerbates land degradation, with concomitant effects on soil health and agricultural productivity. Restoration of degraded landscapes therefore presents significant opportunity for shifting agricultural production away from the remnant old growth forests, including the existing or planned protected areas.

The focus of such restoration efforts should be on regaining ecological functionality and enhancing livelihoods across the degraded landscapes (Lamb, 2014; Acheampong et al., 2020), taking into account history of land use, needs of local communities, and options for achieving long-term sustainability and resilience of the system (Suding et al., 2015). Sierra Leone has recently committed to restoring 0.7 million hectares of degraded land under the African Forest Landscape Restoration Initiative (AFR100), a country-led effort to bring 100 million hectares of land in Africa into restoration by 2030.[3] This commitment presents an opportunity for the country to promote the use of appropriate tree species and innovative practices that deliver multiple ecosystem services while contributing to the conservation of wildlife and biodiversity. Setting aside secondary forests should be a key priority for achieving the target because the natural regeneration process will favor native species (Chazdon and Guariguata, 2016).

With increasing knowledge of opportunities for tree and landscape restoration in the tropics (Chazdon et al., 2017; Holl, 2017; Bastin et al., 2019; Brancalion et al., 2019), countries with highly fragmented and degraded ecosystems are now more than ever best placed to establish clear targets for restoration and promote actions by local communities. For a country like Sierra

2 https://www.birdlife.org/worldwide/news/eat-chocolate-save-rainforest-gola-cocoa-project-tells-you-how

3 https://afr100.org/content/sierra-leone

Leone where habitat loss and land degradation are a major threat to wildlife and human livelihoods, tree and landscape restoration presents an invaluable opportunity to improve conservation and ecosystem services. Because of their economic importance, wood products such as construction poles and biomass fuel have considerable potential for mobilizing large-scale engagement by local communities in landscape restoration. By establishing clear targets in accordance with global priorities and needs for biodiversity conservation and climate change mitigation, landscape restoration can contribute to reducing the degradation of secondary forest cover in Sierra Leone.

Policy options and opportunities for advancing the landscape approach

In addition to the growing need for increased support and improved management of existing protected areas (Spracklen et al., 2015), countries such as Sierra Leone must also make efforts to scale-up conservation in human-modified landscapes. With the growing risk of isolation facing populations of many forest-dependent species, extending conservation efforts beyond the existing protected area network will increase landscape connectivity. For example, Junker et al. (2015) proposed integration of resource development and conservation management plans as a means of maximizing opportunities for safeguarding the western chimpanzee in Liberia.

By recognizing the value and importance of forest and tree cover in the landscape, existing policies can be harnessed to advance the landscape approach. In this section, we discuss how the approach can be applied in practice through actionable options for: (a) increasing protection of forests and tree-based systems, and (b) incentivizing innovative practices. Specific actions under each existing policy to support these options are proposed in **Table 2**.

Protection of forests and tree-based systems

The various Acts and policies already in place include provisions for regulating the conservation and exploitation of forests. To successfully harness these existing Acts and policies, an assessment and delineation of forest and tree cover is needed for the different categories we have identified. This will enable the targeting of areas critical for landscape connectivity, such as remnant old growth forests, managed forests, and agroforestry systems with potential for integration as wildlife habitats. This would also include areas where local communities can be engaged in restoration to increase forest and tree cover. The assessment and delineation should be commissioned by the government and conducted in partnership with scientific and technical institutions.

Successful implementation of the landscape approach will benefit from policy options for expansion of the protected area network. If approved, the additional reserves already targeted for gazettement as National Parks (i.e., Kangari, Kambui, and Tingi Hills) will increase the core areas needed to safeguard populations of the four "flagship" species we have highlighted in this paper. In addition, remnant old growth forests already identified as KBAs (Kouame et al., 2012) and those with confirmed populations of the four species can be targeted as additional core areas for creation of corridors in the landscape (Bennett, 2003). In Guinea Bissau, the protection of remaining suitable habitat and promotion of forested corridors were considered key priorities for long-term conservation of the western chimpanzee (Torres et al., 2010). For those forest remnants under jurisdiction of local communities, alternative management options can be explored to improve their conservation and reduce the risk of future deforestation. In neighboring Liberia, the co-management with communities has been formalized and elevated as a strategy for forest conservation (Bakarr and Prabhu, 2006).

Based on their potential for increasing landscape connectivity, degraded areas can be targeted for restoration with appropriate tree-based systems and practices that can deliver multiple ecosystem services. In addition to increasing tree cover in human-modified landscapes, such restoration efforts should also contribute positive socioecological outcomes at local scales (Brancalion and Chazdon, 2017). In the Greater Nimba Landscape in neighboring Guinea, the Green Corridor Project is promoting restoration to increase landscape connectivity for populations of western chimpanzee (Matsuzawa et al., 2011). The process for deciding on where to restore, who should be engaged in restoration, and how tradeoffs are managed and negotiated among stakeholders, is a major factor for advancing the landscape approach (Mansourian, 2016).

Although human-wildlife conflicts are inevitable when implementing conservation in agriculture-forest mosaic, the improved management of important wildlife habitats and conservation-friendly systems can generate multiple ecosystem service benefits for local communities. For example, while chimpanzees have been implicated in crop-raiding (Hockings et al., 2009; Garriga et al., 2018), they can also disperse seeds of high value trees across the landscape (Hockings et al., 2017). Protection of old growth forest fragments and managed tree-based systems used as nesting sites by the white-necked rockfowl, or riparian forests used by pygmy hippopotamus, could potentially attract ecotourists. Furthermore, the potential

TABLE 2 Harnessing existing policies to advance the landscape approach.

Existing National Acts and policies	Options for implementation by stakeholders*	Increasing protection	Incentivizing innovative practices
The Wildlife Conservation Act	• Establish corridors to increase landscape connectivity for wildlife *(GAs, CSOs, TPs)*	√	
	• Promote schemes for protecting wildlife outside protected areas *(CSOs, LCs, TPs)*		√
The Forestry Act	• Inventory and demarcate forests and tree-based systems *(GAs, CSOs, TPs)*	√	
	• Identify additional forests for gazettement as protected areas *(GAs, CSOs, TPs)*	√	
	• Establish targets and standards for forest landscape restoration *(GAs, CSOs, TPs)*		√
	• Promote schemes for conservation of forest and trees in production systems *(GAs, CSOs, TPs)*		√
	• Promote tenure and rights of communities over trees and tree-based systems *(GAs)*		√
	• Promote systems for production of tree seeds and seedlings *(CSOs, LCs, TPs)*		√
	• Identify and promote high value trees for landscape restoration *(CSOs, LCs, TPs)*		√
The Development of	• Expand target areas for promoting nature-based tourism *(GAs, CSOs, TPs)*		√
Tourism Act	• Promote community managed forests as targets for nature-based tourism *(CSOs, LCs, TPs)*		√
The National	• Establish standards for integrated landscape management *(GAs, CSOs, TPs)*		√
Environmental Policy	• Promote schemes for integrated landscape management *(GAs, CSOs, TPs)*		√
The Mines and	• Exclude from concessions all areas designated for wildlife protection *(GAs)*	√	
Minerals Act	• Enforce standards for restoration of mined areas *(CSOs, TPs)*		√
	• Promote use of native tree species for restoration *(GA, CSOs, TPs)*		√
National Land	• Clarify land ownership and tenure to empower communities *(GAs, LCs)*		√
Policy and Land Commission Act	• Promote schemes for integrated land use planning *(GAs, CSOs, LCs, TPs)*		√
The Environment	• Enforce regulations for protection of forests and trees *(GAs, CSOs, LCs)*	√	
Protection Agency	• Enforce standards for forest landscape restoration *(GAs, CSOs, TPs)*		√
Act	• Promote protection of forests and trees in Environmental Impact Assessments *(GAs, TPs)*		√
The National	• Expand protected area coverage by gazettement all targeted areas *(GAs)*	√	
Protected Area	• Encourage and support designation of community forests as protected areas *(CSOs, LCs, TPs)*	√	
Authority and	• Promote schemes to reward/pay for protection of community forests *(GAs, CSOs, LCs, TPs)*		√
Conservation Trust Fund Act	• Promote schemes to empower and engage communities in management of protected areas *(GAs, CSOs, LCs, TPs)*	√	

*Stakeholders include the following:
- Government Agencies (GAs) responsible for overseeing policy implementation and enforcement;
- Civil Society Organizations (CSOs) engaged in forest and wildlife conservation activities;
- Local Communities (LCs) with rights over land and forest resources, and;
- Technical Partners (TPs) such as research organizations, private sector entities, and funders committed to supporting forest and wildlife conservation activities.

for increasing forest cover through integration of high value trees in the production landscape can create opportunities for communities to access climate or REDD+ finance (Griscom et al., 2017; Bossio et al., 2020). With policy options that incentivize and empower communities, such as payments for ecosystem services and revenue sharing from ecotourism, these practices can be greatly enhanced as part of a landscape approach to forest and wildlife conservation.

Incentivizing innovative practices

The implementation and governance of a landscape approach to forest and wildlife conservation will also require policy options that incentivize and empower diverse stakeholders, especially local communities and farmers (Ola and Benjamin, 2019). Positive incentives can promote sustainable practices, protection of forests, and enhancement of tree cover, while negative incentives can discourage forest- and tree-destroying practices (Nepstad et al., 2018). The existing National Acts and policies include provisions that can be harnessed to address this need in the context of advancing the landscape approach to forest and wildlife conservation. This includes provisions regulating wildlife and forest resource use, tenure and rights of local communities, and land management.

With respect to protected areas, the Gola Rainforest National Park (GRNP) and Tiwai Island Wildlife Sanctuary are emerging as useful models of community engagement in forest and wildlife conservation. The GRNP is also demonstrating how such engagement presents opportunities for extending conservation efforts beyond the protected area boundary and into production systems. Although unconditional cash transfers to communities have not stopped deforestation outside of the National Park (Wilebore et al., 2019), ongoing efforts to promote conservation-friendly cocoa may incentivize more farmers to embrace this practice. Elsewhere, development initiatives seeking to transform livelihoods have been directly linked to practices that also contribute to forest conservation (e.g., Ferraro and Simorangkir, 2020).

Building on existing policies, mechanisms for paying or rewarding farmers and local communities for ecosystems services can be promoted to advance the landscape approach. Such mechanisms can range from rewards for delivery of ready-made ecosystem services to the processes of ecosystem services generation (Namirembe et al., 2014). For example, communities can be rewarded or paid to protect forests as habitat for wildlife or for securing carbon stocks. Similarly, payments for carbon sequestration can be used to incentivize the use of tree-based systems to restore degraded landscapes. This can also create market opportunities for tree seeds and seedlings, as well as tree products, thereby providing additional source of income for communities. These efforts can be further amplified by empowering communities to protect forest fragments identified as important for wildlife conservation, and that can be integrated and management through the landscape approach (Freeman et al., 2015).

A key factor in the effectiveness of reward or payment schemes for is tenure security and rights of local communities and land users (Nawir et al., 2007). As noted by Nepstad et al. (2018), lack of a clear definition of land tenure and usufruct rights can be a major impediment to tree cover enhancement on farms and in deforested landscapes. Recent trends in land tenure and ownership in Sierra Leone suggests that local communities and farmers are highly vulnerable to practices that favor large-scale acquisitions for commercial plantations (Yengoh and Armah, 2016; Yengoh et al., 2016; Cavanagh, 2017). In addition to lack of proper legal and institutional frameworks for protecting local interests in such land deals, the expansion of plantations will force communities into clearing valuable remnant old growth forests for farming, thereby exacerbating threats to wildlife. Improved tenure security for local communities over forests and trees is therefore crucial, including considerations for empowerment of women (Yengoh et al., 2015). Women throughout Africa play a major role in management of natural resources and make up 70% of the smallholder farmers on the continent (Brahmbhatt et al., 2016). Hence, targeting women for tenure security and establishment of property rights can strengthen their role in forest and biodiversity conservation.

Conclusion

Sierra Leone has considerable potential for improving conservation of the Upper Guinea forest ecosystem by advancing the landscape approach. This can be assured by recognizing and valuing forests and tree cover beyond the boundaries of existing protected areas. Existing knowledge from published literature suggests that much can be achieved by streamlining existing policies to foster immediate and short-term engagement by relevant stakeholders. For example, formal gazettement of old growth forests targeted for national parks would create the important "anchors" necessary for implementing the landscape approach. Assessment of forest and tree cover will establish additional areas and targets for designing landscapes to secure critical habitats and increase connectivity for globally important wildlife. The International Union for Conservation of Nature has recently issued *Guidelines for Conserving Connectivity through Ecological Networks and Corridors*, which will include details on how countries can use existing knowledge and best-available practices (Hilty et al., 2020).

Because of the complex interplay between agricultural land use, forest conservation and rural livelihoods in Sierra Leone, the landscape approach will create opportunity for exploring interventions that promote synergies and minimize negative tradeoffs. For example, appropriate schemes can be developed by government and technical partners to incentivize agroforestry practices such as shade-cocoa and coffee that are conservation-friendly and provide diverse benefits for communities. Similarly, climate financing opportunities can be tapped for mobilizing communities to restore degraded lands with high value trees that deliver multiple livelihood benefits while sequestering carbon. Furthermore, the spatial integration of forest and tree cover management will serve as an important strategy for climate change adaptation and resilience in the target landscapes (Mawdsley et al., 2009).

In the long-term and with increased understanding of the social and ecological realities, it is anticipated that the landscape approach will reinforce the need for comprehensive land use planning in Sierra Leone. This will not only create opportunities for tenure security, but also enable collective action for scaling-up conservation of forests and increasing tree cover in production landscapes. In this regard, a key challenge that must be addressed is land and tree tenure security (Rahman et al., 2017; Arvola et al., 2020), as this will empower communities to self-organize for implementing such long-term solutions. According to Wangel and Blomkvist (2013), communities in Sierra Leone even under the most difficult of circumstances, "*are capable of self-governance and collective action to further their economic interests as well as sustaining the common pool resource*." Ultimately, Sierra Leone will need to create landscapes that work for wildlife and for people who depend on agricultural land use. The landscape approach therefore represents an invaluable opportunity for addressing this critical need in one of the world's most threatened ecosystem, the Upper Guinea rainforest.

Author contributions

MB conceived the review. IA-B synthesized national policies. Both authors worked jointly to compile the literature and write the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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