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Scoping Study of Research-to-Action Priorities for Reversing Environmental Degradation in Africa and ASIA (REDAA) Programme:

West Africa

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About the report
This scoping paper was written to inform and enhance the focus and research direction for the Reversing Environmental Degradation in Africa and Asia (REDAA) programme. It was commissioned by the International Institute for Environment and Development (IIED). Summaries of all the scoping papers can be found at www.redaa.org/scoping-studies. For more information about this report, contact: enquiries@redaa.org

About the REDAA programme
REDAA is a programme that catalyses research, innovation and action at local, national and regional levels across Africa and Asia through a series of grant calls. Funded projects are interdisciplinary, often locally led and focus on solutions for ecosystem restoration and wildlife protection, enabling people and nature to thrive together in times of climate, resource and fiscal insecurity.

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EXECUTIVE SUMMARY

This paper was written for the Reversing Environmental Degradation in Africa and Asia (REDAA) programme and provides an examination of environmental degradation issues in West Africa, focusing in particular on deforestation fronts in Côte d'Ivoire, Ghana, Sierra Leone, Nigeria and Liberia. It identifies potential research-to-action priorities (RTAPs) that the REDAA programme could potentially support, where evidence could be strengthened and taken up, tools can be improved and well used, and governance systems can be enhanced to reverse degradation and restore ecosystems. The scoping also identified emerging ecosystem degradation hotspots across West Africa where RTAPs may be located.

The paper drew on a mixed methods approach encompassing both desk research and primary data collection. An extensive literature review synthesized insights from over 320 academic papers, reports and media articles published in the last decade. This search emphasized scholarly literature as well as grey literature from organizations involved in environmental management in the region. In addition, 12 key stakeholder interviews were held with policymakers, practitioners, researchers, community leaders and NGO representatives working on these issues in West Africa. These interviews aimed to gather insights, perspectives and first-hand experiences related to environmental degradation in the region.

Section 3 delves into the ecosystems and landscapes of West Africa and examines environmental degradation including deforestation, soil degradation, water pollution and biodiversity erosion. Deforestation is highlighted as a critical concern, one that precipitates or exacerbates other degradation issues across West Africa. A focus was thus put on the countries with the top five deforestation fronts: Côte d'Ivoire, Ghana, Sierra Leone, Nigeria and Liberia.

Drivers of deforestation vary across the region with slash-and-burn agriculture, cash crop plantations, logging, mining, infrastructure and demographic factors all playing roles. In Ghana and Côte d'Ivoire, cocoa farming drives significant deforestation, whereas in Liberia and Sierra Leone, rubber and oil-palm plantations are major concerns. Throughout the region, logging and agricultural expansion continue to destroy forests.

Section 4 draws on insights from across the literature review, and stakeholder interviews, to review the current evidence, tools and governance issues relating to environmental degradation in West Africa. Key gaps and challenges are identified, and consideration is given to how the REDAA programme might help to address these. RTAPs are then provided under each theme. Findings from this section are summarized below.

Evidence

Evidence suggests that there are some effective initiatives addressing environmental degradation in the region, such as the West Africa Biodiversity and Climate Change (WABiCC) programme and Ghana's development of Community Resource Management Areas (CREMAs). However, challenges persist, notably in grassroots financing, limited data for effective forest management, a policy gap in integrating traditional knowledge, and issues with community participation. The scarcity of comprehensive data impedes decision making and policy formulation, hindering successful initiatives such as Reducing Emissions from Deforestation and Forest Degradation (REDD+). To address these challenges, the REDAA programme should prioritize research on user-friendly data strategies, innovative grassroots financing, and bridging the traditional knowledge policy gap.

Governance systems

In West Africa, environmental governance faces several challenges. Weak enforcement of forest laws, stemming from inadequate data collection, allows unchecked illegal activities. Local forest governance faces hurdles in curbing illegal resource extraction due to insufficient resources, knowledge gaps and policy limitations, hindering effective protection. The REDAA programme can address these issues by supporting research to reform local forest governance policies and enhance data transparency. The associated RTAPs encompass establishing integrated data management systems for enhanced forest governance, reviewing and reforming policies, and evaluating and improving benefit-sharing mechanisms to promote sustainable livelihoods for forest-dependent communities.

Tools

We examined tools addressing three pivotal dimensions: integration of traditional knowledge into restoration projects; building capacity for community-led ecosystem restoration; and enhancing data collection, analysis and sharing on forest resources and management. Notable tools identified include: the Participatory or Public Participation Geographic Information System (PPGIS) for incorporating traditional knowledge; Drone-based Digital Aerial Photogrammetry (DAP) for community-led restoration capacity; and Open Foris and associated tools for comprehensive forest resource management. While PPGIS facilitates spatial knowledge representation and socio-ecological research, challenges persist in data accuracy. DAP, though valuable, requires user-friendly adaptations for local farmers. Open Foris, accompanied by challenges such as data accuracy and spatial resolution, could potentially benefit from the integration of machine learning/artificial intelligence (ML/AI) for improved processing and predictive capabilities. The Amplifund tool addresses financial resource access but necessitates further tailoring for local community organizations. The

recommended RTAPs include enhancing tools for financial access, optimizing ML/AI algorithms for forest monitoring, and advancing tools for integrating traditional knowledge.

We suggest that the RTAPs identified could each be effective if implemented, and even more effective if implemented synergistically together, in promoting environmental restoration in West Africa.

1 INTRODUCTION

Forests are an essential part of our planet's ecosystem, covering around 31% of the global land area (Food and Agriculture Organization, 2020). They provide habitats for millions of species and play a crucial role in climate regulation, water cycles and soil conservation (Brockerhoff et al., 2017). Forests are an essential source of livelihood for over 1.6 billion people worldwide, which is more than 25% of the world's population (Food and Agriculture Organization, 2015). However, global forests face unprecedented challenges due to deforestation, climate change and biodiversity loss (United Nations. Department of Economic and Social Affairs, 2021). Deforestation is responsible for around 11% of global greenhouse gas emissions (United Nations Environment Programme, 2021). Climate change is causing forest fires, droughts, and other extreme weather events that are damaging forests (World Economic Forum, 2022). Deforestation has serious consequences on the health of people directly dependent on forests, as well as those living in cities and towns, as it increases the risk of diseases crossing over from animals to humans (Christina Nunez, 2022). Biodiversity loss is also a major concern, with many species facing extinction due to habitat loss and fragmentation (Turnhout & Purvis, 2020).

Agriculture, forestry and land-based activities are the backbone of Africa's economy. The forest industry in Africa is a vital engine for job creation, industrialization and the establishment of a circular economy (World Economic Forum, 2021). Forests provide wood products, generate income and jobs, meet needs for food, energy and medicinal plants, and deliver regulating and supporting ecosystem services, contributing immensely to the continent's economic growth, employment and food security (Grieg-Gran et al., 2015). Forests will play a crucial role in Africa's green economy transformation. Beyond its economic contributions, effective forest management has the potential to bring about transformative changes, including gender empowerment through the involvement of women in forest management and ecosystem restoration (Canpolat et al., 2022; Fortnam et al., 2019; International Union for Conservation of Nature and Natural Resources, 2019b). By expanding the capacity and knowledge skills of local communities, forests can become a source of environmental sustenance and economic empowerment (Food and Agriculture Organization, 2017).

African countries are particularly at risk from climate change (Mansourian & Berrahmouni, 2021). Deforestation and unsustainable forest management pose a threat to the green economy contribution of forests in Africa (Grieg-Gran et al., 2015). West Africa is a region with a rich diversity of ecosystems, ranging from dense tropical rainforests to arid savannas, wetlands and coastal areas. These provide a wide range of valuable resources to local communities, including food, water and fuelwood. They also provide important ecosystem

services, such as water filtration and flood control, and coastal areas support fisheries and protect against storms and erosion (IPBES, 2019).

The ecosystem services provided by these natural ecosystems and landscapes are needed for the livelihoods and well-being of local communities (WWF & AFDB, 2015). Over the past few decades, however, West Africa's ecosystems and landscapes have experienced significant environmental degradation and loss of biodiversity. Local communities have grown and been joined by many external land and resource users. Human activities have resulted in deforestation, overgrazing, unsustainable land-use practices and conversion of natural ecosystems into human settlements (IPBES, 2019). Some of these actions have led to coastal flooding, erosion and pollution, a loss of soil fertility, water scarcity, and increased vulnerability to extreme events like climate change (Härkin et al., 2018). In 2019 the World Bank estimated that environmental degradation in the coastal areas of Benin, Côte d'Ivoire, Senegal and Togo cost US$3.8 billion, about 5.3% of the four countries' combined gross domestic product (GDP) (The World Bank, 2019). To ensure sustainable production, protect biodiversity and shield livelihoods in the battle against climate change, there is an urgent need to restore Africa's degraded forests and landscapes (Mansourian & Berrahmouni, 2021).

Effective forest restoration and sustainable management of forests are indispensable contributors to achieving the holistic advancement of the Sustainable Development Goals (SDGs) – SDG 15 aims to protect, restore and promote the sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss (WWF, 2018). Forests also contribute to other SDGs such as SDG 6 (clean water and sanitation), SDG 7 (affordable and clean energy), SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production) and SDG 17 (partnerships for the goals) (WWF, 2018), ensuring a harmonious coexistence of environmental conservation and broader sustainable development objectives. Forests help stabilize the climate, regulate ecosystems, protect biodiversity, play an integral part in the carbon cycle, support livelihoods, and can help drive sustainable growth (Osipova et al., 2020). Both adaptation and mitigation efforts related to forest restoration are integral to sustainable development. Halting the loss and degradation of natural systems and promoting their restoration have the potential to contribute over one-third of the total climate change mitigation required by 2030 (Osipova et al., 2020). If adaptation and mitigation are constrained, then sustainable development and the capacity to adeptly manage forest resources will be compromised, thus hindering the realization of the sustainable development aspirations. It is therefore encouraging that forests are considered in the climate plans of West African governments (Box 1).

Box 1: Forest restoration and governance in West Africa's NDCs

The forest restoration efforts and forest governance policies outlined in the Nationally Determined Contributions (NDCs) of West African countries, such as Sierra Leone, Nigeria, Côte d'Ivoire, Liberia and Ghana, reflect a shared commitment to address challenges related to deforestation, emissions reductions and sustainable forest management.

Sierra Leone's NDC acknowledges that forestry emissions are primarily driven by changes in forest land, with key governance challenges including poor coordination, weak law enforcement, and limited community involvement. Proposed measures include the establishment of a National Reforestation and Timber Governance Agency, and the promotion of community-based forest management (Republic of Sierra Leone, 2021).

Nigeria aims to reduce forestry emissions by 20% by 2035, emphasizing the importance of nature-based solutions, climate-smart agriculture and gender inclusion. The country is developing a national forest monitoring system, with community involvement in data transparency. Strategies involve REDD+ implementation, capacity building and equitable access to forest resources (The Federal Government of Nigeria, 2021).

Côte d'Ivoire recognizes the forest sector as a significant contributor to greenhouse gas emissions and has outlined unconditional measures like reforestation, conservation and restoration to address this. The country employs geographic information system technology (GIS), global positioning system technology and remote sensing technology (collectively known as 3S technology) for forestry data, and emphasizes the need to mobilize financial resources for forest genetic resources.

Liberia's NDC commits to reducing deforestation and enhancing forest carbon stocks. The country emphasizes the importance of forest data management, including a national forest monitoring system and a Natural Capital Accounting system for transparency. There is an emphasis on policy measures for sustainable forest management, benefit sharing and alternative livelihoods (Environment Protection Agency, 2021).

Ghana's NDC focuses on climate-smart agriculture, the Green Ghana initiative, and sustainable forest management with a gender-responsive approach. There is an emphasis on transparency of data for informed decision making in forest management. Gender inclusion is prioritized, along with civil society involvement for public support and information flow (Environmental Protection Agency (EPA) & Ministry of Environment Science Technology and Innovation (MESTI), 2021).

West African governments thus have the stated ambition to align their forest restoration efforts with comprehensive governance policies, addressing issues of deforestation, emissions reduction, and community involvement. Furthermore, the integration of technology, traditional knowledge and gender considerations in a holistic approach to sustainable forest management is an impressive ambition in the region.

In West Africa, despite commendable efforts by communities and government agencies to conserve ecosystems and reverse environmental degradation, the region grapples with persistent forest and biodiversity loss. The primary objective of this scoping study is to delineate research-to-action priorities (RTAPs) that could garner support from the Reversing Environmental Degradation in Africa and Asia (REDAA) programme. The study strategically assesses areas where evidence can be enhanced and effectively utilized, the optimization of tools, and the improvement of governance systems crucial for environmental restoration and sustainable natural resource management. Additionally, the study pinpoints emerging ecosystems and degradation hotspots as potential locations for RTAPs.

This report offers an overview of the current status of ecosystems in the region, encompassing various forms and drivers of environmental degradation. By surveying ongoing ecosystem restoration and rehabilitation initiatives, the study identifies key challenges and opportunities in the quest for ecosystem recovery. Notably, the report sheds light on the need for innovative mechanisms, technologies, decision-making support, and participatory tools to facilitate and enhance ecosystem restoration and rehabilitation endeavours. Furthermore, the study highlights critical governance challenges and opportunities within policy and regulatory frameworks governing ecosystem recovery, assessing their impact on the region's recovery efforts. Through this comprehensive analysis, the report not only identifies areas that demand immediate attention and improvement but also delineates opportunities for impactful policy reform in support of ecosystem recovery in West Africa.

2 METHODOLOGY

2.1 RESEARCH APPROACH

This study involved a literature review and key stakeholder interviews to gather relevant information on environmental degradation in West Africa. Using these resources, the study aimed to provide a robust and evidence-based assessment of environmental degradation in West Africa. The research was organized into five main steps.

Step one. Literature review

We reviewed 350 academic, grey-literature and technical reports, analysing them for common themes, key findings and emerging trends related to environmental degradation in the region. We used a set of guiding questions to inform our initial search (see Annex 1), focusing on REDAA's three main output areas – evidence, governance systems and tools.

Step two. An initial list of potential REDAA interventions

We investigated the various forms of environmental degradation and associated landscapes, and identified hotspots, initiatives on environmental restoration and existing governance systems. The effectiveness of the initiatives and governance systems was examined, limitations/challenges identified, and potential solutions to address them were proposed. This was followed by the development of an initial long list of potential REDAA interventions.

Step three. Stakeholder interviews

We engaged stakeholders through key informant interviews to gain a deeper understanding of the identified hotspots, initiatives implemented and existing governance systems. Through this process, valuable insights were gathered on the limitations and challenges.

Step four. Gap-filling

We filled some gaps in the evidence-base identified by stakeholders through further desk research and interrogation of the literature.

Step five. Identification of research-to-action priorities

Finally, through further engagement of key informants the study developed nine potential RTAPs for West Africa on evidence and governance systems and tools, guided by criteria developed for the programme (See Annex 2 for the criteria). Based on the research findings on evidence- and governance-related challenges, we explored and examined the effectiveness of tools being employed for environmental restoration in the sub-region. Broad recommendations were first developed, and then refined into RTAPs.

2.2 DATA COLLECTION, MANAGEMENT AND ANALYSIS

2.2.1 Literature search

The literature review aimed to put environmental degradation into context, identifying degradation hotspots in the region, and exploring existing policies and initiatives at various levels of governance (international, national and local) aimed at reversing environmental degradation. The intention was to develop a comprehensive understanding of the range of governance mechanisms, policies, programmes and tools used to reverse environmental degradation in the sub-region.

We reviewed the following databases: Web of Science, Scopus, JSTOR, Google Scholar, African Journals Online, ResearchGate, and world cart. Specific keywords and search terms were used to refine the search and capture relevant literature. Examples of keywords used include "hotspots", "drivers", "policies", "initiatives", "community", "protected areas", “deforestation”, and "degradation." Furthermore, the study analysed published reports from major multilateral environmental organizations such as the Food and Agriculture Organization of the United Nations (FAO), United Nations Environment Programme (UNEP), World Bank, Global Environment Facility (GEF), World Wildlife Fund (WWF) and United Nations University – Institute for Natural Resources in Africa (UNU-INRA) using specific search terms related to environmental degradation.

The literature search highlighted academic and grey literature published from 2013 onwards. This ensured the inclusion of recent research and findings assessing the state of environmental degradation in West Africa. Media sources were also consulted to fill in gaps in the literature and obtain first-hand information on the effectiveness of policies, initiatives and areas of action in the countries being studied.

2.2.2 Stakeholder engagements

In addition to the literature review, 12 key stakeholders from organizations involved in environmental conservation and management in West Africa were engaged through interviews. These aimed to gather insights, perspectives, and first-hand experiences related to environmental degradation in the region. Key stakeholders included government officials, environmental experts, researchers, non-governmental organizations (NGOs) and local community representatives (see Annex 3).

2.2.3 Reference management

Mendeley reference management software was used to streamline the citation and referencing process. Mendeley ensured that the core findings from the literature were properly cited and attributed throughout the paper.

2.2.4 Data analysis

The data collected from the literature review and key stakeholder interviews were then analysed using qualitative and quantitative methods. MAXQDA software was used to support data coding and analysis, allowing key themes, patterns and insights to be identified.

The analytical process encompassed the following stages:

1. Identifying environmentally degraded hotspots in the region.
2. Outlining the primary drivers behind environmental degradation (see Annex 4).
3. Exploring existing initiatives or programmes implemented to address the degradation.
4. Examining the effectiveness of these initiatives by highlighting positive impacts and acknowledging challenges.
5. Formulating recommendations in response to the challenges identified.
6. Developing a list of potential RTAPs related to the themes of evidence, governance systems and tools (see Annex 7).
7. Refining the potential RTAPs for each of the three output areas into a shortlist of priorities with the most significant potential to reverse environmental degradation.

2.3 LIMITATIONS

The broad scope of the study and the relatively short timeframe imposed certain limitations on the depth and comprehensiveness of the research. The vastness and complexity of environmental degradation in West Africa make it challenging to encompass all aspects within a limited timeframe. As a result, the study's findings and conclusions are based on a selected subset of the available literature and data. They may not capture the entirety of the region's environmental degradation issues. The breadth of the research may have led to a more general understanding of the topic, and specific nuances or context-specific factors could have been overlooked. In addition, focusing on publications from 2013 onwards may have excluded older but still relevant literature and historical data that could have provided valuable insights into long-term trends and patterns of environmental degradation in West Africa.

Every effort was made to mitigate these limitations by employing a rigorous methodology and conducting key stakeholder interviews. However, it is important to recognize that further research, including more in-depth studies and longer timeframes, would help develop a more comprehensive understanding of the complexities and historical dynamics of environmental degradation in the region.

3 ENVIRONMENTAL DEGRADATION ACROSS WEST AFRICA

This section delves into the ecosystems and landscapes of West Africa and examines environmental degradation including deforestation, soil degradation, water pollution and biodiversity erosion. These forms of degradation have severe consequences for both nature and people, and we explore each. However, since deforestation is such a significant degradation issue, and in turn exacerbates the others, we then focus on the five countries in West Africa marked by the highest recent rates of tree cover loss.

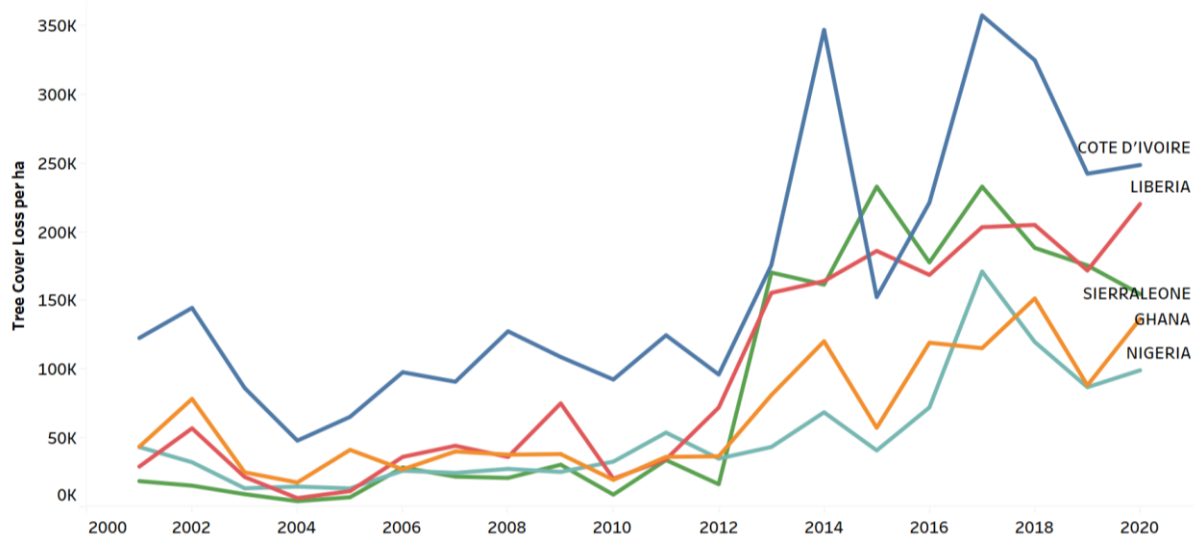
3.1 DEFORESTATION

Deforestation is a very significant environmental issue in West Africa, driven by various factors such as small-scale agricultural expansion, agribusiness, logging, mining, and infrastructure development (FAO, 2010).

Considering deforestation first across landscapes rather than countries, we see several prominent geographical regions in West Africa face particular challenges. These include the Guinea highlands, the Niger Delta and the Volta Basin. The Guinea Highlands, which span across Guinea, Sierra Leone, Liberia and Côte d'Ivoire, is one of the world's 25 top biodiversity hotspots and home to many endemic and endangered species (Nthara & Sanjay Srivastava, 2020). This area faces deforestation due to expanding agriculture, logging activities, and mining operations (FAO, 2010). Liberia has the largest remaining portion of the upper Guinean Forest (Nthara & Sanjay Srivastava, 2020). The Niger Delta region, primarily in Nigeria, has seen extensive habitat destruction due to oil exploration and production, resulting in the clearance of mangroves and other forested areas (Ansah et al., 2022; Enaruvbe & Atafo, 2016). The Volta Basin, which covers parts of Ghana, Burkina Faso and Togo, is experiencing deforestation driven by agricultural expansion, logging practices, population growth and urbanization (Fredua, 2014).

From 2001 to 2022, Côte d'Ivoire experienced one of the highest annual rates of tree cover loss in West Africa at 2.5% per annum, followed by Ghana, Sierra Leone, Nigeria and Liberia (Global Forest Watch (GFW), 2021, 2022). Ghana is estimated to have lost about 135,000 hectares of forest a year (2%) in this period. In recent years, Sierra Leone has experienced significant tree cover loss at an annual rate of 0.9% (GFW, 2023b). Nigeria has lost a substantial amount of its original forest cover, with tree cover loss increasing to an estimated annual loss of 63,359ha (Federal Ministry of Environment Abuja, 2021) at a rate of 0.5% in recent years (GFW, 2023a). These areas continue to experience significant tree cover loss, which has intensified in the past decade despite several initiatives and interventions to address them (Figure 1).

Figure 1: Rising tree cover loss across the top five deforestation fronts in West Africa.



Authors construct based on data sourced from Global Forest Watch, 2023[1]

Côte d'Ivoire, Ghana, Sierra Leone, Nigeria and Liberia face common challenges related to unsustainable logging practices, conversion of forest and mixed forest-farm landscapes to monoculture agribusiness plantation (notably for cocoa and timber), expansion of small-scale mixed agriculture, the spread of human settlements and infrastructure, and other land use changes.

Côte d'Ivoire has experienced extensive deforestation due to the expansion of cocoa farming, a significant proportion of the country's forests having been cleared for this purpose. Ghana faces similar challenges, with cocoa farming playing a major role in deforestation. Nonetheless, cocoa presents a mixed picture. In some areas, particularly with small-scale cocoa farming, significant numbers of shade trees and forest patches are retained (Ameyaw et al., 2018).

Additionally, charcoal production and mining activities are contributing to forest loss. Sierra Leone struggles with deforestation that is primarily driven by slash-and-burn agriculture, logging, and mining operations, particularly for diamonds (Mabey et al., 2020). Nigeria faces deforestation pressures due to agricultural expansion and oil exploration and production in

[1] The 2011–2022 GFW data was produced using updated methodology. Comparisons between the original 2001–2010 data and the 2011–2022 update should be made with caution (GFW, 2023c).

the Niger Delta, as well as infrastructural development (Enaruvbe & Atafo, 2016). Liberia also experiences significant deforestation, largely driven by logging and the expansion of rubber and palm-oil plantations (Goll et al., 2014). To reverse the deforestation trends, Ghana and Sierra Leone aim to restoremillions of hectares from degraded and deforested land by 2030 as part of their commitment to African Forest Landscape Restoration Initiative (AFR100) (AFR100, 2023; Saysay Dede et al., 2016). They also seek to generate carbon credits through the Reducing Emissions from Deforestation and Forest Degradation (REDD+)[2] (Ngom, 2015). In some cases, these large-scale tree-planting projects inadvertently lead to degradation. If poorly executed, monoculture plantations or inappropriate species selection may harm local ecosystems. Additionally, if these projects displace native vegetation or fail to engage local communities, they could exacerbate ecological imbalances.

3.2 SOIL DEGRADATION

Unsustainable agricultural practices, deforestation and mining are common drivers of soil erosion, nutrient depletion and loss of soil fertility, leading to reduced crop yields, food insecurity and economic losses in West Africa (Mabey et al., 2020; Njisah & Nsanyi, 2022).

In Côte d'Ivoire, soil degradation affects over half of the land area, posing challenges for agricultural productivity and water pollution (Kainyande et al., 2023).

Liberia faces a severe problem, with approximately 75% of its land affected by soil degradation, resulting in erosion, nutrient depletion and economic losses (Kissinger et al., 2012; Tabor et al., 2018).

In Ghana, soil degradation is prominent in the northern regions, impacting crop yields, causing erosion and desertification, and threatening food security (FAO, 2021; Kissinger et al., 2011).

Sierra Leone also experiences significant soil degradation, primarily driven by unsustainable agricultural practices and mining activities in diamond mining areas in Kono and Kenema districts, as well as urban and peri-urban areas of Freetown, Bo, Tonkolili and Bombali districts (Mabey et al., 2020).

[2] REDD+ is a mechanism incentivizing efforts to reduce emissions from developing countries' forests (Pistorius, 2012).

Nigeria faces widespread soil degradation in the Nigerian Sahel regions of Katsina, Sokoto and Yobe states, as well as Nasarawa and Benue state in the Nigerian Middle Belt, the Niger Delta region, and the Nigerian coastal zone due to agricultural activities, deforestation, urbanization, mining, climate change and oil spills (Adeniyi et al., 2017; Chukwuone et al., 2020; Inoni et al., 2021; Yusuf et al., 2019). These concerns pose threats to food security, livelihoods and the environment.

In Ghana, the Upper East, Upper West, Northern and Eastern regions are hotspots where vegetation fires and land-surface exposure contribute to soil degradation (FAO, 2021). The Volta Delta also faces soil erosion issues in coastal areas of Ghana.

3.3 WATER POLLUTION

Environmental degradation due to water pollution is a pressing issue in Côte d'Ivoire, Ghana, Sierra Leone, Nigeria and Liberia. These countries face significant challenges resulting from industrial activities, sewage discharge, agricultural practices and mining operations, leading to the contamination of water sources and negative impacts on ecosystems and human health.

In Côte d'Ivoire, water pollution is a consequence of industrial activities, including oil-refining and chemical manufacturing, which release toxic substances into water bodies, causing extensive damage to aquatic life and posing health risks to local communities (Kouassi et al., 2015).

Ghana experiences water pollution due to large-scale mining, and also due to many small-scale illegal 'Galamsey' mining activities, which involve using harmful chemicals such as mercury and cyanide. These chemicals contaminate the rivers and streams into which they are discharged (Owusu et al., 2016). Additionally, inadequate sanitation systems and the discharge of untreated sewage contribute to water pollution in urban areas (Mensah, 2019).

Sierra Leone faces water pollution challenges from mining activities, particularly diamond mining, as well as urbanization and poor waste-management practices that contaminate water sources with heavy metals and other pollutants (Mabey et al., 2020).

Nigeria grapples with water pollution caused by industrial activities, oil spills and inadequate wastewater treatment systems, leading to the contamination of both surface water and groundwater sources (Ighalo et al., 2021). The Niger Delta region experiences severe pollution from oil spills, which cause extensive damage to ecosystems and livelihoods (Ighalo et al., 2021).

In Liberia, water pollution arises from industrial activities, sewage discharges, agricultural practices and mining operations, which contaminate rivers, streams, and groundwater sources. Artisanal and large-scale mining, as well as rubber plantations, exacerbate surface-water contamination and watershed degradation (USAID, 2021).

3.4 BIODIVERSITY LOSS

Biodiversity loss is a critical global concern, threatening the survival of numerous plant and animal species. Several countries in the West Africa are confronted by significant challenges in preserving their unique biodiversity, including Côte d'Ivoire, Ghana, Sierra Leone, Nigeria and Liberia.

Côte d'Ivoire, Ghana, Liberia and Sierra Leone are home to the Upper Guinean forest hotspot, one of the world's biodiversity hotspots with rich diversity of over 15,000 plant species, 500 bird species and 201 mammal species, many of which are endemic (Adjossou et al., 2019).

With its diverse ecosystems encompassing rainforests, mangroves, grasslands and freshwater systems, Nigeria is experiencing rapid biodiversity loss. The primary drivers of biodiversity erosion in Nigeria include deforestation, the illegal wildlife trade, habitat destruction and pollution (Adelekan, 2010). These activities threaten wildlife species such as elephants, chimpanzees and various bird species (Oyediji & Adenika, 2022). Despite the challenges, Nigeria has established national parks, protected areas and conservation initiatives to mitigate biodiversity loss (Federal Ministry of Environment of Nigeria, 2020).

Sierra Leone, known for its rich biodiversity, including tropical rainforests and coastal ecosystems, is also grappling with biodiversity erosion. Deforestation, unsustainable agriculture and illegal logging are the primary causes of biodiversity loss in the country (Kainyande et al., 2023; Republic of Sierra Leone, 2021). These activities threaten species such as the pygmy hippopotamus, chimpanzees and numerous bird species (Conway et al., 2015; LDN Report, 2018). Conservation efforts in Sierra Leone involve establishing protected areas, community-based conservation initiatives, and collaborations between government agencies and NGOs (Republic of Sierra Leone, 2017).

Côte d'Ivoire boasts diverse ecosystems, including rainforests, savannahs and mangroves, harbouring unique plant and animal species. Biodiversity erosion in the country is primarily driven by deforestation, habitat degradation and the illegal wildlife trade (Kouassi et al., 2021). Endangered species such as forest elephants, western chimpanzees and various bird species are particularly vulnerable to these threats (Kouadio, 2021; UK Space Agency, 2020). Conservation efforts in Côte d'Ivoire include establishing protected areas,

reforestation programmes and community-led initiatives (Impact Report, 2022; REDD+ Côte D'Ivoire, 2018).

Liberia has experienced significant biodiversity erosion due to deforestation, illegal logging, and habitat destruction caused by human activities. The country's rainforests, which once covered a significant portion of its land, have been severely reduced, leading to the decline of species such as chimpanzees, pygmy hippos and various bird species (Environment Protection Agency, 2019; Sáfián et al., 2020). Deforestation driven by unsustainable logging practices, the expansion of agriculture, mining activities and infrastructural development has contributed to habitat destruction and the loss of vegetation cover (ClientEarth, 2016; FAO. 2020). Conservation efforts, including protected areas like national parks and reserves, aim to address this issue (UNEP-WCMC, 2022).

Ghana faces significant challenges in preserving biodiversity within its diverse forests, savannahs, wetlands and coastal ecosystems. Biodiversity erosion in Ghana is primarily driven by deforestation, illegal mining (galamsey), unsustainable agricultural practices, and habitat destruction (Forestry Commission of Ghana, 2020; World Bank, 2020). These activities damage wildlife populations, including endangered species such as forest elephants, chimpanzees and various bird species (Afele et al., 2022).

By examining the situation in Nigeria, Sierra Leone, Côte d'Ivoire, Guinea and Ghana, we can gain insights into the diverse range of challenges and conservation efforts in West Africa. Preserving biodiversity in these countries is crucial not only for their ecological integrity but also for the overall objectives of regional and global biodiversity conservation.

3.5 INTERCONNECTED ISSUES

Deforestation is deeply interconnected with other forms of environmental degradation in West Africa, including soil degradation, water pollution and biodiversity erosion. The loss of forest cover leads to soil erosion, as roots play a crucial role in stabilizing the soil. Soil degradation, in its turn, affects crop yields, agricultural productivity and livelihoods, exacerbating the negative impacts of deforestation. Unsustainable agricultural practices, such as slash-and-burn agriculture and overgrazing, contribute further to soil degradation.

Additionally, deforestation has direct consequences on water pollution. Forests act as natural filters, absorbing and regulating water flow, and their destruction disrupts this function. Agricultural run-off, industrial activities and mining contribute to water pollution and are often intensified in deforested areas. Water body contamination with harmful chemicals and untreated wastewater damages aquatic ecosystems, human health, and economic activities such as fishing and agriculture.

Furthermore, deforestation directly contributes to biodiversity loss and habitat destruction. The extensive clearing of forests for agriculture, logging and mining activities disrupts ecosystems. It threatens numerous plant and animal species – soil degradation, water pollution and interconnected issues further compound biodiversity impacts. Loss of habitat and altered environmental conditions due to deforestation, soil degradation and water pollution significantly contribute to species decline and biodiversity erosion in West Africa**.**

3.6 PRIORITY LANDSCAPES

Our literature review pointed strongly to deforestation as the major form of environmental degradation in West Africa, with cross-cutting impacts on the other forms of degradation (see section 3.1). Therefore, in developing an initial list of potential RTAPs for REDAA, we focused on deforestation landscapes within Côte d'Ivoire, Ghana, Sierra Leone, Nigeria and Liberia: the top five deforestation fronts in West Africa.

This choice was corroborated by our initial key informant interviews, where 9 out of 12 of the participants also indicated deforestation as the most significant form of environmental degradation impacting West Africa.

Within the five countries, tree cover loss has intensified in some areas (Table). These include: the Moyamba, Tonkolili and Pujehun districts in Sierra Leone; the Cavally, La Me and Agneby-Tiassa districts in Côte d'Ivoire; the Uhunmwonde, Oredo Edo and Ikwuano districts in Nigeria; the Suakoko, Jorquelleh and Panta-Kpa districts in Liberia; and the Amansie West, Wassa West and Mpohor Wassa districts in Ghana.

Over the past decade and particularly in 2022, the Moyamba district in Sierra Leone experienced the greatest extent of tree cover loss within the region. However, Suakoko district in Liberia has experienced the greatest proportional tree loss.

Table 1: Top three hotspots for tree cover loss in the five countries.

Country	Region	District	Tree cover loss 2022 (ha)	Average loss in the past decade (2013-2022) (ha)	Intensity of loss (decade average/area)
Sierra Leone	Southern	Moyamba	19731	27988	0.040
Sierra Leone	Northern	Tonkolili	17427	20886	0.033
Côte d'Ivoire	Montagnes	Cavally	16702	25051	0.022
Côte d'Ivoire	Lagunes	La Mé	9279	13651	0.018
Sierra Leone	Southern	Pujehun	8045	12834	0.033
Côte d'Ivoire	Lagunes	Agnéby-Tiassa	6984	14437	0.017
Nigeria	Edo	Uhunmwonde	5982	5987	0.030
Liberia	Bong	Suakoko	5571	6813	0.045
Liberia	Bong	Jorquelleh	3833	5448	0.042
Ghana	Ashanti	Amansie West	3799	2982	0.024
Ghana	Western	Wassa West	3227	5522	0.021
Ghana	Western	Mpohor Wassa	3196	4422	0.022
Liberia	Bong	Panta-Kpa	3009	4111	0.042
Nigeria	Edo	Oredo Edo	696	766	0.029
Nigeria	Abia	Ikwuano	491	702	0.030

Data sourced from Global Forest Watch 2023

4 REVIEW OF EVIDENCE, GOVERNANCE AND TOOLS RELATING TO ENVIRONMENTAL DEGRADATION

This section draws on insights from across our literature review, and key informant interviews, to review the current evidence, tools and governance issues relating to environmental degradation in West Africa. We identify key gaps and challenges, and consider how the REDAA programme might help to address these.

Following our analysis and broad recommendations, we summarize shortlisted RTAPs under each theme.

4.1 EVIDENCE

Across the region, many initiatives, operating at international, national and local levels, are dedicated to confronting environmental degradation. We identified and examined ongoing initiatives being implemented in Côte d'Ivoire, Ghana, Sierra Leone, Nigeria and Liberia. A list of the initiatives is presented in Annex 6 (it is not necessarily a comprehensive list, rather it reflects those identified through our literature review, and stakeholder interviews).

One recently concluded regional initiative is the West Africa Biodiversity and Climate Change (WABiCC) programme, which promoted conservation and aimed to nurture climate-resilient, low-emission growth throughout the region between 2015 and 2021 (wabicc.org, 2021). In Sierra Leone, the WABiCC project has made significant strides in environmental protection, livelihood improvement and economic resilience for coastal communities by restoring mangroves, promoting sustainable farming and enhancing biodiversity conservation (Jalloh, 2019).

Elsewhere, a few local communities are re-emerging as dynamic actors and making substantial contributions to conservation and restoration endeavours, championing initiatives tailored to their unique contexts. From our literature review, four examples stood out.

Ghana's innovative Community Resource Management Area (CREMA) initiative aims to empower local communities to manage extensive forested regions, covering approximately 1.2 million hectares, or 12% of the nation's total forest cover (Ghana Forest Investment Program, 2019). Some evidence suggests that, by promoting sustainable livelihoods and fostering accountability and democratization, the CREMA initiative has begun to empower local communities to protect their environment and enhance their well-being (World Bank, 2018).

Nigeria similarly hosts a large area of community forests, spanning approximately 2.2 million hectares, through a community-based forest management system in close partnership with

NGOs and government agencies (Ogunkan, 2022). The successful implementation of the community-based management system in Ngel Nyaki Forest Reserve has reportedly empowered local communities, providing sustainable livelihoods and employment opportunities, and contributing to overall community development (Borokini et al., 2012).

In Sierra Leone, the Forestry Division and Wildlife Division shoulder the responsibility of safeguarding 22% of the country's forests within reserves and conservation areas (Jackson, 2015). Forest-dependent communities' role in curtailing deforestation and environmental degradation is also supported in Sierra Leone's involvement in REDD+ projects (Conservation International, 2023). The active engagement of communities has apparently yielded considerable benefits (Bakarr & Abu-Bakarr, 2022), and could help ensure that globally important habitats, biodiversity and environmental services are conserved in Sierra Leone (Global Citizen, 2023).

In a progressive move in 2019, the Ivorian government introduced a groundbreaking Forestry Code, bestowing ownership of trees upon landowners. This pioneering legislation introduced the concept of community forests, aiming to foster community participation in forest management (LTS International and ONF International, 2011).

4.1.1 Specific gaps and challenges in evidence

1. Limited grassroots financing in ecosystem restoration initiatives: The absence of inclusive financing options poses a substantial barrier to the successful implementation of ecosystem restoration initiatives, including grassroots nature-based solutions (Coello & Frey, 2023; International Union for Conservation of Nature and Natural Resources, 2018). Despite significant funding commitments exceeding US$16 billion from initiatives like AFR100 and the Great Green Wall by development banks and the private sector, a noteworthy portion of this financial support fails to reach local communities leading land restoration efforts (Anderson et al., 2021; World Resources Institute, 2023b). Restoration financing opportunities accessible to local communities remain limited, with funders grappling to identify suitable projects for their portfolios and local organizations facing challenges in meeting funders' prerequisites or uncovering opportunities (World Resources Institute, 2023b).

Innovative financing solutions are being explored to facilitate smallholder access to finance. These solutions encompass digital loans, supply chain finance platforms, secured revolving lines of credit, merchant receivables finance, and investment-based crowdfunding (World Bank, 2022). The objective is to provide smallholders with access to efficient, cost-effective, and customized finance, incorporating alternative techniques to assess creditworthiness, address variable cash flows, and utilize ICT-based products to ensure last-mile reach (Tinsley & Agapitova, 2018). The United Nations Environment Programme has initiated a

financial programme in Côte d'Ivoire to craft investment models that enhance private financing for sustainable land use projects (United Nations Environment Programme, 2018). Similarly, the World Resources Institute's flagship initiative, Terra Match, actively identifies and matches 100 ecosystem restoration local champions across 27 African countries with suitable funding opportunities (World Resources Institute, 2023b).

However, challenges persist in making funding sources more inclusive. Substantial efforts are necessary to engage with the diverse risk profiles of various funding sources. Of the 12 interview respondents, 8 emphasized the urgent need for augmented environmental protection and restoration funding in West Africa. The REDAA programme is a timely opportunity to research and implement innovative, inclusive financing solutions. REDAA could explore mechanisms and strategies to overcome barriers to accessing finance, bolster local capabilities, and unlock strategies for effectively matching available funding with grassroots initiatives and efforts.

Initiatives such as these face challenges and there are substantial gaps in coverage. In Annex 6 we put forward broad recommendations for improvements. Here we discuss some of the key governance challenges undermining ecosystem restoration and rehabilitation efforts.

2. Limited data in forest management across West Africa: The scarcity of comprehensive data and information on forest resources and ecosystems is identified as a critical challenge obstructing effective forest management in West Africa (Day et al., 2014; Food and Agriculture Organization, 2019b), also highlighted by 10 of the 12 interview respondents. This scarcity adversely impacts various aspects, including informed decision making, policy formulation, sustainable resource management, valuation of forest resources and benefits, enforcement of forest laws and regulations, resource availability, market trends development and implementation of equitable benefit-sharing mechanisms, as well as the engagement, empowerment, and adoption of best practices and innovation within local communities (Girolami, 2019) The inability to estimate economic value of forest resources due to lack of data results in lost revenue for both governments and communities (Dumenu, 2013; Lette & de Boo, 2002).

Amidst these challenges, Farmer Managed Natural Regeneration (FMNR) emerges as a widely adopted and cost-effective community-led ecosystem restoration approach, with success stories in countries such as Niger, Ghana, Sierra Leone, and Côte d'Ivoire (Akayeti, 2022). However, despite numerous initiatives aimed at building capacity for promoting FMNR, significant gaps in knowledge persist. Notably, the systematic recording of the species composition of regenerating vegetation across diverse circumstances is lacking,

making the selection and management of appropriate trees more challenging (Chomba et al., 2020). Additionally, evidence collection on the extent to which farmers facilitate the regeneration process, the origin of successful trees in fields, and the preferred tree species in specific areas remains insufficient (Binam et al., 2015; Iiyama et al., 2015). Addressing these knowledge gaps is crucial for predicting the specific restoration benefits and ensuring the success of FMNR as a practice.

The importance of comprehensive data is underscored for identifying successful approaches and replicating them across different regions. Without access to accurate and up-to-date information, learning from the experiences and lessons of others becomes challenging, hindering innovation and creativity in forest management (Food and Agriculture Organization, 2019b). The lack of data and information has impeded REDD+ (Pistorius, 2012). Establishing a robust National Forest Monitoring System (NFMS), developing a Forest Reference Emissions Level, and implementing a Measurement Reporting and Verification system under REDD+ rely on precise data on forest cover, land use and carbon stocks. Unfortunately, these data are often scarce or outdated in many West African countries, including those considered in this study (Day et al., 2014; Food and Agriculture Organization, 2019b).

Moreover, forests face ongoing threats from climate change, invasive species and other factors. Adequate data is necessary to understand these evolving challenges and adapt management strategies accordingly (Keenan, 2015). Invasive species in particular can compete with native species, disrupt ecosystem functions, reduce biodiversity and increase fire risk. The impacts of pests, diseases, fires, storms and other factors on the condition and dynamics of forests further emphasize the necessity of reliable data for designing and implementing effective adaptation measures (Keenan, 2015).

3. Knowledge gap in effective integration of traditional knowledge into ecosystem restoration efforts: Indigenous knowledge has been found to play a pivotal role in ecological restoration efforts. It can be used in various aspects of ecosystem restoration, including the construction of reference ecosystems, selection of appropriate species for restoration plantations, identification of suitable sites for restoration, understanding historical land management practices, managing invasive species, and conducting post-restoration monitoring (Haq et al., 2023). Ecological restoration projects involving Indigenous Peoples and local communities (IPLCs) are more successful (Reyes-García et al., 2019) For example, Tiwai Island, one of the last remnants of ancient rainforest in West Africa located in Sierra Leone, provides a tangible example where effective community engagement actively

contributes to the island's preservation and restoration (International Union for Conservation of Nature, 2023).

According to the International Union for Conservation of Nature and Natural Resources (2019a), the integration of traditional knowledge into ecosystem restoration efforts faces significant challenges, including the lack of supportive legal frameworks, the erosion of traditional knowledge systems due to unfavourable legal environments and evolving communities, lack of interest from key decision makers and sectors, and insufficient documentation of relevant traditional knowledge, among other obstacles. These challenges have resulted in a notable research gap concerning the effective incorporation of traditional knowledge into environmental restoration projects, highlighting the urgency of addressing this knowledge gap to maximize the potential contributions of traditional knowledge to successful ecosystem restoration efforts (Haq et al., 2023).

4. **Ineffective community participation in ecosystem restoration efforts:** Local leadership plays a crucial role in preserving nearly 70% of African land (Du Plessis et al., 2022; Wily, 2011). To ensure the long-term success of restoration initiatives it is essential to empower local communities and allow them to take ownership of ongoing projects (AFR100, 2023). Forests in West African communities, including those in Côte d'Ivoire, Ghana, Nigeria, Liberia and Sierra Leone, hold significant cultural and ecological value as sacred sanctuaries (United Nations Sustainable Development Group, 2022). For instance, the county of Biankouma in western Côte d'Ivoire boasts 6,700 sacred forests (Universitat Autonoma de Barcelona, 2019).

Five out of the twelve interview respondents advocate prioritizing local community participation and considering Indigenous Peoples' interests as highly effective strategies for addressing environmental degradation. Understanding the challenges related to community engagement and addressing these challenges is critical for aligning local needs and priorities.

4.1.2 Evidence-related RTAPs

1. User-friendly and cost-effective data strategies: The REDAA programme could invest in research to explore user-friendly and cost-effective data collection and analysis strategies that communities can adopt and implement to enhance their participation in effective monitoring, record keeping and informed decision making in forest ecosystems.

2. Enhancing grassroot financing in ecosystem restoration initiatives: The REDAA programme could support research that explores effective ways of bolstering local capacity to navigate funding requirements, and generate and manage finance.

3. Addressing the knowledge gap in traditional knowledge integration into ecosystem restoration: The REDAA programme could support research that explores and establishes the links between traditional ecological knowledge and academic ecological knowledge to promote responsible governance and stewardship of forest resources.

4.2 GOVERNANCE

In West Africa, government-led endeavours generally assume responsibility for safeguarding critical natural assets, including national forests, parks and wildlife sanctuaries. Across Côte d'Ivoire, Ghana, Sierra Leone, Nigeria and Liberia various regional and national policies and frameworks have been established to combat environmental degradation. A list of many of these is presented in Annex 5. Some notable current policies with some implementation clearly evident include the Abidjan Convention (covering the marine environment), national REDD+ strategies, the Convention on Biological Diversity's Post-2020 Biodiversity Framework, Liberia's National Oil Palm Strategy and Action Plan (2021–2025), the Ghana Forest and Wildlife Policy (MLNR, 2012), Ghana's National Land Policy (Ministry of Lands and Forestry Accra, 1999), and the Modified Taungya system, a decentralized forest governance intervention (Adjei et al., 2020)

4.2.1 Gaps and challenges in governance

1. Weak enforcement of forest laws and regulations: Weak data collection and monitoring allow illegal activities such as logging, land encroachment and resource exploitation to persist unchecked (Day et al., 2014). The absence of transparent access to forest resource information makes it difficult to hold stakeholders accountable, fostering environments where corruption and illegitimate actions can thrive (Gulzar & Alexander, 2022).

2. Weak local forest governance: Local forest governance faces several challenges to its effectiveness. Eight out of the twelve interview respondents identified weak local forest governance as a pressing issue requiring priority attention. Local forest governance units often struggle to curb illegal forest resource extraction and enforce forest policies due to insufficient power and resources delegated to them (Graphic Online, 2015). They suffer significant capacity constraints such as limited knowledge of forest law compliance issues and technological tools (Food and Agriculture Organization, 2010). Furthermore, forest policies typically lack provisions for including local authorities (Rametsteiner, 2009). They may apply excessive restrictions on legal access to customary forest lands, often without prior consultation, consent or consideration for cultural practices and traditional/religious beliefs (Dickson, 2017). In addition, many forest communities lack clear or recognized rights to own, utilize or manage the forests they depend on (Food and Agriculture Organization,

2010). Such situations create uncertainty and insecurity for communities, limiting their motivation and agency to protect the forests from external encroachment or exploitation (Food and Agriculture Organization, 2010). These challenges have been particularly evident in the implementation of the Modified Taungya System (MTS), a decentralized forest management intervention in Ghana (Adjei et al., 2020). The REDAA programme could support research to review existing local forest governance policies and laws. It would be useful to identify areas that require reform so that they better accommodate local community participation and rights and enhance community leadership and ownership of forest resources.

3. Inadequate incentives and sustainable livelihoods for forest-dependent communities: Forests are integral to supporting impoverished communities and reducing vulnerability to economic and environmental shocks. However, striking a balance between conservation initiatives and the needs of forest-dependent communities and ensuring equitable capital sharing from forest protection remains an ongoing issue (Dickson, 2017). Delays or inadequacies in payments to these communities undermine their livelihoods and well-being (Fox & Dickson, 1990).In Ghana, benefit-sharing mechanisms, such as the Modified Taungya System and commercial plantation development schemes, often proved to be inadequate or ineffective in addressing the needs and rights of forest communities (CSIR-FORIG, n.d.). In our survey, 43% of respondents highlighted the perpetuation of poverty due to inadequate incentives and sustainable alternative livelihoods for forest-dependent communities, hindering the equitable distribution of benefits from forest resources. The complexity surrounding the extent of forests' contribution to poverty reduction and livelihood resilience creates challenges for policymakers overseeing poverty reduction strategies. Conflicting claims and interests from various stakeholders, including central governments, traditional authorities, private companies, and civil society organizations, often result in disputes over the allocation and distribution of benefits (Dickson, 2017).In Ghana, a lack of information on the socio-economic values and benefits of forest resources has hindered the design and enforcement of fair and inclusive arrangements for distributing the benefits from forest management and conservation (CSIR-FORIG, 2011). The REDAA intervention can play a pivotal role in addressing these challenges by enhancing data transparency and researching to illuminate the socio-economic values of forests. This can help ensure that forest management and conservation benefits are distributed fairly and inclusively. The REDAA can also support research to identify livelihood opportunities and diversify the income sources for forest-dependent communities. This can help reduce their reliance on forest resources and promote sustainable livelihoods.

4.2.2 Governance-related RTAPs

Annex 7 offers a list of potential governance-related RTAPs. Here we shortlist those with the most significant potential to reverse environmental degradation in West Africa:

1. Strengthening forest governance through enhanced data transparency: The REDAA programme could support research to establish an integrated data management system that consolidates relevant information on forest resources, land use and ecosystem dynamics, ensuring interoperability with existing databases and systems to avoid duplication and streamline data access.

2. Inclusive policy development: The REDAA programme could support research to review existing local forest governance policies and laws to identify areas that require reform to better accommodate local community participation and rights and enhance community leadership and ownership of forest resources.

3. Enhancing sustainable livelihoods and equitable benefit sharing for forest-dependent communities: The REDAA programme could evaluate the effectiveness of current benefit-sharing mechanisms, such as the Modified Taungya System and commercial plantation development schemes, and identify shortcomings, inefficiencies and areas for improvement to ensure that these mechanisms address the needs and rights of forest-dependent communities.

Box 2: Forging collaborative pathways: the crucial roles of private sector and civil society in ecosystem restoration

The roles of private sector and civil society organizations (CSOs) are believed by many to be crucial for effective implementation of the transformative measures required for achieving sustainable outcomes in ecosystem restoration. Some suggest that the private sector and CSOs hold the potential to establish a reservoir of natural capital, allowing people to benefit from ecosystem services (Zhiming, 2023). Others suggest that public–private partnerships (PPPs) present a viable avenue for addressing development challenges, particularly when traditional funding sources for development face constraints. Additionally, PPPs may foster synergies among partners, leveraging their talents, technologies and expertise, and convening power (Glaser, 2007)

The African Forest Forum suggests that the private sector, as a major player in the forest economy, has the potential to be a driving force for positive change. Beyond profits, it can contribute to the well-being of forest-dependent communities by providing employment opportunities through investments in forest-based enterprises (African Forest Forum, 2019). Effective collaborative efforts between the private sector and local communities could lead to the development of sustainable forest management plans that harmonize economic, social and environmental objectives (PROFOR, 2017).

CSOs evidently have a key role to play in addressing governance challenges. This goes beyond monitoring governments' actions; they may actively raise awareness on environmental issues and lobby for policy decisions that align with principles of sustainable development. The collaborative efforts of the private sector, civil society and the government will be necessary for a holistic and effective approach to ecosystem restoration (Löfqvist et al., 2023).

4.3 TOOLS

Drawing from the research findings on evidence- and governance-related challenges discussed in the preceding text, we explored and examined the effectiveness of tools being employed for environmental restoration in the sub-region. Broad recommendations for REDAA are provided, which are then refined into RTAPs. Annex 8 provides a full list of tools identified during this research.

4.3.1 Gaps and challenges in tools

1. Tools for integrating traditional/Indigenous knowledge into environmental restoration projects: Among the several tools developed to integrate traditional knowledge into environmental restoration initiatives is the Participatory or Public Participation Geographic Information System (PPGIS). This tool combines participatory learning and

action methods with geographic information systems (Institute of Development Studies, n.d.; Ndzabandzaba, 2019). The approach can inform socio-ecological research and land use planning (Fagerholm et al., 2022). It is designed to represent people's spatial knowledge in the form of two- or three-dimensional maps. These can be used for spatial learning discussions, information exchange analysis, decision making and advocacy. The tool aims to empower communities through its user-friendly geospatial technologies, fostering integration among various applications. It also protects traditional knowledge while enhancing innovation and social change (Ndzabandzaba, 2019). The tool has helped manage conflicts over natural resources, and has been useful for collaborative resource planning and preserving intangible cultural heritage in Ghana (Institute of Development Studies, n.d.; Kyem, 2002)

However, challenges remain with data accuracy and how best to represent participatory spatial knowledge (Ndzabandzaba, 2019). The REDAA programme could support research to develop solutions to these challenges.

2. Tools to build capacity on community-led ecosystem restoration: Among the several tools applied to build capacity on community-led ecosystem restoration is Drone-based Digital Aerial Photogrammetry (DAP**).** This is used to characterize the structure of regenerating vegetation to guide decision making on restoration programmes (Nuijten et al., 2021). However, the technology is not user-friendly for local farmers. Improving it could help to improve the human and technical capacity for the systematic characterization of the species composition and regeneration of vegetation across diverse circumstances.

3. Tools to enhance data collection, analysis and data sharing on forest resources and management: The utilization of tools for enhancing data collection, analysis and sharing on forest resources and management is crucial for effective environmental conservation. Open Foris, an open-source software collection, facilitates flexible and efficient processes in Côte d'Ivoire, Ghana, Liberia and Nigeria, ensuring increased accessibility, accuracy and transparent measures in data-related activities (Food and Agricultural Organization, 2020; Open Foris, 2023; UN-REDD Programme, 2023). The World Research Institute and FAO contribute additional tools for forest monitoring and landscape restoration, including guides and indices. These include:

- A guide to identifying priorities for monitoring forest and landscape restoration (The Road To Restoration: https://www.wri.org/research/road-restoration),
- A sustainable index for landscape restoration (the AURORA Monitoring tool, https://www.auroramonitoring.org/#/),

- A guide to monitoring forest and landscape restoration (Mapping Together: https://www.fao.org/documents/card/en/c/CB2714EN),
- A guide to using Open Foris Collect Earth mapathons (https://www.wri.org/research/mapping-together-guide-monitoring-forest-and-landscape-restoration-using-collect-earth) (World Resources Institute, 2023a).

However, challenges persist, such as the availability of accurate and up-to-date data, spatial and temporal resolution limitations, and the need for capacity building among local stakeholders in data collection methods. The West African Forest Degradation Dataset (WAForDD) addresses historical baseline establishment but faces limitations due to factors like cloud cover and inadequate field data (Dwomoh et al., 2020; Sapena et al., 2023). Introducing machine learning/artificial intelligence (ML/AI) into remote sensing applications presents a transformative solution, enabling efficient processing of large datasets, identifying patterns, predicting deforestation, and monitoring forest health (Echeberria, 2022; Greening et al., 2023; Upreti, 2022). REDAA's support for innovative ML/AI algorithms can enhance the accuracy and usability of tools like the West African Deforestation dataset, advancing the effectiveness of remote sensing applications in ecosystem management and conservation efforts.

4. Tools to strengthen local capacity to access financial resources for environmental restoration: Building the capacity for local organizations to source funding for environmental restoration is critical. Among the various tools examined is the Amplifund tool (AmpliFund, 2023), designed to help grant seekers in non-profit organizations and local and state governments write an effective grant proposal. Amplifund is not targeted at local community organizations. The REDAA programme could support the further development of tools like Amplifund so that they also help local organizations to access funds.

4.3.2 Tool-related RTAPs

After reviewing the literature on tools, along with stakeholder interviews, we identified a list of potential tool-related RTAPs (see Annex 7). The following is the shortlist of tool-related RTAs that we believe could best contribute to reversing environmental degradation in West Africa:

1. Empowering local organizations for financial access in environmental restoration: The REDAA programme could collaborate with developers to enhance existing tools like Amplifund or create new, user-friendly platforms, ensuring that these tools are tailored to the unique requirements of local community organizations and facilitating their access to environmental restoration funds.

2. Optimizing ML/AI algorithms for enhanced accuracy and usability in forest monitoring and conservation: The REDAA programme could support research that focuses on refining and optimizing existing algorithms for forest application to enhance the accuracy and usability of tools like the West African Deforestation dataset, addressing persistent issues such as spatial and temporal resolution limitations, and ensuring more efficient processing of large datasets.

3. Advancing tools for integrating traditional knowledge into environmental restoration: The REDAA programme could support research initiatives focused on addressing data accuracy challenges in PPGIS. It could develop protocols and guidelines to ensure accurate and reliable spatial knowledge representation. This may involve co-designing solutions with local communities to respect and preserve traditional knowledge.

4.4 RTAPS IMPLEMENTED SYNERGISTICALLY AND ENHANCING NDCS

We suggest that the RTAPs identified could each be effective if implemented, and even more effective if implemented synergistically together, in promoting environmental restoration in West Africa. The region's NDCs provide important frameworks within which to incorporate action on RTAPs. Such action in turn could enhance NDCs in particular through promoting inclusive policies and ensuring active community-led restoration.

REFERENCES

Abubakar, Z. (2022). *Nigeria Launches National Forest Policy*. https://von.gov.ng/nigeria-launches-national-forest-policy/

Adelekan, I. O. (2010). Vulnerability of poor urban coastal communities to flooding in Lagos, Nigeria. *Environment & Urbanization,* 22(2), 433–450. https://doi.org/10.1177/0956247810380141

Adeniyi, S. A., de Clercq, W. P. & van Niekerk, A. (2017). Development of a composite soil degradation assessment index for cocoa agroforests under tropical conditions of southwest Nigeria. *Solid Earth Discussions,* January, 1–37. https://doi.org/10.5194/se-2016-175

Adjei, P. O. W., Agyei, F. K. & Adjei, J. O. (2020). Decentralized forest governance and community representation outcomes: analysis of the modified taungya system in Ghana. *Environment, Development and Sustainability*, 22(2), 1187–1209. https://doi.org/10.1007/s10668-018-0243-7

Adjossou, K., Fifonsi, A. D., Tossimidé, H., Komla, E. A., Donko, K. K., Atsu, K. G. & Kouami, K. (2019). Forest land use and native trees diversity conservation in Togolese mega hotspot, Upper Guinean, West Africa. *Journal of Ecology and The Natural Environment*, 11(9), 127–142. https://doi.org/10.5897/jene2019.0799

Afele, J. T., Nimo, E., Lawal, B. & Afele, I. K. (2022). Deforestation in Ghana: Evidence from selected Forest Reserves across six ecological zones. *International Journal of Forest, Animal And Fisheries Research*, 6(1), 7–17. https://doi.org/10.22161/ijfaf.6.1.2

AFR100 (2023). *TerraFund for AFR100 Financing Africa's Top Land Restoration Enterprises and Projects*. https://www.africa.terramatch.org/

African Forest Forum (2019). *Public and Private Sector Development on forest products industry in Ghana*. www.afforum.org.

African Plant Nutrition Institute (2020a). *Highlights from the West African Forum on Precision Agriculture – African Plant Nutrition Institute (APNI)*. https://www.apni.net/2020/06/29/highlights-from-the-west-african-forum-on-precision-agriculture/

African Plant Nutrition Institute (2020b). *Highlights from the West African Forum on Precision Agriculture – African Plant Nutrition Institute (APNI)*. https://www.apni.net/2020/06/29/highlights-from-the-west-african-forum-on-precision-agriculture/

Akayeti, E. (2022). *FMNR the sure way to greening Ghana at a low cost yet high results*. Modern Ghana. https://www.modernghana.com/news/1196105/fmnr-the-sure-way-to-greening-ghana-at-a-low-cost.html

Ameyaw, J., Arts, B. & Wals, A. (2016). Challenges to responsible forest governance in Ghana and its implications for professional education. *Forest Policy and Economics*, 62, 78–87. https://doi.org/10.1016/J.FORPOL.2015.07.011

Ameyaw, L. K., Ettl, G. J., Leissle, K. & Anim-Kwapong, G. J. (2018). Cocoa and climate change: Insights from smallholder cocoa producers in Ghana regarding challenges in implementing climate change mitigation strategies. *Forests*, 9(12). https://doi.org/10.3390/f9120742

AmpliFund (2023). *Amplifund Grant Seeker*. https://www.amplifund.com/grant-management-software/grant-seeker

Anderson, W., Gant, A., Iyer, V., Gronkiewicz, M. & Kabiru, S. (2021). *Entrepreneurs Need Funding to Restore Africa's Degraded Land*. https://www.wri.org/insights/financing-entrepreneurs-reverse-land-degradation

Ansah, C. E., Abu, I.-O., Kleemann, J., Mahmoud, M. I. & Thiel, M. (2022). Environmental Contamination of a Biodiversity Hotspot – Action Needed for Nature Conservation in the Niger Delta, Nigeria. *Sustainability*, 14(21), 14256. https://doi.org/10.3390/su142114256

Bakarr, M. I. & Abu-Bakarr, I. (2022). A framework for application of the landscape approach to forest conservation and restoration in Sierra Leone. *Frontiers in Forests and Global Change*, 5(August), 1–16. https://doi.org/10.3389/ffgc.2022.887365

Binam, J. N., Place, F., Kalinganire, A., Hamade, S., Boureima, M., Tougiani, A., Dakouo, J., Mounkoro, B., Diaminatou, S., Badji, M., Diop, M., Babou, A. B. & Haglund, E. (2015). Effects of farmer managed natural regeneration on livelihoods in semi-arid West Africa. *Environmental Economics and Policy Studies*, 17(4), 543–575. https://doi.org/10.1007/s10018-015-0107-4

Borokini, T. I., Babalola, F. D., Amusa, T. O., Ivande, S. T., Wala, Z. J., Jegede, O. O., Tanko, D. & Ihuma, J. O. (2012). Community-based Forest Resources Management in Nigeria: Case study of Ngel Nyaki Forest Reserve, Mambilla Plateau, Taraba State, Nigeria. *Journal of Tropical Forestry and Environment*, 2(1). https://doi.org/10.31357/jtfe.v2i1.571

Brockerhoff, E. G., Barbaro, L., Castagneyrol, B., Forrester, D. I., Gardiner, B., González-Olabarria, J. R., Lyver, P. O. B., Meurisse, N., Oxbrough, A., Taki, H., Thompson, I. D., van der Plas, F. & Jactel, H. (2017). Forest biodiversity, ecosystem functioning and the provision

of ecosystem services. *Biodiversity and Conservation*, 26(13), 3005–3035. https://doi.org/10.1007/s10531-017-1453-2

Canpolat, E., Shakirova, M., Mcelhinny, V., Westerman, K., Cruz, A. & Buppert, T. (2022). *Fostering Gender-Transformative Change in Sustainable Forest Management: The Case of the Dedicated Grant Mechanism (DGM) Climate Investment Funds: Investing in the future*. https://openknowledge.worldbank.org/server/api/core/bitstreams/de00b6fc-97ed-5154-87ba-b440bb5848f8/content

Castañeda, R. (2021). *Forest governance in Ghana should function with transparency and accountability – interview with Mustapha Seidu*. https://resilience-blog.com/2021/05/05/governance-should-function-with-transparency-and-accountability-interview-with-mustapha-seidu/

Chan, K. M. A., Anderson, E., Chapman, M., Jespersen, K. & Olmsted, P. (2017). Payments for Ecosystem Services: Rife With Problems and Potential – For Transformation Towards Sustainability. *Ecological Economics*, 140(October), 110–122. https://doi.org/10.1016/j.ecolecon.2017.04.029

Chomba, S., Sinclair, F., Savadogo, P., Bourne, M. & Lohbeck, M. (2020). Opportunities and Constraints for Using Farmer Managed Natural Regeneration for Land Restoration in Sub-Saharan Africa. *Frontiers in Forests and Global Change*, 3. https://doi.org/10.3389/ffgc.2020.571679

Chukwuone, N. A., Adeosun, K. P. & Chukwuone, C. A. (2020). Socioeconomic factors affecting households' use of indigenous forest management practices in managing non-wood forest products: evidence from forest communities in Nigeria derived savannah. *Heliyon*, 6(10), e05281. https://doi.org/10.1016/j.heliyon.2020.e05281

ClientEarth (2016). *Addressing the risks of a weak legal framework governing forest conversion in Liberia*. https://www.clientearth.org/media/10wbgql0/addressing-the-risks-of-a-weak-legal-framework-governing-forest-conversion-in-liberia-ce-en-pdf.pdf

Coello, J. & Frey, L. (2023). *Funding Options for Ecosystem Restoration in Central America and Africa*. https://www.unique-landuse.de/en/news/2023/funding-options-for-ecosystem-restoration-in-central-america-and-africa/

Conservation International (2023). *REDD+ – Saving forests to keep our climate safe*. https://www.conservation.org/projects/saving-forests-to-keep-our-climate-safe-redd

Conway, A. L., Hernandez, S. M., Carroll, J. P., Green, G. T. & Larson, L. (2015). Local awareness of and attitudes towards the pygmy hippopotamus Choeropsis liberiensis in the

Moa River Island Complex, Sierra Leone. *Oryx*, 49(3), 550–558. https://doi.org/10.1017/S003060531300077X

CSIR-FORIG (n.d.). Socio-economic functions of forest resources. In Cobbinah, R.J., & Acquah, S.B. *The Contributions of Forest to Ghana's Economic Development*.

CSIR-FORIG (2011). Annual Report 2011. *EPPO Bulletin*, 42(3). https://doi.org/10.1111/epp.2606

Day, M., Gumbo, D., Moombe, K. B., Wijaya, A. & Sunderland, T. (2014). *Zambia country profile Monitoring, reporting and verification for REDD+*. https://www.cifor.org/publications/pdf_files/OccPapers/OP-113.pdf

Dickson, A. (2017). Challenges to the efficacy of forestry and wildlife policies in Ghana for environmental protection: A review. *African Journal of Agricultural Research*, 12(39), 2858–2876. https://doi.org/10.5897/ajar2017.12577

Dumenu, W. K. (2013). What are we missing? Economic value of an urban forest in Ghana. *Ecosystem Services*, 5, 137–142. https://doi.org/10.1016/j.ecoser.2013.07.001

du Plessis, E. (2018). *An overview of land use management and the role of traditional leaders in terms of SPLUMA 1*. https://law.nwu.ac.za/sites/law.nwu.ac.za/files/files/Elmien%20du%20Plessis%20SPLUMA%20and%20TL.pdf

Dwomoh, F. K., Wimberly, M. C., Nekorchuk, D., Numata, I. & Mensah, F. (2020). *West Africa Forest Degradation Data System (WAForDD) User Guide Version 2.1*. https://mcwimberly.users.earthengine.app/view/wafordd21

Echeberria, A. L. (2022). Artificial Intelligence for Business: Innovation, Tools and Practices. In *Artificial Intelligence for Business: Innovation, Tools and Practices*. Springer International Publishing. https://doi.org/10.1007/978-3-030-88241-9

Enaruvbe, G. O. & Atafo, O. P. (2016). Analysis of deforestation pattern in the Niger Delta region of Nigeria. *Journal of Land Use Science*, 11(1), 113–130. https://doi.org/10.1080/1747423X.2014.965279

Environment Protection Agency (2019). *Republic of Liberia National Report: Land Degradation Neutrality Target Setting Program.* Monrovia, Liberia. *https://knowledge.unccd.int/sites/default/files/ldn_targets/2019-10/Liberia%20LDN%20TSP%20Country%20Report.pdf*.

Environment Protection Agency (2021). *Liberia's Revised Nationally Determined Contribution (NDC).* Minerva. Internationales Verzeichnis Wissenschaftlicher Institutionen.

Environmental Protection Agency (EPA) & Ministry of Environment Science Technology and Innovation (MESTI) (2021). *Ghana: Updated Nationally Determined Contribution under Paris Agreement (2020-2030)*. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Ghana First/Ghana%27s Updated Nationally Determined Contribution to the UNFCCC_2021.pdf

EU REDD Facility (2023). *Reducing deforestation through improved Land-use governance Côte d'Ivoire*. https://euredd.efi.int/countries/cote-ivoire/

Fagerholm, N., García-Martín, M., Torralba, M., Bieling, C. & Plieninger, T. (2022). Public participation geographical information systems (PPGIS): Participatory research methods for sustainability - toolkit #1. *GAIA – Ecological Perspectives for Science and Society*, 31(1), 46–48. https://doi.org/10.14512/gaia.31.1.10

Federal Ministry of Environment Abuja (2021). *Nigeria's Nationally Determined Contribution*. https://unfccc.int/sites/default/files/NDC/2022-06/NDC_File%20Amended%20_11222.pdf

Federal Ministry of Environment of Nigeria (2020). *Draft Environmental and Social Draft Environmental and Social Impact*.

Food and Agricultural Commodity Systems (2022). *Where Next in Liberia's Sustainable Palm Oil Journey?* https://www.undp.org/facs/blog/where-next-liberias-sustainable-palm-oil-journey

Food and Agricultural Organization (2020). *FAO to hold a series of technical virtual events on forest monitoring tools in West Africa*. https://www.fao.org/redd/news/detail/en/c/1310877/

Food and Agriculture Commodity Systems. (2022). *National Oil Palm Strategy and Action Plan of Liberia (2021-2025)*. https://www.undp.org/facs/publications/national-oil-palm-strategy-and-action-plan-liberia-2021-2025

Food and Agriculture Organization (2010). *Forest Law Compliance and Governance in Tropical Countries*. https://www.fao.org/3/al044e/al044e00.pdf

Food and Agricultural Organization (2010). *Global Forest Resources Assessment 2010 Main Report* (Issue c).

Food and Agriculture Organization (2015). *Forests and Poverty Reduction*. https://www.fao.org/forestry/livelihoods/en/

Food and Agriculture Organization (2017). *Policy Brief: Community-based Forestry - Extent, effectiveness and potential*. www.fao.org/forestry/participatory

Food and Agriculture Organization (2018). *Liberia's REDD+ strategy - to protect forests means to protect its people*. https://www.fao.org/redd/news/detail/en/c/1105763/

Food and Agriculture Organization (2019a). *Strengthening Forest Based Communities and their Livelihoods in Sierra Leone*. https://www.fao.org/3/ca5840en/CA5840EN.pdf

Food and Agriculture Organization (2019b). *Forests without borders: Regional integration in West Africa as a prerequisite for climate change mitigation and sustainable forest management*. https://www.fao.org/redd/news/detail/en/c/1238348/

Food and Agricultural Organization (2020). Global Forest Resources Assessment 2020: Rome. In *Reforming China's Healthcare System*. https://doi.org/10.4324/9781315184487-1

Food and Agriculture Organization (2020). The State of the World's Forests 2020. In *The State of the World's Forests 2020*. FAO and UNEP. https://doi.org/10.4060/ca8642en

Food and Agricultural Organization (2021). *Review of forest and landscape restoration in Africa 2021*. https://doi.org/10.4060/cb6111en

Forest Carbon Partnership (2023). *FCPF Country Participants*. https://www.forestcarbonpartnership.org/about

Forestry Commission of Ghana (2020). Forestry commission Annual Report 2020. *Nature*, 167(4255), 807–808. https://doi.org/10.1038/167807b0

Fortnam, M., Brown, K., Chaigneau, T., Crona, B., Daw, T. M., Gonçalves, D., Hicks, C., Revmatas, M., Sandbrook, C. & Schulte-Herbruggen, B. (2019). The Gendered Nature of Ecosystem Services. *Ecological Economics*, 159, 312–325. https://doi.org/10.1016/j.ecolecon.2018.12.018

Fox, G. & Dickson, E. J. (1990). The Economics of Erosion and Sediment Control in Southwestern Ontario. *Canadian Journal of Agricultural Economics/Revue Canadienne d'agroeconomie*, 38(1), 23–44. https://doi.org/10.1111/j.1744-7976.1990.tb03447.x

Fredua, K. B. (2014). The Economic Cost of Environmental Degradation: A Case Study of Agricultural Land Degradation in Ghana. *SSRN Electronic Journal*, 233(0). https://doi.org/10.2139/ssrn.2534429

GFW. (2021). Côte d'Ivoire deforestation rates & statistics. Global Forest Watch. http://tinyurl.com/yy8kbe3e

GFW. (2023a). Nigeria deforestation rates & statistics. Global Forest Watch. http://tinyurl.com/mszkcacv

GFW. (2023b). Sierra Leone deforestation rates & statistics. Global Forest Watch. http://tinyurl.com/22bjjpke

GFW. (2023c). Tree cover loss. Global Forest Watch. http://tinyurl.com/nhkamykrGhana Forest Investment Program (2019). *Enhancing local community engagement in natural resources management*. 1–4. https://mlnrgfip.com/crema/

Girolami, E. Di. (2019). *Environmental Impacts of Sustainable Forest Management Two Systematic Literature Reviews of Scientific Research on the Environmental Impacts of Forest Certifications and Community Forest Management at Global Scale*. https://edepot.wur.nl/500865

Glaser, B. (2007). Prehistorically modified soils of central Amazonia: a model for sustainable agriculture in the twenty-first century. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 362(1478), 187–196. https://doi.org/10.1098/rstb.2006.1978

Global Citizen (2023). *Understanding Pioneering REDD+ Forest Conservation Projects*. https://www.globalcitizen.org/en/content/connecting-people-forests-sierra-leone/

Global Environmental Facility (2021). *Global Environmental Facility Cote d'Ivoire*. https://www.thegef.org/projects-operations/country-profiles/cote-divoire

Goll, I. I., Nick, B, Jianhua, L., McKay, J. & John, S. (2014). Analysis on the Causes of Deforestation and Forest Degradation in Liberia: Application of the DPSIR Framework. *Research Journal of Agriculture and Forestry Sciences*, 2(3), 20–30.

Government of Liberia (2019). *REDD+ in Liberia*. https://seors.unfccc.int/applications/seors/attachments/get_attachment?code=9HLUGDP8ZW3OK6UYBZ8FJDO8AU0OL8EE

Graphic Online (2015). *The causes, consequences and control of corruption in Ghana*.

Green Growth Partnership (2018). *Where Next in Liberia's Sustainable Palm Oil Journey?* https://goodgrowthpartnership.org/where-next-in-liberias-sustainable-palm-oil-journey/

Greening, H. S., Heck, K. L., McKinney, L. D., Diefenderfer, H. L., Boynton, W. R., Kleiss, B. A., Mishra, D. R., George, A. A., Kraft, B. A. C., Kling, C. A. & Windecker, L. A. (2023). Assessing the Effectiveness of Large-Scale Environmental Restoration: Challenges and Opportunities. *Estuaries and Coasts*, 46(2), 293–301. https://doi.org/10.1007/s12237-022-01149-8

Grieg-Gran, M., Bass, S., Booker, F. & Day, M. (2015). *The role of forests in a green economy transformation in Africa*. https://www.un-redd.org/sites/default/files/2021-10/Forests%20in%20Green%20Economy%20in%20Africa-ENGLISH%20full%20report%20%28421614%29.pdf

Gulzar, A. & Alexander, L. (2022). *Building Transparency and Accountability in Natural Resource Management (NRM): The Role of Social Accountability and Civic Participation in Addressing Corruption in the NRM Sector The Role of Social Accountability and Civic Participation in Addressing Corruption in the NRM Sector Background: Context and Approach*. http://tinyurl.com/mw6ahp4v

Halton, A. (2012). *Liberia: Assessment of key governance issues for REDD+ implementation through the application of the PROFOR forest governance tool*. https://www.profor.info/sites/profor.info/files/Liberia_Assessment%20of%20key%20governance%20issues%20for%20REDD%2B.pdf

Haq, S. M., Pieroni, A., Bussmann, R. W., Abd-ElGawad, A. M. & El-Ansary, H. O. (2023). Integrating traditional ecological knowledge into habitat restoration: implications for meeting forest restoration challenges. *Journal of Ethnobiology and Ethnomedicine*, 19(1). https://doi.org/10.1186/s13002-023-00606-3

Härkin, P., Marttila, R., Pokka, T., Saarela, T. & Hallman, M. (2018). Morbidities associated with patent ductus arteriosus in preterm infants. Nationwide cohort study. *Journal of Maternal-Fetal and Neonatal Medicine*, 31(19), 2576–2583. https://doi.org/10.1080/14767058.2017.1347921

Ighalo, J. O., Adeniyi, A. G., Adeniran, J. A. & Ogunniyi, S. (2021). A systematic literature analysis of the nature and regional distribution of water pollution sources in Nigeria. *Journal of Cleaner Production*, 283, 124566. https://doi.org/10.1016/j.jclepro.2020.124566

Iiyama, M., Njenga, M., Ndegwa, G. & Jamnadass, R. (2015). Opportunities and challenges of landscape approaches for sustainable charcoal production and use. In *Climate-Smart Landscapes: Multifunctionality in Practice*.

Impact Report (2022). *Cavally: community resilience in service of forest regeneration*.

Inoni, O. E., Gani, B. S. & Sabo, E. (2021). Drivers of crop diversification: Evidence from smallholder farmers in Delta State Nigeria. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 69(1), 59–70. https://doi.org/10.11118/ACTAUN.2021.006

Institute of Development Studies (n.d.). *Participatory Geographical Information Systems (PGIS)*. https://www.participatorymethods.org/method/participatory-geographical-information-systems-pgis

International Union for Conservation of Nature and Natural Resources (2018). *Developing a biodiversity conservation strategy for the Niger Delta: integrating biodiversity considerations into SPDC's operations*. https://doi.org/10.2305/iucn.ch.2018.07.en

International Union for Conservation of Nature and Natural Resources (2019a). *Traditional Knowledge key in achieving Africa's climate goals*.

International Union for Conservation of Nature and Natural Resources (2019b). *Benefits of gender equality in sustainable ecosystem management*. https://www.iucn.org/news/gender/201912/benefits-gender-equality-sustainable-ecosystem-management

IPBES (2019). *Summary for Policymakers of the IPBES Global Assessment Report on Biodiversity and Ecosystem Services*. IPBES secretariat, Bonn, Germany. https://doi.org/10.5281/zenodo.3553579

Jabbar, N. M., Alardhi, S. M., Mohammed, A. K., Salih, I. K. & Albayati, T. M. (2022). Challenges in the implementation of bioremediation processes in petroleum-contaminated soils: A review. *Environmental Nanotechnology, Monitoring and Management*, 18, 100694. https://doi.org/10.1016/j.enmm.2022.100694

Jackson, E. A. (2015). Assessment of Forest Valuation to GDP Contribution in Sierra Leone. *Forest Research: Open Access*, 04(02), 2–7. https://doi.org/10.4172/2168-9776.1000143

Jalloh, E. B. (2019). *WABiCC and the future of coastal people in Sierra Leone*. https://www.thepatrioticvanguard.com/wabicc-and-the-future-of-coastal-people-in-sierra-leone

Kainyande, A., Auch, E. & Okoni-Williams, A. (2023). Local perceptions of the socio-demographic changes triggered by large-scale plantation forests: Evidence from rural communities in Northern Province of Sierra Leone. *Environmental Challenges*, 11, 100694. https://doi.org/10.1016/J.ENVC.2023.100694

Keenan, R. J. (2015). Climate change impacts and adaptation in forest management: a review. *Annals of Forest Science*, 72(2), 145–167. https://doi.org/10.1007/s13595-014-0446-5

Kissinger, G., Herold, M. & Sy, V. de. (2012). *Drivers of Deforestation and Forest Degradation: A Synthesis Report for REDD+ Policymakers*. Lexeme Consulting. Vancouver, Canada. https://www.cifor.org/knowledge/publication/5167/

Kissinger, M., Rees, W. E. & Timmer, V. (2011). Interregional sustainability: Governance and policy in an ecologically interdependent world. *Environmental Science and Policy*, 14(8), 965–976. https://doi.org/10.1016/j.envsci.2011.05.007

Kouadio, K. I. (2021). Impact of Urbanization on Forest and Lagoon Environments in Ivory Coast: Case of Abidjan. *International Journal for Research in Applied Science and Engineering Technology*, 9(4), 1287–1296. https://doi.org/10.22214/ijraset.2021.33924

Kouassi, J. L., Gyau, A., Diby, L., Bene, Y. & Kouamé, C. (2021). Assessing land use and land cover change and farmers' perceptions of deforestation and land degradation in south-west Côte d'Ivoire,West Africa. *Land*, 10(4). https://doi.org/10.3390/land10040429

Kouassi, N. L. B., Yao, K. M., Trokourey, A. & Soro, M. B. (2015). Distribution, Sources, and Possible Adverse Biological Effects of Trace Metals in Surface Sediments of a Tropical Estuary. *Environmental Forensics*, 16(1), 96–108. https://doi.org/10.1080/15275922.2014.991433

Kyem, P. K. (2002). Promoting local community participation in forest management through a PPGIS application in Southern Ghana. *Community Participation and Geographical Information Systems*, 218–231. https://doi.org/10.1201/9780203469484-24

LDN Report (2018). *Sierra Leone Land Degradation Neutrality National Report*. https://www.unccd.int/sites/default/files/ldn_targets/Sierra%20Leone%20LDN%20TSP%20Country%20Report.pdf

Lette, H. & de Boo, H. (2002). Economic valuation of forests and nature: a support tool for effective decision-making. International Agricultural Centre (IAC), Wageningen. https://edepot.wur.nl/118103

Löfqvist, S., Kleinschroth, F., Bey, A., De Bremond, A., Defries, R., Fleischman, F., Lele, S., Martin, D. A., Messerli, P., Meyfroidt, P., Pfeifer, M., Rakotonarivo, S. O., Ramankutty, N., Ramprasad, V., Rana, P., Rhemtulla, J. M., Ryan, C. M., Vieira, I. C. G., Wells, G. J. & Garrett, R. D. (2023). How Social Considerations Improve the Equity and Effectiveness of Ecosystem Restoration. *BioScience*, 73(2), 134–148. https://doi.org/10.1093/biosci/biac099

LTS International and ONF International. (2011). Towards a West African forest strategy - working draft. https://www.profor.info/sites/profor.info/files/WAFS-draft-42111_0.pdf

Mabey, P. T., Li, W., Sundufu, A. J. & Lashari, A. H. (2020). Environmental impacts: Local perspectives of selected mining edge communities in Sierra Leone. *Sustainability (Switzerland)*, 12(14), 1–16. https://doi.org/10.3390/su12145525

Mansourian, S. & Berrahmouni, N. (2021). *Review of Forest and Landscape Restoration in Africa*. https://www.fao.org/3/cb6111en/cb6111en.pdf

Mensah, J. (2019). Managing environmental sanitation in the catchment area of Benya Lagoon, Ghana: Education, regulation or infrastructure management as a matter of strategic priority? *Cogent Social Sciences*, 5(1). https://doi.org/10.1080/23311886.2019.1709347

Ministry of Lands and Forestry Accra (1999). *National Land Policy*. https://www.clientearth.org/media/rvlhzmxd/national-land-policy-1999-ext-en.pdf

MLNR (2012). *Ghana Forest and Wildlife Policy*. https://www.clientearth.org/external-resources/ghana/forests-and-wildlife/2012-Forest-and-wildlife-policy-GHANA.pdf

Ndzabandzaba, C. (2019). Participatory Geographic Information System (PGIS): A Discourse Toward a Solution to Traditional GIS Challenges. In *Handbook of the Changing World Language Map* (pp. 1–11). Springer International Publishing. https://doi.org/10.1007/978-3-319-73400-2_122-1

Ngom, C. A. (2015). *REDD + strategies in the management of forest resources Colonel Alassane NGOM, International Consultant*. http://www.ecreee.org/sites/default/files/documents/basic_page/redd_strategies_ecowas_final_12-10-2015_english.pdf

Njisah, Z. F. & Nsanyi, M. S. (2022). *A Preliminary Assessment of Ecosystem Services in the Sherbro River Estuary, Southern Sierra Leone*.

Nthara, K. & Sanjay Srivastava. (2020). *Liberia: Understanding people's dependence on forests*. World Bank. https://blogs.worldbank.org/africacan/liberia-understanding-peoples-dependence-forests

Nuijten, R. J. G., Coops, N. C., Watson, C. & Theberge, D. (2021). Monitoring the Structure of Regenerating Vegetation Using Drone-Based Digital Aerial Photogrammetry. *Remote Sensing*, 13(10), 1942. https://doi.org/10.3390/rs13101942

Nunez, C. (2022). *Why deforestation matters – and what we can do to stop it*. National Geographic. http://tinyurl.com/47cxutee

Odoh, C. K., Zabbey, N., Sam, K. & Eze, C. N. (2019). Status, progress and challenges of phytoremediation - An African scenario. *Journal of Environmental Management*, 237, 365–378. https://doi.org/10.1016/j.jenvman.2019.02.090

Ogunkan, D. V. (2022). Achieving sustainable environmental governance in Nigeria: A review for policy consideration. *Urban Governance*, 2(1), 212–220. https://doi.org/10.1016/j.ugj.2022.04.004

Open Foris (2023). *Open Foris*. https://openforis.org/

Orji, F. A., Ibiene, A. A. & Okerentugba, P. O. (2013). Bioremediation of petroleum hydrocarbon-polluted mangrove swamps using nutrient formula produced from water hyacint (Eicchornia crassipes). *American Journal of Environmental Sciences*, 9(4), 348–366. https://doi.org/10.3844/ajessp.2013.348.366

Osipova, E., Emslie-Smith, M., Osti, M., Murai, M., Åberg, U. & Shadie, P. (2020). Forest and Climate Change. *IUCN World Heritage Outlook 3*. https://doi.org/10.2305/IUCN.CH.2020.16.EN

Owusu, P. A., Asumadu-Sarkodie, S., & Ameyo, P. (2016). A review of Ghana's water resource management and the future prospect. *Cogent Engineering*, 3(1), 1164275. https://doi.org/http://doi.org/10.1080/23311916.2016.1164275

Oyediji, O. T. & Adenika, O. A. (2022). Forest Degradation and Deforestation in Nigeria. *Poverty Link*, 05(10), 2837–2844. https://doi.org/10.47191/ijmra/v5-i10-35

Pistorius, T. (2012). From RED to REDD+: The evolution of a forest-based mitigation approach for developing countries. *Current Opinion in Environmental Sustainability*, 4(6), 638–645. https://doi.org/10.1016/j.cosust.2012.07.002

Pollini, B., Miles, L., Ravilious, C. & Gosling, J. (2018). *Using spatial analysis to support REDD+ land-use planning in Liberia*. https://www.un-redd.org/sites/default/files/2021-10/Liberia_Briefing_%20lowres.pdf

PROFOR (2017). *Private Financing for Sustainable Forest Management and Forest Products in Developing Countries – Trends and Drivers*. https://www.profor.info/knowledge/private-financing-sustainable-forest-management-and-forest-products-developing-countries-%E2%80%93

PROFOR, CIFOR (n.d.). *Report on Forest Certification Effectiveness.* https://sdg.iisd.org/news/profor-cifor-report-on-forest-certification-effectiveness/

Rametsteiner, E. (2009). Governance concepts and their application in forest policy initiatives from global to local levels. *Small-Scale Forestry*, 8(2), 143–158. https://doi.org/10.1007/s11842-009-9078-2

REDD+ Cote d'Ivoire (2018). *National REDD+ Strategy Cote d'Ivoire*. https://reddplus.ci/category/strategie-nationale-redd-cote-divoire/

Republic of Sierra Leone (2017). *Republic of Sierra Leone Environment Protection Agency Strategic Plan*. https://faolex.fao.org/docs/pdf/sie199247.pdf

Republic of Sierra Leone (2021). *Environment Protection Agency Strategic Plan (2017-2021)*.

Sáfián, S., Koïvogui, S., Simonics, G. & Florczyk, K. J. (2020). Butterfly diversity (Lepidoptera: Papilionoidea) in the Ziama Massif in Guinea and the adjacent Wonegizi and Wologizi Mountains in Liberia (West Africa): A transboundary conservation approach. *Metamorphosis*, 31(1), 104–128. https://www.ajol.info/index.php/met/article/view/222900

Sapena, M., Inkoom, J. N., Umaru, E. T., Mast, J., Okhimamhe, A. A. & Taubenböck, H. (2023). Integrating multi-source remote sensing data for monitoring urban development in West Africa. *2023 Joint Urban Remote Sensing Event (JURSE)*, 1–4. https://doi.org/10.1109/JURSE57346.2023.10144165

Saysay Dede, E. D., Franco, L. & Hophmayer-tokich, S. (2016). *The Impacts Of Land Use Practices On The Environment: A Case Study In Butaw, Sinoe County, Liberia 2012-2016.* MSc Thesis.

Tabor, K., Hewson, J., Tien, H., González-Roglich, M., Hole, D. & Williams, J. W. (2018). Tropical protected areas under increasing threats from climate change and deforestation. *Land*, 7(3), 1–14. https://doi.org/10.3390/land7030090

Tanzer, M., Gläsel, A., & Egermann, M. (2022). Elucidating the capabilities of international mechanisms to foster procedural just system change – The case of the 2021 UN Food System Summit. *Environmental Innovation and Societal Transitions*, 45, 72–82. https://doi.org/10.1016/j.eist.2022.09.002

TerraMatch (2023). *People Growing Trees The Right Way: Connecting the world's land restoration champions to funding and technical assistance through a trusted system that vets their work, supports their growth, and monitors their progress.*. https://www.terramatch.org/

The Federal Government of Nigeria (2021). *Nigeria's Nationally Determined Contributions*. https://unfccc.int/sites/default/files/NDC/2022-06/NDC_File%20Amended%20_11222.pdf

The World Bank (n.d.). *Forest Carbon Partnership Facility Liberia*. https://www.forestcarbonpartnership.org/country/liberia

The World Bank (2018). *World Bank Allocates $15 million to Help Cote d'Ivoire Reverse the Trend of Deforestation and Forest Degradation*. https://www.worldbank.org/en/news/press-release/2018/01/26/world-bank-allocates-15-million-to-help-cote-divoire-reverse-the-trend-of-deforestation-and-forest-degradation

The World Bank (2018). *In Ghana, Resourceful Communities Transform Landscapes, Livelihoods*. http://tinyurl.com/y3cx8bt8

The World Bank (2019). *West Africa's Coast: Losing Over $3.8 Billion a Year to Erosion, Flooding and Pollution*. World Bank Blog. https://www.worldbank.org/en/region/afr/publication/west-africas-coast-losing-over-38-billion-a-year-to-erosion-flooding-and-pollution

The World Bank (2020). *Country Environmental Analysis: Ghana*. World Bank, Washington, DC. https://openknowledge.worldbank.org/entities/publication/84fe1427-4233-5b67-ace4-d41bf11d652c

The World Bank (2022). *Finance, Competitiveness, and Innovation Global Practice Fintech and SME Finance: Expanding Responsible Access Fintech and the Future of Finance Flagship Technical Note*. https://openknowledge.worldbank.org/server/api/core/bitstreams/d157af2e-ad06-558f-8e1b-5bf52841d34a/content

Tinsley, E. & Agapitova, N. (2018). *Private Sector Solutions to Helping Smallholders Succeed Social Enterprise Business Models in the Agriculture Sector*. https://documents1.worldbank.org/curated/en/851711521095180329/pdf/124304-WP-PUBLIC-AgriBookMar.pdf

Turnhout, E. & Purvis, A. (2020). Biodiversity and species extinction: categorisation, calculation, and communication. *Griffith Law Review*, 29(4), 669–685. https://doi.org/10.1080/10383441.2020.1925204

UK Space Agency (2020). *State and trends of deforestation in Cote d'Ivoire.* (Issue July).

UNEP-WCMC (2022). *Cocoa agroforestry could help Côte d'Ivoire achieve 20% forest cover target*. https://www.unep-wcmc.org/en/news/cocoa-agroforestry-could-help-cote-divoire-achieve-20-forest-cover-target

United Nations (2019). Capacity development for 2030 Agenda implementation - Review of capacity development gaps, needs, and priorities. https://sdgs.un.org/sites/default/files/2021-01/Draft%20report_VNR_capacity_gaps_analysis_formatted_rev2_0.pdf

United Nations Department of Economic and Social Affairs (2021). *The global forest goals report 2021 : realizing the importance of forests in a changing world*. https://www.un.org/en/desa/global-forest-goals-report-2021

United Nations Development Programme (2022). *Community Forest Management Project kicks off following inception workshop in Gbarnga*. https://www.undp.org/liberia/press-releases/community-forest-management-project-kicks-following-inception-workshop-gbarnga

United Nations Environment Programme (2018). *Blog: A path to sustainable cocoa and forest restoration in Côte d'Ivoire – United Nations Environment – Finance Initiative*. https://www.unepfi.org/regions/africa-middle-east/blog-a-path-to-sustainable-cocoa-and-forest-restoration-in-cote-divoire/

United Nations Environment Programme (2021). *Fact Sheet Deforestation*. https://wedocs.unep.org/bitstream/handle/20.500.11822/35851/DF.pdf

United Nations Sustainable Development Group (2022). *Protecting sacred forests in Côte d'Ivoire, for people and planet*. http://tinyurl.com/42a2y4bd

United States Agency for International Development (2010). *Liberia: Land Rights and Community Forest Program*. https://www.land-links.org/project/land-rights-and-community-forest-program-liberia/

UN-REDD Programme (2023). *Strengthening the forestry legal framework in Ghana*. https://www.un-redd.org/post/strengthening-forestry-legal-framework-ghana

Upreti, A. (2022). *Machine Learning Application in G.I.S. and Remote Sensing: An Overview*. https://doi.org/10.20944/preprints202207.0302.v1

USAID (2021). *Liberia Water Resources Profile Overview Liberia*. http://tinyurl.com/2h72ae9d

wabicc.org (2021). *West Africa Biodiversity and Climate Change (WA BiCC)*. https://www.wabicc.org/en/

Whyte, K. P. (2011). The recognition dimensions of environmental justice in Indian country. *Environmental Justice*, 4(4), 199–205. https://doi.org/10.1089/env.2011.0036

Wily, L. A. (2011). ‘The Law is to Blame’: The Vulnerable Status of Common Property Rights in Sub-Saharan Africa. *Development and Change*, 42(3), 733–757. https://doi.org/10.1111/j.1467-7660.2011.01712.x

World Economic Forum (2021). *How to preserve Africa’s forests and build a green economy*. https://www.weforum.org/agenda/2021/06/preserve-africa-forests-green-economy/

World Economic Forum (2022). *Wildfire risk has increased, but we can still influence where and how fires strike*. https://www.weforum.org/agenda/2022/07/climate-change-wildfire-risk-has-grown-nearly-everywhere-but-we-can-still-influence-where-and-how-fires-strike/

World Resources Institute (2023a). *Global Restoration Initiative - Monitoring Forest and Landscape Restoration*. https://www.wri.org/initiatives/global-restoration-initiative/monitoring-forest-and-landscape-restoration

World Resources Institute (2023b). *TerraMatch connects local land restoration champions to capital and technical assistance through a trusted online system that vets their work, supports their growth, and monitors their progress.* https://www.wri.org/initiatives/terramatch

WWF (2018). *Forests and Sustainable Development: The role of SDG 15 in delivering the 2030 Agenda*. https://wwf.panda.org/wwf_news/?330870/Forests-and-Sustainable-Development-The-role-of-SDG-15-in-delivering-the-2030-Agenda

WWF & AFDB (2015). *African ecological futures 2015*. 100. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/xwwf_african_futures_report_english-lo-rez.pdf

Yusuf, M. B., Abba, U. J. & Isa, M. S. (2019). Assessment of Soil Degradation under Agricultural Land Use Sites: Emerging Evidence from the Savanna Region of North Eastern Nigeria. *Ghana Journal of Geography*, 11(2), 243–263.

ANNEXES

ANNEX 1. QUESTIONS FOR GUIDING THE LITERATURE REVIEW

The following criteria, developed by IIED, guided us through our literature review.

Ecosystems and landscapes

- Where are the hotspots in the region; where does environmental degradation matter for climate, nature and people?
- What are the opportunities to improve evidence, tools and decision-making processes among or across these hotspots?

Evidence quality and use

- What key evidence gaps need to be addressed to tackle environmental degradation in the region?
- How can the use of evidence be improved to better tackle environmental degradation in the region?

Tools

- What are the proven effective tools that can help reverse environmental degradation in the region, and what are the opportunities and challenges involved in encouraging their use more widely?
- What tools need to be developed to address specific issues and challenges, especially those faced by IPLCs and marginalized groups?

Governance systems

- Where environmental degradation in the region is concerned, who gets to decide what, and how do they do it? What are the key issues that need to be addressed?
- What opportunities are there to address issues in decision-making processes?

ANNEX 2. CRITERIA FOR IDENTIFYING POTENTIAL REDAA INTERVENTIONS

The following criteria, developed by IIED, guided us in identifying potential RTAPs that could be implemented by REDAA:

Scale-appropriate: the issue can be usefully addressed with the scale of support that may be possible from the REDAA programme, e.g. a grant of roughly US$50,000 and 100,000 over 6–24 months, or a grant of roughly US$200,000 and 1,500,000 over four years.

Timeframe-fitting: the issue can be thoroughly addressed within 6 months to 4 years, or a significant contribution to addressing the problem can be made and verified within 6 months to 4 years.

Value for money: how the issue is addressed will provide good returns on investment, benefits to costs, and value for money.

Site-specific impact: if the issue were addressed, it would have a major impact in a specific place.

Cross-cutting impact: If the issue were addressed, it would have a major impact on systems or processes that affect many places.

Locally led: the issue is best addressed by locally led action, especially action led by local communities and Indigenous Peoples.

Intersectional: the issue is best addressed through the intersectional understanding and empowerment of vulnerable groups, including Indigenous Peoples, women, youth, migrant workers, landless labourers and displaced peoples.

Cross-disciplinary and multi-stakeholder: the issue is best addressed by fostering multi-stakeholder and cross- or trans-disciplinary collaborations.

ANNEX 3. A DESCRIPTION OF THE KEY INFORMANTS OR STAKEHOLDERS INTERVIEWED

Table 2: List of Key Informants interviewed

Respondent number	Country or region of expertise	Type of organization	Area of expertise
1	West and Central Africa	Multi-lateral organizations	Environment, natural resources and blue economy
2	Ghana	NGO	Environmental conservation
3	Ghana	Media	Environmental journalism (deforestation, coastal pollution, illegal mining)
4	UK-based but works in West Africa	Academia	Natural resource management
5	Ghana	NGO	Natural resource management
6	Nigeria	NGO	Environment and natural resources
7	Nigeria	Governmental organization	Natural resource management
8	Nigeria	Governmental organization	Natural resource management
9	Ghana	NGO	Environment
10	Togo	Academia	Forestry
11	Ghana	Government	Natural resource management
12	Nigeria	Government	Environment and natural resources

ANNEX 4. TYPES AND DRIVERS OF ENVIRONMENTAL DEGRADATION IN WEST AFRICA

This annex provides an overview of the main drivers of environmental degradation in Côte d'Ivoire, Ghana, Sierra Leone, Nigeria and Liberia and provides broad recommendations for improvements in each country. These recommendations were then used to help inform the preliminary list of RTAPs (Annex 7).

This table is not intended to be a comprehensive list of all degradation issues and drivers in these countries, rather it reflects the data gathered through our literature review, stakeholder interviews.

Table 3: Type and drivers of environmental degradation in West Africa and recommendations for improvements.

Category	Country				
	Ghana	**Sierra Leone**	**Nigeria**	**Liberia**	**Côte d'Ivoire**
Deforestation	1. Illegal logging (rosewood) 2. Agricultural expansion (largest driver: cocoa cultivation) 3. Illegal mining 4. urban expansion 6. Weak governance 7. Overexploitation of mangrove forests 9. Weak monitoring systems 10. Dependence on fuelwood and charcoal	1. Extensive illegal logging 2. Illegal mining 2. Agricultural expansion (largest driver: expansion of oil-palm and rubber plantations and commercial farming) 3. Weak law enforcement 4. Unregulated bushfires 5. Unregulated charcoal production	1. Agriculture (slash and burn) 3. Illegal logging 4. Forest conversion for infrastructure development 5. Dependence on fuelwood and charcoal 5. Oil and gas exploration – oil spills 6. Social factors 7. Rapid population growth 8. Poor resource governance	1. Industrial/large-scale agriculture (oil-palm and rubber plantations) 2. Illegal logging (unsustainable timber harvesting) 3. Illegal mining 4. Dependence on fuelwood and charcoal 6. Weak governance and corruption 7. Ineffective land use planning 8. Urban expansion and population growth	1. Agricultural expansion (cocoa) 2. Population growth and urban expansion 3. Illegal logging 4. Artisanal mining 5. Dependence on fuelwood and charcoal 6. Over-exploitation of mangrove 7. Plastic pollution

Category	Country				
	Ghana	**Sierra Leone**	**Nigeria**	**Liberia**	**Côte d'Ivoire**
		5. Dependence on fuelwood 6. Uncontrolled grazing 7. Improper land use planning 8. Destruction of mangroves	9. Poor governance and corruption 10. Low community participation 11. Destruction of mangroves	9. Over-exploitation of mangrove	
Soil degradation	1. Unsustainable agricultural practices (slash-and-burn, over-grazing and shifting cultivation) 2. Mining 3. Soil erosion due to poor land-use practices 4. Use of chemical fertilizers and pesticides	1. Unsustainable agricultural practices (slash-and-burn, over-grazing and shifting cultivation) 2. Artisanal small-scale mining	1. Unsustainable agriculture (over-grazing, intensive farming) 2. Oil spills from the Delta region	1. Unsustainable agricultural practices (slash-and-burn, over-grazing and shifting cultivation) 2. Mining 3. Charcoal burning	1. Unsustainable agricultural practices (slash-and-burn, monoculture, over-grazing, use of chemical fertilizers and pesticides) 2. Mining
Water pollution	1. Improper waste disposal (industrial) into water bodies (plastic pollution) 2. Illegal mining (use of harmful chemicals – mercury, cyanide)	1. Inadequate waste disposal practices (open dumping and untreated sewage) 2. Agricultural run-off and use of agrochemicals	1. Oil spills 2. Industrial activities (untreated waste from industries) 3. Urbanization 4. Groundwater pollution (leaching)	1. Industrial effluence and untreated waste 2. Artisanal mining (cyanide and mercury from artisanal mining and untreated mine tailings)	1. Oil spills 2. Mining 3. Industrial effluence and untreated waste 4. Agriculture (use of chemical fertilizers and pesticides)

Category	Country				
	Ghana	**Sierra Leone**	**Nigeria**	**Liberia**	**Côte d'Ivoire**
	3. Poor sanitation (open defecation, inadequate wastewater treatment and littering) 4. Agricultural run-off and use of agrochemicals	3. Artisanal small-scale mining (mercury and cyanide) 4. Untreated effluence from industrial activities (textile manufacturing, food processing and chemical production) 5. Natural disasters such as floods and mudslides	5. Agricultural run-off and use of agrochemicals	3. Agriculture (use of chemical fertilizers and pesticides) 4. Untreated sewage	
Biodiversity erosion	1. Illegal mining 3. Bushfire 4. Encroachment on protected areas 5. Poaching	1. Illegal logging 2. Hunting 3. Mining	1. Illegal logging 2. Poaching 3. Habitat destruction	1. Illegal hunting 2. Habitat destruction (civil unrest) 3. Encroachment of farms	1. Illegal logging 2. Illegal hunting and poaching 3. Illegal mining 4. Encroachment from nearby agriculture into forest reserves
Recommendations for improvements	Strengthen law enforcement and regulation of illegal logging and deforestation. Encourage sustainable land-use practices and reforestation efforts.	Promote sustainable land-use practices and reforestation efforts. Strengthen law enforcement to combat illegal logging and deforestation.	Encourage sustainable land-use practices and reforestation efforts. Increase public education and awareness of the importance of conservation.	Promote sustainable land-use practices and reforestation efforts. Strengthen law enforcement and regulation of illegal logging and deforestation.	Encourage sustainable land-use practices and reforestation efforts. Strengthen law enforcement and regulation of illegal logging and deforestation. Increase

Category	Country				
	Ghana	**Sierra Leone**	**Nigeria**	**Liberia**	**Côte d'Ivoire**
	Increase public education and awareness on the importance of conservation.	Increase funding for conservation efforts. Develop alternative livelihoods for communities dependent on logging and mining	Strengthen regulation of oil and gas exploration and mining activities to prevent pollution of water sources. Increase funding for conservation efforts.	Increase public education and awareness of the importance of conservation. Develop alternative livelihoods for communities dependent on logging and mining.	public education and awareness of the importance of conservation. Increase funding for conservation efforts. Develop alternative livelihoods for communities dependent on logging and mining.

ANNEX 5. INTERNATIONAL/REGIONAL AND NATIONAL POLICIES TO REVERSE ENVIRONMENTAL DEGRADATION IN WEST AFRICA

This annex provides an overview of current policies (international/regional and national) in Côte d'Ivoire, Ghana, Sierra Leone, Nigeria and Liberia that aim to address environmental degradation and provides broad recommendations for improvements in each country. These recommendations, which were based on a review of the strengths and weaknesses of the existing policies, were then used to help inform the longlist RTAPs (Annex 7).

This table is not intended to be a comprehensive list of current policies in these countries, rather it reflects those identified through our literature review and stakeholder interviews.

Table 4: Current international/regional and national policies that aim to address environmental degradation in West Africa

Côte D'Ivoire	
International/regional policies implemented	• EU REDD Facility • Côte d'Ivoire REDD+ Strategy • The Orientation Law on Sustainable Development • The Post-2020 Global Biodiversity Framework • The Abidjan Convention
National policies implemented	• National Biodiversity Strategy and Action Plan • National REDD+ Strategy Côte d' Ivoire • National Environmental Policy • National Climate Change Policy • National Environmental Action Plan (NEAP) of 2006–2010 • The Forest Code of 1963 (revised in 2002) • The Water Code of 1996 • National Biodiversity Strategy and Action Plan (NBSAP) of 2016–2020 • Code of the Forest • The Orientation Law for Agriculture • National Strategy for Sustainable Cocoa Production (NSSCP)

	• Côte d' Ivoire National REDD+ Strategy • National Plan for the Environment and Sustainable Development (PNEDD)
Recommendations for improvement	• Strengthening of the implementation and enforcement mechanisms of policies to ensure that they achieve their intended outcomes. • There is a need for strong political will and adequate resources to support policy enforcement and implementation. • Improve the capacity of government institutions responsible for implementing policies and regulatory frameworks through training, capacity building, and the provision of adequate resources. • Increase public awareness and education of environmental issues to promote behavioural change and increase public support for environmental conservation. • Regular monitoring and evaluation of policies and regulatory frameworks to ensure they remain relevant, effective and responsive to changing environmental and socio-economic conditions.
Ghana	
International/regional policies implemented	• The Abidjan Convention in Ghana • West African Gas Pipeline (WAGP) Environmental and Social Impact Assessment (WAGP ESIA) • WARFP • The Volta Basin Authority
National policies implemented	• National Land Policy (Ministry of Lands and Forestry Accra, 1999) • Benefit Sharing Plan Ghana Cocoa Forest REDD+ Programme • Ghana Forest and Wildlife Policy • National Environmental Policy • Land Use and Spatial Planning Policy • National REDD+ Strategy • National Water Policy • Voluntary Partnership Agreement • Forest and Wildlife Policy • Community Resource Management Areas (CREMAs) and Community Forest Management Programme (CFMP) • National Forest Policy 2015 • Ghana Cocoa Forest REDD+ Programme

	• Ghana Forest Plantation Strategy, • Forest and WildLife Development Levy • Timber Resource Management Act, Wild Life Conservation Act • Forest Plantation Development Fund Act • National Biodiversity Strategy and Action Plan (2016–2020) • Ghana Forest Plantation Strategy (2012–2042) • Ghana Water Resources Commission Act (1996) • Wildlife Conservation Act (1971) • Environmental Assessment Regulations (1999) • National Biodiversity Act, 2002 (ACT 625) • Water Resources Commission Act, 1996 (Act 522) • Minerals and Mining Act, 2006 (Act 703) • Forestry Commission Act, 1999 (Act 571)
Recommendations for improvement	• Strengthen enforcement of existing environmental policies. • Increase public education and awareness. • Strengthen implementation and enforcement of existing policies and regulations to ensure they are effective in achieving their intended goals. • Prioritize the protection and conservation of threatened and endangered species and their habitats to maintain biodiversity and ecosystem health. • Foster international cooperation and partnerships to leverage knowledge, technology and financial resources to support Ghana's environmental conservation efforts.
Sierra Leone	
International/regional policies implemented	• The Mano River Union Forest Initiative • The WABiCC programme • The Abidjan Convention
National policies implemented	• National Biodiversity Strategy and Action Plan (NBSAP) • The National Forestry Policy • The Sierra Leone Environmental Protection and Pollution Control Act

Recommendations for improvement	• There is a need for increased funding from both national and international sources to support the implementation of policies. • Improve monitoring and evaluation. • Strengthen institutional capacity. • Strengthen law enforcement.
Nigeria	
International/regional policies implemented	• Niger Delta Action Plan (NDAP)
National policies implemented	• National Forest Policy • National Environmental Policy on the Environment
Recommendations for improvement	• Strengthen institutional capacity and enforcement mechanisms for the effective implementation of regional policies. • Invest in research and development. • Regional policies in Nigeria should prioritize research and development to better understand the root causes of environmental degradation and identify effective solutions.
Liberia	
International/regional policies implemented	• Liberia National REDD+ Strategy 2017 (Food and Agriculture Organization of the United Nations, 2018) • Forest Carbon Partnership Facility in Liberia (World Bank, n.d.) • Forest Law Enforcement, Governance and Trade (FLEGT)
National policies implemented	• Liberia: Land Rights and Community Forest Program (United States Agency for International Development, 2010) • National Oil Palm Strategy and Action Plan (Food and Agriculture Commodity Systems, 2022) • National Forestry Reform Law • National Forestry Policy • National Environmental Policy • National Biodiversity Strategy and Action Plan • Coastal and Marine Resources Management Policy • National Water Resources Management Policy • National REDD+ Strategy

Recommendations for improvement	• Strengthen monitoring and evaluation frameworks. • Increase community participation and benefit-sharing. • Increase funding. • Enhance capacity and stakeholder engagement. • Strengthen law enforcement and implementation. • Address governance and corruption issues. • Establish robust monitoring and evaluation systems to track the implementation and impact of forestry policies. • International cooperation: strengthen collaboration with international partners and regional organizations to leverage technical and financial support for sustainable forest-management initiatives knowledge-sharing, and best practices.

Table 5: Challenges Impacting Effective Governance

Challenges	Description
Weak institutional capacity	There is insufficient financial, technical and organizational resources and skills to effectively plan, implement, monitor and evaluate forest policies and programmes (Government of Liberia, 2019; Abubakar, 2022). This often results in poor enforcement of laws and regulations, poor coordination, corruption, and low motivation among forest staff (Food and Agriculture Organization, 2019a; Abubakar, 2022).
Weak enforcement	Non-compliance and poor enforcement of rules to prevent illegal logging, land grabbing and environmental degradation is compromising the effectiveness of efforts to address environmental concerns (Ameyaw et al., 2016; Dickson, 2017; Pollini et al., 2018).
Corruption	Certain elites including traditional authorities, chiefs and land owners, who wield disproportionate power in forest management, collude to exploit forest resources for their own interest while marginalizing and excluding local communities (Ameyaw et al., 2016; Castañeda, 2021; Graphic Online, 2015).
Poor coordination	Limited coordination, collaboration and competing interests of different stakeholders, including government agencies, the private sector, civil society and communities result in a lack of harmonization of forest policies with other sectoral policies (Castañeda, 2021; Government of Liberia, 2019).
Insufficient capacity and awareness	Insufficient capacity and awareness of the benefits and best practices of sustainable forest management among forest users and managers especially smallholders limit their participation in the management of forest resources (Halton, 2012).

Poor infrastructure and market access	Inadequate infrastructure and limited market access for forest products affect smallholder farmers who contend with high transportation costs and low prices (Pollini et al., 2018)
Inequitable sharing of forest resource revenue	In many cases, governments and private sector capture the majority of the revenue while communities receive little or no benefits (Castañeda, 2021).
Lack of participation and representation of marginalized groups	Often marginalized groups including women, youth and Indigenous Peoples are excluded from forest governance processes and benefit-sharing mechanisms (Dickson, 2017; Food and Agriculture Organization, 2019a)

ANNEX 6. INTERNATIONAL, NATIONAL AND COMMUNITY-LEVEL INITIATIVES THAT AIM TO REVERSE ENVIRONMENTAL DEGRADATION IN WEST AFRICA

This annex provides an overview of ongoing initiatives (community, national and international) in Côte d'Ivoire, Ghana, Sierra Leone, Nigeria and Liberia that aim to address environmental degradation and provides broad recommendations for improvements in each country. These recommendations, which were based on a review of the strengths and weaknesses of the initiatives, were then used to help inform the preliminary list of RTAPs (Annex 7).

This table is not intended to be a comprehensive list of all ongoing initiatives in these countries, rather it reflects those identified through our literature review and stakeholder interviews.

Table 6: Ongoing international, national and community initiatives that aim to reverse environmental degradation in West Africa

Côte d'Ivoire	
International initiatives	• World Bank Forest Investment Program (The World Bank, 2018) • Global Environmental Facility (Global Environmental Facility, 2021) • African Forest Landscape Restoration Initiative (AFR100) • EU REDD Facility • Cocoa and Forest Initiative REDD+ • Bonn Challenge • West Africa Coastal Areas Management Program (WACA)
National initiatives	• National Strategy for Sustainable Development National Agricultural Investment Plan • National Programme for Development of Sustainable Agriculture • National Program for the Preservation of Forest • National Water Resource Management Plan • National Forest Plantation Development Program • National REDD+ Investment Plan • National Cocoa and Forest Initiative • National Reforestation and Afforestation Program

Community initiatives	• Resilient Ecosystems and Sustainable Transformation of Rural Economies (RESTORE) • EU NSA Project • Ghana Forest Carbon Partnership • Community Forest Management Program • Sustainable charcoal production • Clean cook stoves • Bountougon Forest Conservation Association • Boli Agro-forestry Association • Goin-debe Community Reforestation Project • Eco-Village Project • Cocoa Forest Restoration Initiative • Community Forest Management Program • Forest Guardians' Program
Recommendations for improvement	• Strengthen institutional capacity and governance structures • Build capacity of local institutions and communities • Increase local participation • Support promising initiatives (to scale up their impact and accelerate progress towards restoration goals) • Strengthen local community involvement (capacity building) • Address the root causes of environmental degradation • Strengthen research, monitoring and evaluation (valuable data to inform policy, identify areas for improvement, and provide the needed intervention) • Increase focus on restoration of coastal and marine ecosystems • Encourage partnership and collaboration (private sector engagement) • Enhance public awareness and environmental education • Strengthen governance and law enforcement • Promote sustainable land-use practices • Promote alternative livelihoods

Ghana	
International initiatives	• Global Environmental Facility (West Africa Biodiversity and Climate Change Project) • REDD+ • Forest and Farm Facility • World Bank Forest Carbon Partnership Facility • Congo Basin Forest Partnership • Sustainable Charcoal Production in Ghana • Ghana Sustainable Landscapes and Restoration Project • Cocoa and Forest Initiative • African Forest Land Restoration Initiative • Tropical Forest Alliance • West Africa Biodiversity Programme
National initiatives	• Biodiversity and Protected Area Management Program • Ghana Sustainable Land and Water Management Project • Ghana Protected Areas Development Project • National Afforestation Progam • National Forest Plantation Development Program
Community initiatives	• Farmer Managed Natural Regeneration (FMNR) • Resilient Ecosystems and Sustainable Transformation of Rural Economies (RESTORE) (United Nations, 2019) • Community-led Reforestation • Planting for Food and Jobs • Community Resource Management Area Initiative • Community-based Forest Management Project • Youth in Natural Resources and Environmental Governance
Recommendations for improvement	• Encourage public–private partnerships • Address policy and regulatory framework • Enforce existing laws and policies • Support promising initiatives (scale-up)

	• Strengthen community involvement/participation and ownership • A focus on market-based solutions (for example carbon credits and financial incentives) has led to neglect of the social, economic and political factors that drive deforestation, focus on these factors should be emphasized • Improve the fairness of benefit-sharing mechanisms • Stronger focus on monitoring to track progress and assess impact • Build local institutional and technical capacity to ensure long-term sustainability • Address land-use and tenure conflicts • Invest in research and development • Promote agroforestry and improve ecological sustainability and build diverse and sustainable livelihoods for local communities • Innovative financing mechanisms (including public-private partnerships)
Sierra Leone	
International initiatives	• West Africa Biodiversity and Climate Change (WABiCC) programme • World Bank Forest Carbon Partnership Facility • Global Environmental Facility • REDD+ • Sustainable Land and Water Management Project • African Forest Landscape Restoration Initiative • United Nations Convention to Combat Desertification • Sierra Leone Agriculture and Environmental Protection Initiative
National initiatives	• National Afforestation Program • Sustainable Land Management Program • National Sustainable Land Management Program
Community initiatives	• Farmer Managed Natural Regeneration (FMNR) • Community-Based Natural Resource Management (CBNRM) • Community-Based Reafforestation Program • Community Forest Management

Recommendations for improvement	• Strengthen institutional capacity and governance structures • Build capacity of local institutions • Increase local participation and ownership (to identify and address the underlying drivers and causes of land degradation, unsustainable farm practices and land-use change) • Strengthen institutional capacity and governance structures • Build capacity of local institutions and communities (sustainable land-use practices such as agroforestry and soil conservation) • Continue investment and support for promising initiatives • Ensure survival and maintenance of planted trees • Improve implementation and monitoring of programmes' objectives • Enforce laws and regulations against illegal logging and land-use change • Promote multi-stakeholder partnerships
Nigeria	
International initiatives	• Global Environmental Facility • REDD+ • Forest Carbon Partnership Facility (Forest Carbon Partnership, 2023) • Africa Forest Restoration Initiative (AFR100) • World Bank Forest Investment Program
National initiatives	• National Biodiversity Trust Fund • National Clean Cookstove scheme • National Reafforestation Program • Green Bond • Payments for Ecosystem Services • Green Recovery Initiative
Community initiatives	• Mangrove for Life • Clean Up Nigeria • Community-based Forest Management Reserves • Community-based Natural Resource Management

Recommendations for improvement	• Better evaluation of the impact, effectiveness and sustainability of promising initiatives on the environment and local communities • Support sustainable agricultural practices • Raise awareness of the importance of sustainable forest management • Increase investment • Strengthen implementation and monitoring of existing initiatives • Explore innovative financing mechanisms • Strengthen institutional capacity • Review/strengthen existing policies and regulations and develop new legal frameworks where necessary • Support research and innovation (develop new technologies and practices)
Liberia	
International initiatives	• Global Environmental Facility • REDD+ • Forest Carbon Partnership Facility (Forest Carbon Partnership, 2023) • Africa Forest Restoration Initiative (AFR100)
National initiatives	• National Biodiversity Liberia Forest Landscape Single Donor Trust Fund • Liberia Forest Landscape Single Plan • Coastal and Marine Resource Management Project • Independent Forest Monitoring Program Strategy and Action Plan
Community initiatives	• Community Forest Management Program (United Nations Development Programme, 2022) • Community Forest Management Agreements • Community-based Ecological Mangrove Restoration • Smallholder Agriculture Development Project • Village Savings and Loans Associations • Community Forest Development Committee
Recommendations for improvement	• Increase investment in sustainable land-management practices • Strengthen institutional capacity (training and capacity-building to ensure all stakeholders have the skills and knowledge needed to effectively implement environmental initiatives)

	• Increase the focus on resolving conflicts over land use • Improve community engagement (promote participatory approaches in the design, implementation and monitoring of environmental initiatives to ensure initiatives are inclusive, transparent and responsive to local needs as well as strengthen mechanisms for resolving conflict over land use) • Promote and support promising initiatives • Improve governance and enforcement (ensure environmental policies and regulations are adhered to) • Increase investment (innovative financing) • Prioritize monitoring and evaluation (establish robust monitoring and evaluation frameworks that involve everyone)

ANNEX 7. PRELIMINARY LIST OF POTENTIAL RESEARCH-TO-ACTION PRIORITIES IN WEST AFRICA

This annex details the preliminary list of proposed research-to-action priorities for REDAA in West Africa. These RTAPs are informed by our literature review, stakeholder interviews and build on the broad recommendations outlined in Annex 6.

Evidence-related RTAPs

1. **Monitor and report rates of deforestation and forest degradation**. This is in response to the lack of comprehensive and up-to-date data on the extent, severity and drivers of environmental degradation. In Ghana, for instance, environmental degradation costs US$6.3 billion annually, and the depletion of non-renewable resources like gold and oil is not able to sustain growth. Therefore, monitoring the rate of forest degradation will inform the necessary response measures.
2. **Evaluate the effectiveness of ongoing initiatives** to identify best practices and inform the development of more effective policies and strategies.
3. **Research the socio-economic drivers of deforestation**. This would help to address the problem of limited understanding of the specific drivers and causes of environmental degradation.
4. **Research the challenges and opportunities for community participation** in environmental management and identify best practices for promoting the community ownership of natural resources.
5. **Assess the effectiveness of coordination and collaboration mechanisms among the relevant stakeholders**. The research can identify challenges and opportunities for improving coordination, information sharing, and joint planning and implementation efforts. This can inform the development of strategies to enhance coordination and collaboration among government agencies, local communities, civil-society organizations and international partners.
6. **Identify opportunities for international cooperation and partnerships** to leverage knowledge, technology and financial resources to support environmental conservation efforts. Efforts should be made to establish partnerships with international organizations, research institutions, and donor agencies to support research, capacity building, and implementation of environmental conservation initiatives.

7. **Interdisciplinary collaboration**. Encourage collaboration among researchers from different disciplines, such as environmental science, social science, economics and policymaking, to develop comprehensive and innovative solutions to environmental degradation.

8. **Identify new funding sources and strategies** to leverage existing resources to scale up environmental management initiatives and ensure their sustainability. In terms of funding, the World Bank has set an example by allocating a total of US$15 million to help the government of Côte d'Ivoire reverse the trend to deforestation and forest degradation through the newly approved Forest Investment Project (FIP).

9. **Knowledge dissemination**. Promote the dissemination of research findings and best practices among stakeholders, including policymakers, practitioners and local communities, to facilitate the scaling-up and replication of successful participatory interventions.

Governance-related RTAPs

Based on these recommendations, research-to-action priorities were developed. These were compared nationwide, and the most relevant ones were selected. Below is the long list of research chosen for governance-related research-to-action priorities.

1. **Research to understand the challenges of policy incoherence and explore solutions to address them.**

2. **Research to assess the effectiveness of existing policies and legal frameworks for environmental management and identify strategies for promoting social inclusion.** This includes an assessment of the effectiveness of current policies and legal frameworks for environmental management and identifying areas for reform, strengthening enforcement mechanisms, and addressing gaps in policy implementation.

3. **Research to identify innovative ways and mechanisms to encourage and foster stakeholder partnerships** to promote collaboration and coordination in environmental management.

4. **Research to identify gaps in institutional capacity** for environmental management at the national and local levels and to identify the most effective approach to building capacity.

5. **Financial incentives/subsidies**. Research to adopt policies that support smallholder farmers' implementation and adoption of sustainable agricultural practices (financial incentives, subsidies).

6. **Policy and regulatory support**. Establish measures for developing and enforcing strong environmental policies and regulations in West Africa to support the implementation of participatory approaches and ensure long-term impacts.

7. **Increase public education and awareness**. There is a need to prioritize public education and awareness campaigns to educate citizens about the importance of environmental protection and their role in addressing environmental challenges. This may include engaging in community-based education programmes, using various media platforms for mass communication, and integrating environmental education into the national curriculum. As part of its approach to addressing environmental degradation, Freetown in Sierra Leone has launched a three-year plan called Transform Freetown. This aims to address environmental degradation and other issues through collaboration with residents and stakeholders.

Tool-related RTAPs

Based on the challenges identified and the profiling of the most frequently occurring tools and approaches used in the region, the following research-to-action priorities on devices are proposed to help address the challenges faced by IPLCs and marginalized groups.

1. **Research to develop effective monitoring, data-management systems and analytical tools**. This research is critical to developing efficient, cost-effective, user-friendly data-management and ecosystem monitoring tools that local communities and governments could effectively implement and maintain. This could include technologies such as remote sensing, data-analysis tools, and machine-learning algorithms for predictive learning to enhance decision making.

2. **Increasing stakeholder participation and community engagements by developing innovative participatory tools**. Research to develop strategies to increase participation and ensure all stakeholders (government agencies, NGOs, community-based organizations) have a voice in research and decision-making processes. This may require training, knowledge sharing, and the provision of technical and financial support. It is therefore critical to develop and test participatory tools and approaches that engage local communities and stakeholders in ecosystem recovery efforts or community-based monitoring. For example, better tools could more accurately record local people's spatial knowledge. Effective stakeholder participation and community engagement will ensure that interventions are culturally appropriate, sustainable, and tailored to the unique environmental challenges the region faces.

3. **Interactive tools that help balance equity and efficiency**. Research to develop strategies to ensure that payments for ecosystem services (PES) programmes are equitable and do not disadvantage marginalized communities. This could be complemented by efforts to increase incentives for farmers to adopt sustainable practices (financial incentives and subsidies, policy changes to support sustainable agriculture).

4. **Developing innovative financing mechanisms**. Research on developing innovative financing mechanisms to support large-scale ecosystem restoration and rehabilitation efforts, such as green bonds, social impact bonds and crowdfunding, or mobilizing funding from multiple sources.

5. **Developing tools to strengthen governance and institutions.** Research to develop strategies to strengthen governance and institutions at the local, national and international levels. This should include research to identify successful models that can be scaled up for more significant impact, including analysing factors contributing to their success and identifying opportunities for replication and scaling up.

6. **Developing indigenous biological control mechanisms (e.g. indigenous microbial strains)**. Developing indigenous microbial strains that can effectively degrade pollutants found in West African soil and water is crucial. This requires thorough research and a comprehensive understanding of the microbial ecology of contaminated sites in West Africa. Research should also focus on identifying the optimal conditions for microbial growth and establishing mechanisms for delivering these strains to contaminated sites.

7. **Identifying and developing processes to optimize environmental conditions**. Optimizing environmental conditions to promote the growth and activity of microorganisms or plants that can degrade pollutants is critical for the success of bioremediation. Research should focus on identifying the best environmental conditions, such as pH, temperature and moisture, for the growth of microorganisms or plants that can degrade pollutants and developing methods to maintain these conditions at contaminated sites.

8. **Developing protocols and tools for the integration of scientific and traditional knowledge**. Recognize and incorporate indigenous and local knowledge systems into scientific research to enhance sustainable resource-management practices. A very good example could be the integration of bioremediation into traditional remediation techniques, such as excavation and chemical treatments, which can enhance the effectiveness of bioremediation. Research should focus on identifying the best methods

for integrating bioremediation with traditional remediation techniques in West Africa to achieve the optimal results. This needs to be supported with adequate funding for both institutional and human capacity building on use of the technique. Public awareness of the effectiveness of bioremediation in West Africa is also relevant to enhance adoption.

9. **Research to develop more advanced and emerging smart technologies** (drones, sensor technologies for monitoring soil health and water quality, remote sensing technologies for monitoring crop growth, Big Data analytics tools) for monitoring and managing environmental impacts. One such task could be to assess the long-term effects of precision agriculture on environmental factors (soil health, water quality, carbon emissions and biodiversity).

ANNEX 8. LIST OF TOOLS EXPLORED

Table 7: Effectiveness and challenges of existing tools

Tool	Effectiveness	Challenges
Payments for Ecosystem Services (PES[3])	1. Modestly effective at reducing deforestation, boosting reforestation efforts and increasing forest carbon stocks. 2. Improves water quality and reduces emissions from deforestation and forest degradation (Whyte, 2011).	1. New externalities 2. Wrongful allocation of rights and responsibilities 3. Crowding out existing motivations 4. Efficiency–equity trade-offs 5. Monitoring costs (Chan et al., 2017a) 6. Combining equity or poverty reduction objectives with environmental objectives 7. The interaction of PES with the broader forest sector 8. Extra-sectoral issues like governance and institutional factors (Chan et al., 2017b).
An Excel model was developed as a decision support tool to assess the profitability of pilot projects initiated by major chocolate manufacturers	It serves as a decision support tool to evaluate financial viability of projects.	
TerraFund for AFR100	A financial initiative that aims to restore Africa's degraded landscapes. It provides a lower-cost solution to the challenges of restoration monitoring (TerraMatch, 2023).	
Green Growth Partnership tool developed to monitor and understand progress in collaborative	Was designed to monitor and understand progress on collaborative action. It has been useful in Liberia for a multistakeholder dialogue and collaboration through which	Ensuring active participation and collaboration of all stakeholders could be difficult. This requires significant efforts in managing various interests as well as maintaining open lines of communication.

[3] Although the study focuses on African experiences with tools, the authors are drawing from the general and copious international literature on PES.

action – has already been piloted in Liberia (Food and Agricultural Commodity Systems, 2022)	insights on ensuring the sustainability in the supply chain of oil palm were gained (Green Growth Partnership, 2018).	
Program on Forests (PROFOR) – forest governance tool in Liberia for assessment of governance issues for REDD+ implementation (Halton, 2012)	It is used to facilitate forests' contribution to sustainable economic growth and environmental protection.	There could be selection bias (non-random participation) in assessing the impacts of forest certification on sustainable forest management and difficulty of scaling down market implications to the level of the farm (PROFOR, CIFOR, n.d.)
Bioremediation	Effective and eco-friendly solution to clean up oil-polluted sites in Nigeria (Orji et al., 2013). The use of indigenous microorganisms and fungi has demonstrated potential in breaking down contaminants and improving soil health in cocoa plantations in Ghana.	Identification and selection of appropriate plant species Limited understanding of the ecological impacts of pollutants The cost: it is expensive It is a lengthy process (Jabbar et al., 2022; Odoh et al., 2019)
Precision agriculture	1. Successfully used by smallholder farmers in soil management. 2. Successfully used for pest management and soil fertility management (Härkin et al., 2018; African Plant Nutrition Institute, 2020a).	1. High financial and technical cost 2. Limited access to technology and information for smallholders 3. Internet connectivity challenges (African Plant Nutrition Institute, 2020b)
Participatory mapping	1. In Ghana, participatory mapping was used to support implementing the Community Resource Management Area (CREMA) initiative, which aimed to promote community-based natural resource management. 2. In Nigeria, participatory mapping was used to support the documentation of sacred forests and traditional land-use practices.	1. Limited availability of accurate and up-to-date data 2. Difficulty in integrating local and scientific knowledge. Indigenous Peoples, for example, possess valuable knowledge on sustainable farming practices (Tanzer et al., 2022). 3. Time-consuming