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Report

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Abstract: Nature-based solutions for climate and biodiversity protection in selected national climate contributions

The Paris Agreement aims to limit the global temperature increase to below 2°C above pre-industrial levels, with a maximum of 1.5°C. Parties submit Nationally Determined Contributions (NDCs) every five years, outlining post-2020 mitigation and adaptation targets, with the aim of increasing ambition over time. Nature-based solutions (NbS) to mitigate climate change are gaining popularity in national climate policies because they enhance natural carbon sinks, such as forests, grasslands and peatlands, and provide additional benefits, such as biodiversity conservation, at a lower cost than technological measures. NbS were officially defined in 2022 at the 5th session of the United Nations Environment Assembly as actions to protect, conserve, restore, sustainably use and manage natural or modified ecosystems that simultaneously address social, economic and environmental challenges while providing benefits to human well-being, ecosystem services, resilience and biodiversity. In June 2023, Germany launched the Federal Action Plan on Nature-Based Solutions for Climate and Biodiversity "Aktionsprogramm Natürlicher Klimaschutz (ANK)", which includes 69 measures for forests, peatlands, coastal ecosystems and agricultural soils to reduce greenhouse gas emissions and to additionally sequester CO_2. The Action Plan integrates NbS for climate mitigation into national strategies to support the achievement of national climate and biodiversity mitigation and adaptation targets (BMUV 2023).

This report aims to inform the implementation of the German Action Plan with experiences from other countries that have also developed NbS measures to strengthen their natural carbon sinks. Finally, six case study countries were selected for analysis: the United Kingdom (UK), the United States of America (USA), Ethiopia, Indonesia, Brazil and China. These countries were chosen because their NDCs mention NbS explicitly or NbS-related measures, such as forest enhancement or peatland rewetting. The UK and the USA were selected for comparative analysis due to their economic and ecosystem similarities with Germany. Furthermore, the case study countries represent diverse income levels and geographical regions. The report examines and summarises the success factors and challenges in implementing NbS in these countries, with conclusions drawn for the implementation of the German ANK.

Kurzbeschreibung: Naturbasierte Lösungen für den Klima- und Biodiversitätsschutz in ausgewählten nationalen Klimaschutzbeiträgen Titel

Das Übereinkommen von Paris hat zum Ziel, den globalen Temperaturanstieg auf unter 2°C über dem vorindustriellen Niveau zu begrenzen, mit einem Maximum von 1,5°C. Die Vertragsparteien legen alle fünf Jahre nationale festgelegte Klimabeiträge (Nationally Determined Contributions, NDC) vor, in denen sie Ziele für die Zeit nach 2020 zur Eindämmung des Klimawandels und zur Anpassung an die Folgen des Klimawandels formulieren, die im Laufe der Zeit immer ehrgeiziger werden sollen. Naturbasierte Lösungen (nature-based solutions, NbS) zum Schutz des Klimas werden in der nationalen Klimapolitik immer beliebter, da sie natürliche Kohlenstoffsenken wie Wälder, Grünland und Moore stärken und zusätzliche Vorteile wie Biodiversitätsschutz zu geringeren Kosten, als technische Maßnahmen bieten. Auf einer Sitzung der Umweltversammlung der Vereinten Nationen in 2022 wurden NbS definiert, als Maßnahmen zum Schutz, zum Erhalt, zur Wiederherstellung, nachhaltigen Nutzung und Bewirtschaftung natürlicher oder veränderter Ökosysteme. Gleichzeitig adressieren NbS soziale, wirtschaftliche und ökologische Herausforderungen und unterstützen das menschliche Wohlbefinden, Ökosystemleistungen, die Widerstandsfähigkeit von Ökosystemen und die biologische Vielfalt. Im Juni 2023 startete Deutschland den Aktionsplan Natürlicher Klimaschutz (ANK), der 69 Maßnahmen für Wälder, Torfgebiete, Küstenökosysteme und landwirtschaftliche Böden umfasst, um Emissionen zu reduzieren und zusätzlich CO_2 zu sequestrieren. Der

Aktionsplan integriert NbS für den Klimaschutz in nationale Strategien, um die Erreichung der nationalen Klimaschutz- und Biodiversitätsziele zu unterstützen (BMUV 2023).

Das Ziel des Berichtes ist es, Erfahrungen aus anderen Ländern, die ebenfalls NbS-Maßnahmen zur Stärkung ihrer natürlichen Kohlenstoffsenken entwickelt und umgesetzt haben, in die Umsetzung des deutschen Aktionsplans einfließen zu lassen. Schließlich wurden sechs Fallstudienländer, das Vereinigte Königreich (UK), die Vereinigten Staaten von Amerika (USA), Äthiopien, Indonesien, Brasilien und China, ausgewählt, weil in ihren NDCs NbS oder NbS-bezogene Maßnahmen, wie Waldmehrung oder Wiedervernässung von Mooren erwähnt werden. Das Vereinigte Königreich und die USA wurden auch wegen ihrer ökonomischen und ökosystemaren Vergleichbarkeit mit Deutschland ausgewählt. Darüber hinaus repräsentieren die Fallstudienländer, unterschiedliche Einkommensniveaus und geografische Regionen. Der Bericht untersucht und fasst die Erfolgsfaktoren und Herausforderungen bei der Umsetzung von NbS in diesen Ländern zusammen. Es werden Schlussfolgerungen für die Umsetzung des deutschen ANK gezogen.

Table of content

List of figures

List of tables

List of abbreviations

Abbreviation	Explanation
10YDP	10-year National Development Plan
AFOLU	Agriculture, Forestry and Other Land Use
ASEAN	Association of Southeast Asian Nations
BAU	Business-as-usual
BMUV	Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz)
BIOFIN	Biodiversity Finance Initiative
CBD	Convention on Biological Diversity
CCC	Climate Change Commitee
CIA	Central Intelligence Agency
CO_2	Carbon dioxide
COP	Conference of the Parties
CRGE	Climate Resilient Green Economy Strategy
DEFRA	Department for Environment, Food and Rural Affairs
EFCCC	Environment, Forest and Climate Change Commission
ERPA	Emissions Reduction Purchasing Agreement
EPAP	England Peat Action Plan
ETAP	England Tree Action Plan
EWCO	England Woodland creation Offer
FAO	Food and Agriculture Organization
FOLU	Forest and other Land Use
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse gas
GLI	Green Legacy Initiative
GNB	Great North Bog
IUCN	International Union for the Conservation of Nature
KfW	Credit Institute for Reconstruction (Kreditanstalt für Wiederaufbau)

Abbreviation	Explanation
LTS	Long-term strategy
LTS-LCCR	Long-Term Strategy for Low Carbon and Climate Resilience of the Republic of Indonesia
LULUCF	Land Use Land Use Change and Forestry
M&E	Monitoring and Evaluation
MRV	Measuring, reporting and verification
MoAD	Ministry of Agricultural Development
MoEF	Ministry of Environment and Forestry of the Republic of Indonesia
NABU	German Nature and Biodiversity Conservation Union
NAP	National Adaptation Plan
NbS	Nature-based solution
NDC	Nationally Determined Contributions
NFPP	National Forest Protection Programme
NFSDP	National Forest Sector Development Programme
NIR	National Inventory Report
N_2O	Nitrous oxide
OFLP	REDD+ Oromia Forest Landscape Programme
PA	Paris Agreement
Plan ABC+	Sectoral Adaption plan for Low Carbon Agriculture for Sustainable Development
PPCDAm	Action Plan for the Prevention and Control of Deforestation in the Legal Amazon
REDD+	Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
RPPN	Private Natural Heritage Reserves
SDG	Sustainable Development Goals
SFDRR	Sendai Framework for Disaster Risk Reduction
SLCP	Sloping Land Conversion Programme
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
VCM	Voluntary Carbon Market

Summary

The Paris Agreement (PA) aims to limit global temperature rise to below 2°C above pre-industrial levels, striving for a 1.5°C cap. Parties must submit Nationally Determined Contributions (NDCs) every five years, detailing post-2020 targets for mitigation and adaptation, with a goal of increasing ambition over time. The PA does not specify targets and allows countries to choose their mitigation methods. Nature-based solutions (NbS) for climate change mitigation are a vital method for reducing greenhouse gas (GHG) emissions and for carbon sequestration because they focus on protecting, managing, and restoring ecosystems to address societal challenges. Also, NbS offer benefits like biodiversity conservation, and ecosystem service enhancement at lower costs compared to technological measures (Griscom et al. 2017). Despite their potential, uncertainties in possible biodiversity impacts also pose risks to NbS and need careful management. Nevertheless, countries have increasingly integrated NbS into their NDCs, recognizing their importance for climate change mitigation and adaptation (Seddon et al. 2019; Zhai et al. 2023). The United Nations Environment Assembly recently defined the term NbS (UNEA 2022), emphasizing the role of these measures in sustainable development and climate action and COP27 highlighted NbS's significance in climate mitigation (UNFCCC 2022). In addition, Germany's Federal Action Plan on Nature-based solutions for Climate and Biodiversity, launched in June 2023, outlines 69 measures to incorporate NbS into national strategies (BMUV 2023).

This report examines NbS implementation in six countries via case studies and aims to guide Germany's Action Plan by identifying effective NbS strategies and synergies between climate action and biodiversity protection. To this end, 168 NDCs were examined for NbS related keywords in three languages (i.e. English, Spanish and French). To narrow down possible case study countries for analysis, additional criteria were set (e.g. NDCs should contain 12+ NbS-related keywords, ecosystems should be comparable to Germany or globally significant etc.). Of the fifty-two NDCs that met the keyword criterion; 16 were selected, including the USA due to expert input despite having only 9 keywords. Common keywords included plant~, natur~, restor~, and protect~, while peat~ and rewet~ were least common.

The final selection of countries included United Kingdom (UK), United States of America (USA), Ethiopia, Indonesia, Brazil, and China for their diverse income levels and geographic coverage. The UK and USA were noted for ecological similarities to Germany, while Indonesia and China were recognized for specific NbS efforts. Brazil is a key political partner of Germany, that also plays a vital role in global carbon sequestration.

For each country case study, a literature research was conducted to shortly describe the country's geography, biodiversity, and climate policies. Also, national NbS policies were briefly reviewed. In a second step, example measures like peatland rewetting and afforestation were selected that are also relevant for NbS measure implementation of the German Action Plan. The example measures were further evaluated in a literature research that included information on the national climate and biodiversity goals, availability of biodiversity monitoring and funding details. The research also included how stakeholders were involved and explored what potential risks are associated with the measure, how implementation and impact are monitored and how synergies between climate mitigation and biodiversity protection are addressed. Some measures are in early planning stages but can still be relevant for this study because their finance structure or stakeholder organisation is already set and can be learned from. Hence, these measures were also included in this study.

Although NbS for climate mitigation features prominently in NDCs under the Paris Agreement, these commitments often lack detailed implementation plans. Analysis of NbS examples from six

diverse case study countries reveals varying national strategies and challenges. Not all measures fulfil the NbS criteria because, for example, criteria for the protection of ecosystem processes or stakeholder participation are not sufficiently fulfilled. In addition, ensuring the permanence of climate benefits poses a critical challenge, as NbS effects can be reversed by deforestation, peatland drainage, and climate-induced changes.

The study identifies common success factors and challenges, although direct comparison between the measures in the sample countries is very difficult, as the respective contexts are very different. The successful implementation of NbS measures hinges on several key factors, according to the analysed case studies. Political commitment and prioritization are crucial; countries like Ethiopia, China, and the USA demonstrate significant success when political leaders support respective NbS initiatives. For instance, Ethiopia's Green Legacy Initiative and China's ecological society goals emphasise the importance of top-level support. However, they entail the risk of political discontinuity (e.g. due to changes in leadership, as in Brazil) and also have a disadvantage for many stakeholders, as there are top-down approaches.

Another factor for success is to link NbS measures with existing environmental programs, which enhances implementation effectiveness and long-term sustainability. Examples include England's peatland restoration and sustainable ranching initiatives in the USA, which leverage local expertise and regulatory frameworks. Brazil's measures against deforestation show how the integration of NbS into broader environmental strategies can effectively distribute the responsibility of many stakeholders. Further, clear target formulation and regular monitoring are essential for NbS success. Brazil's PPCDAm exemplifies this with comprehensive monitoring systems that track deforestation drivers and adapt strategies accordingly. Also, Indonesia's Triple R programme has an extensive monitoring programme. It monitors GHG emissions from the rewetting of peatlands and thus makes a decisive contribution to validating the effectiveness of the measures and offers the possibility of early detection of problems and measure adjustments. The United Kingdom and the USA set quantified targets for their measures in their environmental legislation, which can be monitored and evaluated in order to measure the success of the implementation of the measures. This also means that the measures can be adjusted if necessary if the targets are not met. Another positive impact can be observed for effective and sustainable funding mechanisms, which are critical for NbS implementation. Countries like Ethiopia and Brazil secure substantial international funding for programs like REDD+ through partnerships with entities like the World Bank. Further, diversifying funding sources minimizes financial risks and supports long-term implementation.

Moreover, stakeholder involvement is vital for NbS acceptance and success. Brazil and Indonesia engage local communities in NbS projects through education, alternative livelihoods, and direct support, enhancing local participation and project permanence. In the UK, public consultations led to policy measures such as a ban on the sale of peat and peat-based products for private horticulture, demonstrating the influence of public participation on environmental policy.. In addition, promoting synergies and co-benefits enhances NbS acceptance and societal support. Incentivizing biodiversity protection through payments and policy integration, as seen in England and Brazil, further strengthens NbS implementation. Another key success factor for NbS measures consists of focused action in e.g. ecological priority areas to optimise NbS outcomes. Projects like Indonesia's Sumatra Merang and China's Yangtze River restoration target biodiversity hotspots, maximizing climate and environmental benefits with limited resources.

In conclusion, successful NbS implementation requires political commitment, policy coherence, clear targets, sustainable long-term funding, stakeholder engagement, promotion of synergies, and focused action in priority areas. These elements not only enhance climate mitigation efforts but also contribute to achieve environmental and societal goals.

However, successful implementation of NbS also faces challenges, e.g. from political instability and lack of long-term governance. Disruptive changes in environmental policies can hinder NbS success, as seen in Brazil under the Bolsonaro presidency, where deforestation increased. Similarly, the Trump administration in the USA dismantled climate protection efforts. Ethiopia's Green Legacy Initiative (GLI) shows strong political support on the one hand but lacks robust policy backing, risking long-term effectiveness. Additionally, political instability and frequent government restructuring jeopardize effective NbS planning and implementation. Hence, ensuring consistent political commitment and stable governance structures is crucial for the sustained success of NbS measures.

In addition, lack of effective linkage of political strategies and governance also hinders NbS implementation. For instance, Ethiopia's GLI is not anchored under a specific policy or strategy and is primarily driven by the Prime Minister's office. Funds are allocated to various ministries, agencies, regional governments, and city administrations without a clear connection to other restoration programs, such as those from the World Bank. Additionally, the landscape restoration potential map appears to be underutilized, missing opportunities to prioritize target areas or ensure balanced implementation across the country (Kassa et al. 2022). Governance at the federal level involves multiple ministries and the Prime Minister's office, which is useful for involving sectoral ministries in restoration efforts but is hindered by frequent restructuring, leading to ineffective and unstable governance. Furthermore, there is a lack of a dedicated monitoring, reporting, and evaluation program (Kassa et al. 2022).

Another key challenge consists of ensuring the continued positive impact of NbS measures, mainly caused by political, legal, and sector-specific factors. In Brazil, the PPCDAm plan initially reduced deforestation, but rates rose again due to the complexity of Amazonian deforestation causes and difficulties in promoting sustainable economic activities, according to experts (Bizzo and Farias 2017). Similarly, Ethiopia's Green Legacy Initiative (GLI) planted 25 billion seedlings in four years, but survival rates are low due to inadequate local participation and planting on public land (Kassa et al. 2022). Ethiopia's political instability, civil war, and severe droughts, followed by floods, further threaten the initiative's success (Fikreyesus et al. 2022) "Fikrey". In Indonesia, the Sumatra Merang project's land use license is temporary, creating uncertainty about its long-term viability. Additionally, the project's canal blockings require regular, location-specific adjustments, but sustainability measures are insufficient (Urzainki et al. 2023). These examples highlight the need for consistent political support, legal clarity, and adaptive management to ensure the long-term success of NbS initiatives.

Moreover, lack of policy coherence undermines the climate protection effect of NbS measures. In England, continued peatland burning contradicts the England Peatland Action Plan, releasing significant emissions while public funds are spent on peatland restoration (Defra 2023). Similarly, deforestation for infrastructure diminishes the net rate of woodland creation. Challenges for NbS also arise from specific measure designs. In Indonesia's 3-R program, the economic viability of communities was not sufficiently secured, leading to partial drainage of the project areas. Efforts to support alternative income sources for communities have been inadequate, threatening the program's sustainability (Puspitaloka et al. 2021). Ethiopia's tree-planting initiatives mobilized citizens across regions, but poor management led to inadequate local involvement. Farmers often had little notice and unclear instructions, resulting in many trees being planted in unsuitable terrains (Kassa et al. 2022). These examples highlight the importance of policy coherence, adequate economic support, and effective local involvement to ensure the long-term success of NbS measures.

Therefore, the establishment of NbS measures offers governments the opportunity to improve policy coherence and streamline institutional arrangements for the protection and restoration of nature. In addition, the application of the criteria for NbS offers the opportunity to optimise existing measures. The goal of the long-term positive effectiveness of NbS should be a key aspect in the planning and implementation of measures in order to ensure positive effects for climate and biodiversity protection. Governments must provide adequate, long-term financing for NbS, potentially mobilizing private funding. International exchange on lessons-learned can strengthen global implementation. Political will and stakeholder engagement essentially drive NbS success. All case studies showed that it is of particular importance to address livelihood impacts of e.g. rewetting for land owners and therefore provide alternative income or management practices. The study also revealed that biodiversity impacts of NbS measures receive too little attention, and that biodiversity monitoring and reporting should be improved. Furthermore, by prioritising regions for the establishment of NbS, a more effective contribution to climate and biodiversity protection or other societal goals can be achieved, especially when financial or other resources are scarce. To track the climate impact of NbS measures under the UNFCCC, separate Land Use, Land-Use Change, and Forestry (LULUCF) targets and improved reporting are necessary. While many countries don't explicitly mention NbS in their NDCs, enhancing LULUCF reporting in biennial transparency reports will aid global tracking. Ideally, countries should establish distinct targets for the LULUCF sector to increase transparency.

Zusammenfassung

Das Übereinkommen von Paris zielt darauf ab, den globalen Temperaturanstieg auf unter 2 °C über dem vorindustriellen Niveau zu begrenzen, wobei ein Ziel von 1,5 °C angestrebt wird. Die Vertragsparteien müssen alle fünf Jahre national festgelegte Beiträge (NDCs) einreichen, in denen nach 2020 geltende Ziele für Minderung und Anpassung dargelegt werden, mit dem Ziel, den Ehrgeiz im Laufe der Zeit zu steigern. Das Abkommen legt keine spezifischen Ziele fest und erlaubt es den Ländern, ihre Methoden zur Emissionsminderung selbst zu wählen. Naturbasierte Lösungen (NbS) für den Klimaschutz sind eine wichtige Methode zur Reduktion von Treibhausgasemissionen (THG) und zur Kohlenstoffbindung, da sie darauf abzielen, Ökosysteme zu schützen, zu verwalten und wiederherzustellen, um gesellschaftliche Herausforderungen anzugehen. NbS bieten zudem Vorteile wie Biodiversitätsschutz und die Verbesserung von Ökosystemdienstleistungen zu geringeren Kosten im Vergleich zu technologischen Maßnahmen (Griscom et al. 2017). Trotz ihres Potenzials bestehen jedoch Unsicherheiten in Bezug auf mögliche Auswirkungen auf die Biodiversität, die Risiken für NbS darstellen und sorgfältig gemanagt werden müssen. Dennoch haben Länder NbS zunehmend in ihre NDCs integriert und deren Bedeutung für den Klimaschutz und die Anpassung an den Klimawandel anerkannt (Seddon et al. 2019; Zhai et al. 2023). Die Umweltversammlung der Vereinten Nationen hat kürzlich den Begriff NbS definiert (UNEA 2022) und betont die Rolle dieser Maßnahmen in der nachhaltigen Entwicklung und im Klimaschutz. Die COP27 hob ebenfalls die Bedeutung von NbS für den Klimaschutz hervor (UNFCCC 2022). Darüber hinaus hat das deutsche Aktionsprogramm für natürlichen Klimaschutz (ANK), welches im Juni 2023 gestartet wurde, 69 Maßnahmen zur Integration von NbS in eine nationale Strategie festgelegt (BMUV 2023).

Dieser Bericht untersucht die Umsetzung von NbS in sechs Ländern anhand von Fallstudien und soll die Umsetzung des ANK unterstützen, indem effektive NbS-Strategien und Synergien zwischen Klimaschutz und Biodiversitätsschutz identifiziert werden. Zu diesem Zweck wurden 168 NDCs nach NbS-relevanten Schlüsselwörtern in drei Sprachen (Englisch, Spanisch und Französisch) durchsucht. Um mögliche Fallstudienländer für die Analyse einzugrenzen, wurden zusätzliche Kriterien festgelegt (z. B. sollten NDCs 12+ NbS-bezogene Schlüsselwörter enthalten, die Ökosysteme sollten mit denen Deutschlands vergleichbar oder global bedeutend sein usw.). Von den 52 NDCs, die das Schlüsselwortkriterium erfüllten, wurden 16 ausgewählt. Darunter fielen auch die Vereinigten Staaten von Amerika (USA), die zwar nur 9 Schlüsselworte in ihrem NDC aufzeigten aber aufgrund von Expertenrückmeldungen trotzdem berücksichtigt wurden. Häufige Schlüsselwörter waren plant~, natur~, restor~ und protect~, während peat~ und rewet~ weniger häufig vorkamen.

Die endgültige Auswahl der Länder umfasste das Vereinigte Königreich (UK), die USA, Äthiopien, Indonesien, Brasilien und China aufgrund ihrer unterschiedlichen Einkommensniveaus und geografischen Abdeckung. Die UK und die USA wurden auch aufgrund ihrer ökologischen Vergleichbarkeit zu Deutschland hervorgehoben, während Indonesien und China für spezifische NbS-Bemühungen bekannt sind und daher ausgesucht wurden. Brasilien ist ein wichtiger politischer Partner Deutschlands, der auch eine zentrale Rolle bei der globalen Kohlenstoffbindung spielt.

Für jede Länderfallstudie wurde eine Literaturrecherche durchgeführt, um kurz die Geographie, Biodiversität und Klimapolitik des jeweiligen Landes zu beschreiben. Außerdem wurden die nationalen NbS-Politiken kurz dargelegt. In einem zweiten Schritt wurden Beispielmaßnahmen wie die Wiedervernässung von Mooren und Aufforstung ausgewählt, die auch für die Umsetzung der NbS-Maßnahmen im deutschen ANK relevant sind. Die Beispielmaßnahmen wurden anhand einer eingehenden Literaturrecherche weiter bewertet. Dabei wurden Informationen zu

nationalen Klima- und Biodiversitätszielen, zur Verfügbarkeit von Biodiversitätsmonitoring und zu Finanzierungsdetails der jeweiligen Programme gesammelt.

Die Recherche umfasste auch, wie Stakeholder eingebunden wurden, welche potenziellen Risiken mit der Maßnahme verbunden sind, wie Umsetzung und Auswirkungen überwacht werden und wie Synergien zwischen Klimaschutz und Biodiversitätsschutz berücksichtigt werden. Einige Maßnahmen befinden sich noch in der Planungsphase, können aber trotzdem relevant für diese Studie sein, da ihre Finanzierungsstruktur oder Stakeholder-Organisation bereits festgelegt ist und als Lernbeispiel dienen kann. Daher wurden auch diese Maßnahmen in die Studie aufgenommen.

Obwohl NbS für den Klimaschutz im Rahmen des Übereinkommens von Paris eine wichtige Rolle spielen, fehlt es den Verpflichtungen oft an detaillierten Umsetzungsplänen. Die Analyse von NbS-Beispielen aus sechs verschiedenen Fallstudienländern weist unterschiedliche nationale Strategien und Herausforderungen auf. Nicht alle Maßnahmen erfüllen die NbS-Kriterien, da z.B. Kriterien zum Schutz der Ökosystemprozesse oder die Beteiligung der Stakeholder nicht ausreichend erfüllt sind. Außerdem stellt die Sicherstellung der Permanenz von Klimavorteilen eine zentrale Herausforderung dar, da die NbS-Effekte durch Entwaldung, Moorentwässerung und klimabedingte Veränderungen wieder rückgängig gemacht werden können.

Die Studie identifiziert gemeinsame Erfolgsfaktoren und Herausforderungen, obwohl der direkte Vergleich zwischen den Maßnahmen der Beispielländer sehr schwierig ist, da die jeweiligen Kontexte sehr unterschiedlich sind. Der erfolgreiche Einsatz von NbS-Maßnahmen hängt laut den analysierten Fallstudien von mehreren Schlüsselfaktoren ab. Politisches Engagement und Priorisierung sind entscheidend. Länder wie Äthiopien, China und die USA zeigen signifikante Erfolge, wenn politische Führungskräfte die jeweiligen NbS-Initiativen unterstützen. Am Beispiel von Äthiopiens „Green Legacy Initiative“ sowie Chinas Ziele einer ökologischen Gesellschaft wird die Bedeutung der Unterstützung auf höchster Ebene besonders deutlich. Allerdings bergen sie das Risiko politischer Diskontinuität (z. B. aufgrund von Führungswechseln, wie in Brasilien) und haben auch einen Nachteil für viele Stakeholder, da es Top-down-Ansätzen.

Ein weiterer Erfolgsfaktor ist die Verknüpfung von NbS-Maßnahmen mit bestehenden Umweltprogrammen, was die Effektivität der Umsetzung und die langfristige Nachhaltigkeit erhöht. Beispiele dafür sind die Wiedervernässung von Mooren in England und nachhaltige Weidewirtschaft in den USA, die auf lokales Fachwissen und bestehende regulatorische Rahmenbedingungen zurückgreifen. Brasiliens Maßnahmen gegen Entwaldung zeigen, wie die Integration von NbS in breitere Umweltstrategien die Verantwortung vieler Beteiligter effektiv verteilen kann. Des Weiteren sind klare Zielvorgaben und regelmäßige Überwachung für den Erfolg von NbS unerlässlich. Brasiliens „PPCDAm“-Programm ist ein Beispiel dafür, wie umfassende Überwachungssysteme die Treiber der Entwaldung verfolgen und Strategien entsprechend angepasst werden können. Auch Indonesiens „Triple R“-Programm verfügt über ein umfangreiches Monitoring, das die THG-Emissionen durch die Wiedervernässung von Mooren überwacht und somit einen entscheidenden Beitrag zur Validierung der Maßnahmen leistet und gleichzeitig eine frühzeitige Problemerkennung ermöglicht. Das Vereinigte Königreich und die USA legen in ihren Umweltgesetzen quantifizierte Ziele für ihre Maßnahmen fest, die überwacht und bewertet werden können, um den Erfolg der Maßnahmenumsetzung zu messen. Dadurch können die Maßnahmen ebenfalls angepasst werden, wenn die Ziele nicht erreicht werden. Ein weiterer positiver Einfluss auf die erfolgreiche Umsetzung von NbS haben effektive und nachhaltige Finanzierungsmechanismen. Länder wie Äthiopien und Brasilien sichern sich internationale Finanzierungen für Programme wie REDD+ durch Partnerschaften

mit Institutionen wie der Weltbank. Darüber hinaus minimiert die Diversifizierung der Finanzierungsquellen finanzielle Risiken und unterstützt die langfristige Umsetzung.

Darüber hinaus ist die Beteiligung von Stakeholdern entscheidend für die Akzeptanz und den Erfolg von NbS. Brasilien und Indonesien binden die lokale Bevölkerung durch Bildungsangebote, die Bereitstellung alternativer Lebensgrundlagen und eine direkte Unterstützung in NbS-Projekten ein. Dies stärkt die Teilnahme an Projekten und deren Nachhaltigkeit. Im Vereinigten Königreich führten öffentliche Konsultationen zu politischen Maßnahmen wie dem Verbot des Verkaufs von Torf und torfhaltigen Produkten für den privaten Gartenbau, was den Einfluss der Bürgerbeteiligungen auf die Umweltpolitik zeigt. Zudem stärkt die Förderung von Synergien und Co-Benefits die Akzeptanz und die gesellschaftliche Unterstützung von NbS. Die Anreize für den Biodiversitätsschutz durch Zahlungen und die Integration in die Politik, wie in England und Brasilien, fördern ebenfalls die Umsetzung von NbS. Ein weiterer Schlüsselfaktor für den Erfolg von NbS-Maßnahmen ist gezieltes Handeln in ökologisch betrachtet besonders wichtigen Gebieten, um die Effekte von NbS zu optimieren. Projekte wie die Wiederherstellung des Merang-Torfmoores in Sumatra (Indonesien) und die Wiederherstellung des Jangtse-Flusses in China zielen auf Biodiversitätshotspots, um mit begrenzten Ressourcen maximale Klimaschutz- und Umweltvorteile zu erzielen.

Zusammenfassend betrachtet, erfordert die erfolgreiche Umsetzung von NbS sowohl politisches Engagement, politische Kohärenz, klare Zielvorgaben, eine langfristige Finanzierung, die Einbindung von Stakeholdern und die Förderung von Synergien und gezieltes Handeln in Prioritätsgebieten. Diese Elemente tragen nicht nur zur Verbesserung der Klimaschutzmaßnahmen bei, sondern auch zur Erreichung von Umwelt- und gesellschaftlichen Zielen.

Dennoch stehen der erfolgreichen Umsetzung von NbS auch Herausforderungen gegenüber, wie z. B. politische Instabilität und mangelnde langfristige politische Steuerung. Störende Brüche in der Umweltpolitik können den Erfolg von NbS behindern, wie in Brasilien durch die zunehmende Entwaldung unter der Bolsonaro-Regierung zu sehen ist. Ebenso hat die Trump-Administration in den USA den Klimaschutz stark zurückgefahren. Äthiopiens „Green Legacy Initiative“ (GLI) zeigt auf der einen Seite starke politische Unterstützung, jedoch fehlt eine solide politische Verankerung, was die langfristige Wirksamkeit gefährdet. Zudem bedrohen politische Instabilität und häufige Regierungsumbildungen eine effektive Planung und Umsetzung von NbS. Daher ist es entscheidend, politisches Engagement und stabile Steuerungsstrukturen sicherzustellen, um den langfristigen Erfolg von NbS-Maßnahmen zu gewährleisten.

Darüber hinaus sind eine fehlende Verknüpfung politischer Strategien und Steuerung ein Hinderniss für die Umsetzung von NbS Maßnahmen. So ist Äthiopiens GLI nicht in einer spezifischen Politik oder Strategie verankert und wird primär vom Büro des Premierministers geleitet. Die Mittel werden auf verschiedene Ministerien, Behörden, regionale Regierungen und Stadtverwaltungen verteilt, ohne klare Verbindung zu anderen Wiederherstellungsprogrammen, wie denen der Weltbank. Zudem wird die Karte zur Potenzialanalyse der Landschaftsrenaturierung offenbar zu wenig genutzt, wodurch Chancen verpasst werden, Zielgebiete zu priorisieren oder eine ausgewogene Umsetzung im ganzen Land zu gewährleisten (Kassa et al. 2022). Die politische Steuerung auf Bundesebene umfasst mehrere Ministerien und das Büro des Premierministers, was zwar nützlich ist, um sektorale Ministerien in die Renaturierungsbemühungen einzubeziehen, jedoch durch häufige Umstrukturierungen behindert wird. Zudem fehlt es an einem speziellen Monitoring-, Berichts- und Evaluierungsprogramm (Kassa et al. 2022).

Eine weitere zentrale Herausforderung besteht darin, die kontinuierliche positive Wirkung der NbS-Maßnahmen sicherzustellen, die hauptsächlich durch politische, rechtliche und sektorspezifische Faktoren beeinflusst wird. In Brasilien reduzierte der Plan PPCDAm zunächst die Entwaldung, aber die Raten stiegen wieder an, was auf die Komplexität der Ursachen für die Entwaldung im Amazonasgebiet und die Schwierigkeiten bei der Förderung nachhaltiger wirtschaftlicher Aktivitäten zurückzuführen ist (Bizzo and Farias 2017). Ebenso pflanzte Äthiopiens Green Legacy Initiative (GLI) in vier Jahren 25 Milliarden Setzlinge, aber die Überlebensraten sind niedrig, da es an einer ausreichenden lokalen Beteiligung mangelt und auf öffentlichen Flächen gepflanzt wurde (Kassa et al. 2022). Die politische Instabilität Äthiopiens, der Bürgerkrieg sowie schwere Dürren, gefolgt von Überschwemmungen, gefährden zudem den Erfolg der Initiative (Fikreyesus et al. 2022). In Indonesien ist die Landnutzungslizenz des Sumatra-Merang-Projekts nur temporär, was Unsicherheiten hinsichtlich der langfristigen Lebensfähigkeit schafft. Zudem erfordern die Blockierungen der Kanäle im Projekt regelmäßige, standortspezifische Anpassungen, aber die Nachhaltigkeitsmaßnahmen sind unzureichend (Urzainki et al. 2023). Diese Beispiele verdeutlichen die Notwendigkeit eines konstanten politischen Rückhalts, rechtlicher Klarheit und eines adaptiven Managements, um den langfristigen Erfolg von NbS-Initiativen sicherzustellen.

Darüber hinaus untergräbt mangelnde politische Kohärenz die Klimaschutzwirkung von NbS-Maßnahmen. In England steht die fortgesetzte Torfverbrennung im Widerspruch zum England Peatland Action Plan, da erhebliche Emissionen freigesetzt werden, während gleichzeitig öffentliche Gelder für die Wiederherstellung von Mooren ausgegeben werden (Defra 2023). Ebenso schmälert die Entwaldung für Infrastrukturprojekte die Nettofläche der neu geschaffenen Wälder. Herausforderungen für NbS ergeben sich auch aus der spezifischen Ausgeestaltung von Maßnahmen. Im indonesischen 3-R-Programm wurden die wirtschaftlichen Lebensgrundlagen der Gemeinden nicht ausreichend gesichert, was zu einer teilweisen Entwässerung der Projektgebiete führte. Die Bemühungen, alternative Einkommensquellen für die Gemeinden zu schaffen, waren unzureichend, was die Nachhaltigkeit des Programms gefährdete (Puspitaloka et al. 2021). Äthiopiens Baumpflanzinitiativen mobilisierten Bürger*innen in verschiedenen Regionen, aber das schlechte Management führte zu unzureichender lokaler Beteiligung. Landnutzende hatten oft wenig Vorlaufzeit und unklare Anweisungen, was dazu führte, dass viele Bäume in ungeeignetem Terrain gepflanzt wurden (Kassa et al. 2022). Diese Beispiele verdeutlichen die Bedeutung politischer Kohärenz, angemessener wirtschaftlicher Unterstützung und effektiver lokaler Beteiligung, um den langfristigen Erfolg von NbS-Maßnahmen sicherzustellen.

Daher bietet die Etablierung von NbS-Maßnahmen den Regierungen die Möglichkeit, die politische Kohärenz zu verbessern und institutionelle Arrangements für den Schutz und die Wiederherstellung der Natur zu straffen. Darüber hinaus bietet die Anwendung der Kriterien für NbS die Gelegenheit, bestehende Maßnahmen zu optimieren. Dabei sollte das Ziel der langfristigen positiven Wirksamkeit von NbS bei der Maßnahmenplanung und -durchführung ein wesentlicher Aspekt sein, um positive Effekte für den Klima- und Biodiversitätsschutz sicherzustellen. Regierungen müssen eine angemessene, langfristige Finanzierung für NbS bereitstellen und dabei möglicherweise private Finanzierungsmittel mobilisieren. Der internationale Austausch über gewonnene Erkenntnisse kann die globale Umsetzung stärken. Politischer Wille und die Einbindung von Stakeholdern sind wesentliche Treiber für den Erfolg von NbS. Alle Fallstudien zeigten, dass es besonders wichtig ist, die Auswirkungen auf die Lebensgrundlagen, wie der Wegfall landwirtschaftlicher Nutzfläche, abzumildern und alternative Einkommensquellen oder Managementpraktiken anzubieten. Die Studie zeigte auch, dass die Auswirkungen von NbS auf die Biodiversität zu wenig Beachtung finden und das Biodiversitätsmonitoring und die entsprechende Berichterstattung verbessert werden sollten.

Darüber hinaus kann durch die Priorisierung von Regionen für die Etablierung von NbS ein effektiverer Beitrag zum Klima- und Biodiversitätsschutz oder zu anderen gesellschaftlichen Zielen erzielt werden, insbesondere wenn finanzielle oder andere Ressourcen knapp sind.

Um die Klimawirkung von NbS-Maßnahmen im Rahmen der UNFCCC nachzuverfolgen, sind separate Ziele für Landnutzung, Landnutzungsänderungen und Forstwirtschaft (LULUCF) und eine verbesserte Berichterstattung notwendig. Obwohl viele Länder NbS in ihren NDCs nicht explizit erwähnen, wird die Verbesserung der LULUCF-Berichterstattung in den zweijährlichen Transparenzberichten die globale Nachverfolgung erleichtern. Idealerweise sollten Länder eigenständige Ziele für den LULUCF-Sektor festlegen, um die Transparenz zu erhöhen.

1 Introduction

The Paris Agreement (PA) established a global framework for addressing climate change with the goal of limiting the increase in global average temperature to well below 2°C above pre-industrial levels and taking necessary action to restrict the temperature increase to 1.5 °C (Paris Agreement, UNFCCC 2015, Article 2). As part of the PA commitments, Parties are required to undertake and communicate their mitigation -and adaptation- efforts through Nationally Determined Contributions (NDCs) outlining their post-2020 targets and actions. Parties are required to update their NDCs every five years and should aim to increase their ambition each time (UNFCCC 2015, Article 4).

It is up to Parties to identify how best to mitigate climate change as the PA does not guide countries to set explicit targets. Significant research has been undertaken to demonstrate the importance of Nature-based Solutions (NbS) for achieving mitigation targets (Griscom et al. 2017; Roe et al. 2019; IUCN; Oxford University 2019). The PA does not include an explicit mention of NbS, but includes several references to ecosystems, forests and removals by sinks, for example in its preamble and the Articles on mitigation (Article 4), forests and sinks (Article 5) and adaptation (Article 7) (Seddon et al. 2019). In their first, and second and updated (UNFCC 2024)NDCs, many countries included references to NbS in some form, with some countries making more explicit references than others (Seddon et al. 2019; Zhai et al. 2023). Furthermore, references to NbS quantitative targets vary significantly across NDCs and across NDC submission rounds (UNDP 2019).

NbS is not a terminology or category developed or formally used under the UNFCCC framework. NbS are principally implemented in the Agriculture, Forestry and Other Land Use (AFOLU) sector (UNDP 2019). The term was put forward by civil society organization and science and was recently officially defined during the fifth session of the United Nations Environment Assembly (UNEA-5) in March 2022. According to the resolution, NbS are defined as *"actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits*". The resolution also highlighted the importance of the implementation of social and environmental safeguards in NbS, in line with the Rio Conventions and specific contexts, while recognising the role of NbS in the achievement of the Sustainable Development Goals (SDGs) (UNEA 2022). The importance of NbS for climate mitigation was additionally highlighted in the decision text of the 27th Conference of the Parties (COP27) in 2022 (UNFCCC 2022).

Literature often describes NbS as a set of low-risk, no-regret options (Reise et al. 2022). For example, protecting and restoring habitats like peatlands and forests serves the long-term carbon storage and enhances ecosystem resilience to climate change. But these measures also offer significant synergies with biodiversity protection targets and other ecosystem services like water retention, protection from natural disasters and food provision. The strong co-benefit component of NbS, their potential carbon sequestration as well as their relatively low-implementation cost in comparison to technological measures such as carbon capture and storage place NbS as an important mitigation solution (Griscom et al. 2017). In this regard, NbS positive characteristics have led to calls for increased promotion and funding for NbS.

However, it is important to recognise the limitations of NbS measures. On the one hand, there are high levels of uncertainty associated to the current estimates of the mitigation potential of NbS (Reise et al. 2022; UNDP 2019). These uncertainties arise from the low quality of available data for the land-use sector. Consequently, this has led to an overestimation of the emission

reduction potential of NbS for climate mitigation by at least 10 % (Griscom et al. 2017). Furthermore, Reise et al. (2022) have raised concerns about potential negative impacts on biodiversity -if proper safeguards are not put in place, such as the promotion of non-native monocultures through afforestation projects, which may lead to the spread of new pests and other disasters (Reise et al. (2022)). Therefore, it is important to note that if measures have a negative impact on biodiversity and/or do not contribute to human welfare they should not be considered NbS according to the official UNEA definition.

Despite NbS measures not being fully outlined in the majority of countries' NDCs, countries have gained valuable experience implementing these activities to mitigate the effects of climate change. Examples of NbS measures encompass government-led national or subnational programmes, locally driven initiatives funded by private sources, or projects executed by multilateral institutions or donor agencies in coordination with governments. Indigenous Peoples and local communities have also been playing a crucial role in contributing to mitigation efforts, by for example safeguarding tropical forests or engaging in mangrove restoration projects in coastal areas.

Although NbS are not enshrined in the German Climate Law, they are likely to play a substantial role in achieving the German government's climate change mitigation, biodiversity conservation and adaptation goals. Therefore, in June 2023, the German federal government approved the Federal Action Plan on Nature-based Solutions for Climate and Biodiversity (Aktionsprogramm Natürlicher Klimaschutz, ANK). The action plan outlines 69 measures to strengthen nature-based climate protection in important ecosystems like forests and coastal ecosystems and agricultural soils. Measures include afforestation, strengthening projects to rewet organic soils, restoring marine seagrass meadows and incentivising woody vegetation structures in agricultural landscapes (BMUV 2023). The implementation of the ANK is expected to make a significant contribution to achieving the German government's climate change mitigation, biodiversity conservation and adaptation goals.

In this report, we present a critical examination of the implementation of mitigation strategies and experiences related to NbS in six countries (chapter 3): Brazil, China, Ethiopia, Indonesia, United Kingdom, and the United States of America. The countries were chosen due to their relevant work on NbS and due their relevance for Germany regarding ecosystem similarities and importance for bilateral cooperation (chapter 2). The aim is to inform the design and implementation of NbS within the framework of the Federal Action Plan on Nature-based Solutions for Climate and Biodiversity by identifying strategies and structures that support successful NbS measures and highlighting synergies of nature-based climate action with biodiversity protection.

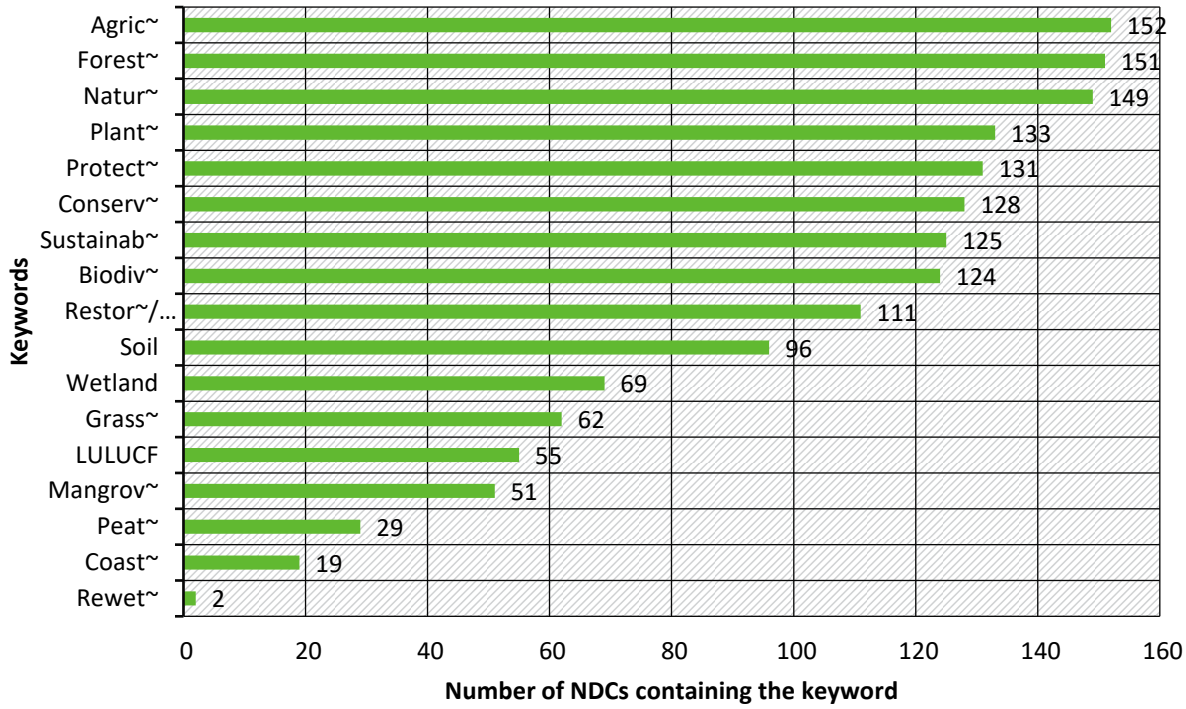
2 Screening of Nationally Determined Contributions for indications of nature-based solutions and selection of case study countries

Parties to the PA communicate their efforts to achieve the objectives of the agreement in their NDCs. Some countries also include information on the need for finance, technology, and capacity building support for these actions.

To search for indications of nature-based solutions among targets and measures expressed by the Parties to the PA, all NDC documents of January 2023 were downloaded from the UNFCCC NDC registry (UNFCCC 2024a). In total 168 NDC documents were downloaded and integrated into a digital library (Citavi) for a full text search. We identified 17 keywords that indicate measures or targets related to NbS. Besides English, the keywords also were used in Spanish and French because some countries publish their NDC in these other official United Nations languages. Seven keywords represent the major ecosystems and landscapes, where NbS are most likely applied: Forests, wetlands, peatlands, grasslands, soils, mangroves, agricultural land and coast. Also, we chose words that are related to activities for NbS: restoration, restauration, conservation, protection, rewetting and sustainability. Other important keywords are biodiversity, nature, plant and the sector where most of the measures related to NbS are finally reported under the UNFCC framework: Land Use, Land Use Change and Forestry (LULUCF). We used the initial word roots (e.g. agric~) to find as many variants of a word as possible. Additionally, if the keywords “forest~” and “agric~” were found in the NDCs, keywords indicating major activities in forest and agricultural ecosystems were used: Afforestation, reforestation, silvopastoral, agroforestry, fertiliser and organic (farming).

The results presented in Figure 1 show that almost all (>149) NDCs have words indicating content related to agriculture, forests as well as nature, which is also consistent with the findings of Zhai et al. (2023). In contrast, only two NDCs, from Indonesia and Uganda, mentioned “rewet~”, although rewetting organic soils is one of the most important measures to reduce emissions in the land use sector.

Figure 1: Number of Nationally Determined Contributions (NDCs; n = 168) containing the initial root words (keywords) that indicate ecosystems as well as actions related to nature-based solutions



Source: UNFCCC (2024b)

In a next step, we defined additional criteria to further narrow down the number of possible case study countries to be analysed:

- The NDC should contain 12 or more of the keywords to indicate that NbS measures probably are of importance to the countries efforts to achieve climate mitigation targets.
- The ecosystems in the country are comparable to Germany or of global significance, like the tropical rainforest.
- The countries reflect a broad geographical coverage, including the five UN regions.
- Importance of the country for political or economic exchange with Germany.
- The countries should represent different levels of income (developed, emerging, developing).
- Countries, which have high potential for gathering insights of NbS implementation.
- The country was mentioned in scientific literature (e.g. Zhai et al. 2023; Seddon et al. 2019; Unger et al. 2020; Leavitt et al. 2021).
- The availability of contacts and expertise from the project team regarding a specific country.

In total, 52 NDCs contain 12 or more keywords. We chose 16 NDCs representing 16 potential case study countries (Table 1) by applying the criteria mentioned above. But we additionally considered the NDCs of the United States of America (USA), which only had 9 keywords. They

were included based on expert knowledge of the authors and scientific literature that showed that both countries are pursuing measures including NbS for climate mitigation. Table 1 summarizes the results of the keyword search in the NDCs of all 16 countries. The keywords plant~, natur~, restor~, protect~ are commonly used and found in all 16 NDC. As mentioned above, the keywords related to peatlands (peat~) and rewetting (rewet~) are the least common in the 16 NDCs. Finally, the 16 NDCs were screened for NbS measures. The majority (9 countries) mentioned the keywords "afforestation" and/or "reforestation" if "forest~" was present in the NDC, indicating that these forest related measures play an important role in the national climate mitigation policy of land uses. The same applies to measures related to agricultural practices (agric~; Table 1).

For all 16 potential case study countries, we further screened their NDCs to obtain information on the key ecosystems mentioned for quantitative or qualitative mitigation and adaptation targets. All information is available in the Annex to this report. In summary, most of the measures expressed by the 16 countries are climate mitigation targets. About half (58) of the stated targets are quantitative.

In a final selection we chose two high income (United Kingdom (UK), USA), two low (Ethiopia, Indonesia) and two middle income (Brazil, China) countries. These countries also represent a sample of broad geographical coverage, including Africa, Asia, Europe, South and North America. Due to their ecological similarities with Germany, the UK and the temperate parts of the USA are of particular interest. Also, these countries are comparable to Germany in their economic development and cultural imprint. Indonesia has significant shares of valuable tropical peatland areas. They are threatened by drainage, and the government established peatland restoration programmes. Also, China made efforts in establishing land use related climate mitigation measures such as reforestation. Brazil is not just an important political partner for Germany, it also has the highest proportion of tropical rainforest, which plays an essential role in global terrestrial carbon sequestration and for the climate system in general.

Table 1: NbS related keywords that were found in the NDCs of 16 preselected potential case study countries.

Country (total number of keywords)	LULUCF	Forest	Wetland	Grass~	Coast~	Agri~	Peat~	Mangrov~	Soil	Biodiv~	Sust-ainab~	Rewet~	Conserv~
Albania (13)		AF, RF				OR, FE,AG							
Bolivia (12)		AF, RF				FE, G							
Brazil (12)						OR, AG							
Burkina Faso (8)		RF				FE, AG							
Canada (14)						OR, FE							
Chile (14)		AF, RF				OR, FE,AG							
China (14)		AF				OR, FE							
Ethiopia (13)		AF, RF				OR, FE,AG							
Ghana (13)						OR							
Indonesia (15)		AF, RF				OR, FE							
Mozambique (14)		AF, RF				OR, FE,AG							
South Korea (13)						FE							
United Kingdom (14)						OR							
United Arab Emirates (14)													
United States of America (9)						FE							
Viet Nam (14)		AF											

Source: Own compilation. Keywords found in the NDC are indicated in green and if absent in red. If the keyword "forest~" and "agric~" were found, further keywords were applied: organic (OR), fertilizer (FE), agroforestry (AG), afforestation (AF), reforestation (RF). Keywords found in all 16 NDCs are not presented here (plant~, natur~, restor~, protect~).

3 Analysis of nature-based solutions for climate and biodiversity protection in case study countries

The information on NbS implementation in the case study countries was compiled through a review of information provided by the analysed countries and scientific publications. First, a brief overview of the case study country is given in terms of its geography, biodiversity and climate policy. Then the implementation of NbS in national policy is outlined and finally analysed in more detail based on two examples of respective measures. The measures were selected because they fulfil one or more of the following aspects and are therefore relevant for the implementation of measures in Germany:

- The measures are similar to those in the German ANK, like peatland rewetting, afforestation or soil protection in arable or grassland areas.
- The measures are particularly important for the case study country and were mentioned in their NDC or national climate mitigation strategies.

Additionally, the measure examples were examined to determine whether they comply with the definition and criteria of NbS (see section 1). An in-depth examination of the measures, e.g. with the help of on-site inspections and stakeholder interviews, is not possible within the scope of this study. The evaluation of the measures is therefore based on reports and information researched on the internet. Essentially, the following criteria, which are based on the report by Reise et al. (2022) should be met in order to classify the measure as NbS:

- The measures must protect, restore or sustainably manage the ecosystem to be aligned with its processes.
- Clear objectives to promote biodiversity are formulated for the measure and biodiversity status and development are measures (biodiversity monitoring)
- Alignment with national policies in climate change and biodiversity protection. For example, an assessment of mitigation potential of the measure.
- Availability of information related to financing of the measure.
- Involvement of stakeholders and or local communities which are affected by the implementation of NbS measures.

Additionally, the following leading questions were addressed to provide NbS implementation experiences for the German NbS policy:

- How are synergies of climate mitigation and biodiversity protection addressed?
- How are implementation and impact of the measure monitored? What are potential risks associated with the measure, for example for non-permanence of climate mitigation, biodiversity and social aspects.

In some cases, the implementation of NbS measures mentioned in the NDC is very recent but due to their relevance for the German NbS implementation, we also considered measures that still are in the planning stage.

3.1 Brazil

Brazil is the largest country in South America and the fifth largest in the world. The agricultural sector plays a key role in the Brazilian economy, being responsible for over 6 % of the country's GDP in 2022 (Statista 2024a). Brazil's population totals over 200 million, with 58 % living in cities located within 200 km of the Atlantic Coast (IBGE 2017a; Agência de Notícias - IBGE 2021). It shares borders with all other South American countries except Chile and Ecuador. To the North, west and southwest, the country borders the Atlantic Ocean, creating over 7,000 kilometres of coastline. Brazil's vast territory encompasses a wide variety of diverse land and marine ecosystems. The most prominent among them is the Amazon Rainforest which covers 49 % of the land mass and is part of the largest continuous rainforest in the world. It provides habitat to thousands of plants and animals, 3,000 of which are endemic (IBGE 2023). Along the eastern coastal region, the Atlantic Forest takes up 13 % of Brazil's territory. Although only 27 % of its original area remains and is protected, the Atlantic Forest is the habitat to over 10,000 endemic plant species (IBGE n.d.). The Cerrado, one of the world's most species-rich savannas, located mostly along Brazil's central highlands, extends across 23.3 % of Brazil's land area. The north-eastern part of the country is covered by the Caatinga shrubland, which occupies 10.1 % of the land area. On the southernmost part of the country, the Pampa grassland covers 2.3 % of the nation's territory, also extending into Argentina and Uruguay. Lastly, the Pantanal is a tropical wetland that extends into Bolivia and Paraguay and covers 1,8 % of the Brazilian territory (IBGE 2023; MMA 2023).

As a result, Brazil stands out as one of the most biodiverse countries globally, with its diverse biomes estimated to contain 15-20 % of the world's biological diversity (Convention on Biological Diversity 2023). Also, Brazil is the homeland of 305 indigenous peoples who speak 274 languages (Convention on Biological Diversity 2023) . The protection of their rights is very important and is also closely linked to the conservation of local biodiversity (Parks and Tsioumani 2023). Brazil's biodiversity faces significant threats, primarily stemming from habitat loss due to deforestation and fragmentation, the introduction of non-native species and diseases, over-exploitation of land, and pollution. The destruction of forests and biodiversity also poses a threat to the lives of indigenous groups (Convention on Biological Diversity 2023; Carneiro Filho and Souza 2009).

Brazil has communicated 4 NDCs to the UNFCCC (2015, 2020,2022 and 2023). The last updated submission was on November 3rd, 2023 and is fully unconditional. This means that Brazil aims to achieve its target solely with its own resources. Through its latest communication Brazil confirmed an absolute net GHG emission target in 2025 of 1.32 Gt CO_2e, consistent with a reduction of 48.4 % in comparison with 2005, according to its latest inventory data. Additionally, Brazil committed to an absolute net GHG emission target in 2030 of 1.20 Gt CO_2e, consistent with a reduction of 53.1 % in comparison with 2005, according to the latest inventory data (Federative Republic of Brazil 2023). In its 2022 NDC, Brazil had committed to reduce its GHG in 2025 by 37%, compared to 2005. The latest NDC submission is seen as an improvement over the 2022 contribution, bringing the country's climate targets back to the level of the first NDC of 2015 (política por inteiro 2023). In addition, Brazil committed to climate neutrality by 2050. The NDC does not specify the strategy the country aims to follow to mitigate its emissions.

The LULUCF and the agricultural sector have been historically major contributors to Brazil's GHG emissions. As reported in Brazil's fourth biennial update report (Ministry of Foreign Affairs 2020), the LULUCF sector was a net emitter between 1994 and 2016, with gross emissions of 0.95 Gt CO_2 and removals of -0.65 Gt CO2, leading to net emissions of 0.25 Gt CO_2 for 2016 (Ministry of Foreign Affairs 2020). According to 2022 data, the LULUCF sector accounted for 48 % of the total CO_2e emissions of the country, while the agricultural sector contributed 27 %.

Emissions from LULUCF increased since 2016, reaching their peak in 2021 at 52 % of the total CO_2e emissions of the country (although it's important to note that the highest LULUCF emissions since 1990 occurred in 2003). The recent surge in emissions is attributed to Bolsonaro's ascent to the presidency in 2018, that led to political changes in the country. Notably, there was a strong emphasis on agricultural expansion in the National Congress, coupled with the systematic dismantling of Brazil's institutional and legal framework on forest protection, human -and indigenous rights (Human Rights Watch 2022). This led, among other consequences, to a 37 % increase in deforestation in the Amazon region between 2016 and 2020 (CAT 2022). It's crucial to highlight that deforestation trends in the Amazon have been the primary controlling factor of Brazilian emissions since 2012 (Tsai et al. 2023) andgriculture is considered to be one of the major drivers of tropical deforestation (Pendrill et al. 2022). Given the key role of the agriculture and LULUCF sector in Brazil it is expected for these sectors to play a key role in the mitigation strategy of the country.

3.1.1 NbS implementation in Brazil

References to NbS in Brazil's NDCs have varied throughout the different communications to the UNFCCC. The NDC from 2015 included many quantitative sectoral targets and measures related to the land sector (e.g., restoring and reforesting 12 million ha of forests by 2030 for multiple purposes; zero illegal deforestation by 2030 and compensating for greenhouse gas emissions from legal suppression of vegetation). However, the subsequent submissions excluded specific sectoral targets and measures, and provide minimal references. For example, the NDC submitted in 2022 contained a commitment to eliminate illegal deforestation by 2028. In the latest NDC update submission (2023), the Brazilian Government has commitment to reach zero deforestation by 2030 (see below). Other references to NbS in the latest NDC are the definition and coordination of interministerial actions to reduce deforestation rates in the national territory, elaboration of action plans for each of the Brazilian biomes and references to Reducing Emission from deforestation and forest degradation (REDD+) results-based payments. It also mentions the Sectoral Adaption plan for Low Carbon Agriculture for Sustainable Development (Plan ABC+) for the period 2020 to 2030. No specific references to biodiversity are included in the latest NDC, only a general reference to Brazil having signed all major multilateral environmental treaties (which includes the Convention on Biological Diversity (CBD). The latest NDC mentions sustainable development but does not make specific reference to the SDGs.

Brazil's 2023 NDC targets will be translated into policies and measures to be detailed and implemented by the Brazilian Federal government (Federative Republic of Brazil 2023). As of November 2023, the Interministerial Committee on Climate Change[1] was still working on the revision of the National Climate Change Policy. The revision will lead to the elaboration of a new Climate Change Plan, composed of a National Mitigation Strategy, with eight sectoral mitigation plans (including the regulation of the Brazilian Emissions Trading System) and the National Adaptation Strategy, as well as fourteen sectoral/thematic adaptation plans (Federative Republic of Brazil 2023). Thus, it is likely that in 2024, Brazil will have clearer or more concrete mitigation actions for the AFOLU sector, which combines the agriculture and LULUCF sector. The new Climate Change Plan will also encompass transversal goals for climate action, including (i) socioeconomic implications of the transition to climate neutrality; (ii) education, research, development and innovation; (iii) means of implementation; (iv) monitoring, evaluation and transparency mechanisms; (v) losses and damages associated with extreme events (Federative Republic of Brazil 2023).

[1] The Interministerial Committee on Climate Change (CIM), instituted by decree 11,550 of 5 June 2023, sets the institutional framework for the elaboration and implementation of public policies on climate change.

Over the last three decades, Brazil has incorporated NbS and biodiversity into its regulatory and policy framework at the constitutional, federal, state, and municipality levels. There isn't a singular institution overseeing NbS and biodiversity; rather, these aspects intersect across various institutions and levels.

On biodiversity matters, Brazil hosted the conference where the CBD was signed (Rio-92). Therefore, the country has played a key role in international discussions on biodiversity -hosting more than 20 regional CBD meetings, COP-8 CBD and Rio+20- and has advanced significantly on its biodiversity institutional arrangements. For example, in 2002 it adopted a National Policy on Biodiversity, and was the first Party in the CBD to adopt a set of measurable biodiversity targets- through its 2006 Action Plan on Biodiversity and CBD-aligned targets (PAN-Bio) (Rocha 2022). Later, the country adopted a National Biodiversity Strategy and Action Plan (2016-2020) with Aichi-aligned targets (2013-2017) (currently under review for alignment with the Kunming-Montreal goals), as well as a Biodiversity Law in 2015. Other environmental laws also govern biodiversity-related matters, including the Forest Code, which specifically regulates the system of biodiversity offsets (OECD 2021). Very early in the 90's Brazil created a National Programme on Biological Diversity and throughout the years "biodiversity" has been further institutionalized through, for example, the creation of a Biodiversity department within the Ministry of Environment (1999), a National Commission on Biodiversity-CONABIO (2003), The Chico Mendes Institute for Biodiversity Conservation (2007), and the Brazilian Biodiversity Information System created in 2018 under the Ministry of Science, Technology and Innovation.

Mitigation policies in Brazil centered on NbS have primarily targeted deforestation. Through its latest NDC communication, the Brazilian government has committed to reach zero deforestation by 2030, which is considered a target by the current government beyond existing laws and policies and is the only specific mitigation action set in the NDC (Federative Republic of Brazil 2023). Given that deforestation is a challenging problem with many stakeholders and interest groups involved, policies and regulations have emerged from diverse perspectives and approaches. In 2004, the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm), led by 13 Ministries under the coordination of Brazil Ministry of Environment (NDC Partnership 2023), was adopted aimed at mainly reducing illegal deforestation in the Legal Amazon (OECD 2021). In 2000 the National System of Protected Areas established a system of federal, state, municipal and private areas subject to special land and environmental regulations (OECD 2021) and since then it has seen a growth in both the number and area of protected areas on land and at sea (Ministerio do Meio Ambiente - CNUC 2023). Consequently, 18.7 % of the land area and 26.5 % of Brazil's marine areas have an environmental conservation status (OECD 2021; Ministerio do Meio Ambiente - Departamento de Areas Protegidas 2021). Brazil's legislation also requires landowners within Brazil's Legal Amazon to conserve 80 % of forest cover on their land, 35 % in the Cerrado biome, and 20 % of the territory in cases where the properties are located in other biomes (Federative Republic of Brazil 2023). In addition, between 2019 and 2020 a Commission and a National Plan for the Control of Illegal Deforestation and Recovery of Native Vegetation were created. Brazil also has regulations concerning, inter alia, payment for ecosystem services, land titling for public lands and traditional communities, fire prevention, and the development of alternative economies for Amazon settlers, all of which are pertinent issues to address in the effort to combat deforestation.

Recent institutional developments include the establishment of a Permanent Interministerial Commission for the Prevention and Control of Deforestation (2023) to coordinate interministerial actions to reduce deforestation rates in the national territory. Action plans for each of the Brazilian biomes will be outlined, with PPCDAm serving as a reference, particularly

as it enters its fifth phase of implementation, as further described below (Federative Republic of Brazil 2023). Another crucial NbS mitigation policy is the Sectoral Adaptation Plan for Low Carbon Agriculture for Sustainable Development (Plan ABC+), as it contains NBS relevant mitigation measures, as further described in the next section.

The NbS-mitigation action and biodiversity conservation finance landscape in Brazil includes public resources at different levels (e.g., Amapá's Public incentives for conservation), private resources, blended finance (Pará's Eastern Amazon Fund) and donations and grants from bilateral cooperation and multilateral institutions (e.g., Biodiversity Finance Initiative-BIOFIN from UNDP). Flagship avenues for NbS and biodiversity finance at federal level include:

- The Brazilian Amazon Fund is a financial mechanism established by Brazil to support projects and initiatives to fight deforestation. It was launched in 2008 receiving funds mainly from Norway and Germany and managed by Brazil's National Development Bank (BNDES). Both countries are currently resuming donations, with Germany earmarking 35 million euros (Wilson Center 2023; Federal Ministry for Economic Cooperation and Development 2023). Until 2018, the Fund had received US$ 1.3 billion in funding (University of Oxford 2023). The fund was suspended after its steering committee was dissolved in 2019 during former President Jair Bolsonaro's administration. It was rebooted by President Lula da Silva. It has recently (October 2023) received US$ 8.4 million donations by Switzerland and the USA. The donation by the USA is part of a $500 million contribution over five years announced by President Biden in April 2023 (University of Oxford 2023; Reuters Media 2023b). In May, the British Prime Minister said the UK would contribute about $100 million (Reuters Media 2023). Funds are allocated within a results-based approach, tying international donations to the accomplishment of reduced greenhouse gas emissions from deforestation and forest degradation in Brazil. The fund focuses on activities related to prevention, monitoring, and combatting deforestation, as well as to promoting the preservation and sustainable use of the Brazilian Amazon. It operates in partnership with non-governmental organizations, governmental agencies, Indigenous Peoples and other stakeholders.
- The recent legislative proposal approved by the Brazilian National Congress for the creation of a Brazilian Greenhouse Gas Emissions Trading System (SBCE) could help leverage private resources for the protection and restoration of forests. This system would require entities emitting over 25,000 t CO_2e annually to meet certain compliance obligations and they will be allowed to use domestic carbon credits to fulfil part of their compliance requirement. Carbon credits from the forestry sector, including REDD+, will be allowed for companies to surrender part of their obligations. Importantly, the draft law explicitly outlines the rights of indigenous peoples and traditional communities in relation to carbon crediting (ICAP 2023).

3.1.2 Examples of NbS measures

Changes in deforestation trends- particularly in the Amazon region-have a direct correlation with emissions from the AFOLU sector in Brazil. Consequently, in this section, we will examine one of the most successful measures of the Brazilian government to reduce emissions related to deforestation in the Legal Amazon region (Ministério do Meio Ambiente e Mudança do Clima 2023a). Also, as agriculture is the second largest source of CO_2e emissions in the country, we will examine the Plan for Low Carbon Agriculture for Sustainable Development (ABC+ Plan), whose focus is on promoting low carbon agricultural practices while promoting sustainable development.

3.1.2.1 Action Plan for the Prevention and Control Deforestation in the Legal Amazon (PPCDAm)

The Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm) is one of Brazil's main instruments for achieving its NDC goal of becoming deforestation-free by 2030[2] and subsequently reducing its GHG emissions. The PPCDAm was first adopted in 2004, and was the main driver for the 83 % decrease in deforestation in the Amazon region between 2004 and 2012, according to data from the National Institute for Space Research (Inpe) (Ministério do Meio Ambiente e Mudança do Clima 2023b). After being suspended during the Bolsonaro administration, its fifth phase was reintroduced in 2023 and will be effective from 2023 until 2027. The plan is consistent with the classification of an NbS measure as described by Reise et al. (2022), as, among other aspects, it does not only address climate change but also promotes human well-being and enhances biodiversity.

As indicated in the plan itself, the PPCDAm is considered one of the key instruments for implementing the National Climate Change Mitigation Plan (PNMC), with a focus on mitigating GHG emissions related to the LULUCF sector (Ministério do Meio Ambiente e Mudança do Clima 2023a). Consequently, the PPCDAm's main aim is to address the primary drivers of deforestation in the Legal Amazon Region through the implementation of actions in four axes: sustainable production activities, environmental monitoring and control, land and territorial planning, and the implementation of regulatory and economic instruments aimed at reducing deforestation (Ministerio do Meio Ambiente - CNUC 2023) (Ministério do Meio Ambiente e Mudança do Clima 2023a). The PPCDAm consists of 12 strategic objectives, accompanied by 38 outcomes and 194 actions. Additionally, it encompasses 142 targets, indicators, deadlines and identifies key actors for monitoring and evaluation (Ministério do Meio Ambiente e Mudança do Clima 2023a). The approval of the PPCDAm was well received by environmental organisations (Folha de S.Paulo 2023). Succesful implementation will depend, inter alia, on the political coordination and the corresponding norms to be developed by the National Congress (WWF 2023b; Lima 2023; Folha de S.Paulo 2023).

The new PPCDAm acknowledges that deforestation and biodiversity crisis are intertwined. In this regard, the Sustainable Production Axis 1 of the PPCDAm places emphasis on the development of a bioeconomy with several targets such as the restructuring of the National Bioeconomy Programme for Socio-biodiversity by 2023" or support small businesses on socio-biodiversity aspects by 2027. In addition, Axis 4 on Rules and economic instruments aims at creating incentives for sustainable biodiversity business and production by, for example, expanding the lines of credit for socio-biodiversity chains. The support for bioeconomy marks an important improvement compared to previous phases of the plan, which failed to effectively promote sustainable production and economic incentives (Costa 14 Apr 2023).

The new plan also acknowledges the impacts that deforestation has on society and has introduced, inter alia, actions aimed at protecting indigenous peoples and traditional communities by strengthening their rights as well as their role in the sustainable production of the Legal Amazon. Some of the specific actions included in the PPCDAm include implementing environment and social-technical assistance and rural extension programmes for Indigenous Peoples considering their traditional knowledge; implementing community-based tourism in their territories; cancelling the registration of properties overlapping with Indigenous Lands; regularise Indigenous Lands to guarantee the recognition of their territories; promote tax and credit incentives for bioeconomy products from Indigenous lands, and the prioritisation of

[2] In the PPCDAm, zero deforestation means stopping illegal deforestation and compensating for legal removal of native vegetation.

payment for ecosystem services to this specific group. (Ministério do Meio Ambiente e Mudança do Clima 2023).

The governance model of the fifth phase resembles the model established for the previous phases of the plan. Its execution will depend on 13 ministries, led by the Ministry of the Environment and Climate Change (MMA), and mechanisms will be put in place to foster transparency and social participation (e.g., public consultations, technical-scientific seminars, annual public consultations of monitoring reports). Furthermore, the Permanent Interministerial Commission for Deforestation Prevention and Control is expected to have an important role. Apart from its responsibility in approving the action plans, such as the PPCDAm, the Commission will be also responsible for ensuring that the actions elaborated in the Plans promote the development and integration of environmental protection systems and contribute to the conservation of biodiversity and the reduction of GHG emissions from deforestation (Ministério do Meio Ambiente e Mudança do Clima 2023a).

The Action Plan is funded by a combination of resources that include funds from the federal government, ministries and agencies planned in the federal Pluriannual Plan (PPA)- the key instrument for the Federal Government's medium-term budget planning (Ministério do Meio Ambiente e Mudança do Clima 2023a, Ministério do Planejamento e Orçamento n.d.). The action plan also relies on funding from the Amazon Fund, the National Fund for Climate Change, the National Fund for Forest Development and the National Environment Fund (Ministério do Meio Ambiente e Mudança do Clima 2023a).

The monitoring of the implementation of the PPCDAm will be done on an annual basis. In this regard, a Monitoring and Evaluation Center (NMA) will be established and coordinated by the MMA with the participation of civil society and academia. Annual reports will be published with information on the performance of each institution, as well as recommendations for targets and indicator adjustments when needed. .

Building on the experience of the PPCDAm, the MMA aims to unveil strategic Action Plans for the Prevention and Control of Deforestation in the remaining Brazilian biomes. The Cerrado Biome's Action Plan was adopted in late 2023, and plans for the Atlantic Forest, Caatinga, Pampa, and the Pantanal are expected to follow soon.

3.1.2.2 The Plan for Low Carbon Agriculture for Sustainable Development (Plan ABC+)

The Sectoral Plan for Adaptation to Climate Change and Low Carbon Emissions in the Agriculture and Livestock Sector (Plan ABC+) released in 2021 for the 2020-2030 period builds upon the 2010 Sectoral Plan for Mitigation and Adaptation to Climate Change for a Low-Carbon Emission Agriculture (Plan ABC). The ABC Plan aimed to reduce annual GHG emissions by 133 to 166 Mt CO_2e relative to projected future levels by the year 2020 (Fernanda Gebara and Thuault 2013; Aquino 2021). Results indicate that the ABC Plan effectively mitigated between 100.21 and 154.38 Mt CO_2e from 2010 to 2018 (Ribeiro Rodriguesa, Renato de Aragão and et al 2019).

As in its previous iteration, Plan ABC+'s main aim is to reduce GHG emissions from the agricultural sector and promote adaptation to climate change. Developed by the Ministry of Agriculture, Livestock and Food Supply (MAPA), the ABC+ Plan, comprising a Strategic Plan and an Operational Plan, serves as a tool to advance sustainable agriculture through strategies targeting both adaptation and mitigation of GHG (Aquino 2021). The plan aims at striking a balance between production and environmental protection while also improving farmers' livelihoods (MAPA 2021; 2022). Nevertheless, as explained further below, not all of its goals are

NbS- oriented and some of its specific actions, such as the recovery of degraded pastures or commercial reforestation, could negatively affect the environment if not carried out with appropriate safeguards. Therefore, we consider the Plan to be partially consistent with the classification of an NbS measure as described by Reise et al. (2022). ABC+ actions are guided by three strategic pillars. The first one, Integrated Landscape Approach (ILA), focuses on promoting the management of agricultural lands while considering elements of rural landscape and natural biome, using watershed as a basic planning unit. ILA's approach aims to provide farmers incentives for, inter alia, the conservation of soil quality, water, biodiversity, and the valorisation of local species and regional cultures. The second pillar places a t focus on the interconnection between GHG mitigation and adaptation. In this regard, it is indicated that the ABC+ adaptation strategies should promote the adoption and maintenance of conservation practices, such as the maintenance of crop residues on the soil surface and crop rotation with species diversification (MAPA 2022).

The third pillar focuses on encouraging the maintenance and expansion of Sustainable Production Systems, Practices, Products and Processes (SPSABC) within areas suitable for agricultural production Potential NbS SPSABC' practices encouraged include recovery of degraded pastures, no-tillage systems, integrated crop-livestock-forestry systems, agroforestry systems and commercial forest reforestation. Some of these practices, such as recovering degraded pastures and fostering commercial forest reforestation (native and exotic), were also supported by the first version of the ABC Plan (World Resources Institute 2020). Nevertheless, some of these practices, if not implemented with proper safeguards (e.g., commercial reforestation including native species, mixed-species forestry, use of silviculture of native species in restoration of degraded areas) can fall outside what we are considering as NbS under this report. This is particularly relevant if we consider that in Brazil 75 % of the planted forest is occupied by eucalyptus (WRI 2020)[3] and that the new ABC+ seems not to move away from using exotic species such as eucalyptus and pines[4][5]. Other promoted practices included in the SPSABC include waste management at animal production and intensive cattle finishing, although these ones fall outside our NbS definition as they mainly focus on livestock (IBA 2017; IBGE 2017b; World Resources Institute 2024).

On a different note, and in line with its earlier version, Plan ABC+ is a good example of setting measurable targets as it establishes clear and quantifiable nationwide targets. Over the 2020-2030 period, the goals are to expand the area of SPSABC to 72.68 million ha, increase treated animal waste by 208 million m^3, and slaughter 5 million additional cattle under intensive finishing. These goals aim to contribute to the mitigation of 1,042 Mt CO_2e (MAPA 2022). Moreover, seven specific and measurable subgoals have been established for the SPSABC target. For instance, the expansion of no-till systems for grain production in 12,5 million ha, promoting 4 million ha of commercial forestry with a GHG mitigation potential of 510 Mt CO_2e and

[3] According to WRI-Brazil (2020), much of industrial forestry was developed before the establishment of the ABC Plan in 2011. In 2011, eucalyptus plantations covered approximately 5 million hectares, whereas in 2017, it had increased to 7.4 million (WRI-Brazil 2020, IBÁ 2017, IBGE 2018).

[4] The mitigation potential estimated in the Plan considers default emission/removal factor for eucalyptus, pine and other commercial tree species (MAPA 2022).

[5] Still it is important to note that there are ongoing projects in Brazil aiming at promoting large-scale reforestation with native species such as the Verena project from WRI (WRI n/d).

expanding 13 million ha of Bio-inputs with a GHG mitigation potential of 23.4 t CO_2e (World Resources Institute 2024; MAPA 2022).

Furthermore, each subgoal specifies its contribution to adaptation[6], and when relevant, its role in biodiversity has been highlighted- although, in some cases, the links might be questionable if the measures are not implemented with proper safeguards. For example, in the case of agroforestry systems, it is indicated that the benefits encompass increased biological properties of the soils and increased water stock and quality, enhanced biodiversity and improved climate stability within production systems, among other aspects (MAPA 2022). These benefits will be less in the cases of agroforestry areas with, for example, a significant number of exotic trees. For the commercial forestry subgoal, it is indicated, inter alia, that it would create habitats for several animal and plant species, thereby fostering increased biodiversity, especially when compared to degraded pasture. According to the Plan, commercial forestry also exhibits the potential to generate bioproducts for different uses. Still, as in the previous case, these co-benefits will vary depending on the type of commercial plantation. One of the flagship programmes created to meet the goals proposed in ABC+ is the Programme for Access to Credit and Financing (Programme ABC+)-which was also first established in the 2010 Plan. It is considered one of the most important lines of financing of the Plan ABC+. The programme provides credit to farmers for activities that reduce GHG emissions (OECD iLibrary 2023). Resources available for the Programme ABC+ increased from BRL 5 billion (USD 968 million) in 2021 to BRL 6.2 billion (USD 1.2 billion) in 2022 (OECD iLibrary 2023). According to government data, the Plan ABC+ has allocated R$ 17 billion for the execution of its activities (Federative Republic of Brazil 2023).

ABC+'s target audience encompasses all segments, types and sizes of farms, without exception, including family and commercial farming, indigenous peoples and communities (MAPA 2022). The execution of the Plan will be coordinated by MAPA, and the Federative States, and municipalities will be encouraged to formally join its execution through the State Management Groups (GGE) and respective State or District Action Plans ABC+ (PAE ABC+) (MAPA 2022).

For the new 2020-2030 cycle, monitoring and evaluation of the ABC+ Plan will be a priority (Aquino 2021). This is significantly different from the previous version, where no formal enforcement or monitoring tools were included (USDA 2021). Periodic biannual updates will review technologies, actions and goals, and participatory processes will be conducted to keep up to date with societal demands. On the other hand, the ABC+ information management system is set to be improved to carry out the Measuring, Reporting and Verification (MRV) of SPSABC and the Monitoring and Evaluation of its portfolio of actions and results. In this regard, an integrated data management system (SINABC) will consolidate various data, including information from the multi-institutional platform for monitoring GHG reductions from agriculture (ABC Platform). As indicated in Plan ABC+, the new and more robust MRV governance structure aims for transparent evaluation of Brazil agricultural sector's efforts in combating climate change (MAPA 2021).

The overall performance of the first version of the ABC plan exceeded its goals, but according to Schmidt et al. (2023), the targets may have been too low considering the extensive agricultural

[6] The Plan ABC+ indicates that adaptation strategies will focus on promoting (i) adoption and maintenance of conservation practices; (ii) adoption and maintenance of integrated systems; and (iii) genetic improvement (e.g., forage plants to cope with water scarcity) and recovery of biodiversity (MAPA 2022).

activities proposed. Moreover, throughout the years, several studies have pointed out several shortcomings in the implementation of the first version of the ABC Plan and Programme. For instance, it was noted that the ABC Plan was implemented slowly, primarily focused on mitigation efforts, and failed to meet targets for rehabilitating degraded pasturelands and reforestation. Additionally, challenges such as excessive bureaucracy and unattractive interest rates within the ABC Programme were identified (Folha de S.Paulo 2022; Souza et al. 2020; Maria Fernanda Gebara 2013).

Consequently, according to MAPA, ABC+ is a product of lessons learned from the 2010 ABC Plan and insights gathered from public documents, prepared by various institutions from the agriculture and climate change arena. The elaboration of the ABC+ Plan involved consultations with 28 national actors, 27 state management groups and contributions from over 200 authors, collaborators, reviewers, and 50 partner institutions (MAPA 2022).

3.1.3 Initial conclusions from NbS measures implementation in Brazil

Over the last three decades, Brazil has integrated NbS and biodiversity into its regulatory and policy framework at the constitutional, federal, state, and municipality levels. There isn't a singular institution overseeing NbS and biodiversity; rather, these areas intersect across various institutions and governance levels.

References to NbS and NbS targets in Brazil's NDCs have varied across different submissions to the UNFCCC. The latest NDC update of 2023 outlines a sole concrete NbS-related mitigation target: The Brazilian Government's commitment to reach zero deforestation by 2030. Brazil's 2023 NDC targets will be translated into policies and measures to be detailed and implemented by the Brazilian Federal government.

In the case of Brazil, the NbS measures analysed are policy instruments. The PPCDAm is a plan focused on the Legal Amazon, whereas the Plan ABC+ has national coverage. As they are government-planning documents, they cover a number of actions. In both cases, the plans' overarching objectives align with what we consider NbS measures in this document, and both instruments showcase government efforts aiming to align mitigation targets in the forestry and agriculture sectors with positive impacts on biodiversity. Also, the Plan ABC+ features concrete and quantifiable GHG mitigation measures. Nevertheless, in the case of Plan ABC+, some of its sub-actions fall outside the scope of NbS measures (e.g., slaughter of cattle under intensive finishing), and some other measures, such as commercial reforestation and recovery of degraded pastures, could only be considered NbS measures if they are implemented with appropriate safeguards. Therefore, the ABC+ Plan can only be partially considered as aligning with NbS criteria.

3.2 China

China is the country with the second largest land area in the world (FAO 2023). Located in eastern Asia, its coastline extends between North Korea and Vietnam onto the Yellow Sea, East China Sea and South China Sea (CIA 2024). China's largest land boarders are with Mongolia to the North and Russia to the Northeast. As of 2023 China has the second largest population in the world (UN DESA 2023). The population exceeded 1.41 billion people in 2020 (NBS 2023) and is projected to peak before 2030 and to stay below 1.5 billion people (UN 2022). China is currently undergoing a period of demographic change. In rural areas a high share of the population is over 65 and as of 2015 there is a decline in the working age population (OECD 2018). The population is mainly concentrated in the eastern provinces (CIA 2024).

More than 60 % of mainland China is composed of mountains, hills and plateaus (China 2018b). Mainland China's plateaus and river basins descend in altitude from west to east (China 2018a). The two longest rivers are the Yangtze (6300 km) and the Yellow River (5464 km), which together have a drainage area of over 2 million km^2 (NBS 2022). The Climate of mainland China varies according to the large geographical scope covered by the country and ranges from sub-artic in the north to tropical in the south (CIA 2024). The East Asian monsoon usually brings high precipitation in the summer months around April to August to the southern part of China (FAO 2011). Variable and heavy rainfall, droughts, and winds are factors that cause loss of fragile ecosystems e.g. through soil erosion or dust storms (Liu and Diamond 2005).

According to the 2022 statistical yearbook China has about 284.1 Mha of forest land, 264.5 Mha of grassland, 23.5 Mha of wetlands and127.9 Mha of cultivated land, which corresponds to about 30 %, about 28 %, about 2 % and about 14 % of the total area of mainland China respectively[7] (NBS 2022; FAO 2022). In total, 5 % of land are settlements (NBS 2022). China has seen severe environmental degradation, pollution and loss of ecosystems driven by agricultural intensification, industrial development and urban expansion in the second half of the 20th century (Yin et al. 2014; Liu and Diamond 2005). Soil erosion, desertification, nitrogen and pesticide pollution are among the main environmental challenges China is currently facing.

Six forest ecoregions are present in China: boreal, temperate mixed, temperate-subtropical, subtropical and tropical (Lu et al. 2022, supplementary material). China is a megadiverse country, it has over 34,500 higher plant species, over 6,400 vertebrate species and is a centre of agrobiodiversity having 10,000 species of crops (CBD 2023a).

China has made significant efforts to increase its forest area from the low levels seen in the 1950s, mainly through afforestation efforts. However, natural old growth forests have been declining up until recently, when their protection became a priority. According to the 9th National Forest Inventory (2014-2018), China currently has 138.7 Mha classified as natural forests[8] and 79.5 Mha of plantations or "nurtured forest" (National Forestry and Grassland Administration 2019). More than 30 Mha of forests are located in protected areas (FAO 2020a). The provinces with the largest forest areas, i.e. above 20 Mha, are Sichuan and Yunnan in the Southwest, Inner Mongolia in the North and Heilongjiang in the East.

The four main types of grassland ecosystems in China are meadow steppe, typical steppe, desert steppe and alpine steppe (Kang et al. 2007). The Tibetan Plateau in the Southwest (over 80 Mha) and Xinjiang in the Northwest and Inner Mongolia (over 50 Mha) are the geographical regions with the largest grassland areas. At the start of the 21st century , 90 % of Chinese grasslands were considered degraded as a consequence of overgrazing, climate change and industrial development (Liu and Diamond 2005).

China has a significant area of terrestrial and coastal wetlands. However, these are among the most endangered ecosystems. Since the 1950 about 60 % of coastal wetlands have been lost (Qiu 2011). Terrestrial wetlands include marsh wetlands, lake wetlands and river wetlands (CBD 2023a). The largest area of terrestrial wetlands is found in Qinghai in the Northwest (over 5 Mha), Tibet (over 4 Mha), Inner Mongolia and Heilongjiang (over 3 Mha). The Sanjian Plain in Heilongjiang province is the largest area of freshwater swamps in China but around 60% have been drained for agricultural purposes (Liu and Diamond 2005).

[7] The percentages were estimated using the total land are for China provided by FAOSTAT for 2021 (938,821,000 ha). China indicates its total land area to be 960 Mha, this figure is last included in the Statistical Yearbook of 2014.

[8] In the national forest inventory natural forests are closed forests with a minimum 20 % stocking (Xi et al. 2012).

Latest GHG emissions data for China is available for 2018 (China BUR3 2023). Total emissions for that year without LULUCF were 13,035 $MtCO_2e$. Agricultural emissions were 793 $MtCO_2e$ and accounted for 6.1 % of total emissions without LULUCF. The LULUCF sector was reported as a sink with -1,257 $MtCO_2e$, representing an increase compared to the figure reported for 2014 -1,115 $MtCO_2e$ (China BUR2 2018).

China has pledged to reach carbon neutrality before 2060 and to peak CO_2 emissions before 2030 (UN news 2021). The 2021 NDC submission mentions "structural adjustments in economy, industry, energy, transportation and consumption" to deliver benefits for both economic development and addressing climate change. In November 2023 China indicated that its next NDC will be economy wide and cover all greenhouse gases (United States Department of State 2023). In its NDC document China explicitly links the targets of carbon peaking and carbon neutrality with its plans for ecological conservation. The NDC includes the commitment to increase the forest stock volume by 6 billion m^3 from the 2005 level (up from the target of 4.5 billion m^3 stated in the previous NDC) and states the intention to promote soil carbon sequestration. According to the Chinese National Bureau of Statistics forest stock volume was 13.721 billion m^3 in 2005 and 17.560 billion m^3 in 2021, an increase of about 3.8 billion m^3 (NBS 2023). In its NDC progress submission to the UNFCCC, China (China 2022) indicates that forest stock volume in 2021 was at 19.493 billion m^3 (a 5.772 billion m^3 increase compared to 2005) and forest cover at 24.02 %. According to these more recent numbers, China has almost achieved its forest related NDC target set for 2030.

3.2.1 NbS implementation in China

Severe degradation of forests and grasslands and other ecosystems, environmental pollution, low air quality, and environmental disasters, such as droughts and floods by the end of the 20th century were the starting point of environmental policies in China focused on nature protection and restoration (Xu et al. 2006; Bryan et al. 2018a; Liu and Diamond 2005). A first Environmental Protection Law was adopted in principle and trialled in 1979; revised and formally enacted in 1989, and updated in 2016 (Zhang et al. 2016). The latest reform also formalized the goal of constructing an "ecological civilization" and introduced requirements for achieving this (Zhang et al. 2016). The Water and Soil Conservation Law was adopted in 1991 and amended in 2010, it aims to prevent loss, protect resources, reduce environmental disasters, restore the environment and guarantee sustainable economic and social development (Standing Committee of the National People's Congress 2010). Bryan et al. (2018a) provide a comprehensive analysis of environmental programmes implemented by the People's Republic of China since 1978 (Table 2). They identify three phases in which these programmes were put in place: from 1978 to 1997, which coincides with the economic opening and reform period of China, from 1998 to 2003 which coincides with a peak of disasters caused by environmental degradation and the period until 2015, the cut-off date of the analysis.

The concept of NbS has been widely adopted by China both at the national level and at the international level, it is seen as a means to integrate and improve the impact of actions in the areas of climate action and biodiversity protection (Qi and Dauvergne 2022; 2022; CCICED 2022). Nature-based solutions are a means to achieve the goal of constructing an "ecological civilization". This concept was introduced with the twelfth five-year plan (2011-2015), included in the Chinese constitution in 2018, and constitutes a framework for achieving development goals and modernization within ecological boundaries and recognizing the role healthy ecosystems play in maintaining society and its wealth. Another important concept to frame NbS in China is that of achieving "national ecological security", which requires the protection and

restoration of ecosystems. NbS implementation is driven from the top down, as the central government establishes the overall targets and issues standards and guidelines for the planning, implementation and monitoring of projects that qualify as NbS. A first such guidance was issued in 2020, the "Guidelines for Ecological Protection and Restoration Projects in Mountain, Water, Forest, Field, Lake, and Grass", issued jointly by the Ministry of Natural Resources, the Ministry of Finance and the Ministry of Ecology and Environment, but there is still the need to harmonize these standards with other older existing guidelines issued by multiple departments often only focusing on one ecosystem (Luo et al. 2024).

Table 2: List of major environmental programmes identified by Bryan et al. (2018a)

1978-1997 (economic opening)	1998-2003 (disaster years)	Until 2015
Shelterbelt Development Programme – Three North (until 2050)	Natural Forest Conservation Programme (until 2020)	Rocky Desertification Treatment Programme (until 2020)
Soil and Water Conservation Programme (until 2017)	Grain for Green Program, also known as Sloping Land Conversion Programme (in consolidation phase)	Grassland Ecological Protection Programme (until 2020)
Shelterbelt Development Programme – Five Regions (until 2050)	Fast-growing and High-yielding Timber Programme (until 2015)	Cultivated Land Quality Programme (until 2030)
Comprehensive Agricultural Development Programme (until 2020)	Forest Ecosystem Conservation Fund (until 2016)	
Soil and Water Conservation Programme Yangtze (indefinite)	Sandification Control Programme-Beijing/Tianjin (until 2022)	
National Land Consolidation Programme (until 2020)	Wildlife Conservation and Nature Protection Programme (until 2050)	
	Partnership to Combat Land Degradation (until 2023)	

Source: Bryan et al. (2018a)

Territorial planning also influences NbS implementation in China. The guiding principle for territorial planning in this case is "three areas, three lines" (Luo et al. 2024). The area component classifies the territory into three categories (ecological, agricultural, urban) and the lines component refers to three thresholds or "control lines" (ecological conservation red lines, permanent prime farmland, and urban development boundary) (Luo et al. 2024). The Ecological Conservation Redlines are used to delimit areas for the protection and conservation ecosystems and ecological functions (China Daily 2021). They are applied to all relevant ecosystems, including forests, grasslands, wetlands, mangrove forests and deserts (ibid).

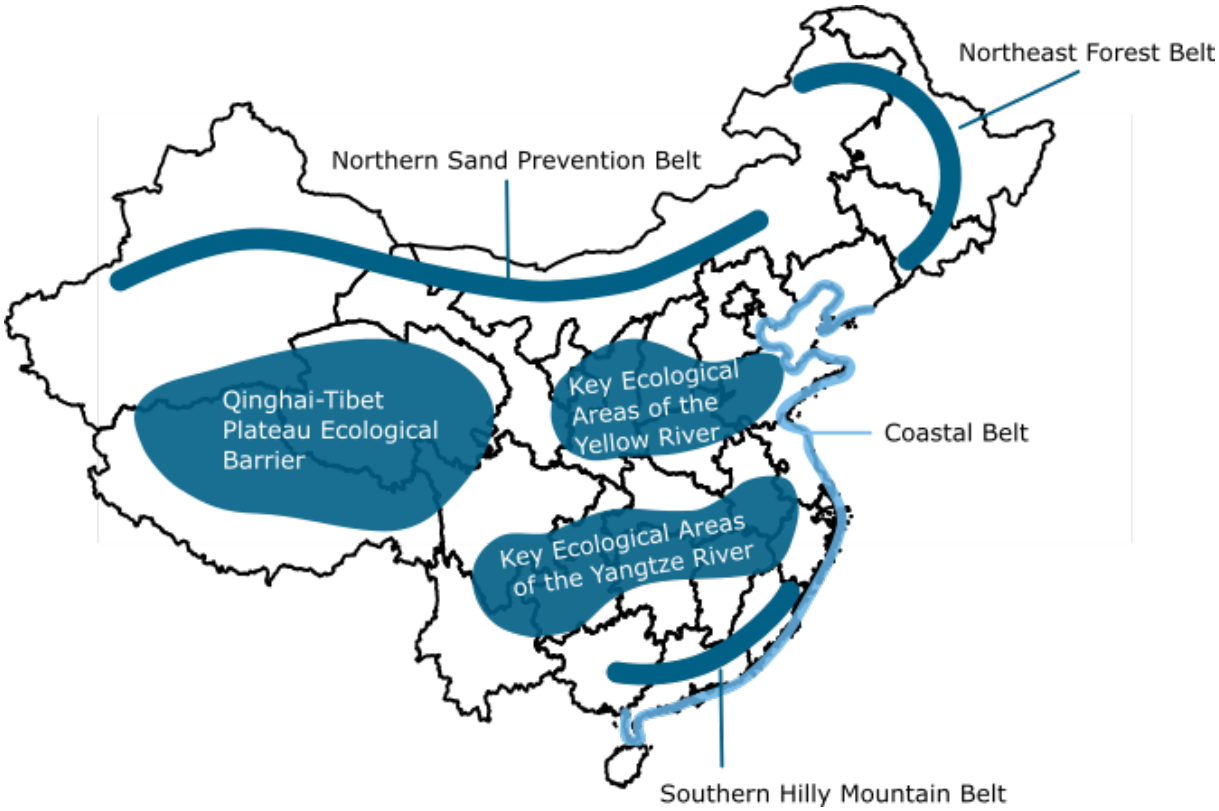
In 2020 the Chinese Government published the "Overall Plan for Major Projects for the Protection and Restoration of Nationally Important Ecosystems for the period 2021 to 2035" (the Plan) (National Development and Reform Commission 2020). The Plan has a comprehensive scope, it encompasses forests, grasslands, deserts, rivers and lakes, wetlands,

and oceans (Table 3). The focus lays on improving ecosystem conditions, ecosystem services and strengthening ecological stability, which are intended to provide ecological support to wider economic development projects, such as the development of the Beijing-Tianjin-Hebei region, the Yangtze River Economic Belt, the construction of the Guangdong-Hong Kong-Macao Greater Bay Area and the integrated development of the Yangtze River Delta.

At the national level, decision-making and implementation of the Plan are under the mandate of the National Development and Reform Commission, the Ministry of Natural Resources and the Ministry of Science and Technology. Other institutions involved at the national level include the Ministry of Finance, the Ministry of Ecology and Environment, the Ministry of Water Resources, the Ministry of Agriculture and Rural Development, the Ministry of Emergency Management, the China Meteorological Administration as well as the State Forestry and Grassland Administration. All these institutions were also involved in the development phase. Previously, the National Ecological Protection and Construction Plan was in place from 2013 to 2020. The overall objective stated in the 2021-2035 Plan is to build a national ecological security barrier by 2035 and to foster a harmonious coexistence between human beings and nature. It also includes quantified targets (Table 3). Until 2025 the focus will be on the protection and restoration of key ecological functional zones, the implementation of ecological protection red lines, and the consolidation of key nature reserves. Major projects will be implemented from 2026 to 2035. These will focus on the following seven key ecological zones (Figure 2):

- Qinghai-Tibet Plateau Ecological Barrier Zone
- Yellow River Key Ecological Zone, including the Loess Plateau Ecological Barrier
- Yangtze River Key ecological zone (including Sichuan-Yunnan)
- The Northeast Forest Belt
- Northern Sand Control Belt
- The Southern Hilly and Mountainous Belt
- The Coastal Belt

Figure 2: The location of the seven key ecological zones in China.



Source: Map for mainland China elaborated on the basis a map showing the ecological zones by Fu et al. (2023).

Although not all the details of the projects are specified, the major projects for each ecological zone and some concrete measures are laid out in the plan. For example, in the Qinghai-Tibet Plateau Ecological Barrier Zone, the focus will be on the restoration of the alpine ecosystem and measures will include the implementation of a grazing ban, and where grazing is allowed ensuring that it remains within the carrying capacity of the ecosystem, replanting grass, establish forests for water containment and soil conservation, protect habitats and establish ecological corridors for species migration, carry out land remediation on formerly mined land. The Northern Forest Belt holds most of the state-owned forest as well as important areas of primary forest and wetlands. These forests are also key for regulating the water cycle. Here the focus will lay on strengthening the protection of natural forests and wetlands, planting forests on mountains and returning farmland to forests and grasslands, restoring degraded forests, increasing the forest stock and cultivating rare tree species and quality timber.

In addition to the projects in the seven key ecological zones, the Plan also lays out actions to strengthen protected areas, referred to as nature reserves. China has a vast network of protected areas, consisting of 400 marine and 13,600 terrestrial protected areas (O'Meara 2021). The Plan specifically mentions protected areas such as, Qilian Mountains between the Loess and Mongolian Pleateaus, Northeast Tigers and Leopards between Jilin Province and Heilongjiang Province, Giant Pandas in Sichuan Province, Hainan Tropical Rainforests and Mount Everest National Park. Actions include adjusting the scope of nature reserves, marking their boundaries, delineating zoning according to management and control requirements, building a rare and endangered species gene depository, as well as establishing infrastructure to support the

reserves and allow them to be used for educational and recreational purposes. The gradual relocation of original residents from core protected areas is also intended. Whether this relocation of the local communities is guided by a participatory process and if people are properly compensated for leaving their homelands is not clear.

As overall support measures the Plan specifies strengthening research and technology development related to restoration and protection, as well as strengthening monitoring and surveillance. The Plan also mentions the need for policy reforms, for broadening investment and financing channels for nature conservation and protection, innovative management, improving compensation mechanisms and raising awareness among the population. The Plan indicates that the implementation of NbS in China has a strong link to national spatial planning, since the establishment of ecological functional zones, ecological red lines and nature reserves are all integrated into spatial planning. It also identifies challenges for ecosystem restoration and protection, which include:

- ongoing pressure from economic development, causing ecosystem degradation;
- limited coherence between different goals, projects, and governance arrangements;
- limited acceptance of measures, often due to a lack of clearly defined rights and responsibilities
- management approaches that do not sufficiently consider ecosystem functioning;
- limited water availability for the projects, since there is severe over-use of water for other purposes, water cycles have been disrupted, and there is limited reuse of wastewater;
- dependency on government funding and lack of private investment;
- limited scientific and technological capacities, for example related to the design of effective measures as well as to monitoring and evaluation.

Another challenge for the implementation of NbS in China is the need to integrate the work of several departments at the local level, which may have conflicting policy targets, for example environmental departments, forestry and grassland departments and housing and construction departments (CCICED 2022).

Table 3: Quantified objectives in the Plan for Major Projects for the Protection and Restoration of Nationally Important Ecosystems for the period 2021 to 2035

Ecosystem	Target
Forests	Increase forest cover to 26 % Increase forest stock to 21 billion cubic meters. Stabilize the area of natural forests at around 200 million ha.
Grasslands	Restoring 60 % of grasslands towards comprehensive vegetation cover
Wetlands	Stabilize the area of wetlands, stop its reduction. Stop the reduction in the number of wetland areas. Protect 60 % of wetlands.
Marine and coastal	35 % of the coastline is protected
Several	Establish 56.4 million m^2 of soil erosion control areas. 75 % of treatable sandy land has been treated.

Ecosystem	Target
	Nature reserves, mainly national parks account for more than 18 % of the land area.

The implementation of NbS in China builds on previous policy efforts, but there is no integrated policy framework with them as a central component (CCICED 2022). Although the international definitions and criteria for NbS are recognized and accepted in China (Luo et al. 2024), China is also developing an own framework, which includes criteria such as the scale at which they are designed (national and local), economic viability, the government processes underlying them, the consideration of trade-offs between environmental goals and the provision of other services, and the integration into spatial planning at jurisdictional scale (CCICED 2022). Luo et al. (2024) point out that the protection and restoration projects as well as promoted NbS measures show a mainly resource management perspective.

Efforts at the national level also feed into the multilateral engagement of China in the area of NbS. In 2023 China entered a collaboration with the IUCN to establish the Asian nature-based solutions hub, with a focus on undertaking research and demonstration projects, developing and promoting technical information to guide implementation, capacity building, and cooperation and exchange with other institutions. A 2023 collaborative publication between the Chinese Ministry of Natural Resources and the IUCN (IUCN 29 May 2023) presents 10 concrete NbS case studies, which include watershed management and restoration to safeguard Beijing's water security, landscape restoration in the Helan Mountains, conservation of black soils to ensure food security and mangrove restoration in the Shenzen metropolitan zone to improve resilience. The case studies are categorized as NbS in natural ecosystems, agricultural ecosystems and urban ecosystems.

3.2.2 Examples of NbS measures in China

3.2.2.1 Afforestation and forest protection: The sloping land conversion programme and the Natural Forest Conservation Programme

Chinese forest ecosystems range from boreal to tropical (Lu et al. 2022), resulting in regionally different mitigation potentials and policy requirements. According to the 9th National Forest Inventory (2014-2018), China currently has 138.7 Mha classified as natural forests and 79.5 Mha of plantations or "nurtured forest" (National Forestry and Grassland Administration 2019). More than 30 Mha of forests are located in protected areas (FAO 2020).

The Sloping Land Conversion Programme (SLCP), also known as the Grain for Green Programme, is a nationwide programme with the overall objective "to increase forest cover, alleviate soil erosion, conserver biodiversity, and increase rural household income" (Bryan et al. 2018b). It came as a response to decades of forest loss as well as unsustainable farming and grazing practices on slopes, floodplains and unstable soils (Bryan et al. 2018a). The SCLP pays subsidies for farmers to convert marginal agricultural land or land on slopes to forests or grasslands. It provides payments per hectare, training and access to seedlings (Bryan et al. 2018b). As of 2020, the SLCP had achieved establishing forest on more than 34 million ha, reached 41 million farmers and received a total investment of over 77 billion USD (numbers converted from Deng et al. (2023)). It currently is in a so-called "consolidation phase", where payments continue but no further conversion targets are issued (Shang 2023).

In 2019 China issued a new Plan for Natural Forest Protection and Restoration (Natural Forest Protection Programme, NFPP). It targets 200 million ha by 2035 and has a long term vision until 2050 focusing on the whole forest ecosystem (State Council of People's Republic of China 2019). The plan will ban all commercial logging in natural forests and strengthen the surveillance and

control system, including the introduction of fines. According to the State Council (2019), China has spent more than 400 billion yuan ($57 billion) in forest protection and restoration in the last twenty years, with funds coming mainly from the central government and to some degree from local governments. The programme is implemented under the authority of the National Forestry and Grassland Administration and concreate work will be carried out by local governments. The NFPP also includes a component of planting forests, which are referred to as "national reserve forests" and aim to reduce the pressure on natural forests, while ensuring wood supply. The first NFPP was established in 1998, it first focused on eliminating or reducing harvesting in natural forest in priority areas, where forest loss was causing significant environmental problems, for example the upper reaches of the Yangtze River and Hainan and Xinjiang provinces (Bryan et al. 2018b). In its second phase it focused on harnessing ecological benefits of forest and increasing harvesting from plantation forests. Until 2050 the focus will lay on restoring natural forests and increasing plantation forest's productivity to meet domestic demand (Bryan et al. 2018b).

This measure was selected for analysis because the Chinese NDC includes an explicit forest related target and because of the long experience accumulated with these programmes. The SLCP started its pilot phase in 1978 and the NFPP started in 1998. Action on forests is a priority for China since according to the 2035 Restoration Plan available forest resources do not sufficiently cover national demand and are of low quality, and there is still pressure on natural forests. (National Development and Reform Commission 2020). Forests also play a key role for China in achieving its 2060 climate neutrality target.

According to the assessment by Bryan et al (2018b), the SLCP and how it was carried out in the early stages also had negative impacts on biodiversity and in addressing societal challenges.

These challenges include:

- Reduced availability of farmland with impacts on food security.
- Increased water stress on non-forest ecosystems in arid and semi-arid ecosystems because water was diverted to establish forests.
- Tensions in water demand between established forests and water use for the population and industrial uses.
- Loss of bird and bee biodiversity because the project prioritized planting monoculture and simple-mixed forest.

Some of the problems identified by Bryan et al. (2018a) are trade-offs that result from the change in land use. For example, a reduced water availability for the population and a decreased area of agricultural land resulted from the expansion of forests. Finally, the Chinese government attempted to improve the compensation to farmers and simplify payments. No information could be found on whether the concrete practices of forest planting have been changed. Hence, it can be concluded that the afforestation and reforestation measures of the SCLP programme do not meet all criteria of NbS measures due to the unintended ecological effects of forest increase on other ecosystems and potentially on the food security of the local population.

As for the NFPP Bryan et al. (2018b) found mainly economic problems resulting from the programme. The revenue for forestry workers declined because industry and local governments were not allowed to harvest timber anymore. However, with time, workers have been retrained and relocated, for example for working in restoration activities.

Three recent studies estimated the mitigation potential for afforestation in China, which have a large variation due to differing assumptions and methods. Lu et al. (2022) estimates an annual

sequestration potential of 77 Mt CO2e yr^{-1} from 2020 to 2030, assuming afforestation on 21.7 Mha and using a method that considers the stand age of trees. For 2020 to 2060 the potential is estimated to be 235 Mt CO2e yr^{-1}, assuming afforestation of 31.8 Mha. Wang et al. (2022) estimate a potential annual sequestration of 118 Mt CO2e yr^{-1} from 2020 to 2060, assuming afforestation of 40.9 Mha. Whereas the estimate by Qiu et al. (2020) for 2050 is 711 Mt CO_2e yr^{-1} assuming the total forest area is 297.1 Mha in that year.

Monitoring of the two programmes takes place at different levels of government. The NFPP is monitored every three years at the local, provincial and national level. The State Forestry Administration is the main responsible for verifying and evaluating programme implementation (Bryan et al. 2018b). The SLCP monitoring is carried out by local governments and since 2016 they must follow the "specifications of monitoring and evaluation of ecological benefits of the grain for green programme" (Bryan et al. 2018b) by 2015.

3.2.2.2 Programme of Soil and Water Conservation in Key Areas of the Upper Yangtze River

The Yangtze River basin covers more than 1.8 million square km. The river runs from West to East. Its headwaters are located in the Tibetan mountains and it discharges into the East China Sea by Shanghai (Encyclopedia Britannica 2024; 2024). Soil and water erosion are amongst the most severe environmental problems of China, they cause the loss of arable land (more than 30 million ha in the last 50 years), economic damages of several percentage points of GDP, and are a contributing factor to poverty in the affected regions. (Ministry of Water Resources China 2015). The upper and middle reaches of the Yangtze River are severely affected by soil erosion and water loss (ibid). This is a result of their biophysical characteristics, such as the mountainous topography, high rainfall, soil and substrate composition, as well as a high population density and traditionally unsustainable land management practices (Bryan et al. 2018b). The Yangtze River basin also encompasses 11.5 million ha of inland wetlands, including marshes and riverine wetlands (Ye et al. 2022). The largest part of the Basin is also referred to as Yangtze River Economic Belt, which is home to over 40 % of Chinese people and contributes to over 40 % of GDP (Chen et al. 2017). The Yangtze River Basin also encompasses 93 national nature reserves (Zhang et al. 2023).

The Yangtze River Conservation Programme focuses on promoting erosion control in the upper reaches, improving the ecological conditions of the river, and promoting economic and social development in the impacted regions. The goal is to reduce sedimentation of the Yangtze River and allow for the continued operation of the Three Gorges reservoir and dam (Bryan et al. 2018b). The programme is implemented in a bottom-up manner. Bryan et al (2018 b) specify that concrete projects are proposed by counties to their provincial water and soil conservation authorities on an annual basis. The Yangtze River Water Conservation Commission then assesses the proposed projects and planned investments and sends this information to the Ministry of Water Resources for final approval. Actions implemented include erosion control on sloping farmland, watershed rehabilitation, reforestation and grassland restoration, soil improvement on farmland, restoration of mined land. The government is the main funding source for this programme. According to Bryan et al (2018b) it had invested 1.6 billion US dollars.

Actions are mainly implemented at watershed level of tributaries to the Yangtze River. For example, in the district of Naxi in Sichuan, soil and water conservation of the Qingxi River contributed to reducing annual soil loss by 75,000 tons, significantly improving water quality and improving farmer's income. This project was financed by combining dedicated funds for

water and soil conservation, with agriculture related funds and social funds, reaching about 750 yuan (Xinhua News Agency 2021). Civil society organizations are also involved in conservation actions in the Yangtze River Basin, for example WWF and Conservation International (WWF 2020; TNC 2024).

The Yangtze River Water Conservation Commission is also tasked with monitoring implementation and progress. Latest results for 2020 show an increase of forest cover in the upper reaches to about 48 % and that the area of barren hills and slopes has decreased by 70 %. However, 220 000 km^2 are still exposed to erosion.

3.2.3 Initial conclusions from NbS implementation in China

China's efforts to promote NbS are the result of severe environmental problems, that have had negative impacts on people and the economy. A focus lays on restoring lost ecosystem functions. The highest levels of government recognize the interdependence of human wellbeing, economic development and healthy ecosystems. This is reflected by the goals of constructing an ecological society and achieving ecological security. Chinese restoration efforts have an ecosystem approach and are strongly linked to territorial planning. China has long experience in implementing protection and restoration measures it considers as NbS. Reforestation is especially prominent, but has also caused ecological problems, for example through the establishment of artificial forests, monocultures and the use of non-native tree species. Therefore, these measures do not always fulfil the official criteria of the UNEA (2022) NbS definition and may cause new ecological and social problems instead of solving them. Additionally, NbS measures often are implemented in a top-down approach and lack public participation and fair compensation policies (Luo et al. 2024). According to (Human Rights Watch 2024) involuntary relocations of rural Tibetans have been observed, which were justified by the local government with "livelihood improvement" and "environmental protection" reasons. This is of course not in line with NbS criteria.

The implementation of the measures in China are tied to long term government programmes, with secure funding, which may be potentially positive for the success of the measures, especially for long-term restoration processes such as reforestation. In cases where restoration measures were accompanied with efforts to alleviate poverty and increase rural incomes, this supported acceptance of their implementation among the population. Hence, supporting human wellbeing and economic development are important for the implementation success of NbS measures in rural areas. Given the progress made by China in the past, the ambition of current restoration targets may be limited. For example, the Restoration Plan has a target to restore forest area to 26 %, while data of 2022 yearbook showed forests already covered an area of 30 % (data for 2023 is not yet available). However, this discrepancy may also be related to varying forest definitions within China used for different reporting purposes. Another reason could be more recent conflicts between forest restoration efforts and efforts to restore agricultural lands, which have led to reversals in forested areas under the Sloping Land Conversion Programme (Shang 2023).

3.3 Ethiopia

The Federal Democratic Republic of Ethiopia is a landlocked country, located in the Horn of Africa and spanning across 1,112,000 square kilometres (Embassy of Ethiopia - 2019). It shares borders with Eritrea, Djibouti, and Somalia in the east, Sudan and South Sudan in the west, and Kenya to the south. Ethiopia is the 10th largest country in Africa (Fashing et al. 2022). With about 123 million people (2022), Ethiopia is the second most populous nation in Africa after

Nigeria, and one of the fastest-growing economies in the region, with an estimated 6.4 % growth in the financial year 2021-2022. However, it also remains one of the poorest, with a per capita gross national income of US$1,020 (World Bank 2023). Ethiopia's economy relies heavily on agriculture and forestry, employing 80-85 % of the population (CAT 2020). Ethiopia is recovering from a severe internal conflict between the government and the Northern region of Tigray, which has been mostly pacified through a peace agreement in early 2022.

Ecologically, Ethiopia's topography varies significantly and presents a diverse set of ecosystems and climates. The lowlands in the southeast and northeast cover approximately 55 % of the land area and are tropical with average temperatures of 25-30 degrees Celsius. The Abyssinian highlands run in a north-south direction through the centre of the country, reaching over 3000m elevation, with the highest peaks up to 4500m above sea level, generating unique afro-montane forests and landscapes. They cover about 45% of the land and have a much cooler climate, averaging temperatures between 15-20 degrees Celsius. Forests cover approximately 15.7 % of the national territory, equating to 17.35 million ha (UNDP 2024) of land area.

Ethiopia is home to one of the richest and most unique assemblages of fauna and flora on the African continent. It holds two major centres of endemism: the mesic Roof of Africa (also known as the Ethiopian Highlands) and the arid Horn of Africa, resulting from the country's varied topography and consequent geographic isolation (Fashing et al. 2022). There is an estimated number of 6,000 species of higher plants of which 10 % are endemic (CBD 2023b). Flagship endemics of the Highlands include the Ethiopian wolf (*Canis simensis*), gelada monkey (*Theropithecus gelada*), and Bale monkey (*Chlorocebus djamdjamensis*), amongst others. Ethiopia is a centre of origin for cultivated crops such as coffee, teff [9], enset[10]. Other important, crop species include durum wheat, barley and sorghum (CBD 2023b). Today, Ethiopia's biodiversity is threatened by rapid human population growth and land use change (Williams et al. 2005).

Ethiopia submitted an updated NDC in 2021 in which it commits to reducing emissions by 68.8 % compared to business-as-usual (BAU) projections by 2030, including a 14 % unconditional reduction and a 54.8% contingent on international support (FDRE 2021b). This is a 20-80 % split of the total financing needs of USD 361 billion for both mitigation and adaptation measures. According to the NDC, the country's emissions were at 247.5 $MtCO_2$ in 2010 and are expected to grow to 403.5 $MtCO_2e$ by 2030 in a BAU scenario (FDRE 2021b).

The main contributor to GHG emissions is the agricultural sector, in particular livestock, followed by land use, land use change and forestry. Both sectors together represent 83 % (LULUCF 35 % and livestock 48 %) of total BAU emissions in 2030 (FDRE 2021b). Agriculture, in particular livestock, is a key emitting sector, accounting for close to 50 % of emissions in 2010, followed by LULUCF at 35 % (FDRE 2021b). The LULUCF sector emissions are estimated to rise to 140.2 Mt CO_2e in 2030, compared to 120 Mt CO_2e in 2010. The emissions from LULUCF have mostly resulted from conversion of forested land for agricultural use and wood fuel consumption (FDRE 2021b).

The latest NDC indicates that the LULUCF sector presents the largest mitigation potential of the country mainly due to ambitious reforestation and restoration targets. In this regard, under an unconditional scenario, Ethiopia commits to reducing LULUCF emissions to 91.8 Mt CO_2e, compared to reducing them to -99.9 Mt CO_2e with conditional support. This equates to a mitigation potential of 48.4 Mt CO_2e unconditionally, and 240.1 Mt CO_2e conditionally, which equates to a relative reduction of 34.6 % and 171 % respectively compared to BAU in 2030.

[9] Teff, also known as Eragrostis tef, lovegrass, or annual bunch grass, is an annual grass, a species of lovegrass native to the Horn of Africa, notably to both Eritrea and Ethiopia

[10] Enset, also known as Ethiopian banana, is an herbaceous species of flowering plant in the banana family Musaceae.

These targets are extremely ambitious, and their feasibility may need to be further assessed. The mitigation potential of the LULUCF sector is partially supposed to compensate for remaining significant livestock emissions to achieve the overall ambitious mitigation target. The NDC also sets out separately defined adaptation actions for each sector, which are aligned with the country national adaptation plan (NAP) (FDRE 2021a).

3.3.1 NbS implementation in Ethiopia

Ethiopia's latest NDC highlights specific NbS measures to achieve its mitigation targets. Mitigation-focused measures include actions for sustainable agriculture by introducing sustainable land management practices and reducing pre-harvest losses, grassland management improvement, reducing residual biomass use through improved cook stoves, reforestation, and restoration. For the latter two, the NDC outlines specific quantitative targets, namely: (i) reforesting 3 million ha of land by 2030 (unconditional) and (ii) restoring 5 million and 9 million ha by 2030 and 2050 respectively (conditional). Species-specific information of the type of trees and vegetation per activity is also provided[11]. This strong emphasis on reforestation and restoration measures reflects clear alignment with other national development plans and targets.

In addition, the updated NDC includes 40 prioritized adaptation actions that derive from the NAP and align with the 10-year National Development Plan (10YDP). These were defined after a thorough assessment of the 18 key adaptation options outlined in the NAP and the numerous adaptation actions under the NAP Implementation Roadmap (FDRE 2021a). The majority of the 40 prioritized adaptation actions are within the agriculture and LULUCF sectors, with additional contributions in the water, health, energy, transport and human settlement sectors. There are 5 forestry and 2 land use priority adaptation measures, through which further climate actions in these sectors will be supported. One of the land use priority adaptation areas specifically links to biodiversity conservation by aiming to "enhance climate resilient livelihoods of wildlife resource dependent communities in protected areas". Under this target, Ethiopia aims to increase the number of dependent communities benefitting from climate resilient wildlife resources from 30,000 people in 2018 to 1.5 million people by 2030 (FDRE 2021b).

The NDC was designed in full alignment with several key national planning documents, which provide guidance on NbS targets and actions. The foundation is the Climate Resilient Green Economy Strategy (CRGE), published already in 2011. The strategy aims to keep greenhouse gas (GHG) emissions low and build climate resilience, while achieving middle-income status by 2025 (FDRE 2011). It identifies four key pillars to building Ethiopia's green economy, which include improving agricultural production, protecting, and re-establishing forests, expanding renewable energy, and using energy-efficient technologies. The supporting Climate Resilience Strategy for Agriculture and Forestry (2015) provided sector-specific details for this strategy. Operationalization of the strategy was achieved through several Growth and Transformation Plans, the latest of which (GTP 2) covered the period between 2015-2020. The recently endorsed 10YDP from 2021-2030 is the new flagship development planning strategy, which is fully aligned with the updated NDC, and provides further overarching guidance towards achieving a climate resilient green economy for all sectors (FDRE 2020). Within the forest and environmental section of the plan the Government targets to increase greenhouse gas emissions reduction capacity from the present 92.7 Mt CO_2e to 162.3 Mt CO_2e.

[11] Reforestation: 20% moist Afromontane, 60% dry Afromontane, 10 % Acacia-Commiphora, 10% Combretum-Terminalia, Restoration: 10% moist Afromontane, 60% dry Afromontane, 10% Acacia-Commiphora, 20% Combretum-Terminalia

Regarding the forestry sector, the National Forest Sector Development Programme (NFSDP) provides clear sector-specific objectives and targets (UNDP 2018). The three-volume series of guidance documents inform forest-related policies, interventions, and activities to transform the forest sector in Ethiopia. The NFSDP is a country-driven initiative that serves as a master plan for the enhancement of sustainable forest management in the country for the period from 2016-2025. It acts as the umbrella framework for translating the CRGE and GTP2/10YDP objectives into actionable measures required to achieving these national objectives (Government of Ethiopia 2016). The NFSDP outlines six pillars, three of which define clear NbS targets under different categories, namely (i) sustainable forest production and value chains, (ii) forest environmental functions, and (iii) forests and rural livelihoods. Many of these targets informed Ethiopia's updated NDC and are aligned with it, with emphasis on reforestation and landscape restoration. Finally, in a more recent achievement, Ethiopia developed its Long-Term Low Emission Development Strategy (LT-LEDS) which defines climate pathways and targets until 2050 and was officially launched in May 2023 (GGGI 2023). Ethiopia is also a member of the Carbon Neutrality Coalition (CNC 2024).

Land and forest degradation are severe problems in Ethiopia, causing low agricultural productivity, food insecurity and rural poverty. These trends could be further amplified by anticipated climate impacts. As such, on a political level, Ethiopia's longstanding priority is forest and landscape restoration to address socioeconomic dimensions, energy needs (fuelwood and charcoal), and climate and biodiversity goals[12]. Ethiopia aims to increase its forest cover from 15.5 % to 30 % and increase the coverage of wildlife habitats from the present area of 8.6 % to 14 % (10YDP). Specific targets and measures are outlined in a multitude of guidance and planning documents, with the 10YPD being the main national planning document, which guide NDC implementation. There is an ongoing process of mainstreaming NDC/10YPD targets into respective sectoral strategies and plans.

Regarding biodiversity projects, it is noteworthy that for many years, the German Nature and Biodiversity Conservation Union (NABU) has been supporting the conservation and biodiversity programme in the Kafa Biosphere Reserve, which is also a UNESCO World Heritage Site. The project enhanced prior efforts on reforestation, participatory forest management and the supply of energy-efficient stoves and further expanded them to integrate further areas and communities in Kafa (NABU n.d.). The Ethiopian Biodiversity Institute is tasked with the conservation and sustainable utilization of all forms of biological resources including plants, animals and microbial genetic resources as well as associated indigenous knowledge.

Having ambitious LULUCF targets poses risk and limitations if proper safeguards are not implemented. Considering the pressing need to meet rising wood and energy demands of the growing local population, the Ethiopian government has opted to utilize exotic tree species to ensure fast growing biomass, such as eucalyptus, specifically in agricultural landscape, whilst greater emphasis is placed on indigenous species in protected areas[7]. However, these species may not always be planted in the most appropriate location, and whilst they may restore the structure of a forest, the restoration of key functions may not be achieved. Furthermore, whilst the tree planting campaign under the Green Legacy Initiative is internationally recognized, with Kenya joining Ethiopia in the effort, there are also questions around choice of ecologically appropriate species as well as the survival rate of the seedlings, especially in light of the frequent and severe droughts[7] (BBC News 29 Jul 2019).

With regards to the monitoring and reporting of NbS measures, specifically those outlined within the NDC, activity level emission reductions are monitored and verified through sectoral MRV

[12] Personal communication, 13 Nov 2023, Dr. Lalisa Duguma (Global Evergreening Alliance)

systems upon implementation of each activity in the context of the 10YDP (Government of Ethiopia 2021). The NDC outlines a clear MRV and M&E framework, however international support will be required to implement it. Nevertheless, progress will be measured through sectoral targets and indicators outlined in the 10YDP, which will feed into NDC progress reporting and subsequently into the Biennial Transparency Reports.

3.3.2 Examples of NbS measures

In its updated NDC, the Government of Ethiopia indicates that the LULUCF sector holds the largest mitigation potential because of highly ambitious reforestation and restoration targets. The potential for net emission removals can be realized through reforesting or restoring up to 15 million ha as a long-term forestry sector goal. This is based on several policies, initiatives and measures, including the Green Legacy Initiative and REDD+ strategic actions, as explicitly highlighted in the NDC. As such, the following two initiatives are further investigated: The government-led Green Legacy Initiative (GLI), which drives the national-level tree-planting agenda in the country, and the World Bank funded jurisdictional REDD+ Oromia Forest Landscape Program (OFLP), which serves as a jurisdictional REDD+ pilot.

3.3.2.1 The Green Legacy Initiative (restoration and reforestation)

Ethiopia's landscapes are massively degraded; about 18 million ha of degraded land is potentially suitable for afforestation and reforestation. In this regard, the Government has prioritised reforestation and landscape restoration and formulated ambitious targets, as reflected in its NDC, and commitments to the New York Declaration on Forests, AFR100 and the Bonn Challenge. Ethiopia made the largest commitment to AFR100 on the African continent, pledging to restore 15 million ha of degraded land by 2030 (AFR100 2023). This is 15 % of the total continental target of reforesting close to 100 million ha. The Green Legacy Initiative (GLI) is a national-level initiative to re-green the country launched by Prime Minister Abiy Ahmed in 2019 under the National Green Development Program. It sets out annual tree-planting targets with a goal of regreening Ethiopia, restoring degraded lands, increasing the forest cover and reducing the impact of climate change. It is currently not anchored under a specific policy or strategy, but mainly driven by the Prime Minister's Office. The Prime Minister's personal commitment and drive have contributed to the nationwide reach of the GLI. The GLI aims to implement national policy priorities such as the CRGE strategy, the NDC, the National Adaptation Plan and the 10YDP. The initiative further aims to address other ecosystem services, such as biodiversity, and soil and water conservation, as well as addressing food security, with an aim to increase adaptability; it meets the criteria for defining an NbS according to Reise et al. (2022).

In its first phase between 2019 and 2023, the GLI targeted to plant 20 billion trees across the country (GLI n.d.). According to official Government data, this was a combination of forestry, agroforestry and fruit seedlings, targeting both rural and urban areas, although it appears urban areas received a higher level of attention. In 2018, the Environment, Forest and Climate Change Commission (EFCCC), in collaboration with the World Resource Institute (WRI), developed a National Tree-Based Landscape Restoration Potential and Priority Map 2018 (Wondimu Zeleke, A., Mengistu Woldie, T., Landsberg, F., Alemu Yimer, B., and Geda Ayane, T. 2018). The map shows a total of 82 million ha of land as having potential for tree-based restoration, of which 11 million ha are classified as priority requiring rehabilitation. There is little evidence to show that this map is being used in informing GLI activities in the country (Kassa et al. 2022). Nevertheless, according to official Government reports, trees were planted in all regions of the country, and the total far surpassed the initial goal. By the end of the fourth year, it was reported the country

had planted 25 billion seedlings by mobilizing more than 20 million citizens throughout the nation, according to Government sources (UN 2024). Phase 2 of the project aims to plant 25 billion seedlings in different agro-ecological zones over the next 4 years.

The initiative is primarily financed by the Government of Ethiopia; although readily-available financing data is limited. By 2022 it appears that more than 420 million birr (about US $11.6 million) have been allocated to federal ministries, agencies, regional states and city administrations for GLI implementation (Fikreyesus et al. 2022). However, it seems the GLI has no official budget line, and thus spending is spread across many events, and figures lack coherence (ibid.). Given the nationwide coverage, multiple other donor projects with similar restoration and reforestation goals have contributed to the overall reforestation and afforestation agenda, such as the World Bank-funded Resilient Landscape and Livelihood Project, or the REDD+ Investment Program (World Bank 2024a). Nevertheless, there appear to be little to no established direct links with these programs. Ethiopia also submitted a Project Idea Note (PIN) to the Green Environmental Facility (GEF) for its STAR allocation 8, in which it seeks funding for Phase 2, namely to scale up best practices and optimize benefits through standardization of the regreening intervention (GEF 2024). Submitted in October 2023, this PIN proposes as grant contribution of USD $8,932,420, with co-funding of USD $27,500,000 over a project duration of 4 years (GEF 2024). Should this grant be approved, it is a turn in the funding strategy; up until now it appears the Prime Minister insisted the GLI to be fully state-funded, so as to increase ownership of the initiative.

At the federal level, the GLI is governed by a national Steering Committee (SC) composed of the Ministry of Agriculture (MoA, Chair), the Environment, Forest and Climate Change Commission (EFCCC, Secretary), the Ministry of Water and Irrigation (MoWI, member), the Ministry of Innovation and Technology (MoIT, member), the Ministry of Urban Development and Construction (MoUDC, member) and the Ministry of Education (MoE, member). It is answerable to the Office of the Prime Minister (PMO) and is advised by a Technical Committee (TC). The TC is made up of the above-mentioned sectoral institutions and is mainly responsible for day-to-day planning, implementation and reporting of GLI activities. It also advises the MoIT, which takes the lead on knowledge management and maintains the GLI database. Both the SC and TC communicate official figures and achievements of the GLI. It is important to note the frequent political restructuring in recent years and Ministries and Departments are frequently renamed. This may influence the most recent departments as part of the SC and TC.

The GLI is seen to be locally designed, implemented and owned. It appears that the Government has the ability to inspire action and mobilize large number of its citizens, mainly driven by the Prime Minister. In 2019's planting season, the country aimed to plant 200 million tree seedlings in 1000 sites across Ethiopia in just one day. It was claimed that the goal was overachieved, and within 12 hours a total of 353,633,660 tree seedlings planted. Some sources deemed this as a new world record (BBC News 29 Jul 2019). Ambitious tree planting requires the generation of sufficient seedlings. Consequently, the Government reported that it had developed more than 120,000 nurseries throughout the nation, and created more than 767,000 jobs, mostly for women and youth. Additional livelihood benefits result from the explicit inclusion of fruit trees, to provide socio-economic opportunities for communities (Kassa et al. 2022). Another notable success is the raised awareness regarding key issues, such as the need for land rehabilitation, amongst some sections of society, especially in urban centres where the GLI has prioritized its focus.

Based on figures reported by the PMO, it was claimed that survival rates of planted trees in 2019 and 2020 were as high as 83.4 % and 79 % respectively (Fikreyesus et al. 2022). These figures however need to be considered with caution, given that there is no dedicated monitoring, evaluation and reporting program in place (Kassa et al. 2022). There seem to exist some discrepancies between the level of success that is reported in official figures and actual impact on the ground. Additional challenges and shortcomings appear to be a disconnect and lack of inclusive decision-making with communities and farmers (ibid.). Few farmers see economic or social benefits from the GLI. Meanwhile, some have incurred losses after being denied access to land previously used for grazing and growing fodder (Fikreyesus et al. 2022). User rights to many of the planted trees are also unclear. Furthermore, site-selection based on ecological factor is limited, and evidence is limited to suggest that planned activities by local experts and communities were adequately informed by the available scientific knowledge and decision-support tools. Finally, some concerns have been raised regarding the planting of exotic species, such as eucalyptus. It appears Phase 1 widely encouraged the planting of non-indigenous trees, which would not directly increase biodiversity conservation value. It seems lessons have been learnt, and the government is prioritizing indigenous species in phase 2. Finally, there is also a lack of appropriate documentation of the planting efforts from which future lessons could be drawn (Kassa et al. 2022).

Lessons to be drawn include the fact that it is possible to achieve nationwide tree planting efforts and mobilize an entire population through strong leadership and a charismatic campaign. On the other hand, there is the need to have a centralized strategy including a clear budget, clarity of communities' user rights to the tree once planted, a more inclusive decision-making procedure, and planting appropriate species in adequate sites based on scientifically evaluated maps and guidance. Furthermore, it is also important to engage community members, especially farmers, from the beginning and to provide post-planting follow-up support to increase actual survival rates.

3.3.2.2 Oromia Forest Landscape Program (REDD+)

Ethiopia's drivers of deforestation are primarily subsistence and commercial forest conversion for agriculture, unsustainable livestock grazing and extraction of fuelwood and charcoal. Recognizing this, Ethiopia embarked on its REDD+ readiness journey in 2008. Supported by the Forest Carbon Partnership Facility (FCPF), the government completed its Readiness Preparation Proposal (R-PP) in 2011 and has since completed its REDD+ readiness elements (BioCarbon Fund ISFL 2024). The Oromia National Regional State holds Ethiopia's largest forested landscapes, which are home to 41 % of the country's forests and over 30 million people. This makes it an important focal area for improved forest management and implementing REDD+ activities. The region has benefited from various land use focused projects. One of the initiatives is the jurisdictional REDD+ Oromia Forest Landscape Program (OFLP). Given the program's characteristics of implementing locally appropriate actions, contributing to sustainable development, addressing biodiversity conservation, ensuring adaptability with natural ecosystem processes and supporting adaptability, it meets the criteria of a NbS as outlined by Reise et al. (2022).

The OFLP entails multi-stakeholder and multi-partner initiatives that address different aspects of land use conversion. The REDD+ component of the OFLP speaks specifically to several policy instruments. Under the national Climate Green Resilient Strategy (CRGE), Ethiopia identified sector-specific activities with a high mitigation potential, for which REDD+ was identified as an investment instrument. Consequently, it is one of the four fast-tracked programs for realizing

targets set in the CRGE (Ministry of Environment, Forest and Climate Change 2018). It is also embedded within the National Forest Sector Development Plan (NFSDP) and the REDD+ Strategy outlines policies and measures for addressing deforestation and degradation. Studies undertaken for the OFLP in fact served as a foundation for defining the National REDD+ Strategy. The OLFP also contributes to the 10YDP, the NDC, the GTP-2, and the 2015 Climate Resilience Strategies for Agriculture and Forest, amongst others.

The OFLP REDD+ component seeks to reduce deforestation by improving sustainable forest management and reforestation activities. It also aims to address emissions resulting from the livestock sector. The program began implementation in 2017 and is supported by the World Bank BioCarbon Funds' Initiative for Sustainable Forest Landscapes (ISFL), serving as a jurisdictional REDD+ pilot program (BioCarbon Fund ISFL 2018). The first phase of the program aimed to support the Government of Ethiopia to strengthen its state-level and local-level enabling environment and implement selected on-the-ground investment activities. At the local level, these grant activities were invested in participatory forest management and reforestation in targeted sites in 49 districts (woredas) that are deforestation hotspots (BioCarbon Fund ISFL 2018). At a state level, the funds were deployed to enhance and strengthen systems related to safeguards, forest monitoring, and cross-sector coordination. The second phase of the BioCarbon funding support included selling Emissions Reductions resulting from activities while also leveraging greater financial resources from multiple sources (ibid.).

Oromia state also hosts independent REDD+ projects, such as the Verra-verified Bale Mountain Eco-Regional REDD+ Project (BMERRP), implemented by Farm Africa and SOS Sahel Ethiopia, and the REDD+ Joint Participatory Forest Management Project Phase II in South-West Ethiopia (REPAFMA II - SW Ethiopia), financed by Norway. These projects are scheduled to be nested/ merged within the OFLP and will be governed by the same rules for coordinating all ongoing and planned REDD+ projects in Oromia. Up until late 2021, these projects underwent independent monitoring and verification. From 2022, they are now integrated in the state-wide MRV system.

Initial funding for the REDD+ component of the OFLP was a five-year grant of USD $18 million from the ISFL, followed by results-based payments for verified emission reductions for up to 10 years. In 2023, a landmark agreement was signed between the Government of Ethiopia and the World Bank ISFL for an Emissions Reduction Purchasing Agreement (ERPA) which will unlock up to $40 million to help communities, government, and stakeholders to reduce carbon emissions and increase carbon sequestration through forest preservation and other environment-friendly land uses (World Bank Group 9 Feb 2023). This ERPA marks the first of its kind for the ISFL and presents a major milestone. Norway's REDD+ Investment Program, also initiated in 2017, provided approximately additional USD $80 million for transformative actions in five regions, including Oromia. Other programs in the state include the World Bank's Resilient Landscape and Livelihood Project I and II, the Climate Action Landscape Management, and two other livestock focused World Bank-funded projects.

Whilst the OFLP may benefit from additional programs implemented in the area, its main administrative entity is the Oromia Environment, Forest and Climate Change Authority (OEFCCA), which works in partnership with other institutions, such as the Oromia Environmental Protection Authority (OEPA), the Oromia REDD+ Coordination Unit (ORCU) and the Oromia Forest and Wildlife Enterprise (OFWE), a quasi-governmental entity, has a significant role in conserving, managing, and using forest resources in the region. Other participating entities include regional bureaus responsible for agriculture, land use planning, energy, and water are also central to forests and land-based resource use and management.

To address the drivers of deforestation, the OFLP applies a multi-pronged approach, made up of three components: (a) Enabling investments and (b) Enabling environment, both of which were the focus of the first five-year $18 million grant, whilst the (c) Emissions Reductions and Removal payments is the third component. The enabling investments included (i) sub-basin land-use planning, (ii) investment and extension services to the ORCU, and (iii) forest management investment in deforestation hotspots, which entails Participatory Forest Management (PFM), including the promotion of forest-based business such as through Non-Timber Forest Products (NTFPs), nature-based tourism and wildlife management, as well as afforestation and reforestation (A/R) activities including the establishment of 9,000 ha of woodlots. Component 2 focused on strengthening the enabling environment to improve the effectiveness and impact of institutions, policies, marketing, BSM, and information (strategic communication and MRV), and safeguards management at the state and local levels. Component 3 is the recently signed ERPA.

The program's monitoring and reporting is aligned with the national MRV system, which was designed to support implementation of the NDC, and other country commitments. To avoid the risk of double counting of emission reduction and removals (ERRs), the ERRs are tracked on the Carbon Assets Trading System (CATS), a registry managed by the FCPF-BioCF/ISFL, to ensure traceability of each ERR generated by the program, until a time when a national registry becomes operational.

Vital ecosystem services, including river basin conservation, erosion control, and sediment runoff into waterbodies, are supported, and sustained through enhanced management and conservation of existing natural forests, as well as reforestation and afforestation measures.

REDD+ efforts further place emphasis on environmental and biodiversity, which this program also aims to address through positive impacts on endemic species, such as the Ethiopian wolf (*Canis simensis*), and the mountain nyala (*Tragelaphus buxtoni*). Oromia's western forests are home to endemic coffee (*Coffea arabica*) that has high potential as a value-added export and they harbour wild varieties of the species (World Bank 2024b).

The success of the OFLP can be traced back from being able to learn from existing initiatives, such as the Bale Mountain Eco-Regional REDD+ Project, which particularly informed the design of the benefit sharing plans and other lessons. Remaining challenges are risks, classified as 'substantial' by the World Bank, from the political and governance environment, institutional and fiduciary capacity for implementation, macroeconomic and fiscal environment, and social and environmental risks. Political instability may also present an additional risk. All in all, however, there are important lessons to be drawn, including the impact of effective coordination. Regular coordination of activities and harmonization among all the different sectors that impact land use is critical for implementation of climate-friendly land-use programs at a jurisdictional scale, such as the OFLP.

3.3.3 Initial conclusions from NbS implementation in Ethiopia

Ethiopia has taken steps towards implementing NbS to achieve a green future and to become a middle-income country, resilient to climate change impacts and with no net increase in greenhouse gas emissions from 2010 levels, as per its Climate Resilient Green Economy Strategy (CRGE). The government has set clear, quantified targets under its NDC, including (i) reforesting 3 million ha of land by 2030 (conditional) and (ii) restoring 5 million and 9 million ha by 2030 and 2050 respectively (conditional). This requires a multi-pronged approach, effective coordination and strong political will. Prime Minister Abiy Ahmed has catalysed nationwide tree planting support under the Green Legacy Initiative. Whilst the long-term impact and success of

the first phase may be limited; it appears that the second phase has taken on lessons learnt to improve this measure. Other efforts, such as the REDD+ OFLR benefit from long-standing funding commitments from donors, such as the World Bank, to advance forest protection, sustainable land management initiatives and climate finance via REDD+ payments. The ERPA signed in 2023 was the first of its kind for the BioCarbon Fund. In addition, Ethiopia benefits from other large-scale programs in support of NbS. Poverty, extreme weather events, and political instability pose external challenges to these NbS, whilst there is also room for improved monitoring, evaluation and learning in some initiatives.

3.4 United Kingdom

The United Kingdom of Great Britain and Northern Ireland (UK) is situated in North-western Europe and comprises the four countries Scotland, Wales, England and Norther Ireland as well as 14 Overseas Territories and three Crown Dependencies. The analysis of this report will focus on the four countries situated in Europe. The European part of the UK is surrounded by the Atlantic Ocean, the North Sea, the English Channel, the Celtic and the Irish Sea. Hence, the only land border is with the Republic of Ireland. The total land area is about 244.000 km^2 with a population of 67 million people (Park 2022). Most of the UK has a temperate climate, 52 % of the land area are used as farmland, while woodlands cover 13 %, which makes the UK one of the countries with the lowest forest cover in Europe. Most of the forests are broadleaf forests (74 %) and 26 % conifer forests which are mainly plantations. In the past, these plantations were also established on drained peatland sites which caused losses of biodiversity and soil organic carbon from the peat (Gregg et al. 2021). Peatlands cover around 12 % (3 million ha) of the total UK land area (Dutton 2019). According to the International Union for Conservation of Nature (IUCN) 80 % of the UKs peatlands are in a damaged and deteriorating condition resulting from peat extraction for horticulture and drainage for agricultural use (IUCN 2018). Other ecosystems like mountains, peatland, heath and semi-natural grasslands cover 21 % of the land area. Freshwater ecosystems like floodplains cover 5 % of the land (Trenbirth 2022). The biggest landowner in the UK is the state, followed by charities, trusts and the Church of England. The UK has a diverse range of species and habitats, which is unusual given the country's small size. About 27 % of the terrestrial and freshwater habitats have a protected status. However, habitat change due to conversion of land for agriculture and urbanisation, and over- and under-grazing as well as pollution with nitrogen, phosphorus and sulphur in surface- or groundwaters are drivers pressuring biodiversity in the UK (CBD 2024a; JNCC 2024; Winn et al. 2014).

Emissions in the UK LULUCF sector amount up to 1.2 Mt CO_2e in 2021 but are decreasing constantly since 1990 (Brown et al. 2023b). The main reason for this is the carbon sink in the forest land category with an increased annual removal of 30 % compared to levels in 1990 (Brown et al. 2023b). This is mainly the effect from past afforestation efforts. Hence, the category forest land shows net removals of - 18 Mt CO_2e in 2021 in the UK (Brown et al. 2023b). Also, emissions from cropland and settlements have decreased significantly since 1990 due to lower rates of land conversion since 2000. Peat extraction still caused about 2 Mt of CO_2 emissions in 2021 (Brown et al. 2023a) and overall peatlands contributed 3.5 % (23 Mt CO_2e) of UK net GHG emissions in 2019 due to degradation from drainage for agricultural use, burning and overgrazing (Wentworth 2022). The agriculture sector of the UK is dominated by CH_4 emissions from livestock and N_2O emissions from fertiliser application and manure management. Emissions were 43 Mt CO_2e in 2021, which is about 10 % of the total UK emissions.

In its most recent updated NDC to the UNFCCC, published in 2022 (UK Government 2022), the UK stated the commitment to reach net zero emissions in 2050. The 2030 target aims at a

reduction of emissions of at least 68 % compared to 1990 levels. This is a far more ambitious target compared to the previous 2030 commitment to reduce emissions by 57 % below 1990 levels. The UK has no separate target for its LULUCF sector. Therefore, it is unclear to what extend the reduction in emissions and carbon storage by forests are expected to contribute to the net zero target of the UK. References to NbS measures can be found in the most recent NDC update which highlights the UK Net Zero Strategy released in 2021 (HM Government 2021). It was submitted as the UK's long-term strategy to the UNFCCC and lists the key policies for natural resources including peatland restoration and afforestation (see chapter 3.4.1).

Overall, the ambition level for the UK's latest climate policies was rated very low by the Climate Change Committee (CCC) in its annual progress report in June 2023 (CCC 2023). They conclude that only about 20 % of the emission cuts needed to achieve the UK's climate targets are covered by credible policies. Also, ambitions for afforestation and peatland restoration are currently not met in the UK although both measures were identified as priority within the land-use sector (CCC 2023).

3.4.1 NbS implementation in the United Kingdom

All four governments in the UK have their own environment strategies which include biodiversity protection goals. In 2018, the UK government published the UK's 25 Year Environment Plan (Defra 2018) which is a comprehensive document describing goals to improve the environment and protect threatened species and habitats. It also provides proposals on how to reform agricultural and fisheries management after the withdrawal of the UK from the European Union (Brexit) and is therefore a very important strategic document for land and sea management in the UK. There are ten 25-year goals to achieve e.g., clean air and water and to mitigate and adapt to climate change. Recommended actions to achieve these goals include peatland recovery and sustainable soil management as well as to support woodland creation by designing a grant scheme. Finally, the UK government introduced the Environment Act 2021 which is a legal document that established an environmental governance system after leaving the EU. It introduces new measures on biodiversity protection, air and water quality, chemicals, and waste treatment. One legally binding target is to halt species decline until 2030. Also, a new Office for Environmental Protection was founded as an independent institution to ensure compliance with environmental law. Besides the Environmental Act, the UK government released the Net Zero Strategy in 2021 which mentions NbS as an approach to tackle climate change and simultaneously achieve biodiversity protection as well as other ecosystem services. Two key targets in this context were introduced, first to restore 280,000 ha of peatlands by 2050 in England and to triple annual afforestation rates in England (approximately 7,500 ha) to contribute to the overall UK target of increasing the woodland cover by 35,000 ha annually from 2025. These targets are presented in two specific strategies from England, the England Tree Action Plan and England Peat Action Plan. Both action plans detail how they will contribute to the stated national targets in the land use sector. Other countries in the UK also developed targets and strategies to restore peatlands and increase tree cover. The Scottish Government declared to restore 250,000 ha of peatlands by 2030 and create 18,000 ha of new woodlands annually by 2024/25. In Northern Ireland, the Forests for our Future Programme aims to establish 9,000 ha of new woodland by 2030. The Welsh Government committed to restore 600 to 800 ha of peatlands annually in its National Peatland Action Programme in 2020.

For this study, we will further focus on the England Tree Action Plan and England Peat Action Plan because both were mentioned in the updated NDC, submitted to the UNFCCC in 2022 (UK Government 2022) as examples on how the UK will use NbS to tackle climate change impacts.

To achieve the targets of both action plans, the government launched the Nature for Climate Fund with a total funding of £764 million until 2025. Most of the fund (£500 million) is allocated to the England Tree Action Plan. Additionally, the UK government already launched two voluntary carbon standards in 2013. One for peatland restoration projects, the Peatland Code and another for woodland creation, the Woodland Carbon Code.

3.4.2 Examples of NbS measures in the United Kingdom

3.4.2.1 England Peat Action Plan and the Great North Bog

The England Peat Action Plan (EPAP) is a strategic policy by the UK government, which was published alongside the England Tree Action Plan in 2021 (DEFRA 2021). The goal of the EPAP is to restore peatlands in England to contribute to the net zero emission target as well as to achieve wider environmental goals, such as biodiversity protection. There are about 1,4 million ha of peatlands in England and the majority is used for intensive agriculture. However, these farmed peatlands only cover 4 % of the total farmed area in England. Besides carbon storage, the EPAP also stresses additional environmental benefits from peatland restoration, including wildlife habitat, regulating water supplies and providing drinking water. The EPAP outlines the target of restoring 35,000 ha of peatlands by 2025, financially supported by the recently launched Nature for Climate Peatland Grant Scheme. This scheme is allocated with £50 million from the Nature for Climate Fund. Besides restoration, there are also funds available for farmers interested in paludiculture through the Paludiculture Exploration Fund. Other targets in the EPAP are the development of recommendations for sustainable lowland agriculture peatlands and an updated England peat map to help inform better landscape planning. Additionally, to protect peatlands from further degradation, the EPAP commits to a phase-out of peatland burning which is not further specified. Also, it recommended banning the sale of peat and peat containing products for private horticulture. This was realised with the help of a public consultation, resulting in a ban that is effective since 2024 (GOV.UK 2022). The EPAP commits to hold stakeholder strategy meetings with local land managers to communicate and discuss practical guidance for peatland restoration.

Besides public funding from e.g., Nature for Climate Fund, the EPAP also refers to private financing via the Peatland Code. The voluntary certification scheme for peatland restoration projects gains funds through carbon offsetting (IUCN Peatland Programme 2023). It was developed by the UK Government's Department for Environment, Food & Rural Affairs (Defra) and the IUCN in 2013 and was recently updated in 2023 (IUCN Peatland Programme 2023). Currently, there are 256 registered projects throughout the UK, covering an area of 38,822 ha and a validated emission reduction of approximately 2,5 Mt CO_2e in 2024 (IUCN Peatland Programme 2024).

One big peatland restoration project, which is also mentioned in the EPAP, is situated in the North of England, called the "Great North Bog" (GNB) (GNB 2023). The GNB started in 2021 as an initiative developed by a coalition of six peatland restoration partners consisting of public and private organisations. Some partners already have experience in restoring peatlands in the area. For example, Moors for The Future Partnership (Moors for the Future Partnership 2024) was formed in 2002 and already restored 24,659 ha of degraded peatland. The total GNB project area covers almost 700,000 ha of peatland soil in a protected landscape including five national parks but most of the land is privately owned (GNB 2024). The GNB harbours most of the remaining globally rare blanket bog in England and is therefore of importance to protect this unique peatland ecosystem. But the GNB area is highly degraded due to past land use, including peat cutting, drainage, overgrazing and burning. This still causes emissions of more than 3 Mt CO_2e per year (GNB 2022). Main restoration activities encompass the blocking of man-made

drains and supporting the revegetation of the peatland by spreading heather brash and seeds as well as introducing *Sphagnum* moss. The partners of the GNB estimate that restoration efforts need to take place for over 20 years with a mixture of public and private investment of about £200 million. The GNB project partners seek to engage more private funding sources via carbon credits as provided by the Peatland Code (IUCN Peatland Programme 2023) to cover the necessary total restoration costs. But landowners have concerns to interact with carbon credit markets, mainly because there is a lack of understanding and the procedure of the Peatland Code application. Another challenge is to commit landowners to change their traditional land management for the long-term (GNB 2023). Public funding is provided by the Nature for Climate Fund, which contributes £14 million. This will secure the restoration of about 7,000 ha of peatland by 2025, leading to an estimated reduction of carbon emission of over 700,000 t CO_2e by 2050 (GNB 2023). The Nature for Climate Fund covers 75 % of the restoration capital costs and requires a 25 % match funding mainly coming from private sources. The GNB project aims to help landowners to access grant schemes like the Nature for Climate Fund and the accreditation with the Peatland Code as well as provide financing via carbon credits (GNB 2023). According to current budget estimations by GNB (2023), the remaining Nature for Climate Fund plus future capital funding could restore more than 34,000 ha of peatlands, which is almost the target set out by the EPAP for 2025.

Although, GNB is a recently initiated project, there already is restoration experience from peatlands in the area. The Moors for the Future Partnership published a report documenting the benefits from revegetation of bare peat with *Sphagnum* plug plants which led to 65 % reduced water peak discharge after six years (Allott et al. 2022). This is positively contributing to flood management in the area. Also, blanket bog indicator plant species reached full coverage ten years after the initial revegetation of the bare peat (Allott et al. 2022). Since similar project partners are involved, it can be expected that biodiversity benefits and ecosystem services like high quality drinking water will be delivered from continuing with the GNB project. There also will be a long-term monitoring of over 20 years based on the standard of the Peatland Code (IUCN Peatland Programme 2023).

The close involvement of public and local stakeholders, especially landowners through the partners of GNB in the project is most likely one important factor for the success of peatland restoration. But still, it is not entirely clear what funding will be available after 2025, which puts the target of restoring all peatlands in GNB into question. The government provided a document, the Environmental Land Management in 2023 to display possible future investment plans in sustainable farming but there has not been an update since (Defra 2023).

So far, about 22,000 ha of degraded peatland is about to be restored funded by the Nature for Climate Peat Grant Scheme according to a presentation held by Defra on the IUCN Peatland conference in 2023[13]. Hence, at least 13,000 ha need to be delivered to reach the target of 35,000 ha of restored peatlands by 2030. According to the CCC (2023) the rate of peatland restoration in the UK is significantly off track and overall restoration targets and actions of the EPAP may not be sufficient to support the net zero plan of the government. Restoration plans only cover about 1 % of the UK peatlands. Also, policies to protect peatlands and restrict peatland burnings need to be improved (CCC 2023). But the implementation of EPAP also shows that public engagement via public consultation can deliver results like the ban on private use of peat in horticulture in 2024.

[13] Defra presentation „Annual update England" on the IUCN Peatland conference in 2023 (slide 39ff.) https://www.iucn-uk-peatlandprogramme.org/sites/default/files/2023-11/%23PeatConf23%20Day%201%20Plenary%20slides%20UK%20Strategy%20Summary%20of%20Progress.pdf

3.4.2.2 England Tree Action Plan

During a consultation process in 2020, called the England Tree Strategy (Defra 2020), it was recognized that most trees have previously been planted in Scotland, while England contributed little to the UK target so far. The consultation resulted in the England Tree Action Plan (ETAP) in 2021 which is the strategic document provided by the UK government to outline the government's plan on how England should contribute to the UK goal of planting 30,000 ha of woodland annually by the end of this Parliament (2025) (UK Government 2021). It sets out the target of at least 12 % wood landcover for England by 2050, which are managed for biodiversity and other ecosystem services including timber production. The Department for Environment, Food & Rural Affairs initially set the target to establish 7,500 ha of new woodland annually by 2025. The ETAP includes more strategic goals besides the expansion of the woodland cover in England. These goals include to encourage the use of local timber in construction, the improvement of woodland condition and resilience by for example deer management and to strengthen the role of woodlands for communities by creating at least three new community forests and ensuring public access to the newly developed forests. Hence, the importance of woodlands for their cultural and recovery benefits is stressed by the ETAP. Also, other benefits are mentioned like woodlands acting as key habitat for nature recovery and to improve soil and water quality in a landscape dominated by agricultural land. In order to realise the objectives of the ETAP, funding will be provided totalling £500 million originating from the Nature for Climate Fund (overall £640 million) between 2020 and 2025 (UK Government 2021). The ETAP addresses landowners, communities, and private investors to apply for grants to expand and connect trees and woodlands. As a result, the grant scheme England Woodland Creation Offer (EWCO) (Forestry Commission 2024) administered by the Forestry Commission was established in May 2021. Its target is to support the creation of 11,000 ha of woodland until 2024 and 2025 in England. The Forest Commission developed an understanding on where and how to plant new trees together with another public organisation, the Natural England (Forestry Commission and Natural England 2023). They conclude that different kinds of woodland types, including commercial tree plantations, multifunctional forests, forests for biodiversity protection, agroforestry as well as trees outside of woodlands are equally valuable to reach the overall target of increasing the national tree cover.

These conclusions are reflected in the application standards and funding opportunities under EWCO. Generally, funding by EWCO is only guaranteed if the targeted future woodland meets the requirements of the UK Forestry Standard (UKFS). The UKFS (Forest Research 2023) sets the technical standard for sustainable forest management in the UK. It outlines requirements on e.g. forest biodiversity and climate mitigation (Forest Research 2023). Also, guidelines are defined on how to meet the requirements. The respective forestry authorities of each country are responsible for the implementation and monitoring of the UKFS by e.g., approving forest management plans and woodland creation proposals (Forest Research 2023).Since 2018, the Forestry Commission also offers a Woodland Creation Planning Grant, which financially supports the planning phase of the project (Forestry Commission 2018).

Under EWCO, the applicants can receive up to £10,200 per ha which support activities to establish the woodland. It is also possible to receive annual maintenance payments for 15 years after the establishment of the woodland of £400 per ha. In addition to the planting of trees, natural colonisation can be supported by EWCO, if a viable tree seed source such as another woodland is located within 75m. Additional payments of up to £12,700 per ha are possible if several benefits for nature recovery and the society are provided. Those benefits include biotope networking and a mix of native tree species of at least 80 % to support nature recovery. Also, if the planting will improve water quality in water catchment areas of poor water quality status or

helps to reduce flood risk or creates a riparian buffer of mainly broadleaved trees alongside a river to improve the ecological water condition by shading the river. Woodland creation close to communities is also rewarded. If the woodland is established in areas specifically suitable for woodland creation ("low sensitivity land"), which excludes open habitats like grasslands and high productive agricultural soils, there are also additional funds available (Forestry Commission 2024).

Generally, biodiversity benefits during woodland creation are most likely achieved with increasing and connecting woodlands already showing high biodiversity. However, this measure as well as all other measures beneficial to different kind of ecosystem services are optional in the EWCO funding scheme. Another aspect influencing local forest related biodiversity is the tree species composition. Forest biodiversity profits most if tree species are native and best adapted to the site (Wohlgemuth et al. 2022). However, standards to consider native tree species in woodland establishment seem very low. The EWCO refers to the UK Forestry Standard, which states that a variety of tree species should be used to enhance forest resilience with a minimum of 5 % native broadleaved tree species (Forest Research 2023). Also, if woodland for nature recovery is established, there still can be up to 20 % of non-native tree species. Additionally, funding is still provided for a tree species composition of up to 15 % of tree species whose potential for invasiveness and susceptibility to known plant health issues are currently not known (Forestry Commission 2024). The introduction of non-native tree species is more likely to increase the risk towards spread of disease and pest problems rather than decreasing it (Ennos et al. 2019). They also potentially increase threats to biodiversity especially if non-native tree species are invasive and endanger native tree species or if they do not provide habitat to native animal, plant, and fungi species. Thereby, they can even decrease the resilience of the newly established woodlands in the long run.

The general achievements of the ETAP are monitored annually in the Forestry Commission Key Performance Indicators, which reflect the objectives of the ETAP in 2022 to 2023 (Forestry Commission 2023). In total 3,128 ha of newly established woodland was recorded in England in 2022 to 2023, which is a 40 % increase compared to the previous year. The majority of the planted woodland was broadleaf (92 %) but the statistic does not provide further information if tree species were native, which allows no further conclusions in regard to forest biodiversity. The EWCO scheme supported 871 ha of woodland creation and the average size of newly established woodland was less than 5 ha (Tubby and Jowitt 2024). But the achieved newly established woodland area under EWCO is much smaller compared to the targeted 7,500 ha for the year 2024 to 2025. Unfortunately, the statistics does not provide updated information on woodland area loss but in 2021 a total of 732 ha of woodland were removed mainly for open habitat restoration (e.g. peatland restoration) and for infrastructure development (Brown et al. 2023b). Therefore, the removal of woodland is almost equal to the area funded under EWCO, which makes achieving tree planting targets in England unlikely.

One major challenge to achieve the target of increased woodland cover is the administrative work that needs to be done to approve woodland creation proposals. Therefore, a fast-track application option was recently established to allow for decisions within 12 weeks (Tubby and Jowitt 2024). One factor contributing to the success of EWCO is to let landowners decide which type of woodland should be targeted (Tubby and Jowitt 2024). Hence, economic valuable woodlands with fast growing conifer trees are equally possible as a woodland designated to benefit biodiversity. The most recent statistics showing most of the woodland was established using broadleaf trees may indicate the latter. But so far there is no statistic on how many funds for additional ecological and social benefits have been used to create new woodlands. The design of the EWCO scheme does not guarantee that forest biodiversity benefits are provided because it

allows for a rather high percentage of non-native tree species. Hence, the ETAP is not necessarily going to deliver woodland creation as a NbS measure as defined in section 1. Also, it is still questionable if the targets of 7,500 ha of woodland creation in the running year can be achieved under EWCO.

3.4.3 Initial conclusions from NbS implementation in the United Kingdom

The UK explicitly mentions NbS in their NDC and introduces the two action plans on peatlands and woodland increase in England. Hence, the UK aims to implement measures of high relevance for the protection of biodiversity in the UK as well as for reducing emissions and increasing the carbon sink in the UK land-use sector. The UK already has experience in peatland restoration and the GNB project is a very good example that joined project team can cover a huge area with great potential for restoration. The EPAP considers biodiversity protection and commits to a strategy for regular stakeholder involvement. Therefore, it is an important incentive to implement peatland restoration and the programme already financed numerous projects like the GNB in England. Still, the targets set by EPAP are not ambitious enough to contribute to net zero in 2050. On the one hand, public funding is low and the engagement of carbon credits via the Peatland Code is described as an obstacle for private landowners due to long-term commitments in land-use changes. On the other hand, there is also no strong official long-term plan from the UK government yet to finance peatland restoration in the future. Similar conclusions apply to the ETAP because they are also far behind the set targets of the government and are not ambitious enough according to CCC (2023). However, the ETAP clearly led to an increase in woodland creation in England because landowners have a lot of freedom to choose the structure and future purpose of their new woodlands. Biodiversity benefits and other ecological and societal benefits are incentivised by offering additional funding. Hence, the woodlands created under ETAP are not necessarily supporting forest biodiversity because the variety of tree species that can be planted include non-native and even potentially invasive tree species. Consequently, the measure does not necessarily comply with the criteria of NbS (see section 1). One factor categorised as important for the implementation of the measure is the quick and easy processing of funding applications. Another aspect for the success of woodland increase is that the decrease in total woodland area should be smaller in order to achieve a greater net increase. One exception, of course, is the decline in forests resulting from peatland restoration.

3.5 United States of America

The United States of America (USA) is a federal republic of 50 states located in North America and is bordered with Canada to the north, and Mexico and the Gulf of Mexico to the south as well as by the Pacific Ocean to the west and the Atlantic Ocean to the east. It is the third-largest country by total area (998 million ha) in the world and the population is about 333 million people (United States Census Bureau 2023), which are mainly living in urban areas along the coasts. Most of the land in the United States is privately owned (60 %) and the federal government owns and manages 28 % of the land, including protected areas. The state and local governments own 8 % of the land and Native Americans according to the Bureau of Indian Affairs hold about 3 % of the total land area in the USA (US Government 2021). Due to its extent, the USA feature divers biogeographic zones ranging from the Arctic in Alaska to the subtropical and tropical regions of Florida and Hawaii (Gopnik et al. 2023). The USA is also topographically diverse and has great mountainous regions like the Rocky Mountains as well as the extended plain grasslands in central USA (Great Plains). Therefore, the USA is one of 17 megadiverse countries (Pariona 2021) with many endemic species and different ecosystem types ranging from Arctic tundras, tropical and temperate forests to grasslands, deserts and coastal

ecosystems. Although the USA has a high level of biodiversity, it has not yet joined the CBD (CBD 2024b).

In 2021, managed forests extend over 280 Mha and unmanaged forests over 10 Mha (EPA 2023). There are approximately 140 different forest types, including temperate forests in the east, as well as about 400 tree species (USDA 2022). In the past forest area was lost due to spread of cropland and settlements but since the late 1980s forest land area has increased by 13 Mha, mainly from abandoned croplands (EPA 2023). Also, grasslands and wetlands were negatively affected by land conversion due to expanding croplands. For example, the northern tallgrass prairie lost almost all its historic extent (NatureServe 2023). But also more recently between 2008 and 2016 grassland in the Midwest of the US was lost due to corn or soybean cultivation for bioenergy (Zhang et al. 2021). Grasslands occupy the largest area in the USA, of which the majority is managed (339 Mha) and 24 Mha are unmanaged (EPA 2023). The US cropland area is concentrated in the midcontinental region and expands on 160 Mha (EPA 2023). Agriculture still is a critical industry in the USA (US Government 2021). Managed (39 Mha) and unmanaged wetlands (4 Mha) are spread along the entire US but are more common in coastal regions, the upper Midwest and eastern portions of the country. The area of settlements has significantly increased by 40 % from 1990 (33 Mh) to 2021 (47 Mha) (EPA 2023).

According to the latest National Inventory Report (NIR) (EPA 2023) the LULUCF sector resulted in a net carbon sink of -754 Mt CO_2e, which led to an offset of about 13 % of total US GHG emissions. Still, the total net emissions of the USA were 5,586 Mt CO_2e, which makes them the second largest emitters worldwide in 2021 after China (Statista 2024b). Forests are the biggest net carbon sink (-666 Mt CO_2e), followed by settlements (-53 Mt CO_2e). Harvested wood products provide a high carbon storage of -103 Mt CO_2e in 2021. But the total removals by forests decreased by 18 % between 1990 and 2021 due to management activities, effects of previous land-use conversions and natural disturbances. Especially, wildfires led to loss in living forest biomass and caused increasing CO_2 emissions since 1990 (52 Mt CO_2) up to 203 Mt CO_2 in 2021. The highest emissions in the LULUCF sector in 2021 are caused by the conversion of grassland and cropland into settlement area (81 Mt CO_2e), followed by the conversion of grassland into cropland (51 Mt CO_2e) (EPA 2023). The agriculture sector was responsible for emissions of 598 Mt CO_2e, which is 9 % of total US GHG emissions in 2021. Overall, emissions from the agriculture sector increased by 9 % between 1990 and 2021, mainly due to N_2O emissions from agricultural soil management through activities such as fertilizer application and CH_4 emissions from enteric fermentation and manure management (EPA 2023). To achieve all national climate mitigation goals, the Biden-Harris Administration created the “National Climate Task Force” in January 2021 consisting of Cabinet-level leaders from different federal agencies (The White House 2024). At the same time an executive order for “Actions to Tackle the Climate Crisis at Home and Abroad, Create Jobs, and Restore Scientific Integrity Across Federal Government” was released that outline national climate mitigation targets as well as the national goal of conserving at least 30 percent of the US lands and oceans by 2030 (The White House 2021a).

In its latest submitted NDC of 2021, the USA committed to the target of reducing emissions by 50 % to 52 % below 2005 levels (incl. LULUCF) by 2030 (US Government 2021). The target is more ambitious compared to the previous NDC target from 2016 of 26 % to 28 % below 2005 levels (incl. LULUCF) by 2025 (US Government 2016).Overall, climate protection has been put back on the US political agenda in the past three years. Previously, climate protection measures were massively cut or completely cancelled under the Trump Administration (2016-2020), such as the control of power plant emissions. During this time, the USA also withdrew from the Paris Agreement.

3.5.1 NbS implementation in the United States of America

The 2021 NDC contains short sector pathways for 2030, where the government stated that emissions from forests will be reduced, and carbon sinks will be enhanced through programs. For example, by supporting climate smart agriculture practices (e.g. cover crops), reforestation, rotational grazing, and nutrient management practices (US Government 2021). Also, according to US Government (2021) state and federal governments will invest in forest protection and management, including efforts to reduce wildfires and restore fire-damaged forest lands. Nature-based measures are only explicitly mentioned in connection with coastal resilience projects including efforts to increase carbon sequestration in waterways and oceans ("Blue carbon") (US Government 2021). In November 2021, the USA published a long-term strategy (LTS) where it officially committed to net zero emissions at the latest by 2050 (US Department of State 2021). The LTS also outlines more detailed pathways to achieve net-zero GHG by 2050 and additionally mentions NbS as an approach to enhance CO_2 removals by strengthening conservation, restoration, sustainable management of ecosystems and simultaneously protecting ecosystem services and biodiversity. Specific focus in the carbon removal pathways lies on forests, agricultural lands and bioenergy. For forests, avoided forest conversion, increased carbon storage in harvested wood products (HWP), longer harvest rotations as well as reforestation and afforestation are mentioned for carbon benefits in the near-term and long term. Agroforestry, rotational grazing, reduced tillage and residue management are listed activities on agricultural lands to achieve carbon benefits. In summary, the LTS Action pathway in the LULUCF sector ranges from emission removals of about -1,350 Mt CO_2e to -650 Mt CO_2e compared to the BAU scenario ranging from about -1,050 Mt CO_2e and -500 Mt CO_2e (US Department of State 2021).

The current US government promotes the implementation of NbS financially with the Inflation Reduction Act (IRA, see below) (The White House 2023) and by providing strategic implementation guidelines and case studies (The White House 2022c; 2022a). But until today, there are no specific overall targets expressed for NbS implementation on the federal level, e.g. for forest or coastal restoration or any other LULUCF sector related measures mentioned in the LTS. The only quantitative target for ecosystem restoration and protection is the 30 % protection goal of US lands and waters till 2030 initiated by the Biden-Harris Administration (s.a.). To meet the target, the voluntary national effort "America the Beautiful" was launched as a 10-year long challenge. Annual reports highlight how the Administration supports local, voluntary efforts to conserve and restore nature (The White House 2021b; 2022b).

In November 2022, the government released the Nature-based roadmap at COP27 to support the strategic implementation of NbS by federal agencies (The White House 2022a). It outlines recommendations to enhance the adoption of NbS not just for climate change mitigation but also for combating loss of biodiversity and social inequities. NbS are initially defined as "actions to protect, sustainably manage, or restore natural or modified ecosystems to address societal challenges, simultaneously providing benefits for people and the environment". It is much shorter compared to the UNEA definition (see section 1) but basically contains the most important elements of the UNEA definition. Only, the aspect of the implementation in an adaptive way is not included in the definition by the US government. The strategic recommendations include updating current federal policies to easily integrate NbS, to improve funding priorities, e.g. for historically underserved communities to improve equity. Also, to educate and train people in planning and implementing NbS to develop sufficient future workforce and jobs for the communities. Another recommendation is to invest in research and adaptive learning to enhance the understanding of the effectiveness of NbS and to develop best practices for the monitoring of NbS benefits. Finally, federal agencies should act as leading

examples to implement NbS. The Nature-Based Solutions Resource Guide (The White House 2022c) complements the recommendation with 30 examples of how federal agencies already used NbS to address many different challenges from controlling invasive species and recharging groundwater to reduce heat stress. However, only about seven examples aim to restore or protect habitats with climate mitigation impacts.

The main financial resources to support NbS are provided by the federal state law the IRA (s.a.; The White House 2023), passed in August 2022 by the USA Congress. Besides investments in climate change mitigation, it aims at curb inflation, promoting national battery production for electromobility. The law provides an investment for climate change mitigation and energy of $783 billion. One specific funding target of the IRA is "Harnessing Nature-Based Solutions and Climate-Smart Agriculture to Deliver Economic, Climate, and Resilience Benefits", which will invest several billions through the US Department of Agriculture (USDA) to e.g. support agricultural producers and private forestland owners to improve soil carbon and sequester carbon dioxide. Also, the IRA provides funding to "Preserving and Protecting the Nation's Lands and Waters for Climate Mitigation and Resilience" and complements investments in the Bipartisan Infrastructure Law for nature-based climate mitigation and resilience solutions. For example, $700 million for the Forest Legacy Program to acquire lands that offer natural carbon sequestration benefits.

3.5.2 Examples of NbS measures in the United States of America

The current administration is actively pursuing the implementation of NbS to address environmental problems and maximise co-benefits. Below we will look at two projects with high relevance for the USA land sector mitigation targets. First the "Life from Soil: The Ranching Sustainability and Viability Planning Network", which is one of the seven NbS examples that aim to restore or protect habitats with climate mitigation impacts from the resource guide for NbS (The White House 2022c). It addresses grassland restoration in central USA states. The second initiative is the national reforestation strategy. Reforestation is one measure mentioned in the latest USA NDC but no specific mitigation goal is mentioned (US Government 2021). Although, no specific climate mitigation goal or references to NbS is explicitly mentioned, reforestation is an important measure that is also highlighted in the German Federal Action Plan on Nature-based Solutions for Climate and Biodiversity.

3.5.2.1 Life from Soil: The Ranching Sustainability and Viability Planning Network

The project "Life from Soil: The Ranching Sustainability and Viability Planning Network (RSVP)" is a community-based initiative to improve the ecological function of grasslands in the Northern Great Plains (NGP) in the U.S. states of Montana, Nebraska and South Dakota. The NGP covers an area of about 72 Mha in the U.S. and Canada and is one of the last remaining biodiversity rich temperate grasslands globally. The majority of the NGP is privately owned (77 %, 904 million acres). Only about 3.6 Mha is managed by native American communities (World Wildlife Fund 2024). Many ranches in the NGP do cattle farming on the grasslands. But the livestock business is more and more challenged by increasing costs due to increased periods of drought and fierce competition with cheaper beef suppliers. At the same time, new farming technologies and lucrative earning opportunities incentivize grassland conversion to cropland. Since 2012 about 12.8 million ha of the Great Plains grasslands have been destroyed mainly turned into cropland (WWF 2023a).

To act against the continued destruction of the valuable grassland ecosystem, the non-governmental organisation Worldwide Fund For Nature (WWF) initiated the RSVP in 2020 in cooperation with private company partners, the Walmart Foundation, McDonald's and Cargill.

The project will be running until 2027 and is embedded in the "Sustainable Ranching Initiative", founded by the WWF already in 2011 to support and educate about sustainable ranching like regenerative grazing to maintain the ecosystem (WWF 2024). The main goal of the RSVP project is to avoid grassland conversion and support improved grassland management. This is to be achieved by providing trainings, access to cost sharing and ecological monitoring to ranches that enrol to the project. Additionally, infrastructure improvements are supported. Ranchers develop a management plan and participate in monitoring. In return, the ranchers commit to not converting the grassland for 10 years (Northern Great Plains Joint Venture 2024). This is not a long time to secure climate mitigation or biodiversity protection effects. The ecological monitoring is organised by the WWF on the site for RSVP enrolled ranches. It is very comprehensive and covers monitoring of biodiversity with the survey of grassland bird species populations and vegetation characteristics. The effect on climate mitigation can be evaluated because soil organic carbon measurements are taken as well as other important indicators of ecological co-benefits like water infiltration and other soil quality related data (Northern Great Plains Joint Venture 2024).

In 2022, the Natural Resources Conservation Service, as part of the USA department of Agriculture, funded the RSVP project with a total amount of 2.9 million USD to improve the ecological function of 0.2 million ha of grasslands. At this point, 0.17 million ha of grasslands were already in the RSVP project. According to the website of the Natural Resources Conservation Service, the total financial contribution of WWF as the leading partner is also 2.9 million USD (Natural Resources Conservation Service 2024).

In September 2023, 85 ranches were enrolled, cultivating over 0.3 Mha of land (Northern Great Plains Joint Venture 2024; WWF 2024). The project's strategy of offering a mixture of education and financial support for the ranchers is a good basis for incentivising sustainable management in view of the NbS criteria. Also, the RSVP project can provide prospects for the people living and working on the ranches. However, it is not clear if Native American communities are especially supported or involved as the original stewards of the GNP. The actual impact on climate and biodiversity protection cannot be evaluated yet but will become available through the monitoring results in the upcoming years. There is no information given about the expected mitigation impact, although the NbS guidelines provided by (The White House 2022c) point to the potential of reduced emissions carbon sequestration through this project.

The RSVP project represents one possible example of a NbS measures implemented on federal level via financial partnership of public and private organisations. As the commitment of farmers in this project is limited to 10 years, non-permanence of the carbon sequestration by the measure represents a possible risk factor. But since the projects aims to build understanding for the importance of healthy grassland ecosystems and long-term sustainable practices, this risk is hopefully limited. The risk could possibly be minimized if funding can be secured for the long term.

3.5.2.2 National Reforestation Strategy

According to the USA Forest Service, national forests are mainly in need of reforestation due to wildfire, which affected about 1 million ha of forests in 2020 and 2021 combined. Following the Repairing Existing Public Land by Adding Necessary Trees (REPLANT) Act, which was passed in November 2021 as part of the Bipartisan Infrastructure Act and Infrastructure Investment and Jobs Act (IIJA), the USA Forest Service will be enabled to plant 1.2 billion trees and create 49,000 jobs over the next ten years. A national Reforestation Strategy for the U.S. was developed. The strategy addresses current and future reforestation needs and five action-oriented goals and a sixth goal for strategic communication outline the further direction of the strategy:

1. "Understand current and future reforestation needs".
2. "Develop a set of shared priorities across the agency and with partners".
3. "Expand reforestation workforce capacity, seed production, nursery capacity, and related infrastructure".
4. "Ensure today's seedlings grow into tomorrow's resilient forests".
5. "Nurture forests to enhance future resilience".
6. "Cultivate a shared story".

The USDA Forest Service develops national and regional 10-year implementation plans following three guiding principles: leading with science and technology, strengthening internal resources and capacity, partner and collaborate to accelerate and amplify success (US Forest Service 2022). The REPLANT Act is a follow-up of the Reforestation Trust Fund which was established by the US Congress already 40 years ago. Reforestation activities were financed by tariffs on imported wood products. The reform removes the previous annual cap of 30 million USD which constrained the resources of the fund in the past. This leverages a huge amount of financial means of an estimated up to 140 million USD for reforestation (Balloffet and Dumroese 2022). For example, since December 2023 the USDA Forest Service collaborates with the NGO American Forests to increase reforestation across national forests over the next five years. In total 20 million USD originating from the REPLANT Act will be used to reforest the 1.6 million ha of wildfire damaged forests. As the USA is one of the countries with the largest forest area in the world, the country's forests and reforestation activities entail a large mitigation potential. There are no official estimates available from the Reforestation Strategy but the NGO American Forests states that: *"It's estimated REPLANT will capture carbon dioxide equal to the emissions from 85.3 billion gallons of gasoline"*, which is equal to 758 Mt CO_2e in the trees lifetime (American Forests 2023). Besides carbon sequestration, biodiversity enhancement, resilience towards wildfires, timber production, improved water filtering and storage as well as improved mental health are mentioned co-benefits of reforestation in the Reforestation Strategy (US Forest Service 2022). But it is not further elaborated how these will be achieved or if and how they will be monitored.

The National Reforestation Strategy is not only supported with funding from REPLANT Act but also from the state, local and tribal governments (National Forest News and Views 2024). Until the REPLANT Act, capacity was limited and there was a serious backlog of 1.2 - 2 million ha of damaged forest in need of reforestation which was growing every year. Finding professional capacity for reforestation is one of the major challenges because there are not enough workers yet to implement the required measures. Still, the USDA Forest Service expects that the new resources from REPLANT Act will solve this problem by providing the additional financial resources (Balloffet and Dumroese 2022).

The Reforestation strategy is only a plan so far, but in December 2023, the US forest service and American Forests signed an agreement to scale up reforestation across national forests over the next five years, using funds from the REPLANT Act. "It kicks off the largest post-wildfire restoration effort on national forest lands in the modern era" (American Forests 2023). The US Reforestation Strategy provides an overarching guideline that consider the spatial need for reforestation, financial support and local education about reforestation measures. However, specific information on the implementation of the measure is not yet provided and unclear. From the provided documents, a possible risk is that the reforestation strategy focuses only on planting trees and rebuilding economically viable forests, not necessarily on maintaining forests in a good condition and providing diverse forests with high environmental quality.

3.5.3 Initial conclusions from NbS implementation in the United States of America

Both NbS measures analysed here are still under development and therefore no scientifically sound material was available to evaluate the implementation of the criteria for NbS in detail. The responsible U.S. Department of Agriculture and Forest Service is financially supporting and working together with NGOs and private companies to achieve grassland restoration and reforestation. This enables the U.S. to mobilise additional private financial resources for national projects and goals. Hence, financial restriction may not be a problem in the medium term. Also, the NGOs are actively involved in or are leading the implementation of the projects, which creates additional implementation capacity. However, the long-term effects on climate mitigation and biodiversity protection are yet not foreseeable. But the RSVP project is accompanied by a comprehensive ecological monitoring which will produce data soon. In the case of the grassland project, the 10-year commitment of the farmers to follow the standards is too short a period to ensure the climate and biodiversity protection effect of the measure in the long term. How biodiversity protection will be ensured in the Reforestation Strategy is still not clear. It is also not clear if the advertised 49,000 new jobs are going to benefit local and native communities, which would increase social benefits of the measure. Simultaneously, still finding labourers who can carry out the tree planting will be a challenge and is not clear if the funding from the REPLANT Act can also be used for special trainings.

3.6 Indonesia

Indonesia is an island country located between the Indian Ocean in the west and the North Pacific Ocean in the east bordering the continents of Asia and Oceania. It consists of over 13,000 islands with the main and largest ones being Sumatra, Java, Sulawesi, Borneo, and New Guinea (Central Intelligence Agency CIA 2023). Indonesia borders with Malaysia on the island of Borneo, with Papua New Guinea on the island of New Guinea and with Timor-Leste on the island of Timor. Indonesia also has sea borders with Australia, India, Palau, Philippines, Singapore, Thailand, and Vietnam (Central Intelligence Agency CIA 2023). The country spans an area of 1.9 million km^2 (CBD 2023c).

A wide variety of vegetation can be found in Indonesia, including lush mangrove forests along its coasts, tropical rainforests in lowland areas, mountain forests in Sumatra, Sulawesi, and Borneo, as well as sub-alpine and alpine vegetation in Papua (Tsujino et al. 2016). Nearly 47 % of the country is covered by forests, which includes extensive rainforests (FAO 2020b). Indonesia also has over 13 Mha of peatland, which is spread across four primary islands: Sumatra (5.85 Mha), Kalimantan (4.54 Mha), Papua (3.01 Mha), and Sulawesi (24 thousand ha) (Anda et al. 2021).

Located on the Pacific Ring of Fire, Indonesia is home to more than 400 active volcanoes (Central Intelligence Agency CIA 2023). The combination of islands, volcanic activity, and the straddling of the Wallace line - a boundary that separates the Asian fauna from the Indomalayan and Australian faunas - make Indonesia an outstanding example of a country rich in biodiversity. As a result of these factors, Indonesia is the world's most biodiverse nation, home to approximately 10 % of the planet's flowering species, nearly 12 % of the world's mammal species, around 16 % of the world's reptile species and 17 % of the world's bird species (CBD 2023c).

Over 270 million people live in Indonesia, however, the population is unevenly distributed. The island of Java is very densely populated and accounted for almost 60 % of the population in 2021 (Badan Pusat Statistik 2022). Furthermore, a significant portion of Indonesia’s population lives in rural areas (30-50 million) and is directly dependent on the forest surrounding it (Interfaith Rainforest Initiative 2019). The combination of increasing population densities, unsuitable land use practices and national economic and development strategies are putting

pressure on natural habitats (LANDac 2016). Consequently, Indonesia grapples with one of the highest deforestation rates globally, along with the loss and degradation of peatlands (Harrison et al. 2019). It is estimated that almost all of Indonesia's peatland area has been degraded to some extent due to drainage, deforestation and burning (Ministry of Environment and Forestry, Republic of Indonesia 2020). In certain regions, such as Sumatra, peatland degradation has reached much higher levels, with only 17 % of natural peatlands remaining in 2014, before fires in 2015, which have since aggravated this situation (Evans 2020; Yuwati et al. 2021; Uda et al. 2017).

In the context of international climate negotiations, Indonesia has pledged multiple commitments in alignment with the Paris Agreement to reduce its carbon emissions. Indonesia's total GHG emissions were 1,845 Mt CO_2e in 2019 (Government of Indonesia 2021b). The AFOLU sector accounts for more than half (50.13 % or 1.03 Gt CO_2e) of the country's total emissions in 2019 with the LULUCF sector accounting for most of the emissions (925 Mt CO_2e in 2019). Peat fires (24.7 % of the country's total emissions, 456 Mt CO_2e in 2019), peat decomposition (21.5 % of the country's total emissions; 398 Mt CO_2e in 2019) and forest loss were the main emission sources in the LULUCF sector (Government of Indonesia 2022b). Indonesia is also the country with the highest peatland emissions globally (UNEP 2022). The main reason for peatland drainage in Indonesia is the conversion into other uses including plantations (e.g. oil palm and timber), agricultural land, settlements, and degraded lands without plantations (Uda 2019).

There is a significant reliance on the LULUCF sector to meet the reduction targets put forward by the Government of Indonesia (Government of Indonesia 2021b). This includes an unconditional emission reduction target of 32 % compared to 2010 levels by the year 2030, and a conditional emission reduction target of 43 % compared to the 2010 baseline (Government of Indonesia 2022a; CAT 2022b). The country aims to reduce emissions in the LULUCF sector by avoiding deforestation, restoring degraded ecosystems including wetlands and promoting sustainable forest management (Government of Indonesia 2022a).

3.6.1 NbS implementation in Indonesia

Indonesia places a strong emphasis on NbS as a means of addressing climate change in its NDC (ASEAN 2022) and has set specific NDC targets, aiming to restore 2 million ha of peatland and rehabilitate 12 million ha of degraded land by 2030 (Government of Indonesia 2022a). Furthermore, Indonesia aims to improve peat water management to raise groundwater levels, reducing peatland decomposition and emissions in palm oil and timber plantations. In the adaptation section of its NDC, Indonesia underscores the synergies between its international commitments (Convention on Biological Diversity (CBD), United Nations Convention to Combat Desertification (UNCCD), Ramsar Convention, Sendai Framework for Disaster Risk Reduction (SFDRR) and 2030 Agenda) and adaptation targets. Further, it acknowledges the interconnected effects of conservation and restoration within these frameworks (Government of Indonesia 2022a). Indonesia has also put forward several programs to achieve its climate resilience targets, some of which may have potential synergies with the CBD, Ramsar Convention, or UNCCD (Government of Indonesia 2022a).

The country also developed the Long-Term Strategy for Low Carbon and Climate Resilience (LTS-LCCR) 2050, which complements its NDC (Government of Indonesia 2021b). This strategy has been designed to align with national, sub-national and international objectives, including the Sustainable Development Goals (SDGs), ensuring a coordinated approach to tackling climate change. The LTS-LCCR provides clear direction for Indonesia's national policies on climate change and outlines a roadmap for achieving a low-carbon, climate-resilient future through a set of activities (Government of Indonesia 2021a).

Indonesia's success in achieving emission reduction targets and turning the LULUCF sector into a net sink depends on several crucial actions. These include reducing deforestation and peatland conversion and drainage, enhancing the capacity of natural forests to sequester carbon, restoring peatlands, implementing forest restoration, adopting sustainable forest management practices, and using unproductive lands for the development of forest and agriculture plantations (Government of Indonesia 2021a). To reduce deforestation, the country has implemented several policies, resulting, inter alia, in the prohibition of the conversion of forested land (productive production forest) into non-forest area. Further, stricter regulations on the termination of new permits and the improvement of primary natural forest and peatland governance have to be adhered too. In addition, guidance on integrated land use planning at national and sub-national levels based on sound ecosystem management is provided (Government of Indonesia 2021a). The Indonesian Government has taken steps to promote sustainable forest management and conservation by passing two important regulations: Government Regulation No.104/2015 and Ministerial Regulation No. 30/ 2016. The former is a regulation allowing for an increase in the amount of protected forest area, based on the value of the area's ecosystem services. The latter is a regulation that makes certification systems mandatory in production forests, thus increasing adoption of sustainable management practices (Government of Indonesia 2021a).

To protect and restore peatland, the Indonesian government has issued the forest moratorium, which became permanent after being extended several times. The forest moratorium, originally a part of the REDD+ readiness program, suspended the granting of new concession licenses for logging, oil palm, and wood fibre concessions in designated areas. This resulted in additional legal protection of peatland areas (Leijten et al. 2020). Furthermore, the private sector and local governments must improve the management of peatland and water usage (Government of Indonesia 2021a). Moreover, peat ecosystems have to be managed by regulating groundwater levels and implement integrated protection and restoration measures for degraded peatlands (Government of Indonesia 2021a; Government of India 2021). Other regulations focus on improving forest fire management and the reduction of the use of fire for land clearing (Government of Indonesia 2021b; 2021a). A more detailed list of laws and regulations related to other sectors can be found in Indonesia's LTS-LCCR report (Government of Indonesia 2021a) and in the country's third biennial update report to the UNFCCC (Government of Indonesia 2021b).

Indonesia has implemented a variety of strategies to combat deforestation and forest degradation. In 2022 the LULUCF Net Sink 2030 Agenda and its operational plan were introduced, which aim to make the Indonesian LULUCF sector a net carbon sink by 2030. This ambitious goal includes achieving an emission level reduction from agriculture and LULUCF of 140 Mt CO_2e by 2030 and 340 Mt CO_2e by 2050 (MeEF 2023). The strategy involves implementing various measures such as avoiding deforestation, reforestation, restoration, protection, sustainable management of forests, peatland management, and shifting from low to high-carbon land-use types. The strategy emphasizes the prioritisation of high conservation value areas for biodiversity protection (Government of Indonesia 2022b). The REDD+ National Strategy 2021-2030 should support achieving the LULUCF net sink 2030 targets as well (MoEF 2022a).

Other NbS approaches have been implemented in Indonesia, for example, restoring mangroves using natural processes combined with engineering techniques (Building with Nature Program) (ASEAN 2022). Additionally, other programs have been launched to accelerate land rehabilitation and protection, including the Social Forestry Programme and Indonesia's Climate Village Programme (PROKLIM) (MoEF 2023). There are also multi-permit policies for forest

concessions that allow degraded lands to be used for agroforestry (Government of Indonesia 2021a).

Indonesia is committed to reducing its GHG emissions, and this commitment is reflected in both its unconditional and conditional goals. However, achieving these goals requires both domestic and international sources of funding. Indonesia's National Development Planning Agency reported that from 2015 to 2019, the country allocated a total of USD 55.01 billion for the implementation of climate change actions and plans (Government of Indonesia 2022a). In its latest NDC, Indonesia has emphasized that it will continue to allocate significant national funding for the implementation of mitigation and adaptation actions between 2020 and 2030 (Government of Indonesia 2022a).

Apart from national funding, Indonesia also receives international support through various channels, including multilateral institutions such as the Global Environment Facility (GEF), World Bank, Green Climate Fund (GCF), and other financial institutions, as well as bilateral channels such as Norway, Germany, Japan, USA, and others. During 2015-2016, Indonesia received a total of USD 1.2 billion in the form of loans and grants through bilateral and multilateral channels (Government of Indonesia 2022a). In its LTS-LCCR report Indonesia emphasises that it is exploring ways to diversify its sources of financing from both domestic and international public and private sources (Government of Indonesia 2021 b). At the national level, Indonesia is looking into opportunities to optimize the state budget by utilizing green bonds and carbon pricing instruments. In addition, Indonesia is exploring ways to access international financial sources through bilateral, regional, and multilateral channels, such as result-based payment for REDD+ under the Paris Agreement, and other potential mechanisms (Government of Indonesia 2021a).

The Environmental Fund Management Agency (BPDLH) is an agency that systematically raises and manages funds for environmental protection from both public and private sources within Indonesia and internationally (including funds from REDD+ results-based payments) (MoEF 2023; Government of Indonesia 2022b). The funds come from various sources including bilateral cooperation, international institutions, the private sector, and philanthropy. As of the end of 2022, the agency had raised and managed a total of USD 968.6 million (MoEF 2023). The Indonesia Climate Change Trust Fund, which also focuses on land-based mitigation activities, manages over 16 million dollars (Climate Funds Update 2022). Furthermore, the GCF has allotted more than USD 496 million to Indonesia (GCF n.d.).

The voluntary carbon market (VCM) also plays a crucial role for implementing NbS in Indonesia. From its inception until 2022, the VCM has been responsible for supplying over 75 Mt of CO_2e in NbS credits (Climate Focus 2022). As a result, it has provided substantial financing to NbS projects across the country. For instance, the Sumatra Meran Peatland Project alone created over 3 million credits by restoring peatlands in a 22-thousand-ha area (NCS 2023).

Indonesia has implemented a range of tools and systems. The National Forest Monitoring System is especially significant, as it produces a remote sensing-based comprehensive land cover map for the entire country and is linked to the REDD+ results report (MoEF 2022b). Additionally, the National Registry System for Climate Change serves as the national system for collecting and reporting data to combat climate change, while the National GHGs Inventory System (SIGN-SMART) provides a further means of tracking greenhouse gas emissions. Peatlands are an extremely important ecosystem that has its own separate monitoring system. The Peat and Mangrove Restoration Agency has created the Peatland Restoration and Mangrove Rehabilitation Information Management System (PRIMS) to keep track of activities that involve clearing, restoring, and rehabilitating peatlands and mangroves. The system also helps calculate

the vulnerability of these areas to drought and fire and monitors the level of water and soil (Peatland and Mangrove Restoration Agency n.d.).

3.6.2 Examples of NbS measures

The high rate of peatland loss and degradation in Indonesia, due to drainage, conversion, illegal logging as well as fires (especially during El Niño phases), is highlighted in the country's third BUR as a main source of CO_2 emissions (Government of Indonesia 2022b). In addition to increased emissions, significant loss of biodiversity, severe impacts on the surrounding ecosystem, human health and the economy have been observed (Lestari et al. 2024). Hence, the potential of peatland restoration for climate change mitigation, as well as for the promotion of socio-economic and environmental co-benefits, is very high in Indonesia. The Indonesian Government is committed to protect and restore 2 Mha of peatlands as part of its NDC (Government of Indonesia 2022a). For Indonesia, two measures targeting peatlands have been chosen for an in-depth analysis of the countries efforts to achieve part of their NDC targets by implementing NbS activities.

3.6.2.1 The "Triple-R programme"

To accomplish the peatland restoration objectives set by the government, Indonesia established the Peat and Mangrove Restoration Agency through a Presidential Regulation, which, besides peatlands also targets mangroves. The agency decided to implement the triple-R programme (Rewetting, Revegetation and Revitalisation of local livelihoods), a measure to reduce peatland loss, improve water management and restore peatland areas, and to increase the target of 2 Mha to 2,6 Mha of protected and restored peatlands. The programme is embedded in national legislation and policies (e.g. Presidential Regulation No. 120 of 2020 to accelerate peatland ecosystems and mangrove rehabilitation efforts; Net Sink 2030, the National Action Programme of Land Degradation Mitigation) (Yuwati et al. 2021). Since the programme has set locally appropriate targets, utilises adaptive actions for the protection, sustainable management and restoration of ecosystems to not only address climate change but also to create human well-being and biodiversity benefits, it complies with the definition of an NbS measure according to Reise et al. (2022).

The programme started in 2017 and is ongoing with numerous projects under implementation (Suwito et al. 2022). Seven main provinces (i.e. Riau, Jambi, South Sumatra, West Kalimantan, Central Kalimantan, South Kalimantan and Papua) have been identified as focus regions, mainly due to their susceptibility to fires, which can, just like drainage of peatlands, result in enormous emissions and impact biodiversity. It is financed through multiple funders, such as the state and international donors (public and private, incl. NGOs) depending on the projects resulting from the programme. Each project follows the programme's triple-R approach. Since a completely wet peatland soil is key for its restoration, rewetting is always the first step (Yuwati et al. 2021). Rewetting is achieved by blocking canals, once used to provide access to and regulation of water systems for agricultural purposes. These canals cause a disturbance to the natural hydrology, resulting in draining of the upper layers, reducing water-storage capacity and increasing surface water runoff. As a result, the water levels drop substantially in the dry season, leading to peat oxidation and degradation and subsequently to increased carbon emissions and fire risk. By carefully designing and constructing blockings (usually dams) as well as considering sufficient distance between them, water tables can be restored, and peatlands rewetted. The second element, revegetation is specific to each project site since the type of revegetation action is chosen according to the damage present at each site. The consideration includes a careful evaluation of the respective action's costs and the site's vulnerability to fire. This ensures that the action taken is locally adapted and cost-efficient. Lastly, revitalisation of livelihoods is

focused on identifying alternative sources of income and participation in restoration efforts (Yuwati et al. 2021).

For the 3-R programme, a real-time monitoring system (S.I.P.A.L.A.G.A, abbreviation for Sistem Pemantuan Air Lahan Gambut (engl. Peatland Water Monitoring System) in Bahasa Indonesia) has been developed. The following data is collected: water table, soil moisture, temperature (soil and air) and rainfall. The data is then used to assess fire vulnerability and subsidence rate (Bhomia and Murdiyarso 2021; Lestari et al. 2024) Progress in restoration is reported by monitoring the total planting area and the survival rate of the vegetation via the P.R.I.M.S (Peatlands Restoration Information Monitoring) system. P.R.I.M.S is an inclusive and participative monitoring system that also allows for evaluation of risk governance. Relevant actors from government bodies, private sector, NGOs as well as civil society organizations can contribute to the collection of data (Budiman et al. 2021).

Of the 2.6 Mha target set by the Peat and Mangrove Restoration Agency 900,000 ha are located outside of concessions, while 1.7 Mha are inside concessions. By the end of 2020 the agency managed to restore more than 835 ha of peatland outside concession areas, which translates to 94 % of its target for outside concession areas (Hatfield Indonesia 2021). According to the BUR, rewetting activities have led to emission reductions of approximately 96.6 t CO_2e between 2017 and 2020. Beyond reduced emissions, peatland restoration has several other positive effects, such as improved habitats for biodiversity due to conserved peatlands (Yuwati et al. 2021). Canals are often used to gain access to peatlands for illegal logging (Ritzema et al. 2014). Hence, blocking canals not only improve water retention, thereby lowering fire susceptibility, but has also reduced the risk for illegal logging (Yuwati et al. 2021).

Many factors have led to the programme's success, such as the holistic 3-R approach, the identification of priority areas (e.g. ex-burnt area, drainage channels) as well as the engagement of all relevant stakeholders, including communities. By 2020, over 1000 community livelihood revitalisation packages had been launched, which involved more than 29,600 community members (Yuwati et al. 2021). Active participation of local communities as well as the identification of alternative livelihoods have been the key drivers for the programme. Under the programme, “field school” training programmes have been conducted in peatland communities together with NGOs and plantation companies through collaborative activities, e.g. making organic compost, building dams, and providing seeds as well as fertiliser for social agroforestry programmes (Miller 2022; Pratama et al. 2022). Due to these efforts, communities (e.g. in Jambi, Central Kalimantan) have turned to economically viable, environmentally friendly and sustainable cultivation options, such as the cultivation of native species that are swamp adaptive, for example, candlenut, areca nut, sago, gelam and illipe nut are cultivated in paludiculture. However, due to their low economic viability, an agroforestry system is used by many farmers, which, in some cases, includes partial drainage. The native crops are cultivated together with commercially viable but non-native crops such as pineapple, coconut and iberica coffee. In addition, native crops, such as sago, cassava, water spinach and mangosteen are also grown in agroforestry systems. While some crops, e.g. sago and water spinach, can be grown in paludiculture, others require at least some drainage (Miller 2022). By still relying on drainage in some cases, a conflict with the first principle of the 3-R approach is inevitable.

There are still issues that need to be resolved for the projects to be sustainable and stringent with the 3-R approach. Paludiculture has been promoted as an alternative for cultivating peatlands, but options remain limited and uptake scarce (Yuwati et al. 2021). Further, some communities struggle with the changes needed to restore and protect peatlands and fear economic instability (Yuwati et al. 2021). They still turn to illegal logging and the usage of fire for hunting and fishing (Puspitaloka et al. 2021) or cultivation of palm oil and rubber, which are

not only less environmentally friendly, but also less socially inclusive since they demand strong physical strength, leading to a preference for young workers as opposed to the elderly (Yuwati et al. 2021). Further, occasionally canal blocking have been destroyed due to unawareness or lack of acceptance of rewetting activities (Puspitaloka et al. 2021). In addition, some blocking methods and materials have been found to not be suitable, leading to permanence issues, and efforts to optimise the design and adapt it to the specific area are still ongoing for many projects (Yuwati et al. 2021). Moreover, land tenure, property and IPLC rights are still barriers for adoption of new livelihoods in many communities. Also, monitoring stations are still limited and need to be expanded (Yuniati 2018).

Lessons to be drawn from the programme include the importance of early and close engagement with communities as well as the identification of alternative income sources and careful and locally adapted designs of canal blockings. More importantly, the programme showcases the benefits of a holistic approach that considers not only rewetting but also revegetation and most importantly, the revitalisation of livelihoods, which enables the sustainability of the former two steps.

3.6.2.2 Sumatra Merang project

This project focuses on the revitalisation of a tropical peatland forest and uses a combination of techniques including afforestation, reforestation, revegetation and wetland restoration and conservation. The project has a direct connection to Indonesia's NDC targets (i.e. reducing deforestation, peatland restoration) and is aligned with national legislations and policies (e.g. FOLU Net Sink 2030, Regulation No. 57/2016 regarding on Protection and Management of Peatland Ecosystem) and has a significant mitigation potential of up to 7.4 Mt CO_2 (WBCSD 2022). Beyond emission reductions and carbon sequestration, the project provides co-benefits by protecting habitats and reducing habitat fragmentation, which has a positive impact on biodiversity. As the program establishes targets tailored to the local context and employs adaptive strategies for safeguarding, sustainably managing, and restoring ecosystems, it not only tackles climate change but also aims to generate benefits for human well-being and biodiversity. Consequently, it aligns with the criteria outlined for an NbS measure by Reise et al. (2022).

The project started in 2016 with crediting period running until 2062. It is funded through the sale of carbon emission reduction credits and already sold more than 3 million credits, with profits supporting the community and restoration efforts (WBCSD 2022). It is registered under Verra's Verified Carbon Standard (VCS) as well as under the Climate, Community & Biodiversity Standard (VERRA 2024). For the latter, it received the gold distinction. To achieve Gold Level, projects must provide exceptional benefits either for communities, for climate change adaptation or for biodiversity. The project fulfils the criteria for the latter two categories, inter alia, through fire prevention and protection of endangered species, such as the Sumatran tiger, sun bear and the rhinoceros hornbill (VERRA 2023). The project did not seek gold level certification for community benefits, arguing that the majority of the residents in local villages near the project area are not below the national poverty line and the project is not owned or co-managed by local communities. However, the project provides employment for local communities and 25 % of jobs created are aimed to be held by women by 2025 (Forest Carbon 2021). The project does not aim for the restored peatland to be cultivated (e.g. as paludiculture) and instead only aims for its protection and conservation.

The project area is in one of the largest peat swamp areas of South Sumatra and a biodiversity hotspot for a variety of critically endangered plant and animal species (Forliance 2021). Reforestation and assisted natural regeneration (ANR) are the key elements of the project's success. One of the major risks to the area, fire, is mitigated by professionally trained staff

patrolling the area to prevent illegal activities as well as to assess fire risk. In addition, the project team is fully equipped with firefighting equipment (e.g. communication systems, protective clothing, pumps, hoses). An early warning system consisting of satellite data alerts, infrared cameras and drone monitoring is employed, which not only detects fires within the project area but also in its surroundings to spot and extinguish fires before they reach the project area (Forest Carbon 2021). GHG impact monitoring includes changes in land cover, peat thickness and water table level. As under the 3-R programme, rewetting is achieved by canal blocking. The project team is trained to monitor the dams and wireless sensors are monitoring the water levels across the project by using an ultrasound sensor. This is further complemented by rainfall measurement systems from multiple weather stations. The improved water quality resulting from reduced peatland erosion benefits local fishermen as well as smallholder farmers. To assess the species which are present in the reserve and to monitor the tiger population, biodiversity monitoring and camera trapping programmes are carried out within the reserve. More than 30 threatened species were captured on the camera traps. Further, the project implements efforts to establish a plant gene pool and uses it for its tree nurseries.

Another major focus of the project strategy is education. Recently, employment regulations in companies around the area (e.g. palm oil, timber) have changed, resulting in significantly less opportunities to find work without a school diploma. To combat this, scholarships for students to attend Indonesia's Open University (Universitas Terbuka) are financed, that enable the scholarship students to become schoolteachers in their communities (Forliance 2021). Through all the additional efforts mentioned, the project supports the following SDGs: 1: No poverty, 4: Quality education, 6: Clean water and sanitation, 8: Decent Work and Economic Growth, 13: Climate Action, and 15: Life on Land (Forliance 2021).

The land is owned by the government and the project is implemented by PT Global Alam Lestari (PT GAL). As the implementing partner, they have the right of using the area for conservation and carbon sequestration efforts. The company can sell the credits, but in alignment with Indonesia's new carbon market regulation a percentage of the credits will be kept for NDC achievement. Up to 5 % of offset credits sold to domestic buyers will be retained, as well as 10-20 % of credits destined for international buyers (Government of Indonesia 2022c).

As of now, PT GAL holds a renewable 25-year license to use the land for carbon storage and sequestration (Ecosphere 2021). Should the license not be renewed, the government would be tasked with ensuring the maintenance of the project area and continuation of conservation measures. Given that the project plays a role in achieving Indonesia’s NDC target, the government will likely have an interest in its continuation, however a certain risk to the long-term permanence of the project remains. Further, a study conducted by Urzainki et al. (2023) partially in the projects area concluded that the distance between canal blockings exceeded the appropriate range, leading to limited positive effects on water table depth.

Lessons to be drawn from the project include the benefits of providing employment of and education to local community members and maximisation of positive biodiversity impacts by not only restoring peatlands but doing so in biodiversity hot spots, inhabited by endangered species. Further, the extensive inclusion of innovative technology in monitoring efforts, helps to significantly reduce the risk for the key source of emissions in Indonesia, i.e. fires in peatlands. However, similar to the 3-R programme, canal blockings need to be planned carefully and their effectiveness should be monitored closely to ensure that positive impacts on water tables are maximised and sustainable.

3.6.3 Initial conclusions from NbS implementation in Indonesia

Indonesia's NDC target has a strong focus NbS measures (ASEAN 2022) aiming to decrease deforestation and increase afforestation and land rehabilitation. Several policies and regulations as well as strategies, such as the LTS-LCCR, the LULUCF Net Sink 2030 Agenda and the REDD+ National Strategy, have been developed in order to reduce emissions in the LULUCF sector.

For peatlands, Indonesia targets the restoration of 2 Mha and the rehabilitation of 12 Mha of degraded land by 2030 (Government of Indonesia 2022a). In this regard, the country also underscores the synergies between its international commitments (e.g. of the CBD) and adaptation targets. Among the key measures to achieve these goals is the 3-R programme, which focuses on rewetting, revegetation and revitalisation of local livelihoods as well as the Sumatra Merang project, a carbon credit project aiming to revitalise tropical peatland forest in the project area, while conserving highly vulnerable and endangered animal species. Both measures have been successful in reducing emissions and for both, a key success factor has been community engagement. Especially the inclusion in the implementation of the project and the provision of alternative income sources has been vital for achieving the measures targets. However, implementation challenges remain in both cases. Peatland restoration requires careful planning, local adaptation and accurate monitoring, which led to the need for regular adjustments (e.g. changing the design of canal blockings) for the project teams. Beyond technical difficulties, economic stability for local communities is crucial and has been the biggest challenge for the 3-R programme. For peatland restoration to attain positive and sustainable outcomes, communities need to be supported in identifying and applying sustainable and economically viable alternative cultivation methods or access other sources of income. If communities are not included in decision-making and not properly supported (e.g. via capacity-building, education), the risk of re-draining of peatlands increases significantly.

4 Factors of success and challenges for the implementation of NbS for climate and biodiversity protection

NbS for climate mitigation are increasingly recognized as important measures to combat climate change (UNEA 2022; UNFCCC 2022), which is also reflected by the submitted NDCs in which the Parties to the Paris Agreement refer to NbS measures (Seddon et al. 2019; Zhai et al. 2023). However, NDCs do not provide comprehensive insight into the implementation of NbS in national climate mitigation policy. The closer examination of NbS examples from six case study countries showed that it is necessary to investigate the domestic arrangements of the countries to better understand i) the administrative implementation of NbS measures; ii) how countries plan to rely on NbS to achieve their mitigation targets and iii) if and how biodiversity protection and stakeholder engagement was considered.

Because the six case study countries represent a wide range of geographical, ecological, political and economic diversity, the NbS implementation strategies and experiences among countries vary accordingly. This heterogeneity poses a challenge for a direct comparison of the case study countries but provides the opportunity to draw conclusions on a meta-level.

First of all, our research on the case study measures shows that not all of them have qualified as NbS. The main reasons are, on the one hand, that these measures were not implemented in alignment with the ecosystem, and it is therefore not ensured that they serve to protect biodiversity. On the other hand, the local population was not involved in the measures in such a way that they could benefit from them and thus improve their livelihoods.

One major challenge as well as important factor of success is securing the **permanence of the climate protection effect of NbS measures**. Carbon accumulation via growing trees or humus accumulation and securing peatland carbon storage can be achieved over medium to short periods of time. But they are quickly reversible through changing to harmful cultivation practices and land-use changes. For example, deforestation and draining of peatlands pose a significant risk to natural carbon stocks. But also, ongoing effects of climate change like increasing drought periods can lead to changes in the carbon fluxes causing net emissions from the ecosystem where the NbS measure was implemented.

In the following two sections, common factors for successful NbS measure implementation and the challenges identified from the case study country analysis are listed and briefly described with examples.

4.1 Factors for successful implementation of reviewed NbS measures

► Political commitment and prioritization are crucial for the implementation of NbS measures.

The level of support and interest shown by the country's government and specifically the involvement of the head of state were identified as decisive factors for the success of NbS implementation. Especially for the provision of finances and for the administrative implementation on site. For example, Ethiopia's Green Legacy Initiative (GLI) was launched specifically by the Prime Minister Abiy Ahmed in 2019 under the National Green Development Programme. Since the start it has been driven by his personal commitment and tree planting has been central to his agenda (Fikreyesus et al. 2022). It is said that the initiative has strong personal patronage and considerable budget from the national treasury, which allows scale to be reached easily. In China constructing an ecological society, and securing ecological security are identified as essential by the top political level. They are guiding principles for President Xi Jinping and captured in high level national policy documents. These were key prerequisites for

the implementation of large-scale and very labour- and cost-intensive projects such as the national afforestation programme (Sloping Land Conversion Programme (SLCP)). In the USA, the current Biden-Harris administration shows significantly more efforts to use NbS for climate mitigation compared to previous presidential administrations (Higgins et al. 2024). As seen in the funding provided for NbS through the Inflation Reduction Act and the practical guidance issued on implementing NbS through case studies.

In many cases, the governments recognised the ecological urgency to mitigate climate change because the society faces harmful ecological consequences that e.g. negatively impact water quality like in the China Yangtse River basin or increasing peatland burning in Indonesia. Other driving factors were the synergies with climate adaptation of some measures which is often mentioned in the NDCs as well.

The negative side of a purely top-down policy support is that it can easily be lost by changes in political leadership. For example, the Brazilian Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm) was one of President Lula's flagship policies, but was suspended by the Bolsonaro administration.

- Linking NbS measures to existing programmes and ensuring long-term implementation and effectiveness through policy coherence.

Building on already existing initiatives like peatland restoration in the Great Northern Bog in England as well as the "Sustainable Ranching Initiative" in the USA has the advantage that local expertise and contacts to landowners were supported a successful implementation. Also, existing projects in Ethiopia helped to inform the design of the REDD+ project in Oromia. In Brazil, regulatory and policy frameworks, e.g. to prevent deforestation were progressively introduced at all levels of government to distribute responsibilities and also profit from past experiences. Establishing a shared responsibility between two public offices with stakes in the NbS measure contributed to the successful implementation of the England Tree Action Plan (ETAP) in the UK. The environmental office (Natural England) and the Forestry Commission were both involved in designing the programme which led to the inclusion of environmental protection and forest economic aspects. Another example is the fruitful collaboration between the public USDA Forest Service and the non-governmental organisation American Forests to increase the reforestation rate in the USA. The agreement with a non-profit private institution created additional administrative and executive capacity to realise public objectives.

The UK's 25 Year Environment Plan issued in 2018 is an example for long-term planning which aims to protect the environment, habitats and threatened species. Whereas the 2021 Environmental Act provides an environmental governance system after Brexit. Compliance of governmental actions with environmental law is organised via the Office for Environmental Protection. This offers a long-term perspective for the enforcement of national biodiversity targets.

The long-term effectiveness of NbS is significantly increased if policy actions which contradict the NbS measure are identified and adjusted. One example is the ban on peat in private horticulture in the UK to decrease the demand to commercially drain and use peatlands. Also, the Indonesian government issued a forest moratorium which suspended the granting of new concession licenses for logging, which also led to the protection of peatlands. Still, a lack of policy coherence is one of the challenges identified in the analysis of NbS implementation in our case studies (see section 0).

- Clear target formulation, frequent monitoring and evaluation are required to make successes visible and, if necessary, to implement target-oriented changes during implementation.

Clear target setting involves quantified targets that can be monitored and evaluated to measure success and allow for adjustments in the implementation if needed. For example, Brazil's PPCDAm's main aim is to address the primary drivers of deforestation in the Legal Amazon Region, to achieve this and track progress, it has established a comprehensive monitoring system that helped to identify new deforestation drivers and led to the inclusion of subsidies for bioeconomy to address economic problems of the local population. Also, increased surveillance and legal enforcement helped to decrease deforestation. The UK government has established targets at different levels, for example the legally binding target to halt species decline until 2030 under the Environment Act 2021. The Net Zero Strategy establishes targets for peatland restoration and woodland creation in 2030 and 2050. To implement these targets the government has issued the ETAP and England Peat Action Plan. The annual monitoring of the ETAP by the Forestry Commission follows Key Performance Indicators which provide a fast overview of the programme's achievements and showed that afforestation efforts must be increased to reach the governments targets. One resulting action was the establishment of a fast-track application to the funding programme to minimize administrative delays.

The GHG monitoring of the "Triple-R programme" in Indonesia allowed for the allocation of emission reductions following the rewetting of peatlands. This data is essential to proof the effectiveness of the measure. In Ethiopia the forest restoration project (REDD+) in Oromia is monitored in alignment with the national monitoring system. Therefore, efforts made in this project also contribute to the achievement of the Ethiopian NDC.

- Effective and long-term funding mechanisms enable the realization of NbS measures and help to implement them in the long-term.

Measures that require restoration actions like rewetting or changing farming practices on a specific area usually require significant financial resources. Hence, the success of these NbS measures heavily depends on the funding that can be committed to secure their medium- and long-term implementation and success. Funding of NbS measures can be particularly challenging for low-income countries and is often dependent on international donors. International funding sources were very effective for the Oromia Forest Landscape Program (OFLP) in Ethiopia, which benefited from long-term dedicated finance primarily from the World Bank as well as foreign governments. At the national level, Ethiopia received grants for . The Government of Ethiopia completed its National REDD+_ Readiness Programme through grants issued by the BioCarbon Fund (BioCF) and the Forest Carbon Partnership Facility (FCPF). This enabled the country to access and effectively use climate financing and other related funds from both international and domestic sources (World Bank Group 2023). REDD+ results-based payments also supported Brazil in fighting deforestation by financing monitoring, science and enforcement actions. Similarly, Indonesia receives funding from international financial institutions like the World Bank and secured tremendous financial support via bilateral agreements with for example Germany. Indonesia also engaged in the voluntary carbon market, which helped to secure the restoration of peatlands in the Sumatra Meran Peatland Project. Carbon credit funding for farmers was also very successful in financing the Brazilian Plan ABC+ programme. Overall, it can be concluded that by diversifying the sources of financing, large sums can be generated for the implementation of measures and the risk of a complete loss of financing can be minimised. In China, the government is the primary source of funding for NbS measures.

High income countries like the UK and the USA invest public money to implement NbS, for example through the USA Inflation Reduction Act. However, the governments of both countries have also set themselves the goal of mobilising private funding. The UK Woodland Carbon Code

and the IUCN Peatland Carbon Code enable companies to engage in verified carbon offsetting while financing the respective measures. In the USA public funding is often complemented with money from private sources, which can increase the budget substantially. Non-governmental organisations play a key role in leveraging funds from foundations and private companies, as can be seen in the Ranching Sustainability and Viability Planning Network to implement sustainable grassland management. The need for long-term funding, may be considered as a deterrent for investing in NbS. However, this argument can be counterbalanced by recent scientific evidence, indicating that properly designed NbS have economic benefits, especially if deployed to support recovery from economic shocks (Chausson et al. 2024).

- Good practice in stakeholder involvement ensures NbS measure implementation and permanence.

Stakeholder involvement is essential to create acceptance and thereby secure the successful implementation of NbS measures. Engagement can take place via stakeholder consultation processes during the design of policies (e.g., Plan ABC+ in Brazil), or also during monitoring during implementation of the measures (e.g., PPCDAm in Brazil). In Brazil the updated PPCDAm puts stronger emphasis on the role of indigenous peoples in protecting the forest. Hence, the project includes actions to directly support participation of indigenous peoples in sustainable production, the protection of federal lands and access to payments for ecosystem services. In Indonesia the active participation of local communities in peatland rewetting was achieved by supporting alternative livelihoods using paludicultures and agroforestry systems that require no or only partial drainage of peatland soils. Unfortunately, the engagement of local communities was not successful in all cases (see section 0). Providing alternative employment and scholarships for higher education to local communities like in the Sumatra Merang project, also supported the end of harmful land use practices. In the Oromia region of Ethiopia, deforestation was addressed with participatory forest management for local people that promoted non-timber forest products, such as nature-based tourism.

Informing the public about the benefits of the NbS measures is crucial to engage people in the implementation. Ethiopia succeeded in raising awareness of landscape degradation and the need for re-greening under its GLI. Education is also a crucial pillar within the USA grassland ranching project to build an understanding for the importance of healthy grassland ecosystems and long-term sustainable practices to secure permanence of the measure. Additionally, promoting alternative livelihoods for the local population to replace harmful land management practices benefits the sustainability of NbS.

In the UK, the GNB shows that long-term cooperation of partners, that engage closely with the public and local stakeholders leads to successful peatland restoration. Additionally, public consultations ultimately led the ban on peat use in private horticulture starting in 2024, which is an important step to protect peatlands and provide policy coherence.

Finally, stakeholder involvement and commitment can be achieved via targeted payments. In many case studies analysed for this report we found that payments to landowners were made to initiate NbS implementation. For example, landowners receive subsidies in China and funding in England to initiate afforestation.

- Promote the synergies and co-benefits of NbS for climate change mitigation to increase stakeholder acceptance and to achieve additional societal targets.

The definition of NbS already specifies that the NbS measures must achieve ecological and social benefits (UNEA-5). But this is not the only reason, co-benefits and synergies of NbS measures are important. They can also serve as motivation to accept and support NbS measures for climate

mitigation. For example, through reforestation and improved management of existing forests in the Oromia region, erosion and sediment flows into rivers could be prevented, which increased their water quality. Additionally, the endemic wild coffee plant could be protected and can potentially provide additional income. Reforestation in the Chinese Yangtze River region also created synergies with the improved ecological status of rivers, which helped to increase farmer's income. Peatland restoration activities in the UK and Indonesia contributed to better flood management and increased water quality. Additionally, peatland restoration activities led to the recovery and protection of peatland biodiversity in both countries.

In the England Tree Action Plan, synergies with biodiversity protection like the use of native tree species and biotope networking are incentivised by additional payments.

In Brazil, the Permanent Interministerial Commission for Deforestation Prevention and Control is also responsible for ensuring that the actions elaborated in the different action plans, such as the PPCDAm, contribute to the conservation of biodiversity and the reduction of GHG emissions from deforestation. Whereas the Plan ABC+'s in the agricultural sector is directly designed to advance sustainable agriculture through strategies targeting both adaptation and mitigation of GHG and biodiversity goals are considered when it comes to actions related to commercial forestry.

- Focused action in hotspot/priority areas to facilitate effective use of resources and enhance achievement of co-benefits and synergies.

Because financial, land and human resources are often scarce to implement NbS measures, the focus on priority areas for e.g. peatland rewetting or hot-spots of deforestation can achieve effective results for climate protection or other societal targets. The Sumatra Merang project explicitly targeted biodiversity benefits by choosing a biodiversity hotspot for their rewetting project. Similarly, the Great Northern Plains in the USA represents one of the last remaining biodiversity rich temperate grasslands globally and is therefore a priority area to achieve synergies between climate mitigation and biodiversity protection. In the "Triple-R programme" in Indonesia, successful peatland rewetting was increased due to its focus on restoration of ex-burnt area and the closing of drainage channels. The Oromia Forest Landscape Program specifically focused its forest management investment on the hotspots of deforestation in the area. The Chinese Government uses great spatial planning to identify key ecological functional zones for restoration, like the Yangtse River region, and ecological protection red lines. Defining these key zones helps large countries like China to prioritise and target its resources to high impact measures.

4.2 Challenges for the successful implementation of reviewed NbS measures

From the various case studies analysed, common challenges have emerged that hinder the successful implementation of NbS measures. Many of the challenges encountered in the case study countries relate to the permanence of NbS measures and can constitute a risk of reversal for achieved progress. Other challenges relate to the specific implementation of measures, and many challenges relate to both broader issues mentioned before.

- Challenges to the permanence of the climate mitigation benefits of NbS measures can be attributed to political, legal, governance, and social causes, and to the nature of the AFOLU sector.

In Brazil, the PPCDAam initially achieved success (mainly between 2004 and 2012), but from 2012 onwards, deforestation rates started to increase again despite the continued implementation of the plan (Bizzo and Farias 2017). Experts have attributed these to the complexity of deforestation patterns in the Amazon that has made sustained progress difficult, as well as the challenge of promoting sustainable economic activities in the region.

Likewise, Ethiopia's GLI has been very successful in planting seedlings, with 25 billion seedlings reported to have been planted in the first four years. Whilst government sources indicate high success rates, research and feedback from the ground have reported a different picture (Kassa et al. 2022). It appears that especially in the early years, survival rates on trees are very low, especially in locations where there was a lack of local participation in the planning stage, or where seedlings were planted on public land. Furthermore, Ethiopia's political situation and civil war in certain regions put at risk the ability to care for recently planted seedlings (Fikreyesus et al. 2022). The GLI also lacks a strong anchorage within a specific policy instrument and political instability and frequent restructuring of government ministries and departments put at risk effective planning, coordination and implementation. Ethiopia also experiences frequent droughts, especially during 2018 and 2023 (European Civil Protection and Humanitarian Aid Operations 2024). Coupled with heavy rains brought by El Nino in late 2023, Ethiopia has experienced severe floods, which has affected over 1.5 million people (ReliefWeb 2023). This further negatively impacts the survival rates of tree seedlings, putting in question the permanence of this large-scale initiative.

In the case of Indonesia, the Sumatra Merang project faces a permanence risk because the license for managing the land issued to the implementing partner expires after 25 years. This license can be renewed, however, as of now there is no clarity on what happens if the project ceases to be implemented and/or the license is not renewed. Furthermore, both measures in Indonesia, also face challenges due to the difficulty and complexity of building canal blockings. The design must be highly adapted to the specific location and requires adjustments on a regular basis. However, the implementation of measures to ensure the sustainability of canal blockings is still scarce.

Disruptive changes in the environment and political agendas also can lead to a reversal of the climate mitigation effect and significantly jeopardize the success NbS measures. For example, Brazil went from policy agendas that successfully prevented deforestation between 2004 and 2012, towards policy agendas that led to an increase in deforestation during the Bolsonaro Administration. Agricultural expansion was emphasized in the National Congress, accompanied by the systematic dismantling of Brazil's institutional and legal framework on forest protection. The Bolsonaro Administration suspended the implementation of the fifth phase of the PPCDAm. The plan to halt deforestation in the Amazon was reintroduced in 2023 when the new president, Lula, assumed power. Also, in the USA, the Trump Administration completely dismantled the climate protection agenda of its predecessor, including the withdraw of the USA from the Paris Agreement.

The implementation of NbS measures often relies on stakeholders directly involved in land management, these may revert to previous land management practices after financial or other kind of support stops, this could for example become the case in the GNB project in the UK, if funds dry out or under the USA Sustainable Ranching Initiative, where ranchers commit to not converting grasslands for 10 years, but there is no specification of what happens next.

- Insufficient funding or lack of long-term finance and bureaucratic barriers jeopardise the climate protection effect of NbS measures and limit a transition away from long-established or lucrative harmful land use practices.

In almost all case study countries governments provide the main funds for the implementation of NbS measures (the USA is the exception). However, some countries also seek to raise funds from private sources. The UK government has stated that financing the GNB project will require £200 million, which will not only come from public funds. The government is seeking to engage private funding through carbon markets, however as stakeholders currently hesitate to engage in them because of a lack of understanding of procedures, it is uncertain whether sufficient funding will be available. (see section 3.4). Funding for the GNB project after 2025 has also not been clarified by the government. In England, bureaucracy and a lack of financial incentives are challenges for convincing farmers to change towards more peat friendly cultivation practices. In Indonesia's 3-R programme, efforts to support communities in identifying alternative income sources were insufficient. Projects, where economic viability for communities was inadequate, still rely on partial drainage of project areas, thereby limiting the overall impact and sustainability of the programme. In some cases where communities were unable to find sufficient alternative income, they returned to the previous peat harming cultivation practices. In Brazil's ABC Programme it was observed that unattractive interest rates and excessive bureaucracy may have contributed to slow progress in the rehabilitation of pasture lands and reforestation.

- Lack of effective governance structures to underpin the implementation of NbS measures.

Governance of NbS measures relate to planning, decision making, fund allocation and monitoring and often need to be coordinated across different administrative levels. In Ethiopia, the GLI is not anchored under a specific policy or strategy and mainly driven by the prime minister's office. Funds are allocated to ministries, agencies, regional governments and city administrations. There is no clear link with other programmes targeting restoration, for example from the World Bank. Also, Ethiopia has a landscape restoration potential map, it seems this is not being used to inform GLI activities, for example for targeting priority areas for restoration or ensuring balanced implementation across the country. At the federal level, multiple ministries and the office of the prime minister are involved in the GLI. While it is important to involve sectoral ministries with stakes in restoration efforts, considering the Ethiopian case, where restructuring of ministries and government agencies is frequent, this arrangement, likely does not contribute to an effective or stable governance of the initiative. Also, there is no dedicated monitoring, reporting and evaluation programme or it is unclear how other existing monitoring efforts in the land sector address the GLI. In the Oromia region of Ethiopia institutional and fiduciary capacity, as well as the macroeconomic and fiscal environment were identified as challenges for the implementation of the Oromia Forest Landscape Program. In China, Xi et al (2012) noted that although figures regarding progress of major forest protection and restoration programs were positive and pointed towards success, information on implementation at the local level was scarce or contradictory.

- Lack of policy coherence jeopardises the climate protection effect of NbS measures.

If actions that are contradicting the objective of the NbS measure are continued, they will jeopardise the climate protection effect. In England, the end of burning of peatlands is still not in effect, hence this practice will continue to release significant emissions while public money is spent to restore peatlands with the England Peatland Action Plan. Also, England targets woodland expansion, but at the same time woodlands are converted for infrastructure development, diminishing the net rate of woodland creation in England. This may delay reaching overall targets for woodland expansion.

In Brazil, while the PPCDAm aims to prevent and control deforestation in the Legal Amazon, in its early phases it did little to provide support and economic incentives for promoting sustainable production and addressing a key driver of deforestation.

- Difficulties in designing and implementing the NbS measure in alignment with the ecosystem to achieve synergies with biodiversity protection and to generate social benefits.

Per definition NbS measures are expected to deliver multiple benefits. This must be considered already in the design phase of the measures, especially when it comes to ensuring measures are aligned with the functioning of the target ecosystem. As some of the measures analysed in this study have been designed and started implementation before the adoption of a generally accepted definition of NbS, we identified cases where features of the measures limited the positive impacts on biodiversity, the climate or society.

In Ethiopia the GLI also uses exotic tree species, such as eucalyptus, to ensure fast growing biomass, especially in agricultural landscapes. Whether ecologically appropriate species are being planted and whether survival of seedlings is sufficiently considered, remains unclear, but these are crucial factors that influence the long-term success of restoration efforts in Ethiopia. Likewise, in China early reforestation efforts under the Sloping Land Conversion Programme did not focus on planting native trees or diverse stands, which had negative effects on ground water levels and biodiversity. In England the Tree Action Plan, does target biodiversity but its standards related to the planting of native tree species are low. Monitoring of newly established woodlands does not track which species are planted, assessing impacts on forest biodiversity difficult. With potential consequences for the spread of invasive species, diseases and pests, and jeopardising long-term resilience of newly established woodlands.

In Ethiopia, negative impacts on communities were observed because it was unclear who can benefit from planted fruit trees. Additionally, afforestation on land previously used for grazing and growing fodder is not accessible anymore for communities and can therefore lead to the loss of livelihoods.

- A lack of ambitious or unclear targets reduces the potential of positive impacts of NbS measures.

Unambitious or unclear targets pose a challenge to effective implementation and are a barrier for realising potential benefits of NbS. For example, while Brazil was able to achieve the targets established in its ABC plan, critics also say that targets were too low from the start which would have limited the overall ambition for implementing measures. In China's Plan for Major Projects for the Protection and Restoration of Nationally Important Ecosystems, the goal for stabilising the area of wetlands is unclear, because no benchmark to assess the target is specified in the document. Another example is the lack of clarity on how the target to stabilize the area of natural forests at 200 Mha by 2035 relates to the different forest types present in China and whether there will be a comprehensive coverage of forest ecosystems representing their natural diversity. In the UK the EPAP commits to a phase-out of peatland burning to protect peatlands from further degradation but does not specify a timeframe, which could result in delays for starting implementation and reaching the target. In the USA there are no specific overall targets expressed for NbS implementation on the federal level, for example for forest or coastal restoration or any other LULUCF sector related measures mentioned in the LTS. Without targets, it is unlikely that effective planning, implementation and monitoring of actions will take place.

5 Conclusions and recommendations

- **NbS offer an opportunity for governments to streamline institutional arrangements and improve policy coherence for the protection and restoration of nature:** The six countries analysed in this study build on previously enacted measures when it comes to implementing NbS. A renewed focus on NbS as an umbrella concept, offers governments the opportunity to reassess their current land-use policy to improve its coherence and effectiveness. Applying the defining criteria of NbS is also key to ensure the quality and effectiveness of measures. It also revealed that not all measures can be defined as NbS, like the afforestation programme in China, England and Ethiopia.

- **NbS must be designed for the long-term implementation:** Ensuring continued implementation of measures is essential for ecological processes like carbon sequestration to show positive effects for climate protection. It is also important to avoid reversals of gains for biodiversity. Therefore, funding, participation of stakeholders, institutional arrangements and enabling frameworks must be designed with a long-term perspective.

- **Success of NbS is shaped by political will and stakeholder engagement:** The country case studies showcased examples of measures where political will is an effective driving force for the implementation of NbS measures. However, it is also evident that early involvement of land managers and other key stakeholders is needed to facilitate their commitment and ownership, as well as for supporting permanence.

- **NbS measures fail if their impact on livelihoods is not compensated:** In the case studies, negative impacts on livelihoods were a barrier to the uptake of alternative land management practices and a risk to the permanence of measures. This must be considered already at the design stage and appropriate alternative income sources should be developed (e.g. considering cultural, economic and gender factor). Likewise, capacity-building is required to facilitate effective implementation of alternative land management.

- **The biodiversity impacts of NbS measures receive too little attention:** When reviewing available documentation for the case studies, little information on biodiversity impacts was readily available. This can be partially explained, because many measures were conceived before the agreed comprehensive definition of NbS measures was adopted. However, it puts into evidence that monitoring and reporting of biodiversity via appropriate indicators must be improved. This would allow to identify challenges at an early stage and provides opportunities to adjust management decisions.

- **Insufficient funding or the lack of long-term finance jeopardise the climate protection effect of NbS measures and limit a transition away from long-established or lucrative harmful land use practices:** Governments must be willing to provide adequate and long-term finance for NbS. In almost all case studies public funds are the most important sources of funding for NbS. It is likely that governments will continue to play a key role for financing NbS, but it is also evident that the scale of funding for a real transition will unlikely be provided by governments alone. Hence, they can aim to mobilize private funding, especially from sectors that rely on ecosystem services for their business. For example, governments can create enabling environments for private sector investments, introducing regulations for directing investments, the use of green taxonomies, and due diligence legislation (UNEP 2023). Wherever possible, international cooperation for NbS should provide long-term funding to developing countries, especially for measures like afforestation or rewetting which require land-use change.

- **Focusing NbS action on priority areas can achieve effective results for climate and biodiversity protection or other societal targets if financial or other resources to implement the measure are scarce:** This could be achieved by focusing NbS for climate change mitigation on biodiversity hot spot areas to strengthen the synergies with biodiversity protection.
- **More international exchange on lessons-learned, successes and failures are needed:** NbS measures are complex and require adjustments to local circumstances. However, showcasing local solutions in international networks can strengthen project design and efficient and effective implementation at the global level, especially in areas that are common to all NbS, for example target setting and monitoring and reporting. Some case studies revealed how target design can positively impact the actual effect of a measure. For example, a target to increase forest cover, may conceal that while the forest cover is increasing in gross area, forest losses are still ongoing, and continue to cause emissions. This is the case for forest related targets for England (chapter 3.4.2) and also in Germany (Reise et al. 2024).
- **Tracking the climate impact of NbS measures under the UNFCCC requires separate LULUCF targets and improved reporting:** Many countries do not explicitly mention NbS in their NDC documents. This is not necessarily a shortcoming because there is no specific requirement to do so. However, climate impact of NbS measures will most likely relate to the LULUCF sector and most NDCs include this sector. Tracking the climate impact of NbS measures at the global level will be facilitated by improved LULUCF reporting in the biennial transparency reports. Ideally, countries will also set separate targets for the LULUCF sector.

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A Summary assessment

Annex table 1: Summary assessment of analysed NbS measures of case study countries

Country	NbS measure name	Targetted ecosystems	Main focus of measure	Status of implementation	Funding source	Alignment with ecosystem process	Effective in promoting biodiversity	Positive effect for climate protection & alignment with national climate change mitigation policies	Involvement of stakeholders and or local communities
Brazil	Action Plan for the Prevention and Control Deforestation in the Legal Amazon (PPCDAm)	Forests	Protection	Under implementation. Fifth phase from 2023 to 2027	Public, national	2	2	2	1
Brazil	Plan for Low Carbon Agriculture for Sustainable Development	Agricultural ecosystems	Sustainable management	Under implementation, from 2020 to 2030	Public, national	1	0	2	1
China	The sloping land conversion programme (SLCP) and the Natural Forest Conservation Programme	Forests and Grasslands	Restoration and protection	Under review. Initiated in 1998, currently payments continue but there are no new targets	Public, national	1	2	1	1

Country	NbS measure name	Targetted ecosystems	Main focus of measure	Status of implementation	Funding source	Alignment with ecosystem process	Effective in promoting biodiversity	Positive effect for climate protection & alignment with national climate change mitigation policies	Involvement of stakeholders and or local communities
China	Programme of Soil and Water Conservation in Key Areas of the Upper Yangtze River	Rivers, forests, farmland	Restoration, Sustainable management	Under implementation since 1989, open ended	Public, national	1	1	2	2
Ethiopia	The Green Legacy Initiative	Forests	Reforestation and Afforestation	Under implementation since in 2019	Public, national & internatio nal	1	0	2	1
Ethiopia	Oromia Forest Landscape Program (REDD+)	Forests	Protection and restoration	Under implementation since 2017	Public, internatio nal & sale of carbon credits	2	2	2	2
United Kingdom	Great Northern Bog	Peatlands	Restoration	Under implementation since 2021	Public, national & sale of carbon credits	2	2	1	2

Country	NbS measure name	Targetted ecosystems	Main focus of measure	Status of implementation	Funding source	Alignment with ecosystem process	Effective in promoting biodiversity	Positive effect for climate protection & alignment with national climate change mitigation policies	Involvement of stakeholders and or local communities
United Kingdom	England Tree Action Plan	Forests	Afforestation	Under implementation since 2021	Public, national & sale of carbon credits	1	1	1	2
USA	Life from Soil: The Ranching Sustainability and Viability Planning Network	Grasslands	Sustainable management	Under implementation since 2020	Private & public, national	2	2	1	2
USA	National Reforestation Strategy	Forests	Afforestation	Under implementation since 2021	Public, national	1	1	1	1
Indonesia	The "Triple-R programme"	Peatlands, mangrove forests	Restoration, reforestation	Under implementation since 2017	Public, national & private internatio nal	2	2	2	1
Indonesia	Sumatra Merang project	Peatland	Restoration, reforestation	Under implementation since 2016	Sale of carbon credits	2	2	2	2

Source: Own compilation. 2= alignment, 1 = alignment but there are issues, 0= severe issues or no alignment