ensure that protection measures are effective in preventing damage (Shah et al., 2021).

At a local level, EbA can often provide a wide range of additional benefits for sustainable development in both rural and urban areas (Wilbanks, 2003; Nelson et al., 2007; Cohen-Shacham et al., 2016; Hobbie and Grimm, 2020; Martín et al., 2020). A number of the case studies above, such as in Durban and at Bhojtal Lake, illustrate this (section 2.6.5). A key element of CRD is ensuring that actions taken to mitigate climate change do not compromise adaptation, biodiversity and human needs. This depends on choosing appropriate actions for different locations (Box 2.2, Cross-Chapter Box NATURAL in this chapter). A particularly notable case of this is the creation of woodland described in Box 2.2: re-afforestation of previously forested areas can provide multiple benefits (Lee et al., 2018; Lee et al., 2020) including those for climate change mitigation, adaptation and biodiversity. However, planting trees where they would not naturally grow can create multiple problems including the loss of native biodiversity and the disruption of hydrology (Box 2.2). It is also the case that protection of existing natural forest ecosystems is the highest priority for reducing GHG emissions (Moomaw et al., 2019) and restoration may not always be practical (see Section 2.6.5.10). (Sections 2.4.3.6, 2.4.3.7, 2.4.4.3, 2.4.4.4, 2.5.2.6, 2.5.2.7, 2.5.3.3, Box 2.2, Cross-Chapter Box NATURAL in this chapter)

In some cases, actions supported by international donors and presented as addressing climate change adaptation and mitigation in the natural environment can have damaging consequences for people and nature as well as failing to deliver adaptation and mitigation. One example of this was presented by Work et al. (2019), who reviewed three climate change mitigation and adaptation projects in Cambodia: an irrigation project, a protected-area forest management project and a reforestation project. In each case, they found evidence of the rights of local communities being violated, maladaptation and the destruction of biodiverse habitats. They concluded that the potential for maladaptation and adverse social and environmental impacts had been ignored by international donors and the national authorities, and that there was a need for much stricter accountability mechanisms. Moyo et al. (2021), using case studies from South Africa, documented greater success of ecosystem restoration projects when they embraced broader SDGs, particularly enhancement of people's livelihoods. Better assessment of the impacts of adaptation and mitigation measures on people and ecosystems, before they are implemented, will be increasingly necessary to avoid unintended and damaging consequences as their deployment is scaled up (Larsen, 2014; Enríquez-de-Salamanca et al., 2017; Pour et al., 2017). This applies to ostensibly nature-based approaches as well as more engineering-based ones.

Cross-Chapter Box NATURAL | Nature-Based Solutions for Climate Change Mitigation and Adaptation

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Nature-based solutions provide adaptation and mitigation benefits for climate change as well as contributing to other sustainable development goals (**high confidence*****). Effective nature-based climate change mitigation stems from inclusive decision-making and adaptive management pathways that deliver climate-resilient systems serving multiple sustainable development goals. Robust decision-making adjusts management pathways as systems are impacted by ongoing climate change. Poorly conceived and poorly designed nature-based mitigation efforts have the potential for multiple negative impacts, including competing for land and water with other sectors, reducing human well-being and failing to provide mitigation that is sustainable in the long term (*****high confidence*****).***

The concept of Nature-based Solutions (NbS) is broad and under debate, but has become prominent in both the scientific literature and policy since AR5, and includes earlier concepts like EbA. The key point is that these are actions benefitting both people and biodiversity (IUCN, 2020) (WGII Glossary). In the context of climate change, NbS provide adaptation and mitigation benefits in ways that support wild species and habitats, often contributing to other sustainable development goals (*robust evidence*, *high agreement*) (Griscom et al., 2017; Keesstra et al., 2018; Hoegh-Guldberg et al., 2019; IPCC, 2019a; Lewis et al., 2019; Lavorel et al., 2020; Malhi et al., 2020; Seddon et al., 2020b) (AR6 WGIII Chapter 12; Sections 2.2, 2.5.4, 2.6.3, 2.6.5, 2.6.7). Well-designed and implemented NbS mitigation schemes can increase carbon uptake or reduce GHG emissions at the same time as protecting or restoring biodiversity and incorporating elements

Cross-Chapter Box NATURAL (continued)

of food provisioning (Mehrabi et al., 2018). A variety of measures can be part of NbS, ranging from the protection of natural terrestrial, freshwater and marine ecosystems to the restoration of degraded ones (this Cross-Chapter Box; Section 13.3) and more sustainable management of naturally regenerating ecosystems used for food, fibre and energy production (Figure Cross-Chapter Box NATURAL.1, Chapter 5 in this report, Cross-Working Group Box BIOECONOMY in Chapter 5). Agro-ecological practices mitigate and adapt to climate change and can promote native biodiversity (*high confidence*) (Sinclair et al., 2019; Snapp et al., 2021).

The Role of Restoration in Nature-Based Solutions

Where natural ecosystems have been degraded or destroyed, re-establishing them and restoring natural processes can be a key action for adaptation and mitigation, and the science of restoration is well established (de los Santos et al., 2019; Duarte et al., 2020) (Section 13.4.1). Such restoration activities need to adapt to ongoing climate change risks for the landscape and oceans and the species composition of biological communities. Indeed, the impacts of climate change may overwhelm attempts at restoration/conservation of previous or existing ecosystems, particularly when the ecosystem is already near its tipping point, as is the case with tropical coral reefs (Bates et al., 2019; Bruno et al., 2019).

Land (e.g., forests) and oceans (e.g., fisheries) managed for products using sustainable practices (whether applied by individuals, states or Indigenous Peoples) can also be carbon- and biodiversity-rich, and thus considered effective NbS (Paneque-Gálvez et al., 2018; Soto-Navarro et al., 2020). Indigenous Peoples and private forest owners manage, use or occupy at least one-quarter of the global land area, over one-third of which overlaps with protected areas, thus combining both protection and production (Jepsen et al., 2015; Garnett et al., 2018; IPBES, 2019; Santopuoli et al., 2019).

The protection/restoration of natural systems including reducing non-climate stressors, and the sustainable management of semi-natural areas emerge as necessary actions for adaptation to minimise extinctions of species, the reaching of tipping points that cause regime shifts in natural system and the loss of whole ecosystems and their associated benefits for humans (Scheffer et al., 2001; Folke et al., 2005; Luther et al., 2020) (Chapters 2 and 3 in this report; AR6 WGIII Chapter 7). Such measures are critical for the conservation of biodiversity and the provision of ecosystem goods and services in the face of projected climate change (Duarte et al., 2020). Supporting local livelihoods and providing benefits to indigenous local communities and millions of private landowners, together with their active engagement in decision-making, are critical to ensuring support for NbS and their successful delivery (*high confidence*) (Chapter 5 in this report; Figure Cross-Chapter Box NATURAL.1)(Ceddia et al., 2015; Blackman et al., 2017; Nabuurs et al., 2017; Smith et al., 2019a; Smith et al., 2019b; Jones et al., 2020a; McElwee et al., 2020; Cao et al., 2021).

Forests

Intact natural forest ecosystems are major stores of carbon and support large numbers of species that cannot survive in degraded habitats (*very high confidence*). Extensive areas of natural forest ecosystems remain in tropical, boreal and (to a lesser extent) temperate biome regions, but in many regions they are managed (sustainably and unsustainably) or have been degraded or cleared. Deforestation and land degradation continue to be a source of global GHG emissions (*very high confidence*) (Friedlingstein et al., 2019). Protection of existing natural forests and sustainable management of semi-natural forests that continue to provide goods and services are highly effective NbS (Bauhus et al., 2009) (*high confidence*).

Natural forests and sustainably managed biodiverse forests play important roles in climate change mitigation and adaptation while providing many other ecosystem goods and services (*very high confidence*) (Bradshaw and Warkentin, 2015; Favero et al., 2020; Mackey et al., 2020). Contributions of natural forests to climate change mitigation are estimated at a median of 5–7 GtCO$_2$ yr^{-1} (Roe et al., 2019). Forests influence the water cycle on a local, regional and global scale (Creed and van Noordwijk, 2018), reducing surface runoff, increasing infiltration to groundwater and improving water quality (Bruijnzeel, 2004; Zhou et al., 2015a; Ellison et al., 2017; Alvarez-Garreton et al., 2019). Recent evidence shows that downwind precipitation is also influenced by evapotranspiration from forests (Keys et al., 2016; Ellison et al., 2017). Protecting existing natural forests and sustainably managing production forests in a holistic manner can optimise the provision of the many functions forests fulfil for owners, conservation, mitigation and for society as a whole (Bauhus et al., 2009; Nabuurs et al., 2013).

Reforestation of previously forested land can help to protect and recover biodiversity and is one of the most practical and cost-effective ways of sequestering and storing carbon (*high confidence*) (Nabuurs et al., 2017; Hoegh-Guldberg et al., 2018; Paneque-Gálvez et al., 2018; Smith et al., 2018; Cook-Patton et al., 2020; Cowie et al., 2021; Drever et al., 2021). This can be achieved through planting or by allowing natural colonisation by tree and shrub species. The most effective method to deploy depends upon local circumstances (e.g., the presence of remnant forest cover) or socio-cultural and management objectives. Reforestation with climate-resilient native or geographically-near species restores biodiversity at the same time as sequestering large amounts of carbon (Lewis et al., 2019; Rozendaal

Cross-Chapter Box NATURAL (continued)

et al., 2019). It can also restore hydrological processes, thereby improving water supply and quality (Ellison et al., 2017) and reducing the risk of soil erosion and floods (*high confidence*) (Locatelli et al., 2015).

Climate change may mean that, in any given location, different species will be able to survive and become dominant and restoring the former composition of forests may not be possible (Sections 2.4, 2.5). Severe disturbances such as insect/pathogen outbreaks, wildfires and droughts, which are an increasing risk, can cause widespread tree mortality resulting in sequestered forest carbon being returned to the atmosphere (Anderegg et al., 2020; Senf and Seidl, 2021), suggesting that we need to adapt (Sections 2.4, 2.5, 13.3 14.4.1, Box 14.1). Adaptation measures, such as increasing the diversity of forest stands through ecological restoration rather than monoculture plantations can help to reduce these risks (*high confidence*). When plantations are established without effective landscape planning and meaningful engagement including free prior and informed consent, they can present risks to biodiversity and the rights, well-being and livelihoods of indigenous and local communities as well as being less climate-resilient than natural forests (*very high confidence*) (Section 5.6) (Corbera et al., 2017; Mori et al., 2021).

Afforesting areas such as savannas and temperate peatlands, which would not naturally be forested, damages biodiversity and increases vulnerability to climate change (*high confidence*), so cannot be considered a nature-based solution and can even exacerbate GHG emissions (Sections 2.4.3.5, 2.5.2.5, Box 2.2 in this chapter). Remote sensing-based assessments of the suitability of land for planting trees can overestimate potential, due to their failure to adequately distinguish between degraded forest and naturally open areas (Bastin et al., 2019; Veldman et al., 2019; Bastin et al., 2020; Sullivan et al., 2020).

Peatlands

Peatlands are naturally high-carbon ecosystems, which have built up over millennia. Draining, cutting and burning peat lead to oxidation and the release of CO_2 (*very high confidence*). Re-wetting by blocking drainage and preventing cutting and burning can reverse this process on temperate peatlands (*medium confidence*) but takes many years (Bonn et al., 2016). Trees are naturally found on many tropical peatlands and restoration can involve removing non-native species like the oil palm and re-establishing natural forest. However, peatland tropical forest is difficult to fully restore, and native pond-fish, vital as a local food, often do not return. Protecting intact peat forests, rather than attempting to restore cleared forest, is by far the more effective pathway, in terms of cost, CO_2 mitigation and the protection of food sources (Kreft and Jetz, 2007). Naturally treeless temperate and boreal peatlands have, in some cases, been drained to enable trees to be planted, which then leads to CO_2 emissions, and restoration requires the removal of trees as well as re-blocking drainage (*high confidence*) (Sections 2.4.3.8, 2.5.2.8, 2.6.5.10).

Blue Carbon

Blue carbon ecosystems (mangroves, saltmarshes and seagrass meadows; see Glossary Appendix II) often have high local rates of carbon accumulation and sequestration (Section 3.5.5.5) (Macreadie et al., 2019). However, quantification of their overall mitigation value is difficult due to the variable production of CH_4 and N_2O (Adams et al., 2012; Rosentreter et al., 2018; MacLean et al., 2019b), uncertainties regarding the provenance of the carbon accumulated (Macreadie et al., 2019) and the release of CO_2 by biogenic carbonate formation in seagrass ecosystems (Saderne et al., 2019). Therefore, blue carbon strategies, referring to climate change mitigation and adaptation actions based on the conservation and restoration of blue carbon ecosystems, can be effective NbS, with evidence of the recovery of carbon stocks following restoration, although their global or regional carbon sequestration potential and net mitigation potential may be limited (*medium confidence*) (Sections 3.6.3.1.6, 13.4.3) (section 5.6.2.2.2 in (Canadell et al., 2021)) (Duarte et al., 2020).

They can also significantly attenuate wave energy, raise the seafloor (thereby counteracting the effects of SLR) and buffer storm surges and erosion from flooding (*high confidence*) (Sections 13.2.2, 13.10.2). Additionally, they provide a suite of cultural (e.g., tourism and the livelihoods and well-being of native and local communities), provision (e.g., mangrove wood, edible fish and shellfish) and regulation (e.g., nutrient cycling) services (*high confidence*) (Section 3.5.5.5). These services have motivated the implementation of management and conservation strategies of these ecosystems (Sections 3.6.3.1.6, 13.4.2). Blue carbon strategies are relatively new, with many of them experimental and small-scale; there is therefore only *limited evidence* of their long-term effectiveness. There is also limited information on the potential emission of other GHGs from restored blue carbon ecosystems, although reconnecting hydrological flow in mangroves and restoring saltmarshes are effective interventions to reduce CH_4 and CO_2 (*limited evidence*, *medium agreement*) (Kroeger et al., 2017; Al-Haj and Fulweiler, 2020).

Urban Nature-Based Solutions

NbS can be a key part of urban climate adaptation efforts. Direct human adaptation benefits may stem from the cooling effects of urban forests and green spaces (parks and green roofs), from coastal wetlands and mangroves reducing storm surges and flooding and from sustainable drainage systems designed to reduce surface flooding as a result of extreme rainfall as well as the general benefits to human

Cross-Chapter Box NATURAL (continued)

health and well-being (*high confidence*) (Sections 2.2, 2.6, Chapter 6) (Kowarik, 2011; Frantzeskaki et al., 2019; Keeler et al., 2019). Not all green schemes are considered 'Nature-Based Solutions' if they do not benefit biodiversity, but carefully designed urban greening can be effective NbS. Careful planning also helps limit negative equity consequences such as benefitting wealthy neighbourhoods more than poor neighbourhoods (Geneletti et al., 2016; Pasimeni et al., 2019; Grafakos et al., 2020). Effective planning should also consider what is appropriate for the climate and conditions of each city. For example, some trees emit volatiles (e.g., isoprene) which, in the presence of certain atmospheric pollutants, can increase surface ozone which can, in turn, cause human respiratory problems (Kreft and Jetz, 2007). Wetland restoration close to human settlements needs to be paired with mosquito control to prevent negative impacts on human health and well-being (Stewart-Sinclair et al., 2020), but it has been shown to provide better filtration and toxicity reduction with a lower environmental impact than other forms of waste-water treatment (Vymazal et al., 2021), including 'green roofs' and 'green walls' (Chapter 6 in this report) (Addo-Bankas et al., 2021).

Agro-Ecological Farming

AF is a holistic approach that incorporates ecological and socioeconomic principles, many of which have been shown to have a positive impact on biodiversity and on the resilience of human and natural systems to climate change (chapter 5, this report). It strives to enhance biodiversity, soil health and synergies between agro-ecosystem components, reduces reliance on synthetic inputs (e.g., pesticides), builds on IKLK and fosters social equity (e.g., supporting fair, local markets) (HLPE, 2019; Wezel et al., 2020). AF practices include inter-cropping; the mobility of livestock grazing across landscapes; organic agriculture; and the integration of livestock, fish and cropping, cover crops and agro-forestry (Sections 5.14, FAQ 12.5, FAQ 13.5).

Agro-forestry, cover crops and other practices that increase vegetation cover and enhance soil organic matter, carefully managed and varying by agro-ecosystem, mitigate climate change (*high confidence*) (Zomer et al., 2016; Aryal et al., 2019; Nadège et al., 2019). Global meta-analyses demonstrate agro-forestry as storing 20–33% more soil carbon than conventional agriculture (De Stefano and Jacobson, 2018; Shi et al., 2018) and reducing the spread of fire (Sections 5.6, 13.5.2, 7.4.3, Box 7.7). Minimising synthetic inputs such as nitrogen-based fertilizers reduces emissions (Gerber et al., 2016). Cover crops can reduce N_2O emissions and increase soil organic carbon (Abdalla et al., 2019). Conservation farming (no-till with residue retention and crop rotation) increases soil organic carbon, particularly in arid regions (Sun et al., 2020). Silvo-pastoral systems (pastures with trees) and other practices that increase vegetation cover and enhance soil organic matter increase sequestered carbon in vegetation and soils (Zomer et al., 2016; Aryal et al., 2019; Nadège et al., 2019; Ryan, 2019). Agro-ecologically improved management of land for crops and grazing has significant mitigation potential, estimated at 2.8–4.1 $GtCO_2$-eq yr^{-1} (Smith et al., 2020) (Sections 5.10, 5.14, Box 5.10, Cross Working-Group Box BIOECONOMY in Chapter 5; WGIII 7.4.3, Box 7.7).

AF enhances adaptation to climate change, including resilience to extreme events. Building organic matter improves the water-holding capacity of soils and buffers against drought; increased perenniality and high levels of ground cover reduce soil erosion during storms; agro-forestry shelters livestock and crops during heat waves; landscape complexity and agro-biodiversity increase resilience to disease and pests and stabilise livestock production; and restoration of oyster reefs provides thermal refugia and storm surge protection (Henry et al., 2018; Kremen and Merenlender, 2018; Kuyah et al., 2019; Gilby et al., 2020; Niether et al., 2020; Richard et al., 2020; Howie and Bishop, 2021; Snapp et al., 2021). Livestock mobility enables adjustment to increased climatic variability while maintaining the productivity of pastoral systems (Turner and Schlecht, 2019; Scoones, 2020). The adoption of agro-ecology principles and practices will therefore be highly beneficial to maintaining healthy, productive food systems under climate change (*high confidence*) (Sections 5.4.4, 13.5.2, FAQ 12.4).

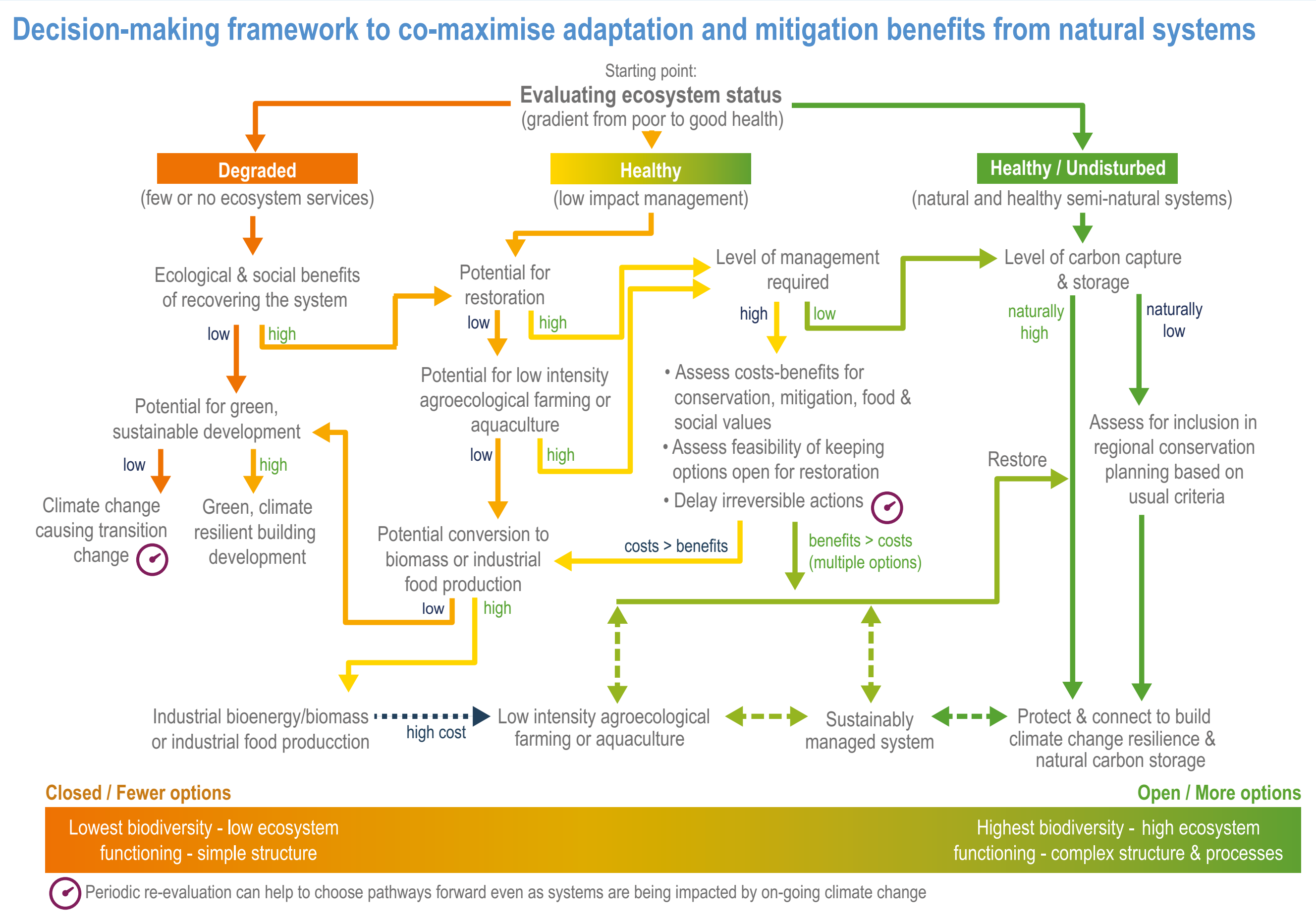
AF practices such as hedgerows and poly-cultures maintain habitat and connectivity for biodiversity, thus aiding the ability of wild species to respond to climate change via range shifts, and support ecosystem functioning under climate stress compared to conventional agriculture (*high confidence*) (Section 5.4.4.4) (Buechley et al., 2015; Kremen and Merenlender, 2018; Albrecht et al., 2020). Increasing farm biodiversity benefits pollination, pest control, nutrient cycling, water regulation and soil fertility (Beillouin et al., 2019; Tamburini et al., 2020; Snapp et al., 2021). Biodiverse agro-forestry systems increase ecosystem services and biodiversity benefits compared to simple agro-forestry and conventional agriculture (*high confidence*), with up to 45% more biodiversity and 65% more ecosystem services compared to conventional production of timber and crops and profits from livestock in the Atlantic Forest in Brazil (Santos et al., 2019), including benefits for birds and local tree species (Braga et al., 2019) and meaning there are fewer invasive exotic plants species (de Almeida Campos Cordeiro et al., 2018). AF includes the conservation of semi-natural woodlands, which can conserve bird predators of insect pests (Gonthier et al., 2019). The richness and abundance of insect species, including essential pollinators, are increased by organic farming (Sections 5.10, 12.6) (Kennedy et al., 2013; Haggar et al., 2015; Lichtenberg et al., 2017).

AF significantly improves food security and nutrition by increasing access to healthy, diverse diets and raising incomes for food producers, due to the increased biodiversity of crops, animals and landscapes (*high confidence*) (Garibaldi et al., 2016; D'Annolfo et al., 2017; Isbell et al., 2017; Dainese et al., 2019; Kerr et al., 2021). Livestock mobility improves the site-specific matching of animals' needs with food

Cross-Chapter Box NATURAL (continued)

availability (Damonte et al., 2019; Mijiddorj et al., 2020; Postigo, 2021), and can generate a form of re-wilding that restores lost ecosystem functioning (Gordon et al., 2021). Conservation of crop wild relatives *in situ* supports the genetic diversity of crops for a range of future climate scenarios (Redden et al., 2015).

System-level agro-ecological transitions require policy support for experimentation and exchange of knowledge by farmers, community-based participatory methodologies and market and policy measures, for example, public procurement, local and regional market support, regulation or payments for environmental services (Mier y Terán Giménez Cacho et al., 2018; HLPE, 2019; Snapp et al., 2021). Scientific consensus about the food security and environmental implications of agro-ecological transitions on a global scale is lacking. Yields of agro-forestry and organic farming can be lower than high-input agricultural systems but, conversely, AF can boost productivity and profit, varying according to the time frame and the socioeconomic, political or ecosystem context (*medium confidence*) (Section 5.14) (Muller et al., 2017; Barbieri et al., 2019; Smith et al., 2019b; Smith et al., 2020). Such contrasting results and the limited investment in agro-ecological research to date mean it is paramount to assess the global and regional impacts of agro-ecological transitions on food production, ecosystems and economies in the context of climate change adaptation (Section 5.14) (DeLonge et al., 2016; Muller et al., 2017; Barbieri et al., 2019).



Decision-making framework to co-maximise adaptation and mitigation benefits from natural systems

Figure Cross-Chapter Box NATURAL.1 | Decision-making framework to co-maximise adaptation and mitigation benefits from natural systems. Decision-making pathways are designed to add robustness in the face of uncertainties in future climate change and its impacts. Emphasis is on keeping open as many options as possible, for as long as possible, with periodic re-evaluation to aid in choosing pathways forward, even as systems are being impacted by ongoing climate change.

Conclusions

NbS provide adaptation and mitigation benefits for climate change as well as contributing to achieving other sustainable development goals (*high confidence*). NbS avoid further emissions and promote CO_2 removal, by using approaches that yield long-lasting mitigation benefits and avoid negative outcomes for other sustainable development goals. Poorly conceived and poorly designed mitigation efforts have the potential for multiple negative impacts: (1) cascading negative effects on long-term mitigation by promoting short-term

Cross-Chapter Box NATURAL (continued)

sequestration over existing long-term accumulated carbon stocks; (2) being detrimental for biodiversity, undermining conservation adaptation; and (3) eroding other ecosystem services important for human health and well-being (*high confidence*). Conversely, well-designed and implemented mitigation efforts have the potential to provide co-benefits in terms of climate change adaptation as well as providing multiple goods and services, including the conservation of biodiversity, clean and abundant water resources, flood mitigation, sustainable livelihoods, food and fibre security and human health and well-being (*high confidence*). A key aspect of such 'smart' climate mitigation is the implementation of inclusive and adaptive management pathways (Section 1.4.2). These entail acceptance of the uncertainty inherent in projections of future climate change, especially at the regional or local level, and using decision-making processes that keep open as many options as possible for as long as possible, with periodic re-evaluation to aid in choosing pathways forward, even as systems are being impacted by ongoing climate change (Figure Cross-Chapter Box NATURAL.1; Cross-Chapter Box DEEP in Chapter 17; Section 1.4.2).

Table Cross-Chapter Box NATURAL.1 | Assessment of benefits and trade-offs between mitigation and strategies for both biodiversity and human adaptation to future climate change. Best practices highlight approaches that lead to maximal positive synergy between mitigation and adaptation; worst practices are those most likely to lead to negative trade-offs for adaptation. Many best practices have additional societal benefits beyond adaptation, such as food provisioning, recreation and improved water quality. Mitigation Potential (Mit. Pot.) and Restoration Potential (Rest. Pot.) are considered.

System	Mit. Pot.	Rest. Pot.	Best practices and adaptation benefits	Worst practices and negative adaptation trade-offs	Additional societal benefits	References
Forests						
Boreal forests	medium	medium	Maintain or restore species and structural diversity, reduce fire risk, spatially separate wood production and sustainably intensify management in some regions	Very large-scale clear cuts, aiming for one or few tree species, although boreal is characterised by few tree species and a natural fire risk	Providing goods and services, jobs and improved air quality and hydrology	(Drever et al., 2021)
Temperate forests	very high	high	Maintain or restore natural species and structural diversity, leading to more biodiverse and resilient systems	Planting large-scale non-native monocultures which would lead to loss of biodiversity and poor climate change resilience	Providing goods and services, jobs and improved hydrology and biodiversity	Sections 2.4.3; 2.5; Box 2.2 ; (Nabuurs et al., 2017; Roe et al., 2019; Favero et al., 2020)
Tropical wet forests	high	moderate	Maintain or restore natural species and structural diversity, high biodiversity, more resilient to climate change	Planting non-native monocultures, loss of biodiversity, poor climate change resilience, soil erosion	Indigenous foods, medicines and other forest products, including sustainable selective logging	Section 2.4.3 (Edwards et al., 2014)
Tropical dry forests	high	moderate	Integrated landscape management	Planting non-native monocultures, loss of biodiversity, poor climate change resilience, soil erosion		(Foli et al., 2018)
Tropical peatland forests	very high	low	Integrated landscape management	Cutting native rainforest and planting palm oil for biodiesel results in very high carbon emissions from exposed peat soils	Forest pond fish are a major food for local communities	Section 2.4.3; 2.5; (Smith et al., 2019b)
Blue carbon						AR6 WGI 5.6.2.2.2 (Canadell et al., 2021)
Mangroves	moderate	high	Conservation, restoration of hydrological flows, re-vegetation with native plants, livelihood diversification, landscape planning for landward and upstream migration	Potential NH_4 emissions	Improved fisheries and biodiversity, coastal protection against SLR and storm surges, recreation and cultural benefits	Sections 3.4.2.5; 3.5.5.5; 3.6.3.1; (Macreadie et al., 2019; Duarte et al., 2020; Sasmito et al., 2020)
Saltmarshes	moderate	high	Conservation, reduction of nutrient loads, restoration of hydrological flows and sediment delivery, re-vegetation with native plants, landscape planning for landward and upstream migration	Potential NH_4 emissions	Improved fisheries and biodiversity, protection against SLR and storm surges, recreational and cultural benefits	Sections 3.4.2.5; 3.5.5.5; 3.6.3.1; (Macreadie et al., 2019; Duarte et al., 2020)

Cross-Chapter Box NATURAL (continued)

System	Mit. Pot.	Rest. Pot.	Best practices and adaptation benefits	Worst practices and negative adaptation trade-offs	Additional societal benefits	References
Seagrasses	moderate	high	Conservation, restoration, improve water quality and reduce local stressors (reduction of industrial sewage, anchoring and trawling regulation)	Potential NH_4 emissions	Improved fisheries and biodiversity, protection from shoreline erosion, recreational benefits	Section 3.4.2.5; 3.5.5.5; 3.6.3.1; (de los Santos et al., 2019; Macreadie et al., 2019; Duarte et al., 2020)
Urban ecosystems						
Urban forests	moderate to high*	moderate	Integrated landscape management. Species richness (including exotics) can be high.	Monoculture of an exotic tree lowers resilience and reduces biodiversity	Recreation and aesthetics, stormwater absorption benefits, heat mitigation, air quality improvements	Chapter 6, this report
Urban wetlands	moderate*	moderate	Integrated landscape management		Recreation and aesthetics, stormwater absorption, heat mitigation, coastal flood protection	Chapter 6, this report
Urban grasslands	moderate*	moderate	Integrated landscape management	fertilised commercial grass monocultures often require irrigation and are less resilient to droughts than native, mixed grasses and forbs	Recreation and aesthetics, stormwater absorption, heat mitigation	Chapter 6, this report
Open grasslands and savanna						
Boreal and temperate peatlands	high	moderate	Block drainage channels, raise water levels to their natural condition, remove planted trees, re-vegetation of bare peat, no fires, increased biodiversity resilience, reduced flood risk	Inappropriate hydrological restoration, e.g., flood surface depth greater than natural depth leading to methane emissions	Improved water quality in some conditions	Sections 2.4.3; 2.5;(Bonn et al., 2016; Nugent, 2019; Taillardat et al., 2020)
Tropical savannas and grasslands (including rangelands)	moderate	high	Control of feral herbivores, reintroduce indigenous burning, reintroduce native herbivores and controlled grazing, strategic design of water holes, community-based natural resource management, grass reseeding, clearing of invasive and encroaching woody plants	Afforestation,over-grazing/stocking, no burning, inappropriate placement and design of watering points. All lead to loss of biodiversity and resilience, soil erosion and water insecurity.	Improved grazing potential for livestock and dairy production, sustainable wildlife harvests, increased water security, income from eco-tourism, medicinal plants, fuel wood, enhanced food security	Sections 2.4.3; 2.5; Box 2.1; (Stafford et al., 2017; Moura et al., 2019; Shackelford et al., 2021; Stringer et al., 2021; Wilsey, 2021)
Temperate grasslands and rangelands	moderate to high	moderate to high	Integrated landscape management, sustainable grazing, community-based natural resource management, native grassland species are more resistant to drought than introduced species	Monocultures (especially of introduced species), over-fertilising with chemical or organic amendments, failure to manage human–wildlife clashes, failure to distribute income equitably, inadequate enabling policy to facilitate integrated landscape management	Sustainable harvest of wildlife, livestock and dairy production, wild fruits, medicinal plants, construction material, fuel wood, income from ecotourism	Sections 2.4.3; 2.5, Box 2.1; (Farai, 2017; Baker et al., 2018; Homewood et al., 2020; Wilsey, 2021)
AF and aquaculture	high	high (context-specific)	Biodiverse systems on the landscape scale, participatory adaptation to context, short value chains, farmer incentives, biodiversity synergies, reduced climate risk	Poorly chosen species, practices and amendments can lead to low yields. Simplified agro-forestry systems and industrial-scale organic agriculture lack a holistic system-wide approach. Over-fertilising with organic amendments.	Food security, human health, livelihoods, socio-cultural benefits, e.g., culturally appropriate foods	Sections 5.4, 5.10, 5.12, 5.14 ; (Coulibaly et al., 2017; HLPE, 2019; Quandt et al., 2019; Sinclair et al., 2019; Smith et al., 2019b; Muchane et al., 2020; Reppin et al., 2020)