This supplementary table belongs to:

United Nations Environment Programme and International Union for Conservation of Nature (2021). Nature-based solutions for climate change mitigation. Nairobi and Gland.

Table 2 – Supplementary Table: Multiple benefits of selected nature-based solutions for climate change mitigation
(qualitative scale: +++ high benefits; ++ medium benefits; + low benefits)

		Environmental Benefits				**Socioeconomic benefits**		
		(often feed into adaptation benefits, including through improved resilience of natural, seminatural and modified ecosystems)						
	Biodiversity and ecosystem services	Biodiversity conservation	Climate stability	Soil health	Water quality	Reduced risks of extreme events	Food and/or energy provision	Cultural services and health security
Nature-based solutions for climate change mitigation	**Avoided Forest Conversion**	+ + + Conservation of high biodiversity value areas (including endemic species) associated with intact and connected forests [a] Forests are responsible for providing habitat for 80 %, 75% and 68% of all amphibian, bird and mammal species, respectively [d]	+ + + Avoided C emissions and continued C sequestration (mainly in humid tropical forests, high-biomass temperate forests and large temperate forested regions) [a] C sequestration from the atmosphere (−15.6 ± 49 GtCO2e gross annually, between 2001 and 2019)[b] Tropical evergreen broadleaf forests contribute to 22% of the global evapotranspiration, thus having a major role in the precipitation regime [hhh]	+ + + Maintenance of soil infiltration by vegetation and soil fauna under forest [a] Maintains soil biological and physical properties ensuring health and productivity of forests [aa]	+ + + Nutrient uptake and retention of nitrogen and phosphorus by forest vegetation that prevents nutrient losses to watersheds [a] Improved availability of water for crop irrigation, drought mitigation; avoided sedimentation and water regulation for hydroelectric dams [bb]	+ + + Erosion prevention by physical buffering of high stream flows and prevention of flash floods [a] [c]	+ + + Food provision mainly in humid tropical forests [a]. About a quarter of rural populations' income in developing countries comes from harvesting non-timber forest products (NTFPs) such as shoots, roots, mushrooms, and insects [h] Globally, an estimated 880 million people collect fuelwood or produce charcoal from forests and over 90% of the extreme poor rely on forests for at least part of their livelihoods[e]	+ + + Scientific value: - control areas for ecological research [a] Cultural value: - at least 36% of Intact Forest Landscapes are within Indigenous Peoples' lands [f] - many indigenous peoples, have long, multigenerational links with specific forest areas and native species, expressed in beliefs, customs, traditions and cultures [e] Recreation value Maintaining forests can make a significant contribution to human health - health benefits of air filtration by forests [cc]
	Reforestation	+ + / + + + (considering reforestation with native species)	+ + + C sequestration (mainly in humid tropical and temperate	+ + Decreased soil compaction,	+ + / + + + Nutrient uptake and retention of nitrogen	+ + Reduced soil loss to erosion associated with	+ + / + + + Food provision (providing that	+ + +

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	Tree plantings can create wildlife corridors and buffer areas that enhance biological conservation [dd] Biodiversity protection increases with the development of secondary forests and are higher when reforestation expands or reconnects remaining forests [a]	regions with high rates of tree growth and biomass) [a] Natural regeneration with high potential for C sequestration (9.1–18.8 t CO_2 ha^{-1} $year^{-1}$) for the first 20 years of growth [g] Questionable net impacts in boreal ecosystems Providing no displacement of other land uses into carbon-dense ecosystems	increased water infiltration and accelerated cycling of soil nutrients [a]	and phosphorus by forest vegetation that prevents nutrient losses to watersheds [a] Improved availability of water for crop irrigation, drought mitigation; avoided sedimentation and water regulation for hydroelectric dams [bb]	reduced compaction and greater infiltration [a] Regulation of water flow, stabilizing supplies in the face of both intense rainfall and drought, in the case of reforestation of upland areas [h] A recent review indicates benefits of up to 19 % reduction in peak flows by riparian forest restoration at the sub-catchment scale, representing 20-40% of the total catchment area [n]	reforestation is not competing with agricultural production) [a]	Restoring green spaces can make a significant contribution to human health (highest in populations with chronic and difficult-to-treat conditions) [a]
Improved plantations	+ /+ + Plantation forests deliver biodiversity benefits by buffering native forest remnants and enhancing landscape connectivity where native woodland is scarce, in addition to providing habitat in the landscape [j]	+ + + Planted forests and woodlots with the highest CO_2 removal rates (compared with natural regeneration, agroforestry and mangrove restoration) ranging from 4.5 to 40.7 t CO_2 ha^{-1} $year^{-1}$ during the first 20 years of growth [g]	+ Capacity to provide vital regulating services by preventing soil erosion and nutrients' loss, depending on the management technique and trees' development stage (in a research with *Eucalyptus* plantations, soil loss rates were close to those observed for native forest after the first two years of the plantation) [ccc]	+ A review showed that New Zealand's planted forests produce high water quality (in terms of temperature, nutrient and sediment concentrations and microbial contamination) and that impacts where greatest when clear-cut harvesting up to the stream edge [bbb]	++ Riparian planting has been undertaken as part of an integrated approach to flood alleviation in the UK [m] Buffering against extreme weather events or natural hazards, such as floods storms and landslides, and hence reducing damaging impacts [zz]	+ ++ Provision of raw materials for construction, pulp and wood, biofuels and essential oils. With an assumed average efficiency rate of 70 %, the potential industrial wood production in 2005 from planted forests was estimated at 1.2 billion m^3 or about two-thirds of the overall wood production in that year [aaa]	+ Provision of scenic and natural landscapes that provide recreation areas important in maintaining mental and physical health and as sites for eco-tourism and outdoor sport, (in a research with a peri urban planted forest in NZ, the economic value of recreation was approximately NZ$8 million in 2009) [ddd]
Natural Forest Management	+ / + +	+ + (depends on end use of forest products) [a]	+ / ++	+	++	+ +	

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	Variable according to the management intensity (intensive management affects negatively species dependent on the continuity of forest cover, deadwood and large trees)[i]	There are synergies from tree growth accumulating C which remains a store for the lifespan of harvested wood products, as well as from fossil fuel substitution in energy and construction [l]	Timber harvesting that removes large amounts of woody debris reduces soil biological and physical properties thereby reducing health and productivity [aa] Participatory Forest Management (PFM) of 22 million hectares of forest land Tanzania in (almost half of the existing forests) has decreased soil erosion and overgrazing [eee]	Variable according to the management practices (some may have a detrimental impact on water quality by increasing diffuse pollution, soil disturbance resulting from cultivation, and harvesting operations can increase turbidity and sedimentation) [k] Harvesting that removes large proportions of biomass increases water flows and flooding thereby altering freshwater ecosystem integrity [ee]		Food provision [a]	
Conservation Agriculture (cover crops)	+ especially compared to reforestation, because land remains cropland with relatively low biodiversity. Some benefits for pollinators for some cover crops, but timing during the growing season may restrict benefits [a]	+ + Soil C storage. Potential is limited by short duration of cover crops in most planting systems, potential conflicts with crop production, and benefits that are easily reversed if cover cropping is discontinued [a]	+ + increased organic matter inputs, increased water infiltration, increased waterholding capacity and benefits to nutrient supply provided by decay of cover crop-derived soil organic matter [a]	+ + reduce nutrient losses by maintaining plant cover for a longer time during the year. The deep rooting of many cover crops helps prevent nutrient losses. The short duration of cover crops limits total nutrient capture potential [a]		+ + +	
Trees in Croplands	+ + Associated with the addition of structural complexity to	+ + Associated with the C stored in trees. Potential is generally less than one-third of the	+ + increased organic matter inputs, increased water	+ / ++ the benefits for water quality can be higher in the case trees are	+ + Reduced erosion associated with reduced compaction and greater	+ + +	

	Environmental Benefits				Socioeconomic benefits		
	(often feed into adaptation benefits, including through improved resilience of natural, seminatural and modified ecosystems)						
Biodiversity and ecosystem services	Biodiversity conservation	Climate stability	Soil health	Water quality	Reduced risks of extreme events	Food and/or energy provision	Cultural services and health security
	croplands and increase of habitats and ecological niches [a]	potential of avoided deforestation or reforestation [a]	infiltration, increased waterholding capacity and benefits to nutrient supply provided by decay of cover crop-derived soil organic matter [a]	planted within heavily fertilized croplands and if they are concentrated along streams or watercourses where they could intercept nutrient run-off [a]	infiltration (increases with the number and coverage of trees and will vary by location) [a]		
Avoided Peatland Impacts	+ + + Conservation of high biodiversity value areas associated with tropical peat forests and connected peatland lowland forests [a]	+ + + Avoided C emissions and continued C sequestration in trees and soil (mainly in tropical peat forests and in temperate and boreal peatland forests with high soil C) [a] Peatlands store nearly 30 % of global soil carbon [ff]. Because they provide an enormous long-term carbon sink, undisturbed peatlands are a critical global asset in the effort to regulate climate [ii]	+ + + Avoidance of losses of soil organic matter that accompany soil drainage. Benefit of avoidance of acid conditions that follow drainage of some peat wetland soils [a]	+ + + High benefits of avoidance of large nutrient losses that accompany peats' (mostly forested ones) removal [a]	+ + + Peatlands and wetland soils attenuate flooding [kk]	+ + + Provision of biomass and food to millions of people [r] In Kalimantan, the fringes of the peat swamp forests have been inhabited and used by Dayak communities, mainly through sustainable harvesting of natural products, hunting and fishing (including small fishpond systems), shifting agriculture and enrichment planting systems) [yy]	+++ Natural haven for culture and recreation [r] In Peru, the palm fruit (*Mauritia flexuosa*) holds sacred cultural value for the indigenous Achuar people [gg]
Peatland Restoration	+ + + Due to the disproportionately high value of peatland habitats. These values occur across biomes [a]	+ / ++ / +++ Restoring peatlands could avoid GHG emissions equivalent to 12–41 % of the remaining GHG budget for keeping global warming below 2°C [s] C sequestration (potential will depend on how much methane is emitted, which may offset potential gains. This is not well known and will	+ + Medium benefits of returning soils to wetland conditions that have high organic matter input and permanent or periodic low oxygen. While these conditions are not desired in agricultural soils,	+ + + Mainly in cropland regions and in locations that are downstream of fertilized croplands or in locations that have contact with nutrient-enriched surface or ground water [a]	+ + + Peatland restoration can alter catchment runoff regimes, reduce peak flows and contribute to Natural Flood Management (NFM) at the small (<20 km^2) catchment scale, with some evidence from modelling that peak flow reductions could	+ / ++ / +++ Through paludicultures, which are the only sustainable mode of agricultural production on peatlands, food and NTFP production is ensured [fff]	+ + Rewetting peatlands reduces fire risk [yy], which in turn improves human health (thus reducing the need for health services to treat lung and pulmonary disorders)

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Biodiversity and ecosystem services	Biodiversity conservation	Climate stability	Soil health	Water quality	Reduced risks of extreme events	Food and/or energy provision	Cultural services and health security
		also depend on type and local setting) (a) The ability of peatland rewetting to CC mitigation depends strongly on the climate zone and current land use: (i) High potential - tropical peat soils; (ii) Medium potential - temperate and boreal agricultural peat soils (methane emissions offset a major part of the cooling for the first decades); (iii) Low potential - temperate and boreal forestry-drained peatlands(v) Reduction of GHG emissions from peatlands drained for different human activities after rewetting vary between 2 tonnes CO_2 ha-1 yr-1 (forest use in boreal zone) to 34 tonnes CO_2 ha-1 yr-1 (cropland use, boreal zone)(xx) In a project to restore peat swamps around Moscow that burned in a 2010 heatwave, 35,000 ha are being restored and CO^2 emissions have decreased by at 175,000 to 200,00 tonnes of C per year as a result (jj)	they facilitate carbon storage and the co-benefit of nutrient removal in peatlands (a)		potentially extend into larger catchments (q)		
Avoided Coastal Impacts	+ + + Diverse habitats for fisheries and aquatic life (a)	+ + + C storage both above and below ground for mangroves and below ground in coastal marshes (a)	+ + + Continued sediment capture and maintenance of wetland and peat	+ + + Nutrient and sediment retention by intact mangroves and marshes (a)	+ + + Increase the resilience in the face of sea level rise (a) Wetlands and marshes help to collect and slow	+ + + Healthy mangroves provide nursery grounds for important species, improving fisheries production (p)	+ + + Coastal communities derive cultural ES from mangroves, including tangible services such as recreation and intangible

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	Maintains the provision of structure, nutrients and primary productivity and nurseries for commercially important fish and shrimp [nn]	Wetland soils hold 35% or more of the estimated 1,500 Gt of organic C that is stored in soils [hh] [ii] A Blue Carbon project in the Gulf of California (Mexico) involving the protection of 16,058 ha of mangroves through conservation concessions from the Mexican Federal Government was estimated to have cumulative avoided emissions of 2.84 million Mg CO_2 over 100 years, valued at $US 426 000 per year (US$15 per Mg CO2 in the California market) [vv]	soils by mangroves and marshes [a]	Coastal wetlands have an assessed economic value of $785-$34,700 in wastewater treatment value [mm] Seagrasses have an economic value estimated at USD 34,000 ha-1yr-1 in the service of improving water quality (by filtering, cycling and storing nutrients and pollutants), a figure greater than many terrestrial and marine habitats [iii]	or prevent the release of floodwater, storing as much as 9-14,000 m^3 of water ha^{-1} [x] The world's existing mangroves are estimated to reduce the number of people affected by coastal flooding globally by some 39% [y] Globally, mangroves protect 15 million people from flooding every year and provide over US$65 billion in flood protection services [ggg] Healthy mangroves can be an effective defence against the destructive impacts of tsunamis, and can reduce wave heights by 5–30% [z]	Coastal communities have long relied on the extraction of fuel wood from mangroves [rr] Mangroves are important providers of food for coastal communities (such as shellfish and finfish) and a recent research has found a convincing scientific evidence of the mangrove-fishery-linkage in the area of the Ciénaga Grande de Santa Marta, the most important lagoon system in the Colombian Caribbean [ss]	services such as aesthetic appeal and spiritual values [pp] It is likely that mangrove tourism attracts tens to hundreds of millions of visitors annually and is a multi-billion-dollar industry. A recent research of the distribution of mangrove visitation places at global scale has mapped 3945 mangrove "attractions" in 93 countries and territories [qq] In Singapore, Pasir Ris Mangrove is valued for the more intrinsic benefits of peace and tranquility, and enjoying time with family [tt]
Coastal Restoration	+/ + + / +++ For mangroves, the benefits in terms of biodiversity are variable depending on the rehabilitation and restoration methods used and on the success of restoration. Different techniques include monoculture plantations, "ecological mangrove restoration"	+ + + Mangrove restoration with high potential for C sequestration (23.1 and 10.5 t CO_2 ha^{-1} $year^{-1}$, the first 20 years of growth and the following 40 years, respectively) [g] Restoration of vegetated coastal ecosystems, such as mangroves, tidal marshes and seagrass meadows (coastal 'blue carbon' ecosystems), could provide CC mitigation through	+/ + + / +++ For mangroves, the benefits in terms of soil health are variable depending on the rehabilitation and restoration methods used and on the success of restoration [a] [pp]	+/ + + / +++ For mangroves, the benefits in terms of water quality are variable depending on the rehabilitation and restoration methods used and on the success of restoration [a] [pp]	+ + + Vegetated coastal and habitats contribute to climate change adaptation by increasing coastal resilience and reducing the impact of sea level rise [p] One estimate valued the storm damage that could potentially be averted by coastal wetland restoration in high risk areas along the gulf coast	+ + + Restoring mangroves in 105 countries and territories could add over 60 trillion young fish and invertebrates of commercially valuable species to coastal waters every year [u] A programme of mangrove rehabilitation in the state of Gujarat in Western India has	+ + + Rehabilitated and restored mangrove ecosystems have important social values for coastal communities [pp]

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	Biodiversity and ecosystem services	Biodiversity conservation	Climate stability	Soil health	Water quality	Reduced risks of extreme events	Food and/or energy provision	Cultural services and health security
		(EMR) approaches and "mangrove ecosystem design," which foregrounds people and their needs [pp] A high diversity of molluscs, crustacea, and snake species, had established at the Pasir Ris mangroves in Singapore after 20 years of restoration efforts. The multi-species, natural regeneration at Pasir Ris has led to faster tree growth and biomass accumulation compared with other restoration sites in Singapore [pp]	increased carbon uptake and storage of around 0.5% of current global emissions annually [o] A recent research revealed a substantial reduction of biomass (82% ± 35%) and soil (54% ± 13%) C stocks in mangroves when affected by land-use and land-cover changes and that regeneration may help restore C stocks back to pre-disturbed levels over decadal to century time scales [uu]			of the United States through 2030 at US$18.2 billion [t]	increased fish catches by artisanal fishers and have had positive influences on offshore commercial fish catches and the contribution of the planted mangroves' nursery ground and habitat service to the fishery sector of Gujarat state is valued at INR36.04 billion (USD0.57 billion) annually [oo] Mangrove plantations are an important source of fuelwood to the majority of the coastal rural households in Bangladesh [rr]	

Sources:
[a] WEF 2021
[b] Harris *et al.* 2021
[c] FAO 2019
[d] Vié *et al.* 2009
[e] FAO and UNEP 2020
[f] Fa *et al.* 2020
[g] Bernal *et al.* 2018
[h] Shackleton *et al.* 2011
[i] Summerville 2013
[j] Procter *et al.* 2015
[k] Brown and Binkley 1994
[l] Sing *et al.* 2018
[m] Nisbet *et al.* 2011
[n] Dixon *et al.* 2016
[o] Intergovernmental Panel on Climate Change 2019
[p] Hoegh-Guldberg *et al.* 2019
[q] Allott *et al.* 2019

[r] Crump 2017
[s] Leifeld *et al.* 2019
[t] Reguero *et al.* 2018
[u] Worthington and Spalding 2018
[v] Ojanen and Minkkinen 2020
[x] UNEP 2016
[y] Losada *et al.* 2018
[z] Spalding *et al.* 2014
[aa] Jurgensen *et al.* 1997
[bb] Ferraro *et al.* 2012
[cc] Nowak *et al.* 2014
[dd] Harrison *et al.* 2003
[ee] Burton 1997
[ff] Scharlemann *et al.* 2014
[gg] Gonzales *et al.* 2020
[hh] Mitsch and Gosselink 2015
[ii] Fennessy and Lei 2018
[jj] Pearce 2020
[kk] Ming *et al.* 2007
[mm] Zedler and Kercher 2005
[nn] Duke *et al.* 2007
[oo] Das 2017
[pp] Ellison *et al.* 2020
[qq] Spalding and Parrett 2019
[rr] Chow 2018
[ss] Carrasquilla-Henao *et al.* 2019
[tt] Thiagarajah *et al.* 2015
[uu] Sasmito *et al.* 2019
[vv] Adame *et al.* 2018
[xx] Barthelmes *et al.* 2015
[yy] Page *et al.* 2008
[zz] Calder and Aylward 2006
[aaa] Carle and Holmgren 2008
[bbb] Baillie and Neary 2015
[ccc] Oliveira *et al.* 2013
[ddd] Dhakal *et al.* 2012
[eee] Patenaude and Lewis 2014
[fff] Joosten *et al.* 2012
[ggg] Menéndez *et al.* 2020
[hhh] Wang-Erlandsson *et al.* 2014
[iii] Short *et al.* 2011

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