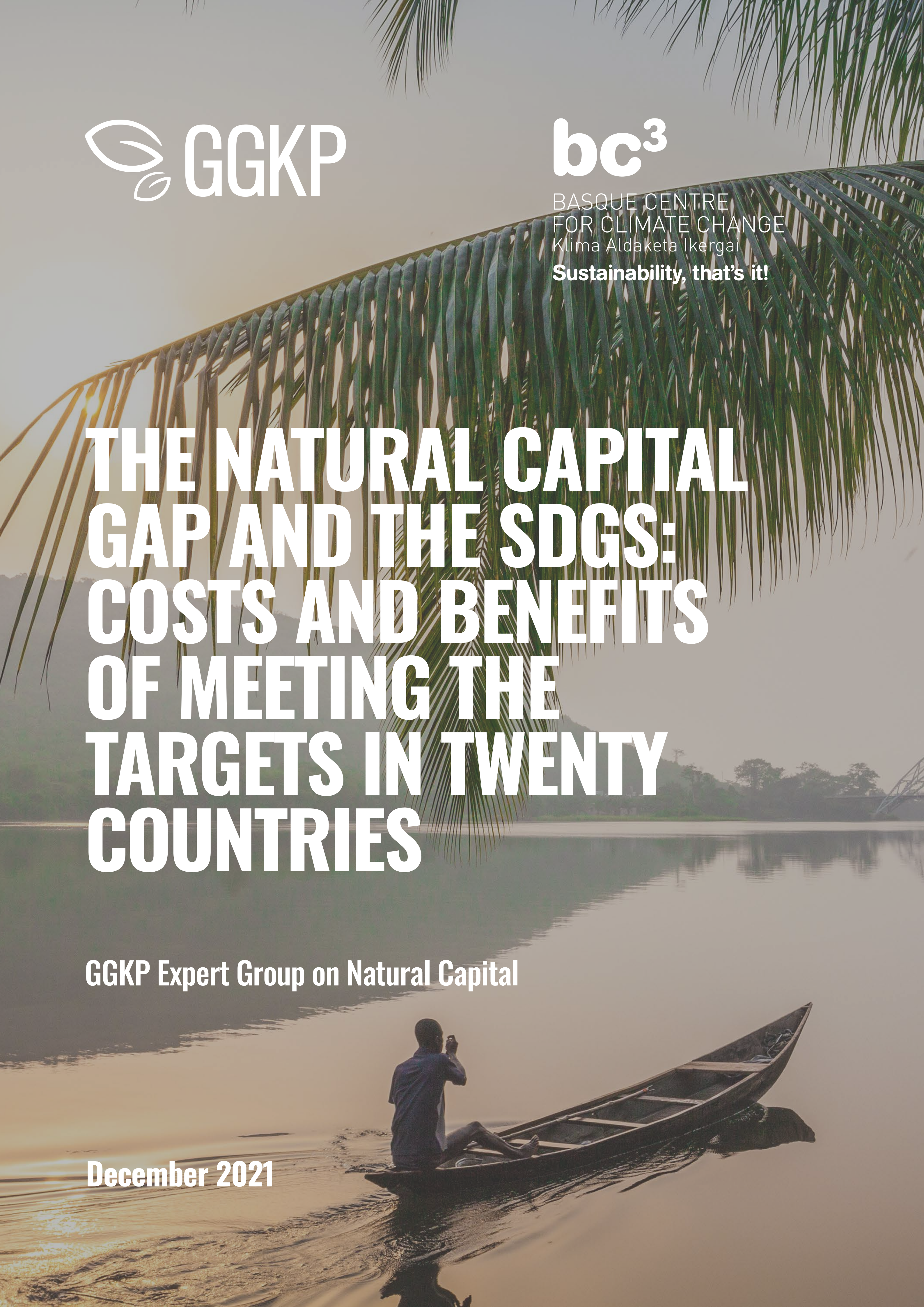

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Klima Aldaketa Ikergai
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THE NATURAL CAPITAL GAP AND THE SDGS: COSTS AND BENEFITS OF MEETING THE TARGETS IN TWENTY COUNTRIES

GGKP Expert Group on Natural Capital

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December 2021

The Green Growth Knowledge Partnership (GGKP) is a global community of organizations and experts committed to collaboratively generating, managing and sharing green growth knowledge. Led by the Global Green Growth Institute (GGGI), Organisation for Economic Co-operation and Development (OECD), United Nations Environment Programme (UNEP), United Nations Industrial Development Organization (UNIDO) and World Bank Group, the GGKP draws together over 80 partner organizations. For more information, visit www.greengrowthknowledge.org.

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CONTENTS

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The Green Growth Knowledge Partnership (GGKP) convenes inter-institutional expert groups to identify and address critical knowledge gaps in green growth theory and practice. The neutral, collaborative expert groups focus on knowledge generation, synthesis and on-the-ground application by partners and in-country stakeholders.

The GGKP Secretariat commissioned the Basque Centre for Climate Change to prepare this report. It is part of a series of reports aiming to measure the costs and benefits of natural capital investment to meet national SDG targets worldwide. The series addresses a key knowledge gap identified by the GGKP Natural Capital Expert Group on the provision of natural capital data and methods to inform national green growth plans.

Equally, the series aims to achieve, in part, the three goals of the GGKP Natural Capital Expert Group, namely, to push forward the knowledge frontier, to mainstream natural capital in global green growth activities and to support stronger implementation of natural capital commitments in national economic plans.

This publication was produced by Anil Markandya (Basque Centre for Climate Change) and Suzette P. Galinato (Basque Centre for Climate Change and Washington State University).

The report received peer review inputs from Charles Akol (United Nations Economic Commission for Africa), Lei Wu (Zhongnan University of Economics and Law), John. J. Maughan (GGKP) and Gregory Watson (Inter-American Development Bank). The methodology underlying the report has also benefitted from two previous peer reviews, including those of Markandya (2020) and Markandya and Galinato (2021).

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We sincerely thank the authors and contributors for making this work possible.

EXECUTIVE SUMMARY

This report provides estimates of the financial costs and benefits of meeting selected targets of the Sustainable Development Goals (SDGs) that are linked to natural capital. It is one of few studies that look at the costs of meeting the SDGs and the only one we are aware of that estimates the gains in natural capital from meeting these goals. In this report, natural capital is viewed as an asset that generates goods and services that have an economic value.

The main contributions of the study are to provide the following:

- Estimates of the "natural capital gap", a quantitative indicator of how much natural capital would have to be increased to meet the associated SDGs for a set of 20 countries.
- Cost estimates at the country level corresponding to each of the SDG targets evaluated.
- A comparison between the increase in natural capital and the costs of bringing this about for each SDG and for each country.

The countries covered in the study are given in Table ES1. They were chosen to include both developed and developing regions, but to give a high representation to countries from sub-Saharan Africa. The 11 sub-Saharan African countries have a combined gross domestic product (GDP) that is 74 per cent of sub-Saharan African GDP. These 11 countries' land area and population are 41 per cent and 65 per cent of the sub-Saharan African totals, respectively. Their contribution to global greenhouse gas (GHG) emissions is around 65 per cent of total GHG emissions in the sub-Saharan region. If Morocco is also included, and the scope expanded to cover both sub-Saharan and North Africa, these 12 countries represent in total 56 per cent of GDP, 34 per cent of land, 58 per cent of population, and 52 per cent of GHGs on the African continent. For all 20 selected countries below, the combined GDP amounts to 54 per cent of world GDP and their combined land area represents 39 per cent of the global land area. The aggregate population and GHG emissions of the 20 countries are 59 per cent of the total world population and 59 per cent of global GHG emissions, respectively.

Table ES1: Countries selected for in-depth analysis of financial needs

Country	Level of Income	Region
DRC	Low	Sub-Saharan Africa
Ethiopia	Low	Sub-Saharan Africa
Madagascar	Low	Sub-Saharan Africa
Senegal	Low	Sub-Saharan Africa
Uganda	Low	Sub-Saharan Africa
Angola	Lower-middle	Sub-Saharan Africa
Cameroon	Lower-middle	Sub-Saharan Africa
India	Lower-middle	South Asia
Indonesia	Lower-middle	East Asia and the Pacific
Kenya	Lower-middle	Sub-Saharan Africa
Morocco	Lower-middle	Middle East and North Africa
Nigeria	Lower-middle	Sub-Saharan Africa
Tanzania	Lower-middle	Sub-Saharan Africa
Brazil	Upper-middle	Latin America and the Caribbean
China	Upper-middle	East Asia and the Pacific
South Africa	Upper-middle	Sub-Saharan Africa
Australia	High	East Asia and the Pacific
France	High	Europe
Germany	High	Europe
USA	High	North America

Source: World Bank (2020)

The selected SDG targets cover those related to agricultural land, air, water, atmosphere, forests, wetlands and protected areas. Some targets related to natural capital, but not included, are those for marine and terrestrial ecosystems and indoor air quality. This is on account of a lack of data. The report is intended to provide guidance to countries of the likely financial requirements to meet their selected SDG targets that affect the quantity and state of natural capital, and the values of gross and net benefits that can be expected from meeting these SDG targets. The cost-benefit information will help countries determine investment priorities in case of limited funds.

The global cost of meeting all the targets is estimated to be between US$620 billion and US$2,608 billion, over the period 2021-2030. This comes out at between US$62 billion and US$621 billion annually. The four sectors with the highest required expenditures to meet the SDG targets globally are for climate change, air quality, protected areas and water quality (in that order). For all targets, however, the value of the increase in natural capital is well in excess of the required expenditures, demonstrating positive returns in every case of natural capital investment.

Globally, the greatest net gains in natural capital, less the costs of bringing it about, come from meeting the targets for forests, wetlands and all protected areas (including marine ones). They make up half of all net benefits. The next largest gains are for improvement in air quality, where the gains in natural capital net of costs are around 28 per cent of the total, followed by water and sanitation, which accounts for 21 per cent. Surprisingly, the gain in natural capital for land is smaller compared to these sectors and makes up only 0.2 per cent of the total, although its share is much higher for selected countries. The net gains from material efficiency and climate change are small but they are still positive. It is also important to note that the range of net gains from addressing these two areas of natural capital loss could be much higher. This estimation has taken an average damage avoided figure; if the true figure is at the upper end of estimations, for example, as it could be, then the net benefits will be much larger.

Information on the benefit-cost ratios (BCRs) by sector and country show the following:

- In the case of protected areas, the BCRs are extremely high (over 5,000 in Senegal and Tanzania) where the area being protected is largely or exclusively marine. Such areas have a high gain in natural capital but modest costs of protection. Data on costs, however, need to be confirmed.
- Agricultural land remediation has BCRs of over 35 in African countries. The exceptions are Kenya, South Africa and Tanzania where it is 14, 17 and 9, respectively.
- Air quality has relatively low BCRs in developing countries (ranging from over one in Kenya to as high as 32 in South Africa) compared to the large emerging economies of China (with a BCR of 98) and India (with a BCR of 939) and developed countries (with BCRs of 113 to 1,333) where industrial pollution is highest.
- The highest BCRs for water quality are in Brazil, South Africa and Nigeria (87, 78 and 47 respectively).
- The BCRs for reduced deforestation are in the range of 1-2 for most countries, which means that reducing deforestation pays for itself with a return of up to 100%.
- Wetland conservation BCRs are more than 100 in Angola, Nigeria, Brazil, China, South Africa, France and Germany. This means that the return on investment will be 100 times the cost of conservation.

The gains of natural capital as a per cent of the estimated current stock of natural capital (as estimated by the World Bank) are especially large across sub-Saharan Africa, but also in some other parts of the developing world. They are more modest in developed countries and emerging economies.

Further work is needed to make the estimates more accurate and extend the coverage, as many marine targets related to the SDGs are currently not covered. The improvement in the estimation applies both on the cost side and natural capital side, but is especially the case for the cost data. Work that is ongoing to improve databases that provide this information will be of great value allowing countries to apply the methods developed here with more accurate data to improve estimates of the costs and benefits of the SDGs and of the gains in natural capital. This will help them prioritize investments in sectors and locations where the greatest gains can be made.

1. INTRODUCTION

The UN Sustainable Development Goals (SDGs) serve as a shared blueprint of countries in addressing critical problems that are interconnected, such as poverty, health, education, economic growth and the environment. In total, there are 17 SDGs, 169 targets and 230 associated indicators that member countries are working to achieve by 2030 (UN, 2016).

Two major reports have provided the costs of meeting the SDG targets in developing countries (UNCTAD, 2020; UN, 2019). Their results show a total investment gap across major industry sectors of $2.5 trillion to $3 trillion per year, on average. A report by the Business and Sustainable Development Commission (2017) found that aligning corporate strategies with SDGs targeted to four sectors (food and agriculture, cities, energy and materials, and health and well-being) will generate new market opportunities and sizeable benefits. For instance, 380 million new jobs will be potentially created globally by 2030, of which about 90 per cent will be in developing countries. Addressing the SDGs on food and agriculture and cities will generate business opportunities valued at about $2.3 trillion and $3.7 trillion per year, respectively.

The difference of this report with the aforementioned studies, and thus its contribution, is the estimation of financial costs and benefits of meeting selected SDG targets that are linked to natural capital. To date, we are not aware of other studies that have done this exact type of work. Although there are some similar exercises, they do not focus on natural capital.

There are several definitions of natural capital in the literature. The World Forum on Natural Capital (2021) defines the term as the stock of natural assets, which include geology, soil, air, water and all living things. It is from this natural capital that humans derive a wide range of services, often called ecosystem services, which make human life possible.

Taking an economic perspective, the Organisation for Economic Co-operation and Development (OECD, 2005) defines natural capital as natural assets in their role of providing natural resource inputs and environmental services for economic production. The World Bank (Lange et al., 2018) focuses on the way natural capital is measured, noting that a particular natural capital asset is measured as the discounted sum of the value of the rents generated over its lifetime. In the case of a renewable resource, the lifetime may be unlimited. In this report, natural capital is viewed as an asset that generates goods and services that have an economic value. That value is measured in the way stated by the World Bank.

Objective and methodology

What are the financial requirements needed to increase natural capital associated with SDGs where such capital has a major role? How do these financial costs compare with the benefits of increased value of natural capital? To answer these questions, the report provides estimates of the costs of meeting the SDG targets for those SDGs where natural resources and the environment are a critical factor as well as estimates of the gains in natural capital resulting from meeting the SDG targets.

A couple of studies are used as a basis for this report. The first study is Markandya (2020) that examined the linkage between selected SDGs and their natural capital requirements. The study also estimated the natural capital gap, which serves as a quantitative indicator of how much natural capital would have to be increased to meet the associated SDGs. The second study is Markandya and Galinato (2021) that applied the methodology of Markandya (2020) to estimate the financial costs of bridging the natural capital gap globally and at the national level for 10 selected countries.

This report builds on the work in both these reports in the following ways:

- Estimates the "natural capital gap" associated with the SDGs for a selected set of 20 countries, including the 10 already identified in Markandya and Galinato (2021).[1] In addition, the estimate for the world has been updated from the earlier study where more recent data have been made available.
- In parallel, cost estimates have been made at the country level corresponding to each of the SDG targets evaluated.
- A comparison has been carried out between the increase in natural capital and the costs of bringing this about for each SDG and for each country.

Table 1 lists the 20 countries. They were selected based on discussions between the Basque Centre for Climate Change (BC3) and Green Growth Knowledge Partnership (GGKP), while considering the representation of different income levels, different geographical regions, biodiversity and data availability. There was deliberately a high representation of countries from sub-Saharan Africa (11 of the 20 countries are from that region) to increase knowledge of the state of natural capital vis-a-vis the SDGs on that continent. The 11 sub-Saharan African countries have a combined gross domestic product (GDP) that is 74 per cent of sub-Saharan African GDP (annual average between 2016 and 2020). These 11 countries' land area and population are 41 per cent and 65 per cent of the sub-Saharan African totals, respectively. Their contribution to greenhouse gas (GHG) emissions is around 65 per cent of total GHG emissions in the sub-Saharan African region. If Morocco is also included, and the scope expanded to cover both sub-Saharan and North Africa, these 12 countries represent in total 56 per cent of GDP, 34 per cent of land, 58 per cent of population, and 52 per cent of GHGs on the African continent (World Bank, 2021a).

For all 20 selected countries, the combined GDP represents 54 per cent of world GDP and their combined land area represents 39 per cent of the global land area. The aggregate population of the 20 countries and greenhouse gas emissions are 59 per cent of the total world population and 59 per cent of global greenhouse gas (GHG) emissions, respectively (World Bank, 2021a).

1 For this reason, the sections about costs to meet the SDG targets are mostly similar to the earlier study. The main differences are updated discussions that include some of the data of the 10 additional countries and updated global estimates.

Table 1: Countries selected for in-depth analysis of financial needs

Country	Level of Income	Region
Congo, Dem. Rep. (DRC)*	Low	Sub-Saharan Africa
Ethiopia*	Low	Sub-Saharan Africa
Madagascar	Low	Sub-Saharan Africa
Senegal	Low	Sub-Saharan Africa
Uganda	Low	Sub-Saharan Africa
Angola*	Lower-middle	Sub-Saharan Africa
Cameroon*	Lower-middle	Sub-Saharan Africa
India	Lower-middle	South Asia
Indonesia	Lower-middle	East Asia and the Pacific
Kenya*	Lower-middle	Sub-Saharan Africa
Morocco	Lower-middle	Middle East and North Africa
Nigeria*	Lower-middle	Sub-Saharan Africa
Tanzania*	Lower-middle	Sub-Saharan Africa
Brazil	Upper-middle	Latin America and the Caribbean
China	Upper-middle	East Asia and the Pacific
South Africa*	Upper-middle	Sub-Saharan Africa
Australia	High	East Asia and the Pacific
France*	High	Europe
Germany*	High	Europe
USA	High	North America

Source: World Bank (2020)

Note: * Additional 10 countries to Markandya and Galinato (2021)

Selected SDG targets are presented in Table 2. The selection is mainly based on the connection of these targets to natural capital (i.e. agricultural land, air, water, atmosphere, forests, wetlands, protected areas) and data availability. There are some targets related to natural capital that were not included due to lack of data, such as some of those related to marine and terrestrial ecosystems, and indoor air quality. In each case, the SDG target taken is as defined in the UN list of indicators where that is available.[2] Where it is not specified in detail in that document, a quantitative version is proposed based on the literature surrounding the SDGs.

2 See: https://sustainabledevelopment.un.org/content/documents/11803Official-List-of-Proposed-SDG-Indicators.pdf.

This paper is intended to provide guidance to countries of the likely financial requirements to meet their selected SDG targets that affect the quantity and state of natural capital, and the values of gross and net benefits that can be expected from meeting these SDG targets. The cost-benefit information will help them determine programme priorities given limited funds.[3]

Sections 2 to 6 address the SDG targets related to the restoration of degraded agricultural land, safe water and sanitation, reduction of GHGs and improvement of air quality, increased efficiency of using natural materials in production and consumption, and reduction of losses in terrestrial ecosystems, respectively. These five sections describe the costs of investments likely to be needed in achieving the selected SDG targets, as well as the benefits that can be expected when these targets are achieved. Section 7 provides a synthesis of the net gain in natural capital by SDG target and by country, and the comparison of gains relative to the natural resource stock. Section 8 concludes the report.

3 A comparable approach to ours is a combination of the models used in the IEEM platform and applied in Brazil and Rwanda (Biodiversity & Ecosystem Services Program | IADB) and BIOFIN by the Inter-American Development Bank. See: https://www.iadb.org/en/environment/Open-IEEM-Platform.

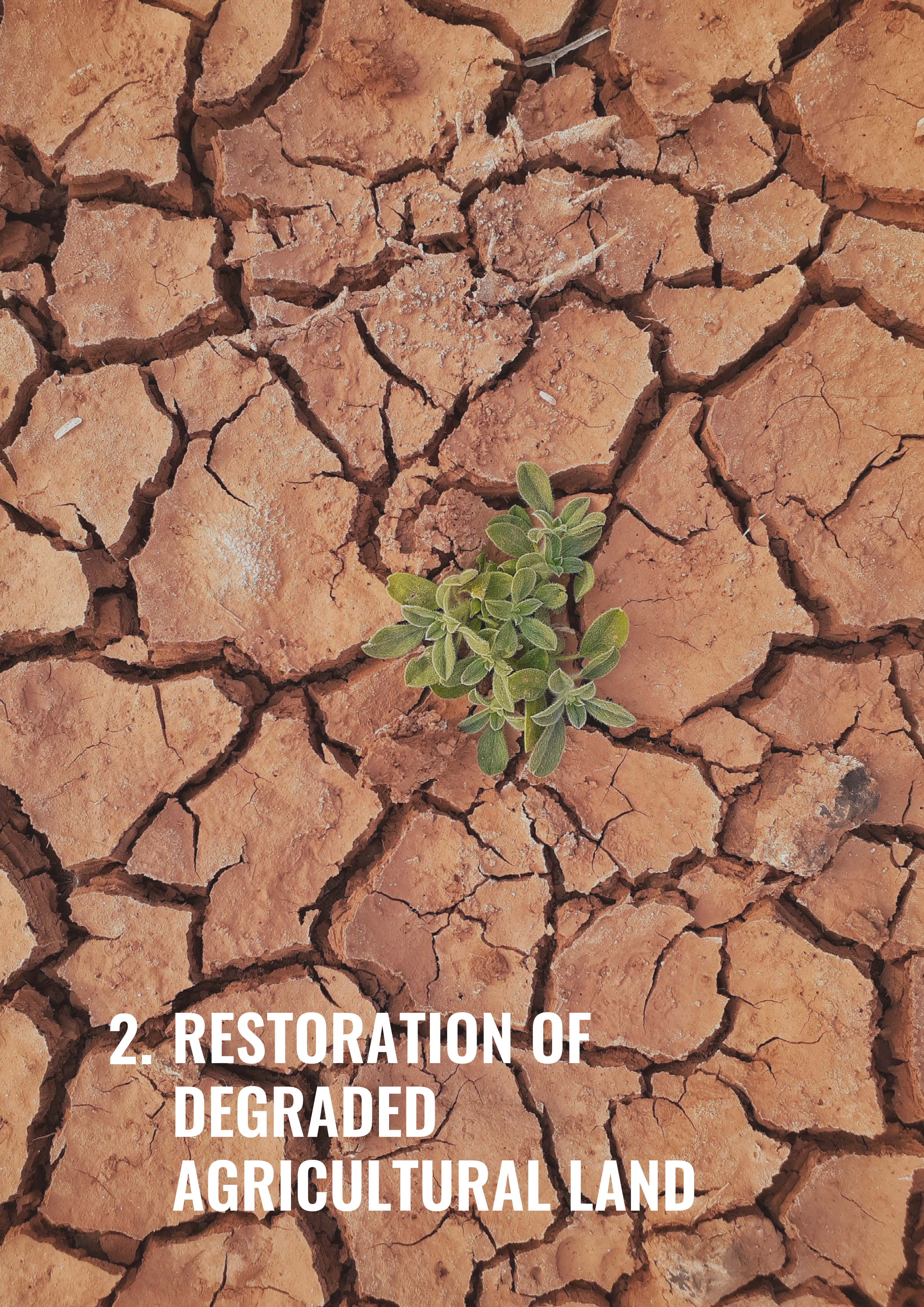
Table 2: Relevant SDG targets and natural capital covered in the analysis

SDG*	SDG target/s*	Relevant natural capital**	Natural capital change	Estimation of financial costs	Data sources
SDG2: Zero Hunger	2.4 – Productive and sustainable agriculture	Agricultural land	Restoration of degraded agricultural land	Costs of remediation	Various, WRI, World Bank, GEF, National
SDG3: Good Health and Well-being	3.9 – Reduction of mortality rate due to hazardous chemicals, air, water and soil pollution and contamination	Air quality Water quality	Reduction of pollutants in air and water	Costs of safe water provision Costs of air pollutant reductions	Various, WHO, World Bank, National
SDG6: Clean Water & Sanitation	6.1 & 6.2 – Adequate and equitable access to safe water and sanitation services				
SDG11: Sustainable Cities and Communities	11.6 – Reduction of environmental impacts, including air quality and waste management				
SDG9: Industry, Innovation and Infrastructure	9.4 – More environmentally sustainable infrastructure and industries	Atmosphere to sustain a stable climate	Reductions in emissions of GHGs	Costs of programmes to reduce GHGs	Various, National
SDG13: Climate Action	13.2 – Integration of climate change measures into national policies, strategies and planning				
SDG12: Responsible Consumption and Production	12.2 – Sustainable management and efficient use of natural resources	Terrestrial biomes that deliver materials	Reduced utilization of natural materials in consumption and production sectors	Costs of introducing efficiency measures to save materials	OECD, UNEP, National
SDG15: Life on Land	15.1 – Conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services	Terrestrial biomes that deliver ecosystem services, i.e. forests, wetlands, protected areas	Increased flow of ecosystem services (ESS) from the terrestrial systems through reduced deforestation, reduced loss of wetlands, and increase in protected areas	Estimates of costs of reforestation, protection of conservation areas	Various, UN studies

Source: Table adopted from Markandya and Galinato (2021)

* Details obtained from UN (2015)

** Natural capital as addressed in this report



2. RESTORATION OF DEGRADED AGRICULTURAL LAND

This section deals with SDG2 – end hunger, achieve food security and improved nutrition, and promote sustainable agriculture – and target 2.4, which uses the "proportion of agricultural area under productive and sustainable agriculture" indicator. The indicator is interpreted further as remediating given areas of degraded land, details of which are given below. The section then calculates the costs associated with the remediation of those areas of degraded agricultural land.

SDG2.4 does not give a figure for what proportion of agricultural land should be productive and sustainable by 2030. This figure is estimated by using available data on degraded land, land restoration commitments, and share of agricultural land in total agricultural and forest areas in the selected countries, as described below.

Degraded land at the country and global levels

Estimates of degraded land vary and are not well determined (Gibbs and Salmon, 2015). The global range is from less than 1 billion hectares, to over 6 billion hectares, with equally wide disagreement on its spatial distribution. An estimate in the middle of the range is Bai et al. (2008) based on the Global Assessment of Land Degradation and Improvement (GLADA) dataset, with national level estimates for all countries. It has been criticized, especially for its estimates in the humid tropics, but it is comprehensive and other datasets such as Global Assessment of Human-induced Soil Degradation (GLASOD) and FAO TerraStat are not accessible. Hence, for this exercise the figures from Bai et al. have been used, recognizing that the results could be different if another dataset were applied. Some discussion of possible bias in the estimates of natural capital due to the data used for degraded land follows.

Bai et al. estimate that, overall, around 27.4 million km^2 have been degraded globally over the period 1981-2003.[4] This amounts to about 21 per cent of the world's land area. According to Sutton et al. (2016), however, the corresponding loss of ecosystem services (ESS) is only about 9 per cent, indicating that the degraded areas do not, on average, contribute as much as non-degraded ones.

Area of degraded land under restoration

A global effort that is linked to the SDG is the Bonn Challenge, which calls for restoring 150 million hectares of degraded and deforested landscapes by 2020 and 350 million hectares by 2030. Based on available data in IUCN (2020a), total area under restoration is 42.8 million hectares, which is about 29 per cent of the 2020 Bonn Challenge target and 12 per cent of the 2030 target. As of 2019, 74 participants from 64 countries had made commitments to this restoration (IUCN, 2020a). If this were to be met, it would amount to remediating about 60 per cent of all degraded land by 2030. One potential way to allocate the 350 million hectares across countries would be under

4 The total given in the paper is 35.1 million km^2, but as Gibbs and Salmon point out the individual country figures total to 27.4 million km^2.

a ‘proportional rule’ by taking the proportion of the Bonn Challenge target of the total degraded land estimated by the Bai et al. study. The resulting rate is about 13 per cent, which is then applied to the degraded land area at the country level to approximate the national shares of area to be restored. Another way would be to base it on national commitments to the Bonn Challenge. The areas that would need to be remediated under the two criteria for the selected countries are given in Table 3.

Not all countries have a commitment under the Bonn Challenge. Among the 20 selected countries for this study, seven do not have a pledge — Angola, Indonesia, Morocco, China, Australia, France, and Germany. Also, of the selected countries, 11 are from the African region. Thirty-one countries in this region pledged 129.8 million hectares, comprising 62 per cent of the aggregate area of all participating countries. Of this regional pledged area, 47 per cent is represented by 10 African countries included in this study.

Furthermore, nine countries commit to more than would be considered equitable on a proportional basis and the remaining commit to less (i.e. DRC, Brazil, South Africa and USA). Table 3 shows the remaining area to be remediated by 2030 given the two criteria. Under the proportional rule, India appears to already meet their target of restoration.

Note that the two criteria represent scenarios. Because only 13 of the 20 selected countries have pledged to the Bonn Challenge, the proportional shares rule is useful in deriving estimates of degraded land areas that need to be restored in the other seven countries, as well as in providing a range of values for the 13 countries with Bonn Challenge commitments.

In 2016, the International Union for the Conservation of Nature (IUCN) developed the Restoration Barometer and its reporting protocol to help the pledgers assess and monitor their progress, identify obstacles and report on restoration commitments they have met under the Bonn Challenge (IUCN, 2020a). The protocol was applied in depth to six countries in 2018, including Brazil and the United States, while rapid assessments were conducted in an additional 13 countries to obtain a snapshot of their progress during the same period (Dave et al., 2018). The total area pledged under the Bonn Challenge is about 208 million hectares. Altogether, the 19 countries that underwent the Barometer assessments pledged about 97.8 million hectares (i.e. representing nearly half of current total commitments), and 44 per cent of their pledge is under restoration. Of the 20 selected countries in Table 3, four countries have shown real progress and two are notable — the US has surpassed its restoration commitment to the Bonn Challenge by 13 per cent, while Brazil has already met about 79 per cent of its pledge.[5] It is expected that the Barometer will be applied to more than 20 countries in 2020 (IUCN, 2020a, 2020b).

5 Degraded land that is remediated does not of course say anything about land being cleared elsewhere. In the case of Brazil, the latter is an issue while the programme to remediate land is relatively successful.

Table 3: Land areas to be remediated in selected countries by 2030 (thousand hectares)

Country	Under proportional rule	Committed under Bonn Challenge	Area under restoration as of 2018*	Remaining area to be remediated by 2030**	
				Under proportional rule	Under Bonn Challenge
DRC	17,510	8,000	0	17,510	8,000
Ethiopia	3,859	15,000	0	3,859	15,000
Madagascar	2,130	4,000	0	2,130	4,000
Senegal	451	2,000	0	451	2,000
Uganda	540	2,500	52	487	2,448
Angola	10,764	-	-	10,764	-
Cameroon	1,971	12,063	1,663	308	10,400
India	7,702	21,000	9,811	*-2,108*	11,189
Indonesia	13,376	-	-	13,376	-
Kenya	1,365	5,100	0	1,365	5,100
Morocco	876	-	-	876	-
Nigeria	1,189	4,000	0	1,189	4,000
Tanzania	5,021	5,200	0	5,021	5,200
Brazil	24,462	12,000	9,425	15,037	2,575
China	28,518	-	-	28,518	-
South Africa	4,570	3,600	0	4,570	3,600
Australia	25,925	-	-	25,925	-
France	607	-	-	607	-
Germany	422	-	-	422	-
USA	25,791	15,000	16,959	8,832	*-1,959*
World	**350,000**	**208,376**	**42,843**	**307,157**	**165,533**

Sources: IUCN (2020a) and Markandya (2020)

* Area restored by pledgers under the Bonn Challenge

** Calculated as the difference between the target area to be remediated under the proportional rule or Bonn Challenge pledge, and the area under restoration as of 2018; the difference may not be exact due to rounding.

Estimates of the costs of remediating degraded agricultural land

As mentioned earlier, this section focuses on estimating the costs of remediation for degraded agricultural land (i.e. cropland, rangeland) in the selected countries. Degraded forest land will be addressed in the section dealing with terrestrial ecosystems. Because the Bonn Challenge does not separate targets between degraded agricultural land and forest land, the following approach was done:

(1) Estimation of degraded agricultural land

Degraded agricultural land of a selected country is estimated by taking the per cent of agricultural land area with respect to the total agricultural and forest areas of that country. This percentage is then applied to the remaining area that must be remediated to meet the target in 2030 given the two criteria (see Appendix 1).

(2) Estimation of remediation costs by country

2.1. Data collection. Estimates of remediation costs have been collected from the following sources: agricultural land remediation projects funded by multilateral organizations;[6] government and NGO-supported grants and programmes for restoration and conservation of agricultural land;[7] and related project reports and journal articles (Dave et al., 2018; Development Alternatives, 2020; Ding et al., 2017; Gama, 2003; Haufler et al., 2013; Santos and Grzebieluckas, 2014; Schell, 2010; Vinholis et al., 2010).

Projects or programmes considered are those that implement strategies to remediate degraded agricultural land (i.e. not field experiments, on-farm demonstrations, development or testing of tools, or workshops/trainings only). These include rehabilitation of rangelands, soil erosion control, treatment or reclamation of sodic or saline fields, integration of fertility management, soil and water conservation, agroforestry, silvopasture and associated technical assistance (e.g. trainings or workshops, agricultural services, improvement of institutional capacity, project management).

The above sources also provided the targeted area of land, so the per hectare cost of a project or programme in each country was derived. Since the sources have different publication dates, the costs were adjusted using the GDP deflator with 2019 as the base year to make the estimates comparable.

2.2. Grouping of costs by income level. Country-specific data are unbalanced in that some countries have programmes/projects that are fewer or more than others. For this reason, the data are grouped by income level. The minimum, average and maximum

6 Abu (2018); Gebremeskel (2020); GEF (2007, 2008a, 2008b, 2010, 2011a, 2011b, 2013a, 2013b, 2014, 2015a, 2015b, 2016a, 2016b, 2016c, 2017a, 2017b, 2017c, 2018a, 2018b, 2018c, 2019, 2020, 2021a, 2021b); IEG (2017); IUCN (2021); Roby and Mbengue (2013); UNDP Ethiopia (2021); UNDP Kenya (2021); World Bank (2010, 2013, 2018, 2019a, 2019b).

7 Australian Government, Department of Agriculture, Water and the Environment (n.d.); Greening Australia (2017); MWE and IUCN (2016); USDA FSA (2019, 2020); USDA NRCS (2020).

per hectare costs for a certain group of countries represented the low to high bound ranges for that group, as presented in Table 4.

Table 4: Estimated remediation cost ranges by level of income (US$/hectare)

Level of income/world	Low	Average	High
High	$85	$1,381	$6,512
Upper-middle	$156	$2,146	$9,120
Lower-middle	$39	$2,129	$29,994
Low	$53	$373	$1,493
World (mixed income)	**$105**	**$1,745**	**$10,955**

Note: Number of projects for each income group, from which the costs have been estimated: low - 8; lower-middle - 25; upper-middle - 8; and high - 9.

Cost estimates include both investment and technical assistance components. The global estimate is a weighted average of the remediation costs in the selected countries. The differences in the costs come from the diverse methods implemented in projects. The lower end of the range includes operating costs and materials (e.g. labour, seedlings, training materials). The costs become higher when there is equipment used or the methods are more complex, for instance when treating or reclaiming saline/sodic soils, improving drainage networks in agricultural fields, revegetating rangelands, using biological measures and agronomic management practices to control erosion and improve soil fertility, and establishing perennial crops for agroforestry.

2.3. Application of costs by income group to estimate the country-specific costs. The figures in Table 4, which are the full capital and operating costs, are used to estimate the annual costs of restoration for individual countries. For instance, the cost ranges for the low-income group are used for the restoration cost estimates in Madagascar; lower-middle income group cost ranges are used in Indonesia; and high-income group cost ranges are used in France.

Table 5 presents the cost estimates to achieve the respective targets of the 20 selected countries over a 10-year span (2021 to 2030) and under two different criteria. For low-income countries, the restoration cost ranges from $1.2 million to $522.8 million per year under the proportional rule, and from $5.5 million to $1,545.1 million per year under the Bonn Challenge. For lower-middle income countries, except India, the restoration cost estimates are between $0.4 million and $16,449.3 million per year under the proportional rule. Within this group, Indonesia has the largest restoration target by 2030, thereby the highest restoration cost estimates. On the other hand, India does not show any costs under the proportional rule because the country already met its target based on this criterion. The case is similar for the US given the Bonn Challenge criterion. Brazil has generally lower requirements under the Bonn Challenge because their pledge is lower than the estimated target area under the proportional rule.

Table 5: Additional costs of meeting the targets for restoring degraded agricultural land in selected countries by 2030 (2019 US$ million/year)

Country	Level of income	Under proportional rule			Under Bonn Challenge		
		Low	Average	High	Low	Average	High
DRC	Low	$18	$130	$523	$8	$60	$239
Ethiopia	Low	$14	$99	$397	$54	$386	$1,545
Madagascar	Low	$9	$61	$245	$16	$115	$460
Senegal	Low	$1	$9	$35	$5	$39	$155
Uganda	Low	$2	$16	$63	$11	$79	$318
Angola	Lower-middle	$19	$1,054	$14,852	-	-	-
Cameroon	Lower-middle	$0	$21	$295	$13	$708	$9,982
India	Lower-middle	$0	$0	$0	$31	$1,715	$24,163
Indonesia	Lower-middle	$21	$1,167	$16,449	-	-	-
Kenya	Lower-middle	$5	$256	$3,603	$17	$955	$13,461
Morocco	Lower-middle	$3	$157	$2,208	-	-	-
Nigeria	Lower-middle	$4	$192	$2,710	$12	$647	$9,118
Tanzania	Lower-middle	$9	$492	$6,928	$9	$509	$7,174
Brazil	Upper-middle	$75	$1,033	$4,388	$13	$177	$752
China	Upper-middle	$320	$4,407	$18,726	-	-	-
South Africa	Upper-middle	$60	$834	$3,543	$48	$657	$2,791
Australia	High	$166	$4,174	$12,662	-	-	-
France	High	$3	$82	$249	-	-	-
Germany	High	$2	$53	$162	-	-	-
USA	High	$43	$1,081	$3,278	$0	$0	$0
World	**Mixed**	**$1,738**	**$28,943**	**$181,707**	**$555**	**$9,243**	**$58,030**

Note: "-" means the country does not have a pledge to the Bonn Challenge

Benefits of remediation

Estimates of the ecosystem services (ESS) loss due to land degradation are taken from Sutton et al. (2016). They use data on the Human Appropriation of Net Primary Productivity (HANPP) as a supply side measure of land degradation. This provides an estimate of the actual net primary productivity of land, which is compared against its potential productivity. The percentage loss is then multiplied by the area to which it applies, times the ecosystem service values per year per hectare for such a type of land cover when it has no degradation. The analysis is done at a highly disaggregated level. Based on this, they derive a comprehensive set of estimates of losses by country of ESS due to land degradation. The analysis in Sutton et al. has limitations, which should be noted. Only terrestrial values of ESS are included, leaving out, for example, coastal estuaries. The values per hectare are taken from Costanza et al. (2014), which have since been updated, but the latest version could not be applied to the dataset. The values in that study are also average global estimates and not ones tailored to the countries individually. Nevertheless, the figures provide an indicative set of values that can be further refined.

To calculate the natural capital gap, an estimate of the amount of degraded land that is to be restored is required. This has been calculated based on the Bonn Challenge as one alternative, or under a proportional rule, as explained above.

The value of the natural capital is derived from the data in Sutton et al. who give an estimate of the loss of ESS from all degraded land in each country. By taking the estimate of degraded area in each country as explained above, we obtain a value of the loss per hectare. This is the assumed gain in value per year from remediating one hectare. To obtain a capital value of the remediation, the present value of the stream of net benefits in perpetuity, discounted at 4 per cent, is calculated. In addition, the present value of the natural capital missing due to the degradation needs to take account of the time it would take to get the ESS going again. It is assumed that the programme of remediation would be spread out equally over the decade 2020-2030 (11 years) and it would take five years for each "slice" to become effective.

Table 6 gives the values for the natural capital gap by country along with the present value of costs reported in Table 5. Gains in natural capital are higher than the costs by a considerable factor in some countries even under the high-cost scenario. The only exception is Angola, where this is not the case, however the gain is more than the low or mid-estimate of costs. Under the proportional rule scenario, the ratio for other countries ranges from values that are less than one (Tanzania, Kenya); and between 1.4 and 8.3 for all the rest except the Democratic Republic of the Congo (DRC), Ethiopia, Senegal, Madagascar and Uganda, where the ratio is between 21 and 112. Globally, the target has a ratio of capital gain-to-cost of about 4.

These numbers are of course subject to change. If the area of remediated land globally is set at 350 million hectares, the amount of ESS lost estimated here is about 13 per cent of the total from all degraded land. However, the 13 per cent figure is based on the estimated degraded land in Bai et al. (2008). If the total amount of degraded land were taken as half that (which may well be the case), then the 350 million hectares would amount to 26 per cent of the total ESS lost due to degradation and the global natural capital gap would be $24 trillion under the proportional rule compared to $12 trillion as given in Table 6. Equally, if the true figure were double that of Bai et al. then the natural capital gap would be half that given in Table 6.

For the selected countries, the analysis can certainly be improved by getting more accurate data on costs, as well as on the value of services from agricultural land. The World Resources Institute (WRI) is working on the cost side with the Food and Agriculture Organization (FAO) to create an improved database, which should be of great help in this regard.

Table 6: Gains in natural capital and costs of agricultural land remediation (US$ billion)

Country	Natural Capital Gap Under Proportional Rule and				Cost of Filling Gap ($Bn)					
	Under Proportional Rule		Under Bonn Challenge		Proportional Rule			Bonn Challenge		
	Area (km²)	Gap Value $Bn	Area (km²)	Gap Value $Bn	Low	Mid	High	Low	Mid	High
DRC	175,100	$186	80,000	$85	$0.31	$2.22	$8.90	$0.14	$1.01	$4.07
Ethiopia	38,586	$189	150,000	$735	$0.24	$1.69	$6.76	$0.93	$6.56	$26.30
Madagascar	21,300	$119	40,000	$224	$0.15	$1.04	$4.17	$0.28	$1.95	$7.83
Senegal	4,505	$67	20,000	$296	$0.02	$0.15	$0.60	$0.09	$0.66	$2.64
Uganda	4,872	$61	24,476	$308	$0.04	$0.27	$1.08	$0.19	$1.35	$5.41
Angola	107,640	$82	-	-	$0.33	$17.94	$252.77	-	-	-
Cameroon	3,080	$13	103,999	$432	$0.01	$0.36	$5.03	$0.22	$12.06	$169.88
India	-21,085	-$218	111,891	$1,159	$0.00	$0.00	$0.00	$0.53	$29.19	$411.24
Indonesia	133,762	$504	-	-	$0.36	$19.87	$279.96	-	-	-
Kenya	13,650	$60	51,000	$223	$0.08	$4.35	$61.31	$0.30	$16.26	$229.10
Morocco	8,762	$71	-	-	$0.05	$2.67	$37.57	-	-	-
Nigeria	11,888	$248	40,000	$834	$0.06	$3.27	$46.12	$0.20	$11.01	$155.18
Tanzania	50,213	$77	52,000	$80	$0.15	$8.37	$117.91	$0.16	$8.67	$122.10
Brazil	150,373	$617	25,752	$106	$1.28	$17.58	$74.69	$0.22	$3.01	$12.79
China	285,181	$461	-	-	$5.44	$75.01	$318.71	-	-	-
South Africa	45,702	$244	36,000	$192	$1.03	$14.19	$60.30	$0.81	$11.18	$47.50
Australia	259,255	$495	-	-	$2.82	$71.03	$215.49	-	-	-
France	6,070	$29	-	-	$0.06	$1.40	$4.24	-	-	-
Germany	4,222	$11	-	-	$0.04	$0.91	$2.76	-	-	-
USA	88,315	$317	*-19,590*	-	$0.73	$18.39	$55.79	-	-	-
World	**3,071,569**	**$12,059**	**1,655,330**	**$729**	**$29.58**	**$492.59**	**$3,092.52**	**$9.45**	**$157.31**	**$987.63**

Note: Angola, Indonesia, Morocco, China, Australia, France and Germany do not have a pledge to the Bonn Challenge.

3. REDUCTION IN AIR AND WATER POLLUTION

The losses due to air pollution have been studied in some depth by several researchers. The World Bank and the Institute for Health Metrics and Evaluation (IHME) have recently summarized the findings in a report (World Bank and IHME, 2016) where they give the total deaths in 2013 due to concentrations of $PM_{2.5}$ and the welfare costs associated with these deaths. The goal for the air pollution section focuses on SDG3.9, which aims to substantially reduce the mortality rate due to air pollution (as well as due to hazardous chemicals, water and soil pollution and contamination), and SDG11.6, which aims to reduce the adverse per capita environmental impact of cities, especially in terms of air quality (and municipal and other waste management).

The relevant indicators are SDG3.9.1 — "mortality rate attributed to household and ambient air pollution" (but the focus of this section is on ambient air pollution) and SDG11.6.2 — "annual mean levels of fine particulate matter (e.g. $PM_{2.5}$ and PM_{10}) in cities". There are no target values specified. The World Health Organization (WHO) guideline is an annual mean concentration of 10 micrograms per cubic metre of air (μg/m^3) (WHO, 2018). Based on this guideline limit, the relevant SDG targets and indicators are interpreted in this study as reducing concentrations of $PM_{2.5}$ below 10μg/m^3 by 2030.

The targets of safe water and sanitation are stated as SDG6.1 (by 2030, achieve universal and equitable access to safe and affordable drinking water for all) and SDG6.2 (achieve access to adequate and equitable sanitation and hygiene for all and end open defecation). Further details of quantifying these targets are given below. Markandya (2020) estimated the increase in natural capital (i.e. clean water) that would result from meeting these targets, in terms of the value of the reduction in lost disability-adjusted life years (DALYs). The same interpretation is taken here.

Costs of meeting air and water pollution targets

Costs of improving air quality

Reductions in GHGs are strongly related to reductions in local pollutants, as many studies have shown (West et al., 2013; Markandya et al., 2018; Shindell et al., 2018). McCollum et al. (2018) estimate the costs of policies to reduce air pollution levels globally in accordance with SDG3.9 at $740 billion for the decade 2020-2030 when no additional measures are taken to accelerate the track to meeting the Paris Agreement targets. If, however, action is taken to meet those targets, specifically the 1.5°C target, the additional costs decline by 16 per cent, down to $620 billion (i.e. $62 billion a year).

The analysis of the measures undertaken by McCollum et al. to reduce concentrations of harmful pollutants and associated costs is based on a paper by Amann et al. (2011), which uses the GAINS model to estimate the costs and the reductions in concentrations. The modelling is essentially one of looking for the least cost combination of measures that will achieve a given target improvement in air emissions in a given country.

The modelling is applied to the European countries, where estimates are made for achieving targeted reductions in emissions. It is not possible to conduct, within this study, a detailed analysis of measures for the individual countries to achieve concentrations of pollutants compatible with the SDG11.6. An approximation of the cost by country has been made by allocating the costs in McCollum et al. by country based on the national population that is currently exposed to concentrations of $PM_{2.5}$ greater than the WHO maximum concentration. These populations are given in the World Bank's environmental statistics for all countries (World Bank, 2017). Transferring the costs from European countries may give a misleading estimate for African and other regions to some extent, but as the measures considered relate to technical features, such as installation of emissions control devices on vehicles, the cost transfer should not be too inaccurate.

In 2017, about 6.8 billion of the world's population was exposed to concentrations of this pollutant above the WHO recommended value. If a country share of that total was, say 20 per cent, then 20 per cent of the additional costs reported in McCollum et al. were allocated to that country. This method has some limitations as it does not capture the severity of exposure, which can vary significantly between countries. The choice of $PM_{2.5}$ for health impacts can be justified as it is by far the most important pollutant as far as health impacts are concerned (WHO, 2018). The allocation of costs based on shares of populations exposed is, to be sure, an approximation but unfortunately a necessary one.

The cost estimates for meeting the air quality target for the selected countries are given in Appendix 2. They are estimated under two scenarios: (i) countries follow measures to meet the 1.5°C target; or (ii) no such measures are undertaken. To meet the target by 2030, the countries facing the largest costs are China and India at around $12 billion per year in both countries. Australia appears to already satisfy the air quality target so there are no associated investment costs.

Costs of improving water quality

The costs of achieving the targets have been estimated in other studies, notably Hutton and Varughese (2016). Their report estimates the costs of achieving both a "basic" level of water supply and sanitation as well as those of "safely managed" levels of these services. Basic services would consist of access to a safe community water source within a 30-minute round-trip; basic sanitation includes an improved toilet and no open defecation.

Safely managed services require an on-plot water supply for every household and for sanitation they include a toilet with safe management of faecal waste. Estimation is based on detailed data collected across developing countries of how much it costs to provide both safe sanitation and safe water. In this report, only the costs of meeting the safely managed level of services are considered.

Estimates for the selected countries as annual costs are given in Appendix 3. Annual costs of safe sanitation range from $61 million in Morocco to nearly $15 billion in India. There is also uncertainty about the estimates: the range indicates a lower bound that is about 36 per cent lower and an upper bound that is 57 per cent higher than the mean. On the other hand, annual costs of safe water range from $66 million in Morocco to about $10 billion in India. The lower-bound and upper-bound figures differ from the mean by 22 per cent and 21 per cent, respectively.

In terms of progress towards these goals, Hutton and Varughese (2016) conclude that current levels of financing[8] are sufficient to meet the basic levels of services by 2030 across all countries. However, basic services do not necessarily equate to safely managed services. This means that additional financing will be needed to attain the safely managed levels over the next decade. Appendix 3 also gives an estimate of the additional funding needed each year over the next 10 years to achieve this goal in each country. The amounts vary considerably. For small countries (population less than 35 million), the additional finance needed, on average, is around $137 million to $407 million per year; however, for much larger countries (population more than 1 billion), the amounts are more than 30 times higher — about $4.6 billion per year in China and $13.4 billion per year in India, on average.

Benefits of meeting air and water targets in terms of increased natural capital

Benefits of air quality improvements relative to costs

The losses due to air pollution have been studied in some depth by several researchers. The World Bank and IHME have recently summarized the findings in a report (World Bank and IHME, 2016) where they give the total deaths in 2013 due to concentrations of $PM_{2.5}$ and the welfare losses associated with these deaths. Welfare loss is measured by the willingness to pay of individuals to reduce their risks of premature mortality due to fatal illness attributed to air pollution. Benefits represent the present value of avoided premature deaths, or in other words, avoided welfare loss. Table 7 summarizes the data from that report for our 20 countries.[9,10]

Global benefits are $86 trillion, compared to a cost of between $1.2 trillion and $1.5 trillion (the lower cost figure applies if the climate change policies are consistent with those for meeting the 1.5°C target). The ratio of benefits to costs is lowest in Kenya (1.1 with the high-cost alternative). In other countries in sub-Saharan Africa, it ranges

8 Additional financing is calculated as: annual cost of safe sanitation and safe water services minus annual cost of basic sanitation and water services; and the difference is multiplied by 1.5. The 1.5 factor is based on the Hutton and Varughese paper stating that the safe water and sanitation cost estimates assume 50% of households have the basic sanitation and water.

9 In all, there are 214 countries, but data on the others is not available for air pollution. The ones included make up 96 per cent of the global population.

10 In calculating the present value of costs, we have assumed that the annual costs in the Appendix tables will need to be maintained into the future. A 40-year horizon is taken. The same applies to the costs of avoiding air pollution.

from 2 (Democratic Republic of the Congo) to 29 (South Africa). In other parts of the world, the ratio is very high: In India it is 860, in Western Europe it is between 100 and 200 and in the US it is over 1,200. Further work is needed to pin down the costs data for air pollution at the country level.

Table 7: Benefits and costs of improved air quality (AQ), (US$ billion)

Country	Air Pollution			Costs of Meeting AQ Targets	
	Costs		Benefits if SDG is Met by 2030 $Bn	With 1.5°C Target $Bn	With No Climate Policy $Bn
	No. of Deaths Per Annum	Loss $Mn. Per Annum			
DRC	62,412	$1,964	$33	$14	$17
Ethiopia	71,018	$5,059	$85	$18	$22
Madagascar	18,718	$1,377	$23	$3	$3
Senegal	7,747	$1,005	$17	$7	$8
Uganda	20,658	$1,927	$33	$4	$5
Angola	N.A.	N.A.	N.A.	$5	$5
Cameroon	16,392	$2,785	$47	$4	$5
India	1,403,136	$505,103	$8,531	$8	$10
Indonesia	162,410	$125,119	$2,113	$238	$284
Kenya	18,237	$3,102	$52	$42	$50
Morocco	7,034	$3,723	$63	$6	$7
Nigeria	97,248	$37,609	$635	$33	$39
Tanzania	25,370	$3,552	$60	$10	$12
Brazil	62,246	$82,612	$1,395	$21	$25
China	1,625,164	$1,589,767	$26,850	$249	$297
South Africa	19,802	$20,656	$349	$10	$12
Australia	777	$3,361	$57	$0	$0
France	21,138	$81,840	$1,382	$11	$13
Germany	41,485	$180,099	$3,042	$15	$18
USA	91,045	$454,675	$7,679	$5	$6
World	**5,323,364**	**$5,095,685**	**$86,062**	**$1,227**	**$1,465**

Note: "N.A." means data are not available.

Benefits of water quality improvements relative to costs

The water quality improvements are based on losses from water pollution. The WHO in its Burden of Disease calculations has estimated the loss of disability-adjusted life years (DALYs) for almost all countries. Table 8 reports the available figures (which are for 2004 and hence rather dated) for the same countries as the World Bank data for air pollution. The valuation of benefits is as follows:

$$\text{Benefits} = \text{Value of saved life} \div 22$$

where the value of a saved life is equal to the avoided loss of DALYs due to water pollution; and 22 is the recommended approximation suggested by the World Bank (Cropper and Khanna, 2014) on the assumption that, on average, the person whose life is saved would survive for 22 years. The value of an avoided death is taken from the air pollution calculations in that table. The same table also gives the cost figures of avoiding such losses. The present value of benefits over 10 years (2021-2030) are then calculated using a discount rate of 4 per cent.

Benefits globally are 48 times the high costs, with national ratios ranging from 3 for the Democratic Republic of the Congo to 59 for Brazil. In sub-Saharan countries, estimates range from 3 to 53. While more information on local costs will be helpful, the main update that is required is to replace DALY losses for a more recent year. The estimates used here, taken from WHO, are more than 15 years old.

Table 8: Benefits and costs of improved water quality (WQ), US$ billion

Country	Water Pollution			Costs of Meeting WQ Targets $Bn		
	Cost		Benefits if SDG is Met by 2030 $Bn	Mean	Low	High
	No. of DALYs Per Annum (000)	Loss $Mn Per Annum				
DRC	5,023	$7,184	$121	$27	$19	$38
Ethiopia	5,929	$19,196	$324	$30	$21	$42
Madagascar	1,043	$3,488	$59	$9	$6	$13
Senegal	597	$3,519	$59	$3	$2	$5
Uganda	1,377	$5,836	$99	$14	$10	$21
Angola	2,229	N.A.	N.A.	$7	$5	$10
Cameroon	762	$5,885	$99	$5	$3	$7
India	24,997	$409,020	$6,908	$234	$156	$349
Indonesia	1,866	$65,342	$1,104	$32	$22	$47
Kenya	1,176	$9,094	$154	$14	$10	$20
Morocco	186	$4,471	$76	$3	$2	$4
Nigeria	9,125	$160,400	$2,709	$58	$40	$84
Tanzania	1,693	$10,773	$182	$19	$13	$27
Brazil	1,181	$71,261	$1,204	$14	$9	$20
China	4,534	$201,607	$3,405	$77	$51	$116
South Africa	587	$27,842	$470	$6	$4	$9
Australia	3	$636	$11	$0	$0	$0
France	2	$368	$6	$0	$0	$0
Germany	15	$3,040	$51	$0	$0	$0
USA	69	$15,757	$266	$0	$0	$0
World	**90,606**	**$3,942,327**	**$66,582**	**$979**	**$680**	**$1,400**

Note: "N.A." means data are not available.

4. CLIMATE CHANGE AND GHGs

The relevant natural capital being addressed in this section is the atmosphere to sustain a stable climate. In the case of reductions in GHGs, we compare the value of the gain in the reduction through the social cost of carbon (i.e. when GHGs are reduced the costs of carbon loss are avoided) against the costs of achieving the reduction. Each is considered in turn.

SDG13 calls for countries to "take urgent action to combat climate change and its impacts", while SDG9 aims to "build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation". No specific values have been specified in the SDGs although there is an indicator for CO_2 emissions per unit of GDP in SDG target 9.4. In Markandya (2020), the goal of the SDGs was translated as ensuring that GHG emissions were on track to meet the Paris Agreement of limiting global warming of 2°C, and possibly 1.5°C, by 2030. The same consideration about the overall aims of SDGs 9 and 13 is applied in this section.

Investments for reducing GHGs

Measures to reduce emissions of GHGs and reorient the economies of countries towards a low-carbon future require not only a change in the types of investment made to increase the supply and efficiency of sustainable energy systems, as well as production and consumption systems more widely, but also an increase in the total amount of the investments in these areas.

A large number of studies have modelled the changes required under different assumptions about the role of market-based instruments, such as carbon taxes, to incentivize the shift to low-carbon investments. A comprehensive attempt is represented by McCollum et al. (2018), in which the authors use six global modelling frameworks to estimate investments needed to chart a course toward "well below 2°C" as mandated in the 2015 Paris Agreement, and to pursue the 1.5°C target. The paper also estimates investments to meet the other SDGs and finds that meeting SDG13 on "limiting warming to well below 2°C and pursuing efforts for 1.5°C" also reduces the expenditures needed in meeting the SDG3.9 on air pollution, which aims to "substantially reduce the number of deaths and illnesses from air pollution".

Based on the supplementary materials of McCollum et al., Table 9 gives the present value of the additional investments required over the period 2021-2030 in the selected 20 countries to keep the global economy on track for below 2°C and 1.5°C. Investments are based on total estimate to 2030. In the table, the estimates for China, India and the US are directly taken from the paper. Those for Angola, Cameroon, the Democratic Republic of the Congo, Ethiopia, Kenya, Madagascar, Morocco, Nigeria, Senegal, South Africa, Uganda and Tanzania are estimated from the paper's total for Middle East and Africa, allocated to these individual countries based on its share of GHG emissions from the region. Similarly, the figures for Indonesia are estimated as a share of the East Asia total, those for Brazil from the Latin America and Caribbean total, and those for Australia, France and Germany from the OECD total.

The annual amounts of investment, on average, are highest in China, followed by the US and India for either target. Other countries' requirements are an order of magnitude smaller (or even more). Another important observation is the range of costs across the different models. Given a climate target of 2°C, the lower bound is between 70 per cent and 120 per cent lower than the mean, while the upper bound is 80 per cent to 145 per cent greater than the mean. In some cases, the lower bounds are negative, implying the costs of the low-carbon investments are less than those of the business-as-usual scenario. Regions with the greatest ranges are Brazil, Australia, France, Germany and the US on the lower bound and the same countries plus India on the upper bound. Thus, it makes a great deal of difference which option for reduction is realized.

Given a climate target of 1.5°C, the variation of cost estimates relative to the mean is not very different from those of the 2°C target — the lower bound is 60 per cent to 120 per cent lower than the mean, while the upper bound is 80 per cent to 135 per cent greater than the mean. Countries with the greatest ranges on the lower bound are the same as in the 2°C target. India, Indonesia, Brazil, South Africa and the US have the greatest ranges on the upper bound. These results mean that financial needs depend significantly on the measures in place to encourage low-carbon investments, as well as parameters of the economic structure around which there is still some uncertainty. Globally, costs are estimated at $2,458 billion a year, on average, for the 2°C target (range is $308 billion to $4,493 billion) and $3,715 billion (range is $608 billion to $6,667 billion) for the 1.5°C target.

Benefits of the reductions in GHGs

The annual reduction in emissions over the period to 2030 is valued using the social cost of carbon (SCC). The SCC values are based on the discounted costs arising from a tonne of CO_2 over the long term and therefore are sensitive to the discount rate adopted. The higher the discount rate, the lower will be the value attached to future costs and hence the lower will be the discounted present value of the costs. The discounted values also increase over time as costs rise with higher levels of GHGs in the atmosphere. The elements in the SCC are explained in the Natural Capital Gap paper (Markandya, 2020). Based on a review of different models to estimate damages, the document gives a range of $11-52/tonne CO_2 in 2015, rising to $16-$76/tonne CO_2 in 2030[11] (in US$ 2007). These values have been converted to US$ 2020 prices, giving a range of $16-$74/tonne CO_2 in 2015, rising to $20-$94/tonne CO_2 in 2030.

11 These values are averages depending on the discount rate used. The lower bound is the result of a 5 per cent discount rate while the upper bound is the result of a 2.5 per cent discount rate. There is a further much wider range that can be derived, depending on what is assumed about costs, but for this study the above is considered a reasonable representation of the values most researchers would use in sensitivity analysis for the SCC.

According to the UN Emissions Gap Report (2018), GHG emissions in 2017, including land-use change, reached 53.5 $GtCO_2e$. They need to be 25 per cent or 55 per cent lower in 2030 than in 2017 to put the world on a least-cost pathway to limiting global warming to 2°C or 1.5°C, respectively (UNEP, 2018). Under current policies, emissions are expected to be around 59 $GtCO_2e$ in 2030. Hence, the reduction in emissions for the year 2030 relative to where they would be under current policies is 18.9 Gt for the 2°C target or 34.9 Gt for the 1.5°C target.

To get to these targets by 2030, a progressive reduction will be required over the next 10 years. It is assumed that these reductions will grow at a constant rate to get to the 2030 target values, giving a total cut globally of 115 $GtCO_2e$ under the 2°C scenario and 227 $GtCO_2e$ under the 1.5°C scenario. The benefits for the two values of SCC are given in Table 9. Reductions for each country are based on its share of the total costs on the cost side of the table.[12] It is noted that the largest costs and benefits are also from the largest emitters of GHGs among the selected countries — China, India and US whose share in the global GHG emissions are about 45 per cent, 12 per cent and 21 per cent, respectively, as of 2018 (World Bank, 2021a). Altogether, the mean costs and benefits of these three countries account for about 60 per cent of the costs and benefits of meeting the global climate target.

Given the costs and the gains in natural capital in Table 9, a comparison shows a significant difference, with the global increase in natural capital being double the costs for the mean case. Comparing the lower value of SCC against the lower costs, we get a ratio of 5 and with the higher costs of reduction against the higher SCC, the ratio is back to around 2. These are for the 2°C target values. With the 1.5°C target, the ratios of gains to costs are slightly higher: 2.5 in the mean case, 5.3 with the low SCC/low costs and 2.3 with the high SCC/high costs. As benefits are global (so they are the same per tonne for each country) and as they are allocated in proportion to the costs borne by each country, these ratios apply to all countries.

Further work is needed to investigate the costs of reduction at the national level and to make the estimates of the actual sharing of burdens other than the simple one adopted here.

12 The assumption of emissions reductions being in proportion to share of costs should be checked once data for reductions at the country level can be obtained along with the costs of the reductions for countries where approximations have been made.

Table 9: Benefits and costs of meeting climate targets, US$ billion

Country	PV of Benefits of Climate Target 2021-2030 ($Bn)						PV of Cost of Climate Target 2021-2030 ($Bn)					
	2°C			1.5°C			2°C			1.5°C		
	Mean	Low	High	Mean	Low	High	Mean	Low	High	Mean	Low	High
DRC	$3.7	$2.9	$13.6	$9.0	$1.9	$17.3	$1.9	$0.5	$3.6	$3.6	$0.4	$7.5
Ethiopia	$6.4	$5.0	$23.7	$15.7	$3.3	$30.2	$3.4	$0.9	$6.2	$6.3	$0.6	$13.2
Madagascar	$1.0	$0.8	$3.7	$2.5	$0.5	$4.8	$0.5	$0.1	$1.0	$1.0	$0.1	$2.1
Senegal	$1.4	$1.1	$5.2	$3.5	$0.7	$6.7	$0.7	$0.2	$1.4	$1.4	$0.1	$2.9
Uganda	$2.9	$2.2	$10.6	$7.0	$1.5	$13.5	$1.5	$0.4	$2.8	$2.8	$0.3	$5.9
Angola	$10.7	$8.3	$39.6	$26.2	$5.6	$50.3	$5.6	$1.6	$10.4	$10.5	$1.1	$22.0
Cameroon	$3.0	$2.3	$11.0	$7.3	$1.5	$13.9	$1.6	$0.4	$2.9	$2.9	$0.3	$6.1
India	$508.6	$427.8	$2,029.9	$928.4	$729.4	$2,006.1	$267.7	$81.1	$657.0	$373.1	$137.9	$876.0
Indonesia	$89.0	$128.5	$609.7	$179.5	$99.1	$347.6	$46.9	$24.4	$73.1	$72.2	$18.7	$151.8
Kenya	$6.6	$5.2	$24.5	$16.2	$3.4	$31.1	$3.5	$1.0	$6.4	$6.5	$0.7	$13.6
Morocco	$10.5	$8.2	$38.8	$25.7	$5.5	$49.3	$5.5	$1.6	$10.2	$10.3	$1.0	$21.5
Nigeria	$50.7	$39.6	$187.8	$124.5	$26.5	$238.7	$26.7	$7.5	$49.2	$50.0	$5.0	$104.2
Tanzania	$4.7	$3.7	$17.6	$11.7	$2.5	$22.4	$2.5	$0.7	$4.6	$4.7	$0.5	$9.8
Brazil	$72.7	*-$43.3*	*-$205.3*	$117.1	*-$51.9*	$242.5	$38.3	*-$8.2*	$93.0	$47.1	*-$9.8*	$105.9
China	$1,741.4	$1,283.4	$6,089.6	$3,350.3	$2,789.1	$4,978.2	$916.5	$243.3	$1,914.2	$1,346.4	$527.2	$2,173.7
South Africa	$32.8	$25.6	$121.4	$80.5	$17.1	$154.3	$17.2	$4.9	$31.8	$32.3	$3.2	$67.4
Australia	$36.3	*-$13.2*	*-$62.7*	$77.0	$14.4	$132.9	$19.1	*-$2.5*	$43.2	$31.0	$2.7	$58.0
France	$65.6	*-$23.9*	*-$113.2*	$139.1	$26.1	$240.1	$34.5	*-$4.5*	$78.1	$55.9	$4.9	$104.8
Germany	$91.2	*-$33.2*	*-$157.4*	$193.5	$36.3	$333.9	$48.0	*-$6.3*	$108.6	$77.8	$6.9	$145.8
USA	$585.6	*-$128.3*	*-$609.0*	$1,170.6	$343.3	$2,451.9	$308.2	*-$24.3*	$689.4	$470.4	$64.9	$1,070.6
World	**$4,669.5**	**$1,625.6**	**$7,713.4**	**$9,243.5**	**$3,218.1**	**$15,268.9**	**$2,457.6**	**$308.2**	**$4,493.4**	**$3,714.8**	**$608.3**	**$6,667.2**

Note: PV means present value. In a few cases the lower bound is negative, implying that the climate target could be achieved by a gain in the value of economic activities. Studies of the costs of mitigation in the climate change literature include a number of such estimates for selected countries.

5. MATERIAL USE AND EFFICIENCY

The main Sustainable Development Goal related to materials is SDG12 on sustainable production and consumption and SDG target 12.2, which states sustainable management and efficient use of natural resources. Indicators include: 12.2.1 (material footprint, material footprint per capita and material footprint per GDP) and 12.2.2 (domestic material consumption, domestic material consumption per capita and domestic material consumption per GDP). The precise target increase in efficiency of materials use is based on work by the Organisation for Economic Co-operation and Development (OECD) and United Nations Environment Programme (UNEP) as explained below.

According to the OECD, global primary materials use is projected to almost double from 89 gigatonnes (Gt) in 2017 to 167 Gt in 2060. Non-metallic minerals – such as sand, gravel and limestone – represent the largest share of total materials use. These non-metallic minerals are projected to grow from 44 Gt to 86 Gt between 2017 and 2060. Metal use is smaller when measured in weight, but is projected to grow more rapidly and metal extraction and processing is associated with large environmental impacts (OECD, 2019). Table 4 shows changes in material use to 2060 as well as materials efficiency measured as GDP in constant US$PPP (purchasing power parity) per tonne of material. Growth in materials is expected to be less than growth in GDP, indicating an increase in efficiency. This is greatest for fossil fuels and biomass at around 2 per cent p.a., 1.4 per cent p.a. for non-metallic minerals and least for metals (0.75 per cent).

Given the significant environmental impacts of material extraction and production, and scarcity of some minerals raising concerns that overuse could lead to future limits to growth, SDG12 looks to increase materials efficiency even further. UNEP and the International Resources Panel (IRP) have published a Global Resources Outlook (IRP, 2019), in which they claim that "concerted resource-efficiency and sustainable resource-management measures can reduce resource extraction by 25 per cent, significantly mitigate negative impacts and boost the economy by 8 per cent by 2060" (IRP, 2019). The 25 per cent reduction is relative to an historical trends scenario that has a total of 187 Gt in 2060, with a different breakdown between the four categories of materials from the OECD study. They further claim that the historical trends projected increase to 2060 "would result in substantial stress on resource supply systems and in higher levels of environmental pressures exceeding the safe operating spaces for society and companies" (UNEP, op. cit.).

The relationship between reduced use of materials and the natural capital gap is complex. Three sources of value of natural capital associated with reducing the use of such materials are: a reduction in the loss of ecosystem services by having less impact on the environment; more materials being available for future generations to use, the value of which should be based on the scarcity rent of the current extraction; and an increase in GDP brought about by creating innovation and developing new areas of economic activity related to materials recovery.

On the first of these, there are no data to value the reduced damages from less materials recovery accurately. Various studies on the costs of environmental degradation give estimates in the range of 2-8 per cent of GDP and it is likely that for materials the costs will be in this range as a per cent of total value of output.[13] Hence, indicative estimates have been made on that basis. With regard to scarcity rents, research done some time ago shows that such rents only amount to a significant amount when expected reserves are less than a few decades worth of current extraction (Farzin, 1992). There are hardly any minerals for which this is the case and so no scarcity rents have been included here. Lastly, evidence for higher growth as a result of a more efficient resource use policy, as suggested in the UNEP and IRP (2019), is very limited. It is not considered credible enough to be included in the valuation of the natural capital gap.

In making the estimates reported here, the following assumptions have been made on the projections from the two sources and on the valuation of minerals:

- Biomass use can be reduced from the OECD estimate of 37 Gt to the UNEP/IRP target of 32 Gt by 2060.
- Fossil fuel use can be reduced from the OECD estimate of 24 Gt to the UNEP/IRP target of 8 Gt by 2060.
- Metal use can be reduced from the OECD estimate of 19.5 Gt to the UNEP/IRP target of 9.4 Gt by 2060.
- The non-metallic minerals target for 2060 are the same in the OECD and UNEP/IRP projections so no change is expected there.
- Changes in intervening years to 2060 are in proportion to the changes for 2060.
- Values of different materials are a weighted average of latest prices,[14] with weights based on current quantities.

Costs of improved material efficiency

Data on costs are quite limited. In the International Energy Agency (IEA) report on materials efficiency (IEA, 2019), some cost data are given in terms of the cost per tonne CO_2 abated by reducing materials use. The report refers to a study by Material Economics, which notes that strategies accounting for a considerable portion of material demand reduction in the Clean Technology Scenario are estimated to have positive although moderate costs, such as EUR 50 (euros) per tonne (t) of carbon dioxide (CO_2) abated for buildings reuse and EUR 60/t for reducing steel fabrication losses. Other strategies that account for a substantial portion of the additional material demand reductions in the Material Efficiency variant are at the higher end of the cost curve, such as EUR 85/t abated for material efficiency in buildings design and construction, and EUR 100/t for vehicle light weighting. All strategies in the Material Economics analysis have abatement costs no higher than EUR 100/t.

To convert these costs into cost per tonne of materials, such as metals, a link between

13 Reductions in fossil fuel use will provide benefits of lower GHGs. These are valued separately under Target 9.4. See Section 4 above.
14 Prices are taken for 2019 from: https://www.imf.org/en/Research/commodity-prices and some other sources.

materials use and CO_2 emissions is required. In the UNEP report cited above, the extraction and processing of metals make up about 10 per cent of total GHGs. In 2017, these emissions were estimated at 53.5 $GtCO_2e$, including from land-use change (UNEP, 2018). Thus, the share that is attributed to metals is 5.35 $GTCO_2e$. Metal use in production in 2017 globally was 8.63 Gt. Thus, emissions per tonne of metals were 620 kg CO_2. Costs of reduction of CO_2 per tonne abated according to the IEA report lie in the range of €50-100/t CO_2 abated. An average of €75/t is used, which was equal to $82.5/t CO_2 at the exchange rate of the year of the estimate (2015). This implies that the cost per tonne of metal reduced is $51.2. This figure is used (with the ranges of $34.1 to $68.2) in estimating the costs of metal materials reduction measures.

The other category of materials for which there is an efficiency target is biomass. The UNEP and IRP (2019) report estimates the share of emissions from this sector at 17 per cent of global emissions, equal to 9.10 $GtCO_2$ in 2017. Biomass use in 2017 globally was 21.5 Gt. Thus, emissions per tonne of biomass were 423 kg. Measures to improve crop efficiency and land use management would include increased grassland management, improved agronomy practices, and dietary additives and feed supplements to reduce emissions from livestock. McKinsey (2007) estimates that the average cost per tonne CO_2 abated is around €1, equal to $1.4 at the exchange rate of the time of estimation. This would imply a cost of $0.6/t of biomass abated. A range of +/-25 per cent is taken based on the MACC curve in the McKinsey paper, given a cost range of $0.45 to $0.75 per tonne. The above cost estimates for metals and biomass targets should be considered preliminary. As the IEA report notes, further analysis is required in this area.

These estimates, combined with the targets for reductions in metals and biomass use form the basis of the estimates given in Table 10, which gives the reduction in Gt of metals and biomass over the decade 2020-2030, as well as cost estimates per year over this period to achieve these reductions. It should be noted that these are averages over the decade. As reductions and costs increase over time, one can expect lower costs in the initial years and higher ones later. Globally, the costs range from $45 billion to $91 billion a year over the next decade, with the largest amount required in China (around a third of the total), followed by India and the US (10 per cent and 8 per cent, respectively, of the total). All African countries, except South Africa, have lower requirements to achieve materials efficiency the lower bound is less than $145 million and the upper bound is less than $245 million, accounting for less than 0.32 per cent of the global cost.

Most of the costs in Table 10 are for reducing the use of metals in production; costs of biomass reduction only make up 0.5 per cent of the total. Given that the programme identified here has not yet started, one can assume that these expenditures represent additional financing that will be needed over the coming decade.

Benefits of improved materials efficiency

The value of the natural capital gap is also presented in Table 10. It is the present value of the reduction in ESS losses on account of the lower extraction and use of raw materials and the savings in materials. The reductions are initially those for 2030 as that is the date for the SDGs. Once the initial measures have been put in place to increase material efficiency, the benefits will flow for future years beyond 2030 and that has not been taken into account. The gap is estimated between $1.8 and $2.9 trillion, for the decade based on the UNEP Towards Sustainability Scenario (IRP, 2019).

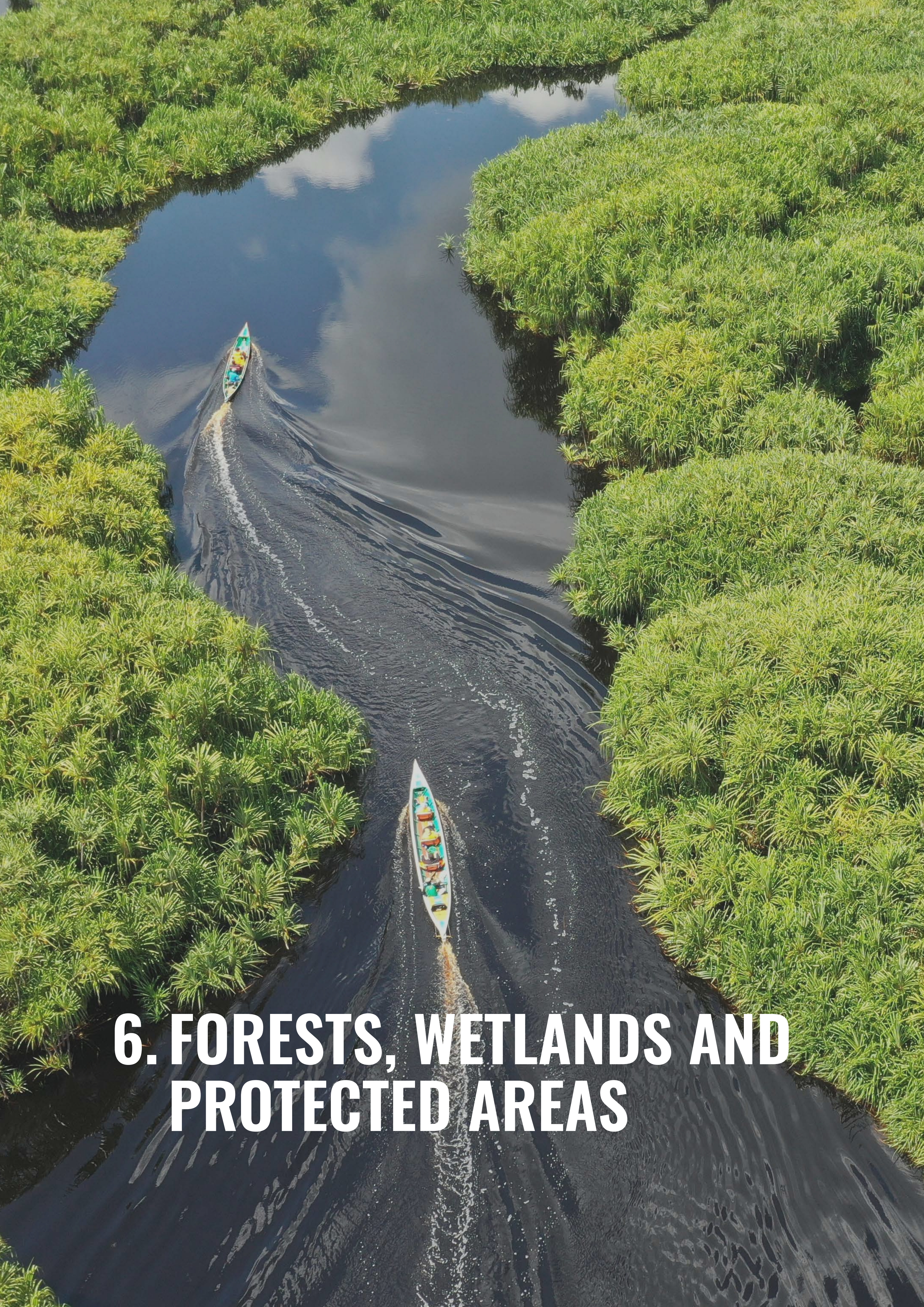
A comparison of the costs and benefits can be made from the data in Table 10. Benefits are between three and four times the costs across all countries. More data is needed, however, to make this comparison more accurate at the country level. In particular, information on the materials savings will vary by country more than is allowed for here. Furthermore, the information on costs of substitution is very limited and more would have to be connected.

Table 10: Costs and benefits of achieving materials efficiency in selected countries by 2030

Country	Metals				Biomass				PV of Total Cost ($Mn/Year)**			Metals & Biomass		
	Reduction 2021-2030 (Gt)*	Period Cost ($Mn/Year)**			Reduction 2021-2030 (Gt)*	Period Cost ($Mn/Year)**						PV of Benefits ($Mn/Year)**		
		Average	Low	High		Average	Low	High	Average	Low	High	Average	Low	High
DRC	0.017	590	393	786	0.007	3	2	4	$593	$395	$789	$730	$74	$804
Ethiopia	0.030	1,030	686	1,373	0.013	5	4	7	$1,036	$690	$1,379	$1,276	$129	$1,405
Madagascar	0.005	163	108	216	0.002	1	1	1	$163	$109	$218	$201	$20	$222
Senegal	0.007	228	152	304	0.003	1	1	1	$229	$153	$305	$282	$29	$311
Uganda	0.013	461	307	614	0.006	2	2	3	$463	$309	$617	$570	$58	$628
Angola	0.050	1,719	1,145	2,290	0.022	9	7	11	$1,728	$1,151	$2,301	$2,128	$215	$2,343
Cameroon	0.014	476	317	634	0.006	2	2	3	$478	$319	$637	$589	$60	$649
India	1.531	52,970	35,279	70,557	0.668	271	203	339	$53,241	$35,482	$70,896	$65,583	$6,642	$72,225
Indonesia	0.556	19,258	12,826	25,652	0.243	99	74	123	$19,357	$12,900	$25,776	$23,844	$2,417	$26,261
Kenya	0.031	1,062	707	1,415	0.013	5	4	7	$1,068	$712	$1,422	$1,315	$133	$1,448
Morocco	0.015	524	349	699	0.007	3	2	3	$527	$351	$702	$649	$67	$717
Nigeria	0.236	8,156	5,432	10,864	0.082	33	25	42	$8,189	$5,457	$10,906	$10,098	$814	$10,912
Tanzania	0.022	764	509	1,018	0.000	0	0	0	$764	$509	$1,018	$946	$0	$946
Brazil	0.399	13,797	9,189	18,378	0.172	70	52	87	$13,867	$9,241	$18,465	$17,082	$1,710	$18,792
China	5.172	178,996	119,214	238,428	2.231	905	679	1,131	$179,901	$119,893	$239,560	$221,618	$22,181	$243,799
South Africa	0.081	2,787	1,856	3,713	0.035	14	11	18	$2,802	$1,867	$3,731	$3,451	$346	$3,797
Australia	0.235	8,122	5,410	10,819	0.102	41	31	51	$8,163	$5,440	$10,870	$10,056	$1,009	$11,065
France	0.101	3,510	2,337	4,675	0.051	21	16	26	$3,530	$2,353	$4,701	$4,345	$510	$4,856
Germany	0.141	4,880	3,250	6,501	0.071	29	22	36	$4,909	$3,272	$6,537	$6,042	$710	$6,752
USA	1.263	43,700	29,105	58,210	0.545	221	166	276	$43,922	$29,271	$58,487	$54,106	$5,421	$59,527
World	**15.916**	**550,801**	**366,842**	**733,684**	**6.475**	**2,626**	**1,969**	**3,282**	**$553,427**	**$368,811**	**$736,966**	**$681,956**	**$64,358**	**$746,314**

Sources: *OECD (2019), and UNEP and IRP (2019).

****Own calculations.**



6. FORESTS, WETLANDS AND PROTECTED AREAS

This section applies to SDG15 – "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss". Although agricultural land is part of the terrestrial ecosystems, it is covered in section 2 of this report. This section focuses on ecosystems found in forests, wetlands and protected areas.

The target year in SDG15 for losses of terrestrial and freshwater inland ecosystems is 2020, but that is obviously unrealistic, so 2030 has been adopted as the target date. The target reduction of losses for forests (SDG15.2), wetlands and protected areas (SDG15.1) are not specified in the SDG, but they are stated in the Aichi Biodiversity Targets that were adopted as part of the Convention of Biological Diversity's Strategic Plan for Biodiversity 2011–2020.

The Aichi targets are closely related to the SDGs; hence it is reasonable to adopt them. The relevant ones for this exercise are: halving the rate of loss of natural habitats, including forests and wetlands (Aichi Target 5); and ensuring that at least 17 per cent of terrestrial and inland water areas and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved (Aichi Target 11). There has, however, been a push to raise the protected areas together from 27 per cent to 30 per cent (Waldron et al., 2020). If each target were raised in proportion, that would make the terrestrial target 18.9 per cent and the marine 11.1 per cent. It must also be noted that while the Aichi Target 11 addresses protection of terrestrial and aquatic ecosystems, this section does not include aspects about the latter due to data limitations.

There is no formal statement, however, in the literature setting these as the new targets and so the report has retained the original Aichi targets.[15] Conservation is undertaken through effectively and equitably managed, ecologically representative and well-connected systems of protected areas, other effective area-based conservation measures, and integration into the wider lands.

Reducing the rate of deforestation

Data on the rate of deforestation is taken from the World Development Indicators (World Bank, 2017). To estimate the costs of halving the rate of loss, only one study –undertaken by the Secretariat of the Convention on Biological Diversity (CBD, 2013) – was available. It estimated the costs of this target, assuming the programme was initiated in 2013 and completed in 2020, by which time the rate of loss would be halved if the programme was successful.

In terms of what has been achieved since 2013, there are divergent views. One comes

15 A Global Biodiversity Framework is currently being drafted with revised targets. Once these are available the report can be updated for those targets.

from Global Forest Watch (GFW) compiled from satellite images by the World Resources Institute (WRI, 2020). It estimates the decline in tree cover in 2020 was 12.2 million hectares, almost 50 per cent more than in 2015. That analysis is supported by on-the-ground observations, especially in South-East Asia, where forest continues to be converted to oil palm. If true, it would indicate that the programme has not worked so far.

The other source is the Global Forest Resources Assessment (FRA), compiled from government inventories by the UN Food and Agriculture Organization (FAO). It estimates the annual net loss, once forest regrowth is taken into account, at barely a tenth as much – just 3.3 million hectares and says deforestation rates have declined by more than 50 per cent in the past decade.

The difference is not resolved, but the discussions on the topic suggest that GFW, based on satellite data and not dependent on national reporting of registered land use, is possibly closer to the right figure. In any event, neither measure would claim that deforestation rates were halved between 2013 and 2020. In this analysis, it is assumed that the target of reducing the rate of deforestation by 50 per cent relative to 2020 levels remains in place, to be achieved by 2030.

Costs of reduced deforestation

The estimates of the costs are based on work done by the Convention for Biological Diversity (CBD) Secretariat. They include preparation of biodiversity inventories, setting up monitoring systems, training and education of professional officers, law enforcement and the creation of enabling conditions (financial incentives which counter illegality). The global cost was estimated at $10.5 billion in investments over three years and $83.1 billion in recurrent costs over eight years. These costs are in 2012 prices, thus to convert to 2020 prices they are raised by a factor of 1.129, making a total cost of $105.6 billion over 8 years. To be consistent with the other programmes, these costs are spread out for the coming programme over 10 years.

To link this to a cost per hectare, an estimate of the level of deforestation was taken at the start of the period (2012-2013). As noted, there are very different opinions of the rate at that time. The GFW figure for that period was 22 million hectares while the FAO figure was around 3.3 million hectares. Based on these, the costs of the CBD programme work out between $4,804/ha and $32,028/ha spread over 10 years in 2020 prices.

The reduction in hectares of forest as a result of the programme is calculated assuming the rate of deforestation is halved. Since forest areas will decline over time as deforestation takes place, the estimate must allow for that. If the rate of deforestation is μ and initial forest area is F hectares then the loss of forest over a period of 10 years is given by ΔF, where

$$\Delta F = F * (1-(1-\mu)^{11})$$

The resulting decline in deforestation is half that – i.e. $0.5*\Delta F$.[16] That amount is shown in Table 11, along with the costs for the selected countries and the world. Costs are given both for the whole period 2021-2030, as well as an average annual cost over that period, under the basis of GFW and FAO data. Global costs amount to between $105 billion and $700 billion, which is a wide range. The highest costs (nearly half the total) are in Brazil, followed by Indonesia, Tanzania, the Democratic Republic of Congo and Nigeria. The lowest costs are in Madagascar and Senegal. Large countries, such as China and India, that have high costs of other SDGs do not need finance for this SDG, as they are not facing deforestation.

Benefits of reduced deforestation

Primary forests provide a wide range of ecosystem services. There are no direct estimates of all these services for each country. However, two data sources provide some estimates of values per hectare. The first is a global database that includes forests everywhere and has been assembled by de Groot et al. (2020). In addition, a meta-analysis has been conducted using global data to estimate some forest ecosystem services in all countries (Siikamaki et al., 2015). These original estimates were updated for the World Bank publication, Changing Wealth of Nations (World Bank, 2021).

The preferred source was the meta-analysis mentioned above, which gives values by country for the following services: recreation; habitat/species protection, non-timber forest products (NTFPs); and water services.[17] These are available for each of the 20 countries in the sample. However, the list of services provided by forests is wider than that. The de Groot et al.'s most recent survey of global studies includes the following other services: genetic resources; water flow regulation; air quality regulation; climate regulation; extreme event moderation; waste treatment; erosion prevention; soil fertility; and pollination. These have also been included to complete the set of services provided.

The figures in the de Groot et al. paper are in PPP dollars. As all our figures are in market prices converted using market exchange rates, we have adjusted the figures from the de Groot study to allow for this. The estimates of benefits from reduced deforestation assume that the current values of ecosystem services will continue for the indefinite future and the present value is calculated using a 4 per cent discount rate.[18] These benefits are also shown in Table 11. The comparison of the benefits of reduced deforestation relative to the costs of bringing it about depends critically on the cost figures taken. With the lower costs, the benefits are between 3 and 10 times the cost. With the high cost estimates, however, the increase in natural capital is less than the cost for almost all selected countries (although globally the increase is 1.5 times the cost). These results indicate that more effort needs to be made to estimate the costs more accurately at the country level. There will also be something to be gained from estimating the benefits in a more focused way, although the values given here should offer a good point of departure.

16 The same applies in the case of wetland loss.

17 The original figures were in 2018 US dollars, so to bring them up to 2020 dollars an inflation factor of 3.1 per cent has been applied.

18 A discount rate of 4 per cent was used in the calculation, which is a common discount rate employed in wealth accounting for natural assets (Kunte et al., 1998; Lange et al., 2018; Markandya, 2019).

Reducing the rate of loss of wetlands

The Aichi target is to halve the rate of loss of wetlands, where feasible bring it to zero, and significantly reduce degradation and fragmentation. The original date for achieving this was 2020, but as that has not been met, a new date is set at 2030. The baseline for this is difficult as not all countries have up-to-date figures. The global baseline estimate is for 2015.

Costs of reducing wetland loss

Costs of achieving the goal as estimated by the CBD were between $290 and $323 billion over 8 years in 2012 prices. Updating to 2020 prices gives a range of $327 billion to $365 billion. The total area of wetlands, on which the estimate was based, was 1,213 million hectares, facing a loss of 19.4 million hectares a year, or 155 million hectares over the 8 years. The costs related to that loss rate are $1,598-2,349 per hectare spread over 8 years originally, but to be consistent with the other programmes the costs are spread over 10 years (2021-2030).

The figures for individual countries are calculated using this cost range, but applying it to the loss rates relevant to each of the countries. Estimates of these were difficult to obtain in some cases and the figures used are from various sources as cited in Table 12. Further work is needed to get better or more recent estimates, especially for Angola and those countries whose data were obtained from Ramsar (2021). Wetlands recognized as Ramsar Sites have national and international importance, but not all wetlands in a country are included in the List of Sites. Given this limitation, the table provides an estimate of total costs of meeting the wetland target. Globally, the figures are $158 billion to $232 billion, or $16 billion to $23 billion a year. The five countries with the largest requirements to meet their respective targets are Indonesia, China, Brazil, India and the Democratic Republic of Congo. Some small countries with a high loss rate and large wetland area, such as Uganda, will also need significant amounts of finance; in its case the figures indicate an amount of $51 million to $75 million a year. Another example is Tanzania with an annual cost of $63 million to $93 million to meet the target of halving the loss of wetlands in the country by 2030.

Benefits of reducing wetland loss

Estimates of the value of services from wetlands are estimated in de Groot et al. (2020) at $78,452/ha/year for inland wetlands and $48,647/ha/year for coastal wetlands (mainly mangroves). These are global averages in PPP terms. To get values at the country level, two adjustments are made. First, a meta-analysis (Salem and Mercer, 2012) shows that values decline with per capita income. A 1 per cent decline relative to average global income results in a 0.79 per cent decline in the value of the ecosystem services. This factor has been used to calculate country values. Second, as the values are in PPP terms, a further adjustment has been made to correct for the ratio of PPP based values and market-based values. The estimates of change in benefits from reduced wetland loss assume that the current values of the ecosystem services will continue for 50 years, and the present value is calculated using a 4 per cent discount rate.

The results are shown in Table 12, along with the cost data. Benefits are much higher than costs for all countries, by a factor of about 30 to 195 for the non-OECD countries and by a factor of 190 to 655 for the OECD countries. These ratios of benefits to costs are taken using the high cost estimate.

The main ongoing work is to improve the data on the cost side. Estimates of the value of ESS at the country level would also help improve the calculations but there are likely to change less than the cost data.

Increasing protected areas

The Aichi targets for protected areas (PA) state that such areas should account for at least: 17 per cent of terrestrial and inland water areas; and 10 per cent of marine and coastal areas. Since then, there has been a strong push in the post-2020 global biodiversity framework to increase PA coverage to 30 per cent for terrestrial areas and marine areas taken together (Waldron et al., 2020).

As noted in the introduction to this section, however, the 30 per cent overall figure does not separate the marine and terrestrial targets and so it has not been adopted for the purpose of this report. The Protected Planet Report 2016 (UNEP-WCMC and IUCN, 2016) puts the protected terrestrial protected areas at 14.7 per cent and marine ones at 10.1 per cent each of their respective total areas. In terms of hectares, the report states that to meet the target an additional 3.1 million km^2 would need to be protected globally. For marine and coastal areas, the same report states that the 10 per cent target has been met globally, but not for all countries. This arises because a few countries have coverage well in excess of 10 per cent. Estimates of the additional areas needed to be protected for the selected countries are taken from the World Database on Protected Areas.[19]

Costs of Increasing Protected Areas

The costs of meeting the goals are spread over 10 years (2021-2030). For terrestrial areas, the unit costs are taken from Hussain et al. (2011). The cost of converting land to protected areas is considerable. Hussain et al. carried out a detailed survey of the different components of the cost, which include transfer of property rights in some cases, establishing and maintaining networks of areas, transactions costs and, most importantly, opportunity costs of the alternative use of the land. Costs per hectare turn out to be in the range of $2,792 to $11,869 (the original figures have been adjusted for inflation to get them into 2020 prices). The CBD (2013) study also makes some estimates, with even wider ranges, but with less detail on method, so the Hussain et al. estimates have been used. For marine sites, the CBD study has been used. It estimates the costs of meeting the 10 per cent target between $16.3 billion and US$39.4 billion (prices adjusted for inflation to get them into 2020 prices). The amount of land they

19 See the Protected Planet dashboard, the online interface of the World Database on Protected Areas: https://www.protectedplanet.net/en.

would protect is estimated at 1,097 million hectares, given a cost per hectare of between $15 and $36.

In addition to these costs, Waldron et al. (2020) estimate an additional annualized cost for meeting the 30 per cent combined target at between $78.7 billion and $153.7 billion, of which $43.1 billion is additional funding required to make existing protected areas effectively protected. The total cost estimates from that study for new areas cannot be converted into a cost per hectare as the additional terrestrial and marine areas protected are not specified in the paper. The costs of upgrading management for existing sites, however, can be converted into a cost per hectare as current areas are given as 19.8 million km^2 (terrestrial) and 14.9 million km^2 (ocean). Together they imply an additional $12.4/ha. As this is not included elsewhere, it has been added to the cost data.

Table 13 gives the estimates of the finance needed over 10 years to meet the targets for protected areas. Global costs per annum amount to $62 billion to $261 billion – a very wide range. Most of these costs are for terrestrial areas, with largest shares going to the US and India, followed by China, Angola and South Africa. Even smaller countries like Cameroon and Madagascar, however, would also need a significant amount to meet the targets by 2030 – Cameroon in the range of $0.8 billion to $3.4 billion per year, and Madagascar from $1.6 billion to $6.8 billion per year. Further work is needed to pin these estimates down more accurately.

Benefits of protected areas

In terms of benefits, Hussain et al. (op. cit.) estimate the biophysical changes resulting from the protection and value the ecosystem services that such a change provides. The areas that increase in most parts of world include grassland and forest, but in some cases protected areas are created by reducing land from these biomes as well.

The value of the services is derived by taking the value of ESS from forest areas (as outlined above) for the share of the total terrestrial area that is forests and by taking the value of ESS from grasslands for the share that is grasslands. The latter is obtained (along with many of the other ecosystems in this section) from de Groot et al. (2020). The average global value in PPP dollars is $1,597/ha/year. This has been adjusted for each country to convert it into market dollars. In addition, some protected areas are marine areas, for which the value in the de Groot et al. study is $30,794/ha/year. This has also been adjusted for each country to convert it into market dollars.

Since the areas marked for protection already provide some of the services associated with the corresponding ecosystems, we need an estimate of how much their classification as protected areas will increase the value of these services or prevent them from declining. It is reasonable to assume that if the areas remain unprotected, the flow of ecosystem services from them will decline. It is assumed that 10 years from now they would only provide 10 per cent of what they currently provide. In addition, moving them into protected status will restore full value gradually over 5 years. Clearly, these assumptions need further investigation.

Finally, the estimates of change in benefits from reduced wetland loss assume that the current values of the ecosystem services under each condition will continue for the next 50 years and the present value is calculated using a 4 per cent discount rate.

The results are given in Table 13 along with the cost data. Benefits range from $2 billion in present value terms for Uganda to $6 trillion for Indonesia. The ratio of the present value of benefits (i.e. the increase in natural capital) to the costs ranges between 1 and 2 in Uganda, Ethiopia, Angola and Cameroon to over 113 in Indonesia and over 5,000 in two outliers (Senegal and Tanzania). The reason is that these two countries only have marine protected areas and the costs of protection for these areas is estimated to be very low ($35-$62/ha in Senegal and $46-$82/ha in Tanzania) compared to nearly $3,000 to $149,600/ha for terrestrial areas of sub-Saharan countries in the table. In addition, the value of ESS is very high for marine areas relative to terrestrial ones.

Table 11: Costs and benefits of reducing deforestation by half in 2021-2030, US$ million

Country	Deforest-ation Rate (% per year)	Forest Area (Ha)	Based on GFW Data		Based on FAO Data		Benefits of Reduced Deforestation		
			Cost of Halving Loss ($Mn)	Annual Cost ($Mn/Year)	Cost of Halving Loss	Annual Cost ($Mn/Year)	ESS per	Reduction (ha) 2021-2030	PV of Gain $Mn
DRC	0.2	152,569,100	$7,982	$798	$53,217	$5,322	1,021	1,661,578	$42,429
Ethiopia	0.6	12,500,000	$1,923	$192	$12,822	$1,282	722	400,345	$7,223
Madagascar	0.3	12,454,800	$973	$97	$6,484	$648	604	202,449	$3,057
Senegal	0.5	8,299,000	$1,069	$107	$7,129	$713	899	222,602	$5,001
Uganda	4.1	2,090,400	$1,853	$185	$12,354	$1,235	727	385,716	$7,008
Angola	0.2	57,860,800	$3,027	$303	$20,182	$2,018	841	630,142	$13,249
Cameroon	1.1	18,825,400	$5,180	$518	$34,536	$3,454	833	1,078,318	$22,463
Kenya	-1.4	4,438,200	-	-	-	-	-	-	-
India	-0.5	70,757,400	-	-	-	-	-	-	-
Indonesia	0.6	90,962,400	$13,996	$1,400	$93,307	$9,331	680	2,913,308	$49,498
Morocco	-0.8	5,619,600	-	-	-	-	1,126	-	-
Nigeria	4.1	7,014,700	$6,218	$622	$41,455	$4,146	1,231	1,294,338	$39,849
Tanzania	0.8	46,072,000	$9,358	$936	$62,390	$6,239	798	1,947,997	$38,871
Brazil	0.4	493,122,000	$51,087	$5,109	$340,595	$34,060	1,142	10,634,293	$303,525
China	-1.1	208,413,600	-	-	-	-	-	-	-
South Africa	0.0	9,218,800	-	-	-	-	-	-	-
Australia	0.2	124,448,400	$6,511	$651	$43,408	$4,341	2,292	1,355,325	$77,668
France	-0.7	16,988,000	-	-	-	-	-	-	-
Germany	0.0	11,412,300	-	-	-	-	-	-	-
USA	-0.1	310,083,300	-	-	-	-	-	-	-
World	**0.1**	**3,995,776,400**	**$105,050**	**$10,505**	**$700,363**	**$70,036**	**2,004**	**21,867,215**	**$1,095,681**

Sources: The deforestation rate is from World Bank (2017), reporting average figures from 2000 to 2015 (the negative numbers indicate an increase in forest areas); data for forest areas are for 2015 and obtained from World Bank (2017); costs are based on CBD (2013).

Table 12. Costs and benefits of reducing loss of wetlands by half in 2021-2030, US$ million

Country	Inland Wetlands (000 ha)[A]	Coastal Wetlands (000 ha)[A]	Total Wetlands (000 ha)[B]	% Loss per Year[C]	Cost of Both Targets 2021-2030 ($Mn)		Annual Cost of Targets 2021-2030 ($Mn/Year)		Reduction of Loss 2021-2030 (000 ha)		PV of Gain $Mn
					Low	High	Low	High	Inland Wetlands	Coastal Wetlands	Inland & Coastal
DRC	11,841	66	11,907	-1.6%	$1,547	$2,274	$155	$227	963	5	$120,634
Ethiopia	1,370	0	1,370	-1.6%	$178	$262	$18	$26	111	0	$12,209
Madagascar	1,993	155	2,148	-1.6%	$279	$410	$28	$41	162	13	$13,482
Senegal	146	11	157	-1.6%	$20	$30	$2	$3	12	1	$1,698
Uganda	2,631	0	2,631	-2.5%	$514	$755	$51	$75	321	0	$33,035
Angola	400	90	490	-1.6%	$64	$94	$6	$9	33	7	$6,560
Cameroon	662	165	827	-1.6%	$107	$158	$11	$16	54	13	$7,838
India	10,557	4,743	15,300	-2.5%	$2,987	$4,391	$299	$439	1,289	579	$198,886
Indonesia	16,950	22,650	39,600	-1.6%	$5,145	$7,563	$514	$756	1,378	1,841	$370,194
Kenya	102	164	266	-1.6%	$35	$51	$3	$5	8	13	$1,472
Morocco	82	164	246	-1.2%	$24	$36	$2	$4	5	10	$1,290
Nigeria	1,048	0	1,048	-1.6%	$136	$200	$14	$20	85	0	$15,104
Tanzania	4,272	597	4,869	-1.6%	$633	$930	$63	$93	347	49	$44,992
Brazil	17,369	9,425	26,794	-1.6%	$3,481	$5,117	$348	$512	1,412	766	$712,726
China	42,870	10,550	53,420	-1%	$4,468	$6,568	$447	$657	2,243	552	$1,269,312
South Africa	2,636	189	2,825	-1.6%	$367	$540	$37	$54	214	15	$74,643
Australia	3,320	4,980	8,300	0%	$0	$0	$0	$0	0	0	$0
France	2,795	690	3,485	-0.8%	$238	$350	$24	$35	120	30	$229,070
Germany	114	703	817	-0.8%	$56	$82	$6	$8	5	30	$15,654
USA	42,200	2,400	44,600	0%	$0	$0	$0	$0	0	0	$0
World	**1,128,090**	**84,910**	**1,213,000**	**-1.6%**	**$157,592**	**$231,656**	**$15,759**	**$23,166**	**91,699**	**6,902**	**$56,560,742**

Sources: Davidson et al. (2018); Angola - Finlayson and Spiers (1999); Ethiopia - Desta (2003); DCR, Cameroon, Kenya, Nigeria, Tanzania, Senegal, Madagascar, Morocco, Brazil - Ramsar (2021); Uganda - Government of Uganda (2016); South Africa - van Deventer et al. (2020) India - Bassi et al. (2014) and Prasher (2018); Indonesia - Margono et al. (2014) and Sulaiman et al. (2019); China - Meng et al. (2017); Australia - Australian Government, Department of Agriculture, Water and the Environment (2013); USA - U.S. Fish and Wildlife Service (2011); and France, Germany and World - Ramsar Convention on Wetlands (2018).

[A] The respective inland and coastal wetlands area of Senegal and Madagascar are based on Davidson et al. (2018), where they estimate that globally, inland is 92.8 per cent and coastal is 7.2 per cent of total continental wetlands.

[B] In total wetlands area, Ramsar Sites are used for some countries due to lack of data for the individual countries.

[C] The global average loss per year is 1.6 per cent. This estimate was used in countries where country-level data are not available.

Notes: In the case of Australia and the USA, no additional costs are involved as current programmes meet the target.

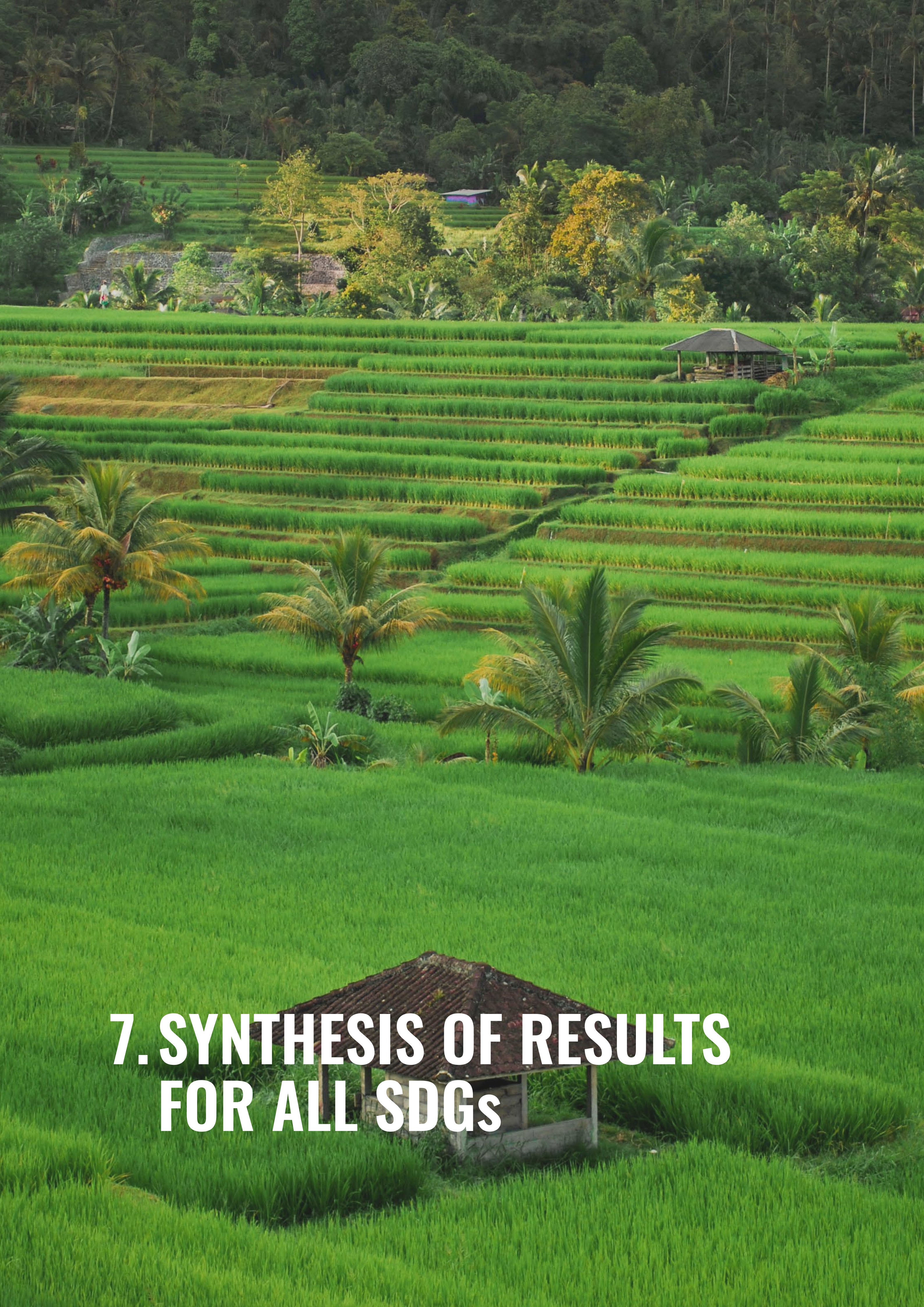
Costs are based on CBD (2013).

Table 13: Costs and benefits of meeting the protected areas targets by 2030, US$ million

Country	Terrestrial Target by 2030 (000 ha)	Marine Target by 2030 (000 ha)	Cost of Terrestrial Target 2021-2030 ($Mn)		Cost of Marine Target 2021-2030 ($Mn)		Cost of Both Targets 2021-2030 ($Mn)		Annual Cost of Both Targets 2021-2030 ($Mn/Year)		Benefits of Protected Areas (2021-2030)		
			Low	High	Low	High	Low	High	Low	High	Terrestrial ($/ha)	Marine ($/ha)	PV of Gain ($Mn)
DRC	7,431	129	$20,841	$88,296	$4	$6	$20,844	$88,302	$2,084	$8,830	$12,743	$228,155	$124,237
Ethiopia	1,067	0	$2,993	$12,681	$0	$0	$2,993	$12,681	$299	$1,268	$9,282	$166,185	$9,907
Madagascar	5,656	10,961	$15,861	$67,200	$298	$529	$16,159	$67,729	$1,616	$6,773	$7,656	$137,083	$1,545,858
Senegal	0	1,291	$0	$0	$35	$62	$35	$62	$4	$6	$10,268	$183,836	$237,364
Uganda	229	0	$641	$2,716	$0	$0	$641	$2,716	$64	$272	$8,748	$156,633	$1,999
Angola	12,590	0	$35,307	$149,587	$0	$0	$35,307	$149,587	$3,531	$14,959	$10,080	$180,473	$126,904
Cameroon	2,840	0	$7,965	$33,744	$0	$0	$7,965	$33,744	$796	$3,374	$9,972	$178,536	$28,320
India	29,020	22,460	$81,384	$344,805	$611	$1,085	$81,996	$345,889	$8,200	$34,589	$7,875	$135,176	$3,264,597
Indonesia	9,209	41,279	$25,825	$109,413	$1,123	$1,994	$26,948	$111,407	$2,695	$11,141	$8,799	$151,027	$6,315,236
Kenya	2,687	1,039	$7,537	$31,931	$28	$50	$7,565	$31,981	$756	$3,198	$10,108	$180,969	$215,113
Morocco	5,185	2,571	$14,540	$61,602	$70	$124	$14,610	$61,726	$1,461	$6,173	$9,805	$184,419	$524,945
Nigeria	2,807	1,825	$7,872	$33,351	$50	$88	$7,921	$33,439	$792	$3,344	$10,461	$187,303	$371,197
Tanzania	0	1,697	$0	$0	$46	$82	$46	$82	$5	$8	$10,189	$182,429	$309,591
Brazil	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$13,310	$256,648	$0
China	12,919	3,970	$36,230	$153,498	$108	$192	$36,338	$153,690	$3,634	$15,369	$14,203	$273,864	$1,270,783
South Africa	10,248	0	$28,740	$121,764	$0	$0	$28,740	$121,764	$2,874	$12,176	$11,584	$207,405	$118,716
Australia	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$24,096	$464,623	$0
France	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$18,551	$357,711	$0
Germany	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$18,860	$363,660	$0
USA	49,445	0	$138,664	$587,484	$0	$0	$138,664	$587,484	$13,866	$58,748	$24,453	$450,455	$1,209,083
World	**218,177**	**326,667**	**$611,859**	**$2,592,287**	**$8,889**	**$15,776**	**$620,748**	**$2,608,063**	**$62,075**	**$260,806**	**$17,785**	**$289,150**	**$98,335,956**

Sources: CBD (2013), Hussain et al. (2011), UNEP-WCMC and IUCN (2016), and UNEP-WCMC (2021)

Notes: The world figure for marine areas only covers the selected countries. Targets are estimated from the Aichi targets as explained in the text. Marine costs are based on CBD (2013). Other costs are from Hussain et al. (2011). Terrestrial target or marine target that is “0” means that the relevant Aichi target has been met by the county. Furthermore, Australia and Brazil have expanded their protected area networks since 2016.



7. SYNTHESIS OF RESULTS FOR ALL SDGs

Net gains in natural capital by sector and country

The results for the different SDGs by sector and country are summarized in Tables 14-15. Table 14 gives the net benefits for each SDG by country based on average costs and average gains in natural capital. Table 15 gives the ratios of benefit to cost under the same assumptions.

Table 14: Net benefits of meeting the selected SDG targets, (US $billion)

Country	Ag land reme-diation[A]	Air pollution[B]	Water & sanitation	Climate Change[C]	Material Efficiency	Terrestrial[D] Ecosystem & All Protected Areas[D]	Net Benefits of All Selected SDG Targets ($Bn)
DRC	$84.09	$17.78	$94.43	$1.74	$0.14	$216.66	$414.84
Ethiopia	$728.13	$65.65	$294.50	$3.03	$0.24	$16.82	$1,108.37
Madagascar	$221.57	$20.25	$49.88	$0.48	$0.04	$1,525.07	$1,817.29
Senegal	$295.68	$9.21	$55.96	$0.67	$0.05	$240.68	$602.25
Uganda	$307.06	$27.77	$84.15	$1.36	$0.11	$34.40	$454.85
Angola	-	N.A.	N.A.	$5.06	$0.40	$62.25	$67.71
Cameroon	$420.06	$42.40	$94.42	$1.40	$0.11	$25.49	$583.88
India	$1,130.19	$8,521.65	$6,674.05	$240.90	$12.34	$3,286.96	$19,866.10
Indonesia	-	$1,852.07	$1,071.15	$42.17	$4.49	$6,624.17	$9,594.04
Kenya	$206.63	$6.74	$139.72	$3.13	$0.25	$206.49	$562.96
Morocco	-	$56.03	$72.40	$4.96	$0.12	$495.25	$628.77
Nigeria	$822.99	$598.90	$2,650.85	$24.02	$1.91	$389.90	$4,488.57
Tanzania	$71.26	$49.34	$162.76	$2.25	$0.18	$363.67	$649.46
Brazil	$102.71	$1,372.07	$1,189.67	$34.46	$3.22	$853.92	$3,556.04
China	-	$26,576.69	$3,327.63	$824.91	$41.72	$2,458.55	$33,229.50
South Africa	$181.19	$337.91	$464.23	$15.52	$0.65	$131.95	$1,131.45
Australia	-	$56.76	$10.73	$17.21	$1.89	$57.42	$144.02
France	-	$1,370.02	$6.22	$31.08	$0.81	$228.83	$1,636.97
Germany	-	$3,025.44	$51.34	$43.22	$1.13	$15.60	$3,136.74
USA	-	$7,673.29	$266.12	$277.40	$10.18	$914.60	$9,141.60
World	**$571.19**	**$84,715.65**	**$65,602.90**	**$2,211.93**	**$128.53**	**$154,198.46**	**$307,428.66**

Note: "N.A." means data are not available.

[A] Agricultural land remediation is based on estimates of remaining pledge under the Bonn Challenge. Countries with "no data" did not commit to the Bonn Challenge, except for USA that already met their pledge.

[B] In calculating the cost, the average of the "With 1.5°C Climate Target" and "With No Additional Climate Investment" was taken.

[C] Estimates are for the 2°C target.

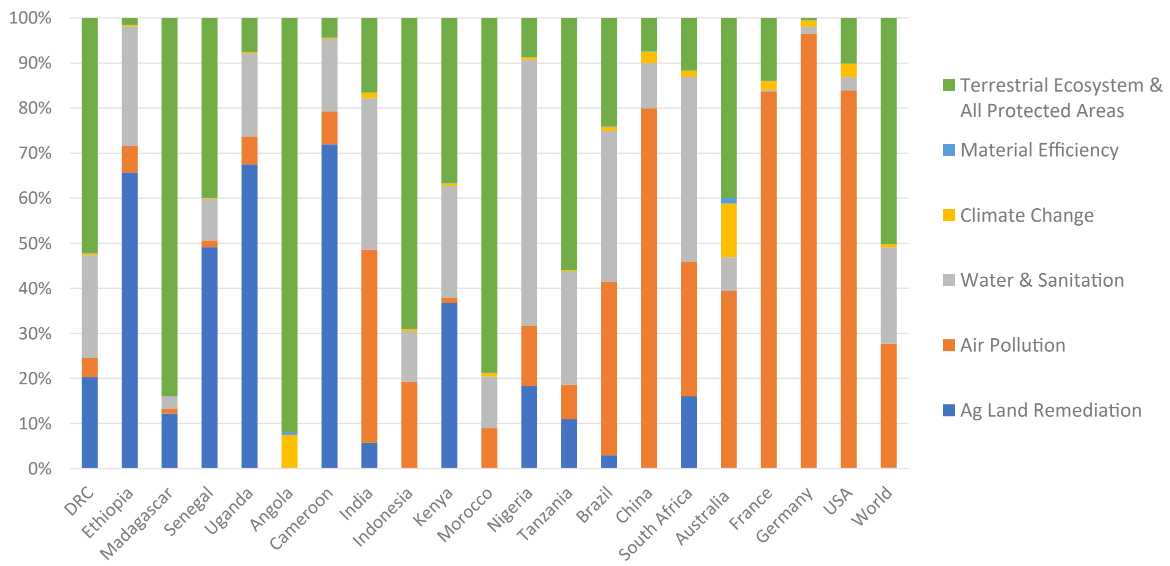
[D] Refers to reducing the rate of deforestation and loss of wetlands by half and increasing protected areas. Deforestation is based on FAO data.

Globally, the greatest net gains come from meeting the targets for terrestrial ecosystems and all protected areas (including marine ones). They make up half of all net benefits. The next largest gains are for improvement in air quality, where the gains in natural capital net of costs are around 28 per cent of the total, followed by water and sanitation, which accounts for 21 per cent. Surprisingly, the gain in natural capital for land is smaller compared to these sectors and makes up only 0.2 per cent of the total, although its share is much higher for selected countries. The net gains from material efficiency and climate change are small but they are still positive. It is also important to note that the range of net gains from addressing these two areas of natural capital loss could be much higher. The estimation has taken an average damage avoided; if it is at the upper end, for example, as it could be, then the net benefits will be much larger. Action on climate change and materials is partly to avoid the risk of such losses.

As mentioned, the global picture is not repeated for all the 20 countries, which is further illustrated in Figure 1. Deviations from the global shares of net gains are the following:

- Cameroon has the greatest gain in natural capital through agricultural land remediation (72 per cent of total), followed by safer water and sanitation (16 per cent).
- Ethiopia, Senegal, Uganda and Kenya also have natural capital gains from remediating land as the top item. Conservation of terrestrial ecosystems and all protected areas (including marine) and water quality improvements provide the next two important net gains.
- Nigeria and South Africa differ from the rest of Africa in having other areas at the top of the list. In Nigeria, the greatest gain in natural capital is from water quality (59 per cent), followed by land remediation (18 per cent) and air quality (13 per cent). In South Africa, improvements in water quality and air quality are first and second (41 per cent and 30 per cent, respectively), followed by land remediation (16 per cent).
- In the large countries of Asia, the dominant gains in natural capital come from air quality and conservation of terrestrial ecosystems and of protected areas (including marine).
- In the developed countries, the areas of gain are similar to India and China: air quality is top or second, followed by conservation of terrestrial ecosystems and protected areas (terrestrial and marine).

Figure 1: Shares of net benefits (per cent) for meeting natural capital-related SDG targets with respect to total net benefits in selected countries by 2030



Benefit-cost ratios (BCRs) by sector

Another indicator of where the greatest gains in natural capital can be made is the ratio of the increase in capital to the expenditures required to achieve it (Table 15).

Table 15. Benefit-cost ratios (BCRs) for selected SDG targets

Country	Ag land remediation[A]	Air pollution[B]	Water & sanitation[C]	Climate Change[D]	Material Efficiency	Deforestation[E]	Wetland[F]	Protected Area[G]	All Targets
DRC	83.9	2.2	4.5	1.9	1.2	1.7	77.8	2.8	4.6
Ethiopia	112.0	4.3	10.9	1.9	1.2	1.2	68.2	1.6	16.2
Madagascar	114.5	7.7	6.5	1.9	1.2	1.0	48.1	45.4	35.9
Senegal	449.4	2.2	17.1	1.9	1.2	1.5	80.5	5,902.9	38.0
Uganda	228.4	6.8	6.8	1.9	1.2	1.2	64.1	1.5	16.1
Angola	-	N.A.	N.A.	1.9	1.2	1.4	101.8	1.7	1.5
Cameroon	35.8	10.1	20.0	1.9	1.2	1.4	72.4	1.7	11.3
India	39.7	938.7	29.5	1.9	1.2	-	66.5	18.8	26.8
Indonesia	-	8.1	34.0	1.9	1.2	-	71.8	112.6	23.8
Kenya	13.7	1.1	11.1	1.9	1.2	1.1	41.7	13.4	5.0
Morocco	-	9.2	24.3	1.9	1.2	-	51.2	17.0	14.4
Nigeria	75.7	17.5	46.6	1.9	1.2	2.1	110.2	22.1	26.4
Tanzania	9.2	5.6	9.5	1.9	1.2	1.3	70.9	5,881.3	10.1
Brazil	35.1	60.2	86.8	1.9	1.2	1.9	204.4	-	15.0
China	-	98.3	44.0	1.9	1.2	-	283.6	16.5	22.7
South Africa	17.2	31.9	78.3	1.9	1.2	-	202.7	1.9	11.3
Australia	-	-	-	1.9	1.2	3.8	-	-	4.0
France	-	113.5	-	1.9	1.2	-	956.8	-	33.4
Germany	-	187.0	-	1.9	1.2	-	276.4	-	46.3
USA	-	1,333.2	-	1.9	1.2	-	-	4.1	15.0
World	**4.6**	**63.9**	**68.0**	**1.9**	**1.2**	**3.4**	**358.3**	**75.1**	**43.2**

[A] Agricultural land remediation is based on estimates of remaining pledge under the Bonn Challenge. Countries with no data mean they did not commit to the Bonn Challenge, except USA that already met their pledge.

[B] "N.A." means data are not available. "-" means the country already met the air pollution target.

[C] "-" means the country already met the water and sanitation target.

[D] Estimates are for the 2°C target.

[E] Refers to reducing the rate of deforestation by half. "-" means the country does not have investment costs to address the SDG target because they have positive annual rates of change in their forest areas.

[F] Refers to reducing the rate of loss of wetland by half. In the case of Australia and the US, "-" means no additional costs are involved as current programmes meet the target.

[G] Refers to increasing protected areas. "-" means the country already met the target.

Benefit-cost ratio (BCR) results show the following:

- Globally, the benefit-to-cost ratio is highest for wetland restoration, followed by protected areas, water quality, air quality, and agricultural land remediation.
- Ratios are less than 2 for materials efficiency and climate change. The data for the values of reduction in emissions and material use (benefits) are only available globally. When calculating the BCR, the global benefits are divided by the global costs. This result applies to all countries, explaining why their BCRs do not differ
- The ratios vary a little across countries but not much. The following variations are worth noting:
    - In the case of protected areas, the BCRs are very high when the area being protected is largely or exclusively marine. Such areas have a high gain in natural capital but modest costs of protection. Data on costs, however, need to be confirmed. This is the case for Senegal and Tanzania in Africa.
    - Agricultural land remediation has BCRs of over 35 in African countries. The exceptions are Kenya, Tanzania and South Africa.
    - Air quality has relatively low BCRs in developing countries compared to the large emerging economies of China and India and developed countries.
    - The top three BCRs for water quality are in Brazil, South Africa and Nigeria.
    - The BCRs for reduced deforestation are in the range of 1-2 for most countries in the sample.
    - Wetland conservation BCRs are more than 100 in Angola, Nigeria, Brazil, China, South Africa, France and Germany

Additions of natural capital achieved relative to stock

The gains in natural capital for some categories reported here can be compared to estimates of the stock of that capital (Table 16). The World Bank has recently completed an update of trends in capital that covers some components of natural capital (World Bank, 2021b). It includes, as separate forms of natural capital, the following renewable resources: forests, mangroves, fisheries, protected areas, cropland and pastureland. In addition, it also covers a number of sub-soil assets, namely: oil, gas, coal and metals and minerals. It does not value assets such as clear air or water, so a number of important items in our assessment are not tracked in these accounts. The report will be made public in November 2021.

Meeting the SDGs will increase the value of natural capital associated with natural resources by very significant amounts, especially in developing countries. For the developed countries, the increases are modest: from a low of 4 per cent in Germany to a high of 42 per cent in France. In Africa, the smallest increase is in South Africa, with a gain for 180 per cent to a high of 2,706 per cent in Madagascar. In Asia, the gains are 36 per cent in China, 150 per cent in India and 621 per cent in Indonesia. Globally, the total natural capital gains of $157 trillion amounts to a 442 per cent increase.[20]

Table 16: Gains in natural capital as per cent of stock

Country	Natural Capital Gains ($ Bn)					Stock of Capital, 2018 ($ Bn)	Increase as % of Stock
	Crop and Pasture Land*	Forests	Wetlands	Protected Areas	Total		
DRC	$85	$42	$121	$124	$372	$283	132%
Ethiopia	$735	$7	$12	$10	$764	$196	390%
Madagascar	$224	$3	$13	$1,546	$1,786	$66	2706%
Senegal	$296	$5	$2	$237	$540	$39	1386%
Uganda	$308	$7	$33	$2	$350	$59	594%
Angola	-	$13	$7	$127	$147	N.A.	N.A.
Cameroon	$432	$22	$8	$28	$491	$142	346%
India	$1,159	$0	$199	$3,265	$4,623	$3,074	150%
Indonesia	-	$0	$370	$6,315	$6,685	$1,077	621%
Kenya	$223	$49	$1	$215	$489	$186	263%
Morocco	-	$0	$1	$525	$526	$156	337%
Nigeria	$834	$40	$15	$371	$1,260	$260	485%
Tanzania	$80	$39	$45	$310	$473	$176	269%
Brazil	$106	$304	$713	$0	$1,122	$2,558	44%
China	-	$0	$1,269	$1,271	$2,540	$7,074	36%
South Africa	$192	$0	$75	$119	$386	$214	180%
Australia	-	$78	$0	$0	$78	$804	10%
France	-	$0	$229	$0	$229	$543	42%
Germany	-	$0	$16	$0	$16	$433	4%
USA	-	$0	$0	$1,209	$1,209	$4,185	29%
World	**$729**	**$1,096**	**$56,561**	**$98,336**	**$156,721**	**$35,448**	**442%**

* This is based on estimates of remaining pledge under the Bonn Challenge. Countries with "-" mean they did not commit to the Bonn Challenge. In the case of US, they have already met their pledge.

Note: "N.A." means data are not available.

20 It would be interesting to make a comparison across asset classes, within a country but at present the full data set for doing that is not available.

8. CONCLUSIONS

This report has brought together an analysis of the costs of meeting certain key natural capital-related SDGs in selected countries and the gains in natural capital that meeting them will generate. The top four sectors with the highest costs, globally, are associated with meeting the respective SDG targets for climate change, air quality, protected areas and water quality (in that order). However, the BCR results show that benefits outweigh the costs. Globally, the results show a large gain from the perspective of renewable natural capital from undertaking actions to meet SDGs in the areas of air and water quality, forests and wetlands, and in terrestrial and marine protected areas.

In terms of results regionally and country-wise, agricultural remediation has very high benefits relative to costs in most sub-Saharan African countries. The exceptions are Kenya, Tanzania and South Africa. The gains from air quality improvement are greatest in the large emerging economies of India, China and Brazil, followed by the developed countries. The highest gains for water quality improvement are in Brazil, South Africa and Nigeria. Reduced deforestation generally has a modest benefit to cost ratio of around 2, while wetland conservation has a higher ratio widely, with it going above 100 in Angola, Nigeria, Brazil, China, South Africa, France and Germany.

The gains for climate change and material efficiency are more moderate, based on average values of gains. However, there is an issue of uncertainty: with climate change, the gains could be much greater if we avoid huge climate-related losses; and with materials, the damages from extraction and disposal maybe much higher than the figures we have taken. Thus, the estimated benefit to cost ratios may be underestimated for these two in particular.

The gains of natural capital as per cent of stock are especially large across sub-Saharan Africa, but also in some other parts of the developing world. They are more modest in developed countries and emerging economies. Gains in natural capital from actions towards climate change and materials efficiency, while also positive and greater than the estimated cost, are lower than for targets related to the SDGs mentioned above. Finally, gains from meeting remediation targets for degraded land make up a small part of the gain in overall natural capital globally but play a much larger role for many sub-Saharan Africa countries.

Further work is needed to make the estimates more accurate and extend the coverage: at present many marine targets related to the SDGs are not covered. The improvement in the estimation applies both on the cost side and on the natural capital side, but is especially the case for the cost data. Work that is ongoing to improve the information database will be of great value. There is currently an initiative by WRI in collaboration with FAO to create such a database. Once available it would certainly make further work in this area easier. The idea is that individual countries can apply the methods developed here to improve estimates of the costs and benefits of the SDGs and of the gains in natural capital with more accurate data. This will help them in prioritizing sectors for action and, within sectors, locations where the greatest gains can be made.

APPENDICES

Appendix 1: Estimated agricultural areas to be remediated in 20 selected countries by 2030 (thousand hectares)

Country	Remaining area to be remediated by 2030*		Share of agricultural land**	Degraded agricultural area to be remediated by 2030	
	Under Proportional Rule	Under Bonn Challenge		Under Proportional Rule	Under Bonn Challenge
DRC	17,510	8,000	20%	3,502	1,600
Ethiopia	3,859	15,000	69%	2,662	10,350
Madagascar	2,130	4,000	77%	1,640	3,080
Senegal	451	2,000	52%	234	1,040
Uganda	487	2,448	87%	424	2,129
Angola	10,764	-	46%	4,952	-
Cameroon	308	10,400	32%	98	3,328
India	-2,108	11,189	72%	-1,518	8,056
Indonesia	13,376	-	41%	5,484	-
Kenya	1,365	5,100	88%	1,201	4,488
Morocco	876	-	84%	736	-
Nigeria	1,189	4,000	76%	903	3,040
Tanzania	5,021	5,200	46%	2,310	2,392
Brazil	15,037	2,575	32%	4,812	824
China	28,518	-	72%	20,533	-
South Africa	4,570	3,600	85%	3,885	3,060
Australia	25,925	-	75%	19,444	-
France	607	-	63%	382	-
Germany	422	-	59%	249	-
USA	8,832	-1,959	57%	5,034	-1,117
World	**307,157**	**165,533**	**54%**	**165,865**	**89,388**

Source: FAOSTAT Land Use (http://www.fao.org/faostat/en/?#data/RL)

* From Table 3

** Agricultural land as percentage of total agricultural land and forest land by country

Note: "-" means the country has no commitment under Bonn Challenge.

Appendix 2: Additional costs of meeting air quality standards by 2030 (US$ million/year)

Country	% Population > WHO Std.	Population (Million)	Population > WHO Std. (Million)*	Cost to Meet Air Quality Target ($Mn/Year)	
				With 1.5°C Climate Target	With No Additional Climate Investment
DRC	100	77	77	$709	$846
Ethiopia	100	99	99	$912	$1,088
Senegal	100	15	15	$139	$165
Uganda	100	39	39	$358	$427
Madagascar	99	24	24	$220	$262
Angola	100	25	25	$229	$274
Cameroon	100	23	23	$214	$255
Kenya	99	46	46	$419	$500
India	100	1,311	1,311	$12,027	$14,354
Indonesia	89	258	229	$2,103	$2,510
Morocco	34.4	100	34	$316	$377
Nigeria	100	182	182	$1,671	$1,995
Tanzania	100	54	54	$491	$586
Brazil	56	208	116	$1,067	$1,274
China	100	1,371	1,371	$12,578	$15,012
South Africa	100	55	55	$505	$602
Australia	0	24	0	$0	$0
France	92	67	61	$561	$670
Germany	100	82	82	$749	$894
USA	9	321	29	$265	$317
World	**92**	**7,347**	**6,759**	**$62,000**	**$74,000**

Sources: McCollum et al. (2018) and World Bank (2017)

* This number is the product of "% Population > WHO Std." and "Population".

Appendix 3: Additional costs of meeting the safe water and sanitation targets by 2030 (US$ million/year)

Country	Unimproved[A]		Population (000)[B]		To Connect By 2030 (000)		Annual Cost For Safe Sanitation[C] ($Mn/Yr)			Annual Cost For Safe Water[C] ($Mn/Yr)			Additional Finance to Attain Safe Water & Sanitation ($Mn/Yr)		
	Sanitation %	Water %	2015	2030	Sanitation	Water	Mean	Low	High	Mean	Low	High	Mean	Low	High
DRC	71	48	75,413	107,350	85,481	68,135	$794	$507	$1,243	$709	$555	$860	$1,143	$1,071	$1,296
Ethiopia	72	43	92,596	123,971	98,044	71,191	$910	$582	$1,426	$814	$636	$987	$1,311	$1,229	$1,487
Madagascar	88	48	23,728	33,270	30,423	20,932	$283	$181	$442	$252	$197	$306	$407	$381	$461
Senegal	52	21	14,043	18,791	12,050	7,697	$112	$71	$175	$100	$78	$121	$161	$151	$183
Uganda	81	21	39,119	59,961	52,528	29,057	$488	$312	$764	$436	$341	$529	$702	$658	$797
Angola	48	51	22,013	31,855	20,409	21,069	$190	$121	$297	$169	$132	$205	$273	$256	$309
Cameroon	54	24	21,659	27,315	17,352	10,854	$161	$103	$252	$144	$113	$175	$232	$217	$263
India	60	6	1,307,933	1,528,595	1,005,422	299,138	$9,336	$5,965	$14,620	$8,343	$6,524	$10,119	$13,442	$12,599	$15,247
Indonesia	39	13	251,396	277,364	124,012	58,649	$1,152	$736	$1,803	$1,029	$805	$1,248	$1,658	$1,554	$1,881
Kenya	70	37	45,566	60,593	46,923	31,886	$436	$278	$682	$389	$304	$472	$627	$588	$712
Morocco	23	15	33,955	36,367	10,222	7,505	$95	$61	$149	$85	$66	$103	$137	$128	$155
Nigeria	71	31	178,837	252,724	200,861	129,327	$1,865	$1,192	$2,921	$1,667	$1,303	$2,021	$2,686	$2,517	$3,046
Tanzania	84	44	51,352	73,026	64,810	44,269	$602	$385	$942	$538	$421	$652	$867	$812	$983
Brazil	17	2	203,150	222,819	54,204	23,732	$503	$322	$788	$450	$352	$546	$725	$679	$822
China	24	5	1,363,420	1,380,651	344,452	85,402	$3,199	$2,044	$5,009	$2,858	$2,235	$3,467	$4,605	$4,316	$5,223
South Africa	34	7	52,494	58,585	23,940	9,766	$222	$142	$348	$199	$155	$241	$320	$300	$363
Australia	0	0	24,140	29,562	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0
France	0	0	64,696	70,324	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Germany	0	0	82,124	81,357	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0
USA	0	0	322,835	361,029	0	0	$0	$0	$0	$0	$0	$0	$0	$0	$0
World	**32**	**9**	**6,019,353**	**6,950,479**	**3,269,737**	**1,584,743**	**$30,363**	**$19,400**	**$47,546**	**$27,134**	**$21,216**	**$32,907**	**$60,003**	**$48,157**	**$76,728**

Sources: [A]UNICEF and WHO (2015); [B]Riahi et al. (2017); [C]Cost estimates are derived from Hutton and Varughese (2016).

Note: Global population figures exclude countries where no improvements are required.

REFERENCES

Abu, A. (2018). *Nigeria Erosion and Watershed Management Project (NEWMAP) - additional financing - P164082. Project Information Document-Integrated Safeguards Data Sheet*. http://documents.worldbank.org/curated/en/193161525194153230/Project-Information-Document-Integrated-Safeguards-Data-Sheet-Nigeria-Erosion-and-Watershed-Management-Project-NEWMAP-Additional-Financing-P164082

Amann, M., Bertok, I., Borken-Kleefeld, J., Cofala, J., Heyes, C., Höglund-Isaksson, L., Klimont, Z., Nguyen, B., Posch, M., Rafaj, P., Sandler, R., Schöpp, W., Wagner, F., & Winiwarter, W. (2011). Cost-effective control of air quality and greenhouse gases in Europe: Modeling and policy applications. *Environmental Modelling & Software, 26*(12), 1489–1501. https://doi.org/10.1016/j.envsoft.2011.07.012

Australian Government, Department of Agriculture, Water and the Environment. (n.d.). *Smart Farms Small Grants*: Round 1 grantees. https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/natural-resources/landcare/sfsg1-list-successful-projects.pdf

Australian Government, Department of Agriculture, Water and the Environment. (2013). *Australia's Ramsar Sites*. Department of Agriculture, Water and the Environment. https://www.environment.gov.au/water/wetlands/publications/factsheet-australias-ramsar-sites

Bai, Z. G., Dent, D. L., Olsson, L., & Schaepman, M. E. (2008). Proxy global assessment of land degradation. Soil Use and Management, 24(3), 223e234. http://dx.doi.org/10.1111/j.1475-2743.2008.00169.x

Bassi, N., Kumar, M. D., Sharma, A., & Pardha-Saradhi, P. (2014). Status of wetlands in India: A review of extent, ecosystem benefits, threats and management strategies. *Journal of Hydrology: Regional Studies*, 2, 1–19. https://doi.org/10.1016/j.ejrh.2014.07.001

Business and Sustainable Development Commission. (2017). *Better business, better world*. Business and Sustainable Development Commission, London, UK. https://sustainabledevelopment.un.org/content/documents/2399BetterBusinessBetterWorld.pdf

CBD (Convention on Biological Diversity). (2013). *Resourcing the Aichi biodiversity targets: A first assessment of the resources required for implementing the Strategic Plan for Biodiversity 2011-2020.* http://www.cbd.int/doc/meetings/fin/hlpgar-sp-01/official/hlpgar-sp-01-01-report-en.pdf

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S.J., Kubiszewski, I., Farber, S., & Turner, R.K. (2014). Changes in the global value of ecosystem services. *Global Environmental Change, 26,* 152-158.

Cropper, M., & Khanna, S. (2014). How should the World Bank estimate air pollution damages? *RFF Discussion Paper 14-10*. Resources for the Future, Washington, D.C.

Dave, R., Saint-Laurent, C., Murray, L., Daldegan, G., Brouwer, R., Alberto, C., Scaramuzza, M., Raes, L., Simonit, S., Catapan, M., Contreras, G., Ndoli, A., Karangwa, C., Perera, N., Hingorani, S., & Pearson, T. (2018). *Second Bonn Challenge progress report: Application of the barometer in 2018. International Union for Conservation of Nature*. https://portals.iucn.org/library/sites/library/files/documents/2019-018-En.pdf

Davidson, N. C., Fluet-Chouinard, E., & Finlayson, C. M. (2018). Global extent and distribution of wetlands: trends and issues. *Marine and Freshwater Research, 69* (4), 620. https://doi.org/10.1071/mf17019

Desta, Z. (2003). Challenges and opportunities of Ethiopian wetlands: the case of Lake Awassa and its feeders. In Y.D. Abebe and K. Geheb (Eds.), *Wetlands of Ethiopia* (pp. 67-75). IUCN – The World Conservation Union, Switzerland.

Development Alternatives. (2020). *Economics of land degradation: evaluating the impact of land remediation through the lenses of natural capital and SDGs in the Bundelkhand region in Madhya Pradesh, India. Report to GiZ in its program on the Economics of Land Degradation*.

van Deventer, H., van Niekerk, L., Adams, J., Dinala, M.K., Gangat, R., Lamberth, S.J., Lotter, M., Mbona, N., Mackay, F., Nel, J.L., Ramjukadh, C-L., Sknowno, A., & Weerts, S.P. (2020). National Wetland Map 5 - An improved spatial extent and representation of inland aquatic and estuarine ecosystems in South Africa. *Water* SA, 46(1). https://watersa.net/article/view/7887

Ding, H., Faruqi, S., Wu, A. Altamirano, J-C., Ortega, A.A., Cristales, R.Z., Chazdon, R., Vergara, W., & Verdone, M. (2017). *Roots of prosperity: the economics and finance of restoring land*. World Resources Institute, Washington, D.C.

Finlayson, C.M., & Spiers, A.G. (Eds). (1999). Global review of wetland resources and priorities for wetland inventory. *Supervising Scientist Report 144/Wetlands International Publication 53*. Supervising Scientist, Canberra.

Gama, M. de M. B. (2003). Análise técnica e econômica de sistemas agroflorestais em Machadinho d'Oeste, Rondônia [Thesis (Doctorate in Forestry Science), Federal University of Viçosa]. In *www.locus.ufv.br.* https://www.locus.ufv.br/handle/123456789/9221?show=full

Gebremeskel, E.N. (2020). Disclosable Version of the ISR - *lowlands livelihood resilience project. P164336 Sequence No. 4.* http://documents.worldbank.org/curated/en/274891608241508350/Disclosable-Version-of-the-ISR-Lowlands-Livelihood-Resilience-Project-P164336-Sequence-No-04

GEF (Global Environment Facility). (2007). *Community-based integrated natural resources management in Lake Tana Watershed. Project Identification Form.* https://www.thegef.org/project/sip-community-based-integrated-natural-resources-management-lake-tana-watershed

GEF (Global Environment Facility). (2008a). *Participatory control of desertification and poverty reduction in the arid and semi-arid high plateau ecosystems of eastern Morocco. Project Information Form*. https://www.thegef.org/project/menarid-participatory-control-desertification-and-poverty-reduction-arid-and-semi-arid-high

GEF (Global Environment Facility). (2008b). *SIP: reducing land degradation on the highlands of Kilimanjaro. Project Identification Form*. https://www.thegef.org/project/sip-reducing-land-degradation-highlands-kilimanjaro

GEF (Global Environment Facility). (2010). *Mainstreaming sustainable land management in agropastoral production systems of Kenya. Project Document*. https://www.thegef.org/project/sip-mainstreaming-sustainable-land-management-agropastoral-production-systems-kenya

GEF (Global Environment Facility). (2011a). *Fifth operational phase of the GEF Small Grants Program in Brazil. Project Identification Form*. https://www.thegef.org/project/fifth-operational-phase-gef-small-grants-program-brazil

GEF (Global Environment Facility). (2011b). *Shaanxi Weinan Luyang integrated saline and alkaline land management. Project Identification Form*. https://www.thegef.org/project/shaanxi-weinan-luyang-integrated-saline-and-alkaline-land-management

GEF (Global Environment Facility). (2013a). *Integrated SLEM approaches for reducing land degradation and desertification, India. GEF Data Sheet*. https://www.thegef.org/project/integrated-slem-approaches-reducing-land-degradation-and-desertification

GEF (Global Environment Facility). (2013b). *Sustainable land use management in the semi-arid region of northeast Brazil (Sergipe). Project Information Form*. https://www.thegef.org/project/sustainable-land-use-management-semi-arid-region-north-east-brazil-sergipe

GEF (Global Environment Facility). (2014). *Land rehabilitation and rangelands management in small holders agropastoral production systems in soutwestern Angola. FAO/GEF Project Document PAD*. http://www.fao.org/gef/projects/detail/en/c/1056797/

GEF (Global Environment Facility). (2015a). *Securing multiple ecosystems benefit through SLM in the productive but degraded landscapes of South Africa. CEO Endorsement Request Document*. https://www.thegef.org/project/securing-multiple-ecosystems-benefit-through-slm-productive-degraded-landscapes-south-africa

GEF (Global Environment Facility). (2015b). *Securing watershed services through sustainable land management in the Ruvu and Zigi catchments, eastern arc region, Tanzania. CEO Endorsement Request Document*. https://www.thegef.org/project/securing-watershed-services-through-sustainable-land-management-ruvu-and-zigi-catchments

GEF (Global Environment Facility). (2016a). *CPP: Sub-program for sustainable land management in Boucle de Mouhoun region*. https://www.thegef.org/project/cpp-sub-program-sustainable-land-management-boucle-de-mouhoun-region

GEF (Global Environment Facility). (2016b). *LCB-NREE Cameroon child project: Improving agro-pastoral systems in the far north region of Cameroon. Request for CEO Endorsement (revised)*. https://www.thegef.org/project/lcb-nree-cameroon-child-project-improving-agro-pastoral-systems-far-north-region-cameroon

GEF (Global Environment Facility). (2016c). *LCB-NREE: Nigeria child project: comprehensive and integrated management of natural resources in Borno State*. *Request for CEO Endorsement Document*. https://www.thegef.org/project/lcb-nree-nigeria-child-project-comprehensive-and-integrated-management-natural-resources

GEF (Global Environment Facility). (2017a). *Food-IAP: integrated landscape management to enhance food security and ecosystem resilience in Nigeria. CEO Endorsement Request Document*. https://www.thegef.org/project/food-iap-integrated-landscape-management-enhance-food-security-and-ecosystem-resilience-0

GEF (Global Environment Facility). (2017b). *Food-IAP: reversing land degradation trends and increasing food security in degraded ecosystems of semi-arid areas of Tanzania. CEO Endorsement Request Document.* https://www.thegef.org/project/food-iap-reversing-land-degradation-trends-and-increasing-food-security-degraded-ecosystems

GEF (Global Environment Facility). (2017c). *Sustainable Land Management in target landscapes in Angola's southwestern region. Project Identification Form*. https://www.thegef.org/project/sustainable-land-management-target-landscapes-angola-s-southwestern-region

GEF (Global Environment Facility). (2018a). *The Restoration Initiative, DRC child project: improved management and restoration of agro-sylvo-pastoral resources in the pilot province of South-Kivu. Project Document PAD*. https://www.thegef.org/project/restoration-initiative-drc-child-project-improved-management-and-restoration-agro-sylvo

GEF (Global Environment Facility). (2018b). *Enhancing integrated natural resource management to arrest and reverse current trends in biodiversity loss and land degradation for increased ecosystem services in the Tana Delta, Kenya. GEF Project Document.* https://www.thegef.org/project/enhancing-integrated-natural-resource-management-arrest-and-reverse-current-trends

GEF (Global Environment Facility). (2018c). *Supporting the implementation of integrated ecosystem management approach for landscape restoration and biodiversity conservation in Tanzania. CEO Endorsement Request Document*. https://www.thegef.org/project/supporting-implementation-integrated-ecosystem-management-approach-landscape-restoration-and

GEF (Global Environment Facility). (2019). *Sustainable land management of Lake Nyasa catchment in Tanzania. Project Implementation Report*. https://www.thegef.org/project/sustainable-land-management-lake-nyasa-catchment-tanzania

GEF (Global Environment Facility). (2020). *Eldoret-Iten water fund for tropical water tower conservation. Project Identification Form*. https://www.thegef.org/project/eldoret-iten-water-fund-tropical-water-tower-conservation

GEF (Global Environment Facility). (2021a). *Scaling up sustainable land management and biodiversity conservation to reduce environmental degradation in small scale agriculture in western Kenya. GEF Project Information Form*. https://www.thegef.org/project/scaling-sustainable-land-management-and-biodiversity-conservation-reduce-environmental

GEF (Global Environment Facility). (2021b). *Sustainable agro-pastoral and land management promotion under the national community development program*. https://www.thegef.org/project/sustainable-agro-pastoral-and-land-management-promotion-under-national-community-development

Gibbs, H.K., & J.M Salmon. (2015). Mapping the world's degraded lands. *Applied Geography, 57*, 12-21.

Government of Uganda. (2016). Uganda Wetlands Atlas Volume Two. *In Ministry of Water and Environment, Republic of Uganda*. https://www.mwe.go.ug/sites/default/files/library/Uganda%20Wetlands%20Atlas%20Volume%20II_Popular%20Version.pdf

Greening Australia. (2017). Introducing Whole of Paddock Rehabilitation: A new approach to regreening the farm (Brochure). *In Greening Australia*. https://www.greeningaustralia.org.au/wp-content/uploads/2017/11/BROCHURE_Whole-of-Paddock-Rehabilition.pdf

de Groot Rudolf, Brander, L., & Solomonides, S. (2020). Update of global ecosystem service valuation database (ESVD). *FSD report No 2020-06*. Wageningen, The Netherlands (58 pp).

Haufler, J., Yeats, S., & Mehl, C. (2013). *Evaluating treatments for native grassland restoration*. Ecosystem Management Research Institute. Conservation Innovation Grant NRCS 69-3A75-9-152.

Hussain, S., McVittie, A., Brander, L., Vardakoulias, O., Wagtendonk, A., Verburg, P., Tinch, R., Fofana, A., Baulcomb, C., & Mathieu, L. (2011). *The economics of ecosystems and biodiversity: quantitative assessment*. Draft final report to the United Nations Environment Programme.

Hutton, G., & Varughese, M. (2016). The costs of meeting the 2030 Sustainable Development Goal targets on drinking water, sanitation, and hygiene. *In The World Bank*. https://openknowledge.worldbank.org/handle/10986/23681

IEA (International Energy Agency). (2019). Material efficiency in clean energy transitions – Analysis. *In International Energy Agency*. https://www.iea.org/reports/material-efficiency-in-clean-energy-transitions

IEG (Independent Evaluation Group). (2017). BR GEF Rio Grande do Sul Biodiversity. Implementation Completion Report Review. In *The World Bank*. http://documents1.worldbank.org/curated/en/813711488326577110/pdf/ICRR-Disclosable-P086341-02-28-2017-1488326567653.pdf

IRP. (2019). *Global resources outlook 2019: natural resources for the future we want*. Oberle, B., Bringezu, S., Hatfield-Dodds, S., Hellweg, S., Schandl, H., Clement, J., and Cabernard, L., Che, N., Chen, D., Droz-Georget, H., Ekins, P., Fischer-Kowalski, M., Flörke, M., Frank, S., Froemelt , A., Geschke, A., Haupt , M., Havlik, P., Hüfner, R., Lenzen, M., Lieber, M., Liu, B., Lu, Y., Lutter, S., Mehr , J., Miatto, A., Newth, D., Oberschelp , C., Obersteiner, M., Pfister, S., Piccoli, E., Schaldach, R., Schüngel, J., Sonderegger, T., Sudheshwar, A., Tanikawa, H., van der Voet, E., Walker, C., West, J., Wang, Z., & Zhu, B. A Report of the International Resource Panel. United Nations Environment Programme, Nairobi, Kenya.

IUCN (International Union for Conservation of Nature). (2020a). *Bonn Challenge Barometer*. InfoFLR. https://infoflr.org/bonn-challenge-barometer

IUCN (International Union for Conservation of Nature). (2020b). *Progress | Bonn Challenge*. Restore Our Future, Bonn Challenge. https://www.bonnchallenge.org/progress

IUCN (International Union for Conservation of Nature). (2021). Enhancing integrated natural resource management to arrest and reverse current trends in biodiversity loss and land degradation for increased ecosystem services in the Tana Delta. https://www.iucn.org/restoration-initiative/projects/kenya-tana-delta

Kunte, A., Hamilton, K., Dixon, J., & Clemens, M. (1998). *Indicators and environmental valuation: estimating national wealth - methodology and results*. https://millenniumindicators.un.org/unsd/envAccounting/ceea/archive/Framework/Kunte_etal_1998.PDF.

Lange, G.-M., Wodon, Q., Carey, K., & World Bank. (2018). *The changing wealth of nations 2018: building a sustainable future.* World Bank Group.

Margono, B. A., Bwangoy, J.-R. B., Potapov, P. V., & Hansen, M. C. (2014). Mapping wetlands in Indonesia using Landsat and PALSAR datasets and derived topographical indices. *Geo-Spatial Information Science*, 17(1), 60–71. https://doi.org/10.1080/10095020.2014.898560

Markandya, A. (2019). Natural capital and the rate of discount. In P. Kumar, S. Esen, & P. Nunes (Eds.), Mainstreaming natural capital and ecosystem services into development policy (pp. 256–284). Routledge.

Markandya, A. (2020). *Natural capital and the Sustainable Development Goals. GGKP Expert Group on Natural Capital, Working Paper No. 4*. Green Growth Knowledge Partnership, Geneva.

Markandya, A., & Galinato, S.P. (2021). A methodology for assessing countries' financial needs to meet the SDGs through natural capital investment. Green Growth Knowledge Partnership, Geneva. https://www.greengrowthknowledge.org/research/assessing-countries-financial-needs-meet-sdgs-through-natural-capital-investment

Markandya, A., Sampedro, J., Smith, S. J., Van Dingenen, R., Pizarro-Irizar, C., Arto, I., & González-Eguino, M. (2018). Health co-benefits from air pollution and mitigation costs of the Paris Agreement: A modelling study. *The Lancet Planetary Health,* 2(3), e126–e133. https://doi.org/10.1016/s2542-5196(18)30029-9

McCollum, D. L., Zhou, W., Bertram, C., de Boer, H.-S., Bosetti, V., Busch, S., Després, J., Drouet, L., Emmerling, J., Fay, M., Fricko, O., Fujimori, S., Gidden, M., Harmsen, M., Huppmann, D., Iyer, G., Krey, V., Kriegler, E., Nicolas, C., … Riahi, K. (2018). Energy investment needs for fulfilling the Paris Agreement and achieving the Sustainable Development Goals. *Nature Energy,* 3(7), 589–599. https://doi.org/10.1038/s41560-018-0179-z

Farzin, Y.H. (1992). The time path of scarcity rent in the theory of exhaustible resources. *The Economic Journal, 102*(413), 813-830.

McKinsey & Company. (2007). *Costs and potentials of greenhouse gas abatement in Germany*. https://www.mckinsey.com/business-functions/sustainability/our-insights/costs-and-potentials-of-greenhouse-gas-abatement-in-germany#

Meng, W., He, M., Hu, B., Mo, X., Li, H., Liu, B., & Wang, Z. (2017). Status of wetlands in China: A review of extent, degradation, issues and recommendations for improvement. *Ocean & Coastal Management, 146*, 50–59. https://doi.org/10.1016/j.ocecoaman.2017.06.003

MWE (Ministry of Water and Environment, Republic of Uganda) and IUCN (International Union for the Conservation of Nature). (2016). *Forest landscape restoration opportunity assessment for Uganda*. https://portals.iucn.org/library/sites/library/files/documents/2016-076.pdf

OECD (Organisation for Economic Co-operation and Development). (2005). Glossary of statistical terms. https://stats.oecd.org/glossary/detail.asp?ID=1730

OECD (Organisation For Economic Co-Operation and Development). (2019). *Global material resources outlook to 2060: economic drivers and environmental consequences.* OECD Publishing.

Prasher, K. (2018). The case of India's disappearing wetlands. *The Weather Channel.* https://weather.com/en-IN/india/news/news/2018-11-08-the-case-of-indias-disappearing-wetlands

Ramsar. (2021). *Ramsar Sites Information Service*. https://rsis.ramsar.org/ris-search/?pagetab=1

Ramsar Convention on Wetlands. (2018). *Global wetland outlook: State of the world's wetlands and their services to people.* Ramsar Convention Secretariat. https://www.global-wetland-outlook.ramsar.org/outlook

Riahi, K., van Vuuren, D. P., Kriegler, E., Edmonds, J., O'Neill, B. C., Fujimori, S., Bauer, N., Calvin, K., Dellink, R., Fricko, O., Lutz, W., Popp, A., Cuaresma, J. C., KC, S., Leimbach, M., Jiang, L., Kram, T., Rao, S., Emmerling, J., … Tavoni, M. (2017). The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. *Global Environmental Change, 42*, 153–168. https://doi.org/10.1016/j.gloenvcha.2016.05.009

SSP Database (Shared Socioeconomic Pathways) - Version 2.0. https://tntcat.iiasa.ac.at/SspDb/dsd?Action=htmlpage&page=10

Roby, D., & Mbengue, A. (2013). Terminal evaluation of the groundnut basin soil management and regeneration. *In Global Environment Facility*. https://www.thegef.org/project/groundnut-basin-soil-management-and-regeneration

Salem, M., & Mercer, D.E. (2012). The economic value of mangroves: a meta analysis. *Sustainability*, 4, 359-383.

Santos, S. da S., & Grzebieluckas, C. (2014). Sistema silvipastoril com eucalipto e pecuária de corte: uma análise de viabilidade econômica em uma propriedade rural em Mato Grosso/Brasil. *Custos e @gronegócio Online, 10(3)*. http://www.custoseagronegocioonline.com.br/numero3v10/Artigo%2014%20silvapastoril.pdf

Schell, K. (Ed.). (2010). *SDGC producers invited to be part of new grassland restoration project*. South Dakota Grassland Coalition.

Shindell, D., Faluvegi, G., Seltzer, K., & Shindell, C. (2018). Quantified, localized health benefits of accelerated carbon dioxide emissions reductions. *Nature Climate Change, 8(4)*, 291–295. https://doi.org/10.1038/s41558-018-0108-y

Siikamäki, J., Santiago-Ávila, F.J., & Vail, P. (2015). *Global assessment of non-wood forest ecosystem services: spatially explicit meta-analysis and benefit transfer to improve the World Bank'sBank's Forest Wealth Database*. *Working Paper*. Program on Forests, Washington, D.C.

Sulaiman, A. A., Sulaeman, Y., & Minasny, B. (2019). A framework for the development of wetland for agricultural use in Indonesia. *Resources*, 8(1), 34. https://doi.org/10.3390/resources8010034

Sutton, P.C., Anderson, S.J., Costanza, R., & Kubiszewski, I. (2016). The ecological economic of land degradation: impacts on ecosystem values. *Ecological Economics*, 128, 182-192.

UN (United Nations). (2015). *The 17 Goals*. https://sdgs.un.org/goals

UN (United Nations). (2016). *Final list of proposed Sustainable Development Goal indicators*. https://sustainabledevelopment.un.org/content/documents/11803Official-List-of-Proposed-SDG-Indicators.pdf

UN (United Nations). (2019). *United Nations Secretary-General's roadmap for financing the 2030 agenda for sustainable development (2019-2021)*. https://www.un.org/sustainabledevelopment/wp-content/uploads/2019/07/UN-SG-Roadmap-Financing-the-SDGs-July-2019.pdf

UNCTAD (UN Conference on Trade and Development). (2020). *World investment report 2020*. https://unctad.org/system/files/official-document/wir2020_en.pdf

UNDP (United Nations Development Programme) Ethiopia. (2021). *Integrated landscape management to enhance food security and ecosystem resilience in Ethiopia. Project Document*. https://www.et.undp.org/content/ethiopia/en/home/projects/integrated-landscape-management-to-enhance-food-security-and-eco.html

UNDP (United Nations Development Programme) Kenya. (2021). Sustainable land management (SLM) - *agro-pastoral Kenya*. https://www.ke.undp.org/content/kenya/en/home/operations/projects/environment_and_energy/Land_Management.html

UNEP (2018). *The Emissions Gap Report 2018*. United Nations Environment Programme, Nairobi.

UNEP (United Nations Environment Programme). (2018). *Emissions gap report 2018: Executive summary*. https://wedocs.unep.org/bitstream/handle/20.500.11822/26879/EGR2018_ESEN.pdf?sequence=10

UNEP (United Nations Environment Programme), & IRP (International Resource Panel). (2019). *Global resources outlook 2019: Natural resources for the future we want*. https://wedocs.unep.org/handle/20.500.11822/27517

UNEP-WCMC (UNEP-World Conservation Monitoring Centre), & (IUCN) International Union for Conservation of Nature. (2016). *Protected planet report 2016*. UNEP-WCMC and IUCN. https://wdpa.s3.amazonaws.com/Protected_Planet_Reports/2445%20Global%20Protected%20Planet%202016_WEB.pdf

UNICEF (United Nations Children's Fund), & WHO (World Health Organization). (2015). *Progress on sanitation and drinking water: 2015 update and MDG assessment.* UNICEF. https://www.unicef.org/publications/index_82419.html

United Republic of Tanzania. (2016). *Food-IAP: reversing land degradation trends and increasing food security in degraded ecosystems of semi-arid areas of Tanzania. GEF 9132. Detailed Design Report*. https://www.thegef.org/project/food-iap-reversing-land-degradation-trends-and-increasing-food-security-degraded-ecosystems

U.S. Fish and Wildlife Service. (2011). *National wetlands inventory: Status and trends of wetlands in the coterminous United States 2004 to 2009.* https://www.fws.gov/wetlands/documents/Key-Messages-Status-Trends-Wetlands-Conterminous-US-2004-2009.pdf

USDA FSA (United States Department of Agriculture, Farm Service Agency). (2019). *Conservation Reserve Program (CRP) enrollment and rental payments by state, 1986-2019*. https://www.fsa.usda.gov/programs-and-services/conservation-programs/reports-and-statistics/conservation-reserve-program-statistics/index

USDA FSA (United States Department of Agriculture, Farm Service Agency). (2020). *Conservation Reserve Program fact sheet*. https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/2019/conservation-reserve_program-fact_sheet.pdf

USDA NRCS (United States Department of Agriculture, Natural Resources Conservation Service). (2020). *Conservation Innovation Grants*. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/cig/

Vinholis, M. de M. B., Nicodemo, M. L. F., Santos, P. M., & Cola, G. G. (2010). *Cost of implementing silvopastoral production systems in São Carlos, SP* (Translated). National Meeting of Production Engineering. Production engineering maturity and challenges: business competitiveness, working conditions, environment - annals. Original: "Custo da Implantação de Sistemas de Produção Silvipastoris em São Carlos, SP."

Waldron, A. et al. (2020). *Protecting 30% of the planet for nature: costs, benefits and economic implications. Working paper analysing the economic implications of the proposed 30% target for areal protection in the draft post-2020 Global Biodiversity Framework*. https://www.conservation.cam.ac.uk/files/waldron_report_30_by_30_publish.pdf

West, J. J., Smith, S. J., Silva, R. A., Naik, V., Zhang, Y., Adelman, Z., Fry, M. M., Anenberg, S., Horowitz, L. W., & Lamarque, J.-F. (2013). *Co-benefits of mitigating global greenhouse gas emissions for future air quality and human health. Nature Climate Change, 3*(10), 885–889. https://doi.org/10.1038/nclimate2009

WHO (World Health Organization). (2018). Ambient (outdoor) air pollution. *Fact Sheet.* https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health

World Bank. (2010). *Western Kenya integrated ecosystem management project. Implementation Completion and Results Report.* http://documents.worldbank.org/curated/en/744731468044993792/Kenya-Western-Kenya-Integrated-Ecosystem-Management-Project

World Bank. (2013). *Cameroon - sustainable agro-pastoral and land management (SLM) promotion under the PNDP. Implementation Completion and Results Report.* https://documents.worldbank.org/en/publication/documents-reports/documentdetail/924551468017355251/cameroon-sustainable-agro-pastoral-and-land-management-promotion-project-under-the-community-development-program-support-project-papndp

World Bank. (2017). *The Little Green Data Book 2017: World development indicators.* World Bank. https://openknowledge.worldbank.org/handle/10986/27466

World Bank. (2018). *Nigeria - erosion and watershed management project.* http://documents.worldbank.org/curated/en/513991530329697812/Nigeria-Erosion-and-Watershed-Management-Project

World Bank. (2019a). *Ethiopia - sustainable land management project. Implementation Completion Report Review.* http://documents.worldbank.org/curated/en/836131570649770928/Ethiopia-Sustainable-Land-Management-Project

World Bank. (2019b). *India - Third Uttar Pradesh sodic lands reclamation project. Implementation Completion and Results Report.* http://documents.worldbank.org/curated/en/973101562010748497/India-Third-Uttar-Pradesh-Sodic-Lands-Reclamation-Project

World Bank. (2020). WDI - *The world by income and region.* https://datatopics.worldbank.org/world-development-indicators/the-world-by-income-and-region.html

World Bank. (2021a). *World Development Indicators: DataBank*. https://databank.worldbank.org/reports.aspx?source=world-development-indicators

World Bank (2021b). The Changing Wealth of Nations 2021: Managing Assets for the Future. World Bank, Washington DC.

World Bank, & IHME (Institute for Health Metrics and Evaluation) (2016). The Cost of Air Pollution: Strengthening the Case for Action. World Bank, Washington DC.

World Forum on Natural Capital. (2021). What is natural capital? https://naturalcapital-forum.com/about/

WRI (World Resources Institute). (2020). *Global Forest Watch: Forest monitoring designed for action. World Resources Institute.* http://www.globalforestwatch.org/

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