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Climate Change Mitigation in the East and Southern Africa Region: An Economic Case for the Agriculture, Forestry and Land Use Sector

by
Giacomo Branca
Paxina Chileshe

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Table of contents

Abstract

The achievement of the goal of zero hunger by 2030 can be facilitated through green growth investments in the agriculture, forestry and land use (AFOLU) sector. Significant levels of finance are needed to support countries to implement such strategies and fulfil the commitments made in their Nationally Determined Contributions (NDCs), and private finance remains a key source. This report is a useful guide to shape investments by IFAD, and other international donors, in climate change mitigation actions in the East and Southern Africa (ESA) region.

We quantify the ESA countries' mitigation commitments with a focus on the AFOLU sector and introduce cost-effectiveness criteria to evaluate such capacity, also in view of attracting private financing. Our results show that most emissions in the region come from the energy sector, followed by AFOLU. Full implementation of conditional and unconditional mitigation targets set forth in the NDCs would limit the increase in regional net emissions to about 20 per cent above the baseline. We argue that mitigation investments can be prioritized to enhance the efficiency of available financing (economy of scope), maximize the mitigation results (economy of scale) and create synergies with economic development needs. However, trade-offs exist from the perspective of social equity and economic development goals.

In its 12th replenishment cycle, IFAD has increased its focus on mitigation. In line with this, we find that investment in AFOLU is a profitable way to invest in climate change mitigation, being more competitive than energy and other sectors in attracting mitigation finance. Investing in mitigation through AFOLU is certainly more feasible given the increasing prices recorded in the carbon market. Revenues from this market may provide the necessary resources to fill the funding gap and drive a competitive restructure of the AFOLU sector to help achieve the Sustainable Development Goals. Prioritizing low-income countries would minimize the trade-offs and enhance the synergies between mitigation and economic development, therefore supporting socio-economic growth.

Acronyms and abbreviations

AFOLU	Agriculture, forestry and land use
BAU	Business as usual
CO_2e	Carbon dioxide equivalent
COP	Conference of the Parties
COSOP	Country Strategy and Opportunities Programmes
CSN	Country Strategy Note
ESA	East and Southern Africa
ETS	Emissions Trading System
GDP	Gross domestic product
GHG	Greenhouse gas
IFAD	International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial process and product use
LULUCF	Land use, land use change and forestry
MAC	Marginal abatement cost
MACC	Marginal abatement cost curve
NDC	Nationally Determined Contributions
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SECAP	Social, Environment and Climate Assessment Procedures
tCO_2e	Tons of carbon dioxide equivalent
UNFCCC	United Nations Framework Convention on Climate Change

List of Tables

List of Figures

List of Boxes

1. Introduction

In December 2015, at the 21st Conference of the Parties (COP 21) in Paris, Parties of the United Nations Framework Convention on Climate Change (UNFCCC) adopted the Paris Agreement to address climate change. Countries have made commitments through their Nationally Determined Contributions (NDCs), through which they communicate their climate commitments to the international community and report on the progress made.[1] Achievement of these commitments is estimated to result in aggregate global greenhouse gas (GHG) emissions of 57 $GtCO_2e$ in 2030 – a decrease of 4 $GtCO_2e$ compared to pre-NDC forecasts (UNFCCC 2015a).

The agriculture, forestry and land use change (AFOLU) sector plays an important role in the NDCs. Mitigation actions in the sector are included in 84 per cent of the Parties' NDCs (Richards et al. 2015). Globally there is a strong economic case to invest in agriculture for future food security and rural livelihoods under climate change (IFAD 2016b), and international organizations working in the field of agriculture and rural development are committed to it. For example, the International Fund for Agriculture Development (IFAD) works with governments and communities to reduce vulnerability to climate variability and longer-term climate change, and is committed to scaling up related investments (IFAD 2020; 2018a; 2018b; 2016a).

With reference to the East and Southern Africa (ESA) region, IFAD has already identified the priorities for investments to enhance the mitigation potential of the agriculture sector (see IFAD 2020).

However, reducing GHG emissions while ensuring food security will be a challenge in the region, as agriculture drives the rural economy (FAO 2017) and there are trade-offs between mitigation and economic development (Cohen et al. 2021; Thornton and Comberti 2017). Green growth could be a solution. The international development community has generally converged on a definition of green growth consisting of job creation or economic growth that is either compatible with or driven by reduced emissions, improved efficiencies in the use of natural resources and protection of ecosystems (OECD 2011; World Bank 2012; UNEP 2011). In Africa, green growth will mean pursuing inclusive economic growth through policies and programmes that invest in sustainable infrastructure, better manage natural resources, build resilience to natural disasters and enhance food security (Sperling et al. 2012). Public and private investment in low-emission agriculture must rapidly scale up to meet climate change mitigation targets.

In this context, we present here an economic case for investing in climate change mitigation and supporting low-carbon development in ESA. We aim to quantify the mitigation commitments of the region with specific reference to the AFOLU sector, and discuss possible socio-economic criteria for orienting investments to exploit such mitigation capacity and to shift from business as usual (BAU) to greener agriculture. The results will help shape investments from IFAD, and other international donors, in climate change mitigation in the ESA region.

The paper is structured as follows: section 2 describes the data and methods used; section 3 illustrates and discusses the results; section 4 reports the conclusions.

[1] Most NDCs began life as Intended NDCs (INDCs), which countries submitted before the Paris Agreement. At the start of COP 21 in Paris – also known as the 21st session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) – some 190 countries had submitted their INDCs. Upon formal acceptance of the Paris Agreement, which entered into force on 4 November 2016, most countries converted their INDCs into NDCs. Under the terms of the Agreement, countries also agreed to communicate and update their NDCs by 2020 and every five years thereafter. For the sake of simplicity, in this report we adopt only the term NDC.

2. Data and methods

2.1. Data

The analysis is developed with reference to the countries and sub-regions that comprise the IFAD ESA region,[2] as shown in Table 1.

Table 1. List of countries and sub-regions considered in the analysis

	East Africa and Indian Ocean		Southern Africa		Horn of Africa
1	Burundi	1	Angola	1	Eritrea
2	Comoros	2	Botswana	2	Ethiopia
3	Kenya	3	Eswatini (Swaziland)		
4	Madagascar	4	Lesotho		
5	Mauritius	5	Malawi		
6	Rwanda	6	Mozambique		
7	Seychelles	7	Namibia		
8	Uganda	8	South Africa		
9	United Republic of Tanzania	9	Zambia		
		10	Zimbabwe		

Source: Authors' own elaboration.

Data sources include country documents and global datasets. Specifically:

- the UNFCCC GHG Data Interface, which includes data from the National Communications, 1990-2015
- the FAOSTAT dataset on GHG emissions from agriculture[3]
- NDCs available in the online registry,[4] which include baseline data from various years (2005-2020) and target reductions up to 2030
- World Bank national accounts data and Organisation for Economic Co-operation and Development (OECD) National Accounts data files for various years, 2016-2019
- International Monetary Fund international financial statistics and data files for various years, 2005-2019
- IFAD Country Strategy and Opportunities Programmes (COSOP) documents prepared under various IFAD Performance-based Allocation System (PBAS) replenishment cycles, and the related Social, Environment and Climate Assessment Procedures (SECAP) document; when they are not available, the Country Strategy Note (CSN) is used instead
- country-level green growth strategies and/or national investment plans for agriculture and rural sectors (NAIPs), when available.

Different timeframes apply for the NDCs. While the same projected year is used (2030 for all the NDCs considered), different countries use different baseline years. Similarly, the COSOPs cover different time periods and PBA cycles. Therefore, data are standardized for meaningful comparison across countries. For example, the abatement costs are computed as annual averages. A list of the NDCs, COSOPs and CSNs consulted is provided in **Error! Reference source not found.**.

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[2] South Sudan could not be included in the analysis, since its NDC has not been submitted.
[3] The FAOSTAT domain "Agriculture Total" contains estimates of the GHG emissions from agricultural activities. These emissions consist of non-CO_2 gases, namely methane (CH_4) and nitrous oxide (N_2O) from crop and livestock production and associated management activities within the farm gate. Data are computed using Tier 1 default factors from the Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. A useful note about the use of the FAOSTAT data can be found in Tubiello et al. (2013).
[4] See https://www4.unfccc.int/sites/ndcstaging/Pages/Home.aspx.

Financial budgets associated with the mitigation targets included in the NDCs are derived from the NDC documents. They are already expressed in US dollars (US$), so no issues related to the use of local currencies arise. However, since financial figures refer to different time periods, they have been adjusted to account for inflation rates. They are therefore expressed in constant 2010 US$, with 2010 chosen as the reference year for the analysis. For each country, we adjust financial data using the US consumer price index as a measure of inflation[5] through equation (1):

$$\left(Adjusted\ cost\ _{2010\ prices}\right) = \left(Cost_{year\ t\ prices}\right) \times \frac{CPI_{year\ 2010}}{CPI_{year\ t}} \qquad (1)$$

Table 2. List of country NDCs and COSOP documents available

Country	COSOP[a]			NDC[b]			
	Period	Approval date[c]	PBAS cycle[d]	Submission	Date	Baseline year	Projected year
Angola	2019-2024	EB 12/2017	11, 12, 13	1st	16/11/2020	2005	2030
Botswana	-	-	-	1st	11/11/2016	2010	2030
Burundi	2016-2021	EB 4/2016	10, 11, 12	1st	17/01/2018	2005	2030
Comoros	CSN	July 2016	-	1st	23/11/2016	2015	2030
Eritrea	2020-2025	EB 4/2020	11, 12, 13	1st	19/06/2018	2010	2030
Eswatini (Swaziland)	COSOP 2006; CSN, 8/20-12/21	August 2020	-	1st	21/09/2016	2010	2030
Ethiopia	2017-2021	EB 12/2016	10, 11, 12	1st, updated	23/07/2021	2010	2030
Kenya	2020-2025	EB 12/2019	11, 12, 13	1st	28/12/2016	2010	2030
Lesotho	2020-2025	EB 12/2019	11, 12, 13	1st	22/06/2018	2015	2030
Madagascar	2015-2019	EB 12/2014	10, 11	1st	21/09/2016	2010	2030
Malawi	2016-2022	EB 12/2016	10, 11, 12	1st	29/06/2017	2015	2030
Mauritius	-	-	-	1st	22/04/2016	2015	2030
Mozambique	2018-2022	EB 4/2018	11,12	1st	04/06/2018	2020	2030
Namibia	-	-	-	1st	21/09/2016	2010	2030
Rwanda	2019-24	EB 05/2019	11, 12	1st, updated	20/05/2020	2015	2030
Seychelles	CSN	21/07/2016		1st	29/04/2016	2020	2030
South Africa	CSN	31/10/2016		1st	01/11/2016	2020	2030
Uganda	2021-2027	draft, 9/2020	11, 12, 13	1st	21/09/2016	2015	2030
United Republic of Tanzania	2016-2021	EB, 4/2016	10, 11	1st	18/05/2018	2015	2030
Zambia	2019-24	EB 05/2019	11, 12	1st	09/12/2016	2010	2030
Zimbabwe	2020-2025	EB 09/2020	11, 12, 13	1st	07/08/2017	2020	2030

Source: Authors' own elaboration.

[5] US inflation rates more accurately reflect the price changes of tradable resources (which are often globally purchased and priced) than local inflation rates. However, they may not reflect the price changes of local, non-tradable resources. As US inflation rates are typically lower than local inflation rates, we may underestimate the adjusted costs related to non-tradable resources. The AFOLU sector is characterized by high use of tradable resources (inputs and energy), while the main local resource is labour, whose market is often imperfect. Also, here we are interested in a comparison of different values, rather than in the absolute values. Therefore, any underestimation of costs would have only a limited effect on our findings.

Notes: [a] COSOP documents are available online on the IFAD country pages; [b] Source: NDC registry available at https://www4.unfccc.int/sites/ndcstaging/Pages/Home.aspx; [c] IFAD Executive Board meeting date; [d] IFAD8 = 2010-2012; IFAD9 = 2013-2015; IFAD10 = 2016-2018; IFAD11 = 2019-2021; IFAD12 = 2022-2024; IFAD13 = 2025-2027.

2.2. Methodology

The work presented here includes the countries listed in table 1. It encompasses the 20-year period 2010-2030, given that the timeframe for GHG accounting in similar analyses is usually 20 years. The year 2010 is chosen as a reference year, in line with the reference year set for the NDCs' baselines.

a) Determining the mitigation profile of the AFOLU sector

Using data from the National Communications and the national inventories, we determine the mitigation profile of the AFOLU sector by: (i) computing the current net GHG emissions as the difference between the direct emissions and the removals (through carbon sinks); and (ii) quantifying the mitigation targets by reviewing the NDC submissions, proposed actions and targeted sectors.[6]

We examine all sectors included in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines), namely: energy; industrial process and product use (IPPU); agriculture; land use, land use change and forestry (LULUCF); and waste. We specifically look at the agriculture and LULUCF sectors (which are often aggregated as AFOLU). We consider only the mitigation commitments; adaptation is excluded from the analysis.

b) Assessing mitigation capacity

We assess the economy-wide GHG emissions potentially mitigated by the national commitments (measured in tCO2e) either by directly deriving them from the NDCs or by computing the difference between the projected emissions in the BAU 2030 scenario and the projected emissions according to the information reported in the NDCs. We also calculate the sectoral quantity of GHG emissions mitigated by weighting the economy-wide quantity by the percentage contribution of each sector (energy, IPPU, AFOLU and waste) to overall emissions, as derived from the National Communications.

c) Assessing the mitigation costs

While in principle it would be preferable to adopt a bottom-up approach, starting from the mitigation costs of specific technologies/actions for each ton of carbon to more aggregated sectoral/economy-wide carbon mitigation costs, due to data limitations we use a top-down approach instead and start from the aggregate mitigation costs. We derive the economy-wide cost of mitigating 1 ton of carbon – i.e. the marginal abatement cost (MAC), measured in US$/tCO2e – by dividing the total amount of funding that countries indicated in their budget as the mitigation funding needed (i.e. the mitigation budget indicated in each NDC, under the conditional scenario),[7] by the planned number of tons of mitigated carbon use.

[6] A "target" represents an intention to achieve a specific result within a given timeframe, for example to reduce GHG emissions to a specific level (GHG target – i.e. -20 per cent by 2030) or increase energy efficiency to a specific level (non-GHG target – i.e. achieve an energy matrix with 50 MW of electricity from renewable sources by 2030). An "action", on the other hand, represents an intention to implement specific means of achieving GHG reductions, such as policies (i.e. revision of the building code to improve energy performance through thermal building and renovation standards and a certification process) or projects (i.e. completion of the US$165 million Kénié hydropower project in Swaziland between 2015 and 2020).
[7] An unconditional contribution represents a commitment to achieve a certain goal (i.e. a target or action) that a country declares to undertake irrespective of any conditions. On the other hand, a conditional contribution represents a commitment to achieve a certain goal (i.e. a target or action) given that certain conditions are met, such as the provision of finance, capacity-building and technology transfer, and usually represents a progression from the unconditional contribution. Since we provide a guide for international donor investments in climate change mitigation actions and the possible contribution from international financing here, the analysis looks at the conditional scenario. However, when countries have only reported unconditional targets in their NDCs, such targets have been used in the analysis.

Also, we derive the mitigation costs by sector by weighting the total budget required to reduce emissions by the percentage value-added contribution of the sector to the economy. [8] We then compute the sectoral MAC (by dividing the sectoral mitigation cost by the sectoral mitigation capacity) to account for the different costs to reduce emissions in the various sectors.

The formulas used to compute the economy-wide and sectoral MACs are indicated by equations (2) and (3), respectively.

$$MAC_{country\ j} = \frac{mitigation\ budget_{\ j}}{mitigation\ target_{\ j}} \tag{2}$$

$$MAC_{sector\ i, country\ j} = \frac{(mitigation\ budget_{\ j} * \%\ VA_{\ i,j})}{mitigation\ target_{\ i,j}} \tag{3}$$

d) Deriving marginal abatement cost curves (MACCs)

Following earlier research into MACCs (Jiang et al. 2020), we apply them to quantify emissions abatement costs for each country. To deal with the heterogeneity of countries' economies, we adopt a "bottom-up" approach, similarly to previous works in the literature (e.g. see Branca et al. 2015; 2020). For each country, we link the budget foreseen under the conditional scenario (which is used as a proxy for the expected costs) with the mitigation capacity resulting from the corresponding mitigation targets.

The economy-wide and AFOLU-related MACCs are built by plotting the abatement costs of various countries (per unit of CO_2e mitigated) on the vertical axis, and the volume of emissions saved (total units of CO_2e mitigated by the 2030 target year) on the horizontal axis. Positive gross margins indicate negative abatement costs (and vice versa). The curve slopes upwards. The list of countries is ordered by increasing abatement costs and volumes of CO_2e abated. The results are also compared with reference to gross domestic product (GDP) per capita, which is selected as a proxy for the size of the countries' economy. We compute the unitary mitigation capacity in terms of constant 2010 US$ per ton of carbon dioxide equivalent (tCO_{2e}) abated compared with the BAU scenario (counterfactual).

Unfortunately, countries do not use a common metric to estimate the emissions and financing pledges assessed in the National Communications and NDCs. Mechanisms to compare domestic efforts to mitigate global climate change are key for ex ante comparison of proposed pledges and ex post assessment of subsequent actions delivering on those pledges in the international climate policy architecture emerging from the Paris Agreement (Aldy et al. 2016). While data exist in the public domain for emissions levels, making the estimated levels universal, measurable and replicable, the assessment of emissions abatement and related costs is challenging (Aldy and Pizer 2015). Our methodology represents an objective method which allows changes at national level to be analysed and standardized, looking at comparison across countries more than at absolute values, with evident useful implications for policymaking. More in-depth analysis would require modelling tools and subjective choices to determine counterfactual and to model costs (e.g. see Markandya and Boyd 1999; Böttcher et al. 2011), which are outside the scope of this paper.

[8] Indeed, the various sectors are characterized by different levels of carbon intensity and economic performance, and the abatement cost may vary by sector. Thus, we cannot simply divide the total budget by the total emissions indicated as a mitigation target in the NDCs, and there is a need to introduce a weighting system. We use the value added for manufacturing, industry and services to weight the emissions reduction costs for the energy, IPPU and waste sectors, and the value added for agriculture, forestry and fishing for the AFOLU sector. The value added data are extracted from the World Bank national accounts dataset and Organisation for Economic Co-operation and Development National Accounts data files. The period chosen is 2015-2019 to be in line with the NDCs, and to ensure data consistency given data availability. While in principle using value added weights measured before 2015 would avoid NDCs already affecting the sectoral value added, it is plausible to expect that the investments/actions planned in the NDCs did not affect sectoral value added during the first years of implementation, being long-term development plans. Thus, even if a small bias is introduced, it will not affect the results discussed in this paper.

We build economy-wide and AFOLU-related MACCs – the former referring to all sectors indicated in the 2006 IPCC Guidelines, and the latter considering only the AFOLU sector (a sum of the agriculture and LULUCF sub-sectors).

3. Results and discussions

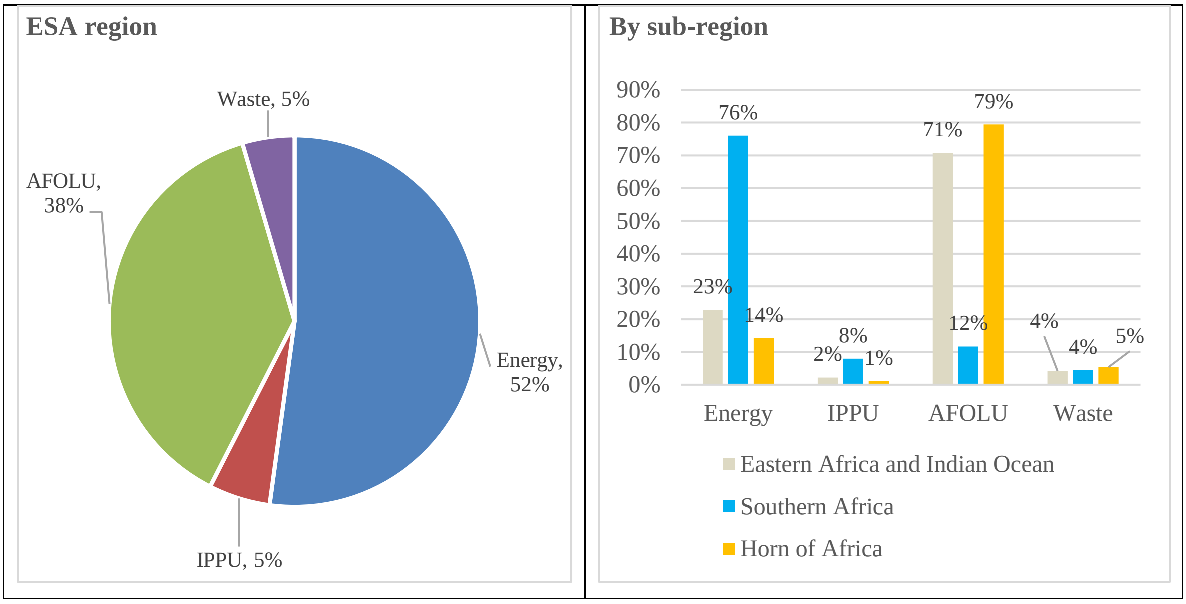
In this section, we: (i) summarize the results from the analysis of the National Communications (inventories) and FAOSTAT data describing the GHG emissions profile at regional and country levels; (ii) report the quantitative results of the analysis of the regional and national mitigation capacity which emerges from the NDCs and the relative budget under the conditional scenario; and (iii) present the planned measures and the country strategies, also with reference to the IFAD programme of work in the region.

3.1. The GHG emissions profile

Based on the latest figures reported in the GHG inventories available from the National Communications, the economy-wide level of net GHG emissions amounts to about 819 $MtCO_2e$/year for the reference period 1990-2015. Looking at the contribution from the different sectors (

Figure **1**), the energy sector represents the largest share of net emissions in the region (52 per cent), followed by the AFOLU sector (which also includes land use change) (38 per cent) and the waste and IPPU sectors (5 per cent each).

Figure 1. Net GHG emissions per sector, by region and sub-region



Source: Authors' own elaboration using data from the UNFCCC GHG Data Interface (1990-2015).

While the agriculture sector constitutes a source of annual net emissions (0.29 $GtCO_2e$), the LULUCF sector is almost neutral, with annual net emissions of only 0.02 $GtCO_2e$. Within the AFOLU sector, GHG emissions from agriculture and LULUCF have a similar weight (36 per cent and 32 per cent, respectively), as can be seen by examining the detailed contributions to GHG emissions reported in Table 3. The largest sources of emissions in the region are forest degradation, grassland biomass burning, enteric fermentation and non-CO_2 emissions from managed soils, cropland biomass and manure management. Negative values indicate removals, due to enhanced forest management and afforestation within the LULUCF category (FAO 2017).

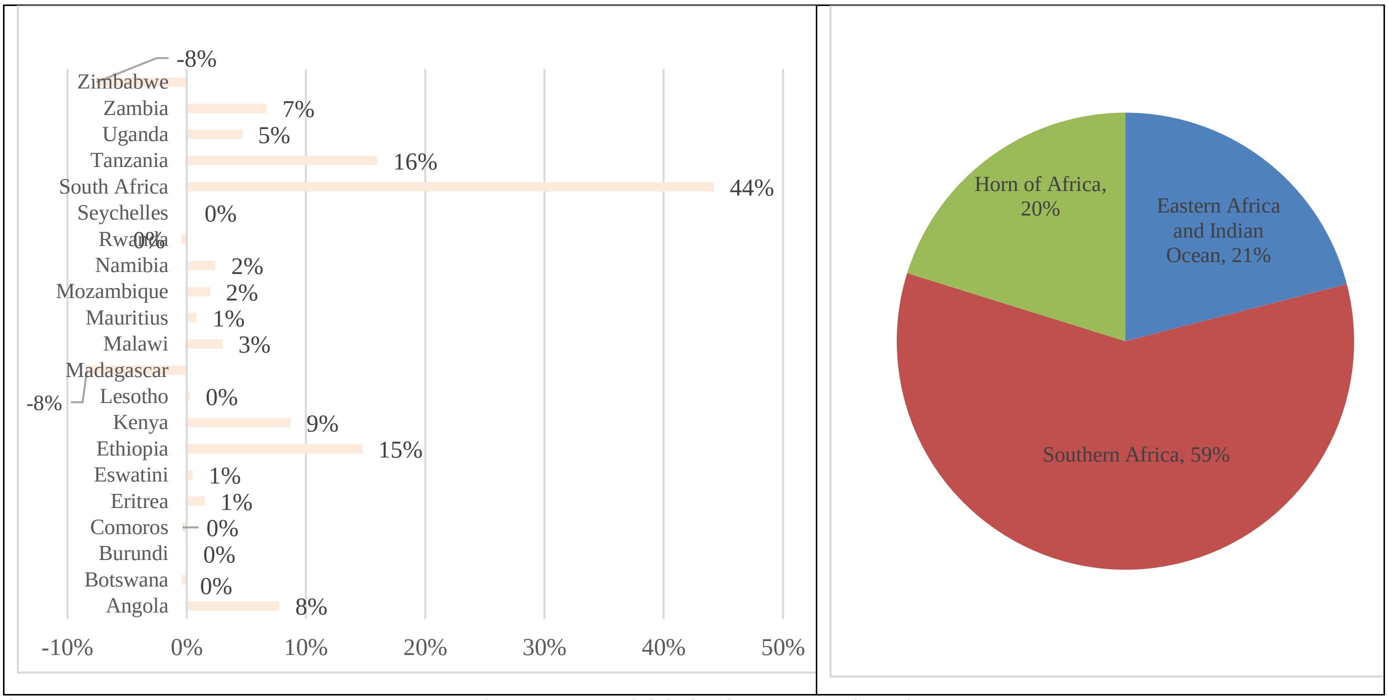
Table 3*.* Net annual GHG emissions per sector from ESA countries' national inventories ($MtCO_2e$/year)

Country	Energy	IPPU	Agriculture	LULUCF	Waste	Total
Angola	37.7	0.4	22.6	1.9	1.0	63.5
Botswana	6.9	0.5	16.4	-27.5	0.1	-3.5
Burundi	1.1	0.0	0.4	-1.3	0.2	0.4
Comoros	0.1	0.0	0.2	-3.2	0.0	-2.9
Eritrea	0.8	0.0	3.1	8.3	0.0	12.2
Eswatini	1.1	4.9	1.2	-3.3	0.3	4.3
Ethiopia	20.0	1.8	67.2	25.5	6.1	120.5
Kenya	16.3	2.2	29.6	21.2	1.9	71.1
Lesotho	1.1	0.0	2.2	-1.4	0.2	2.1
Madagascar	3.0	0.2	24.1	-96.2	0.5	-68.4
Malawi	3.7	0.1	3.2	17.5	0.1	24.6
Mauritius	4.9	0.8	0.0	-0.4	1.5	6.9
Mozambique	1.9	0.1	4.6	7.7	1.7	16.0
Namibia	2.2	0.0	6.7	10.6	0.2	19.7
Rwanda	1.7	0.1	2.9	-8.5	0.6	-3.8
Seychelles	0.3	0.0	0.0	-0.8	0.1	-0.5
South Africa	297.6	30.4	35.5	-18.6	16.4	361.2
Uganda	4.9	0.2	21.8	10.5	0.7	38.1
United Republic of Tanzania	6.9	0.4	29.7	91.4	2.2	130.6
Zambia	2.6	1.0	10.4	40.3	0.4	54.7
Zimbabwe	10.6	0.9	9.0	-83.0	0.6	-61.8
Total ESA	427.8	43.8	290.9	17.5	37.2	817.2
East Africa and Indian Ocean	39.1	3.8	108.8	12.6	7.2	171.4
Southern Africa	365.3	38.2	111.8	-55.7	21.1	480.7
Horn of Africa	23.4	1.8	70.3	60.6	8.9	165.0

Source: Authors' own elaboration using data from the UNFCCC GHG Data Interface (1990-2015).

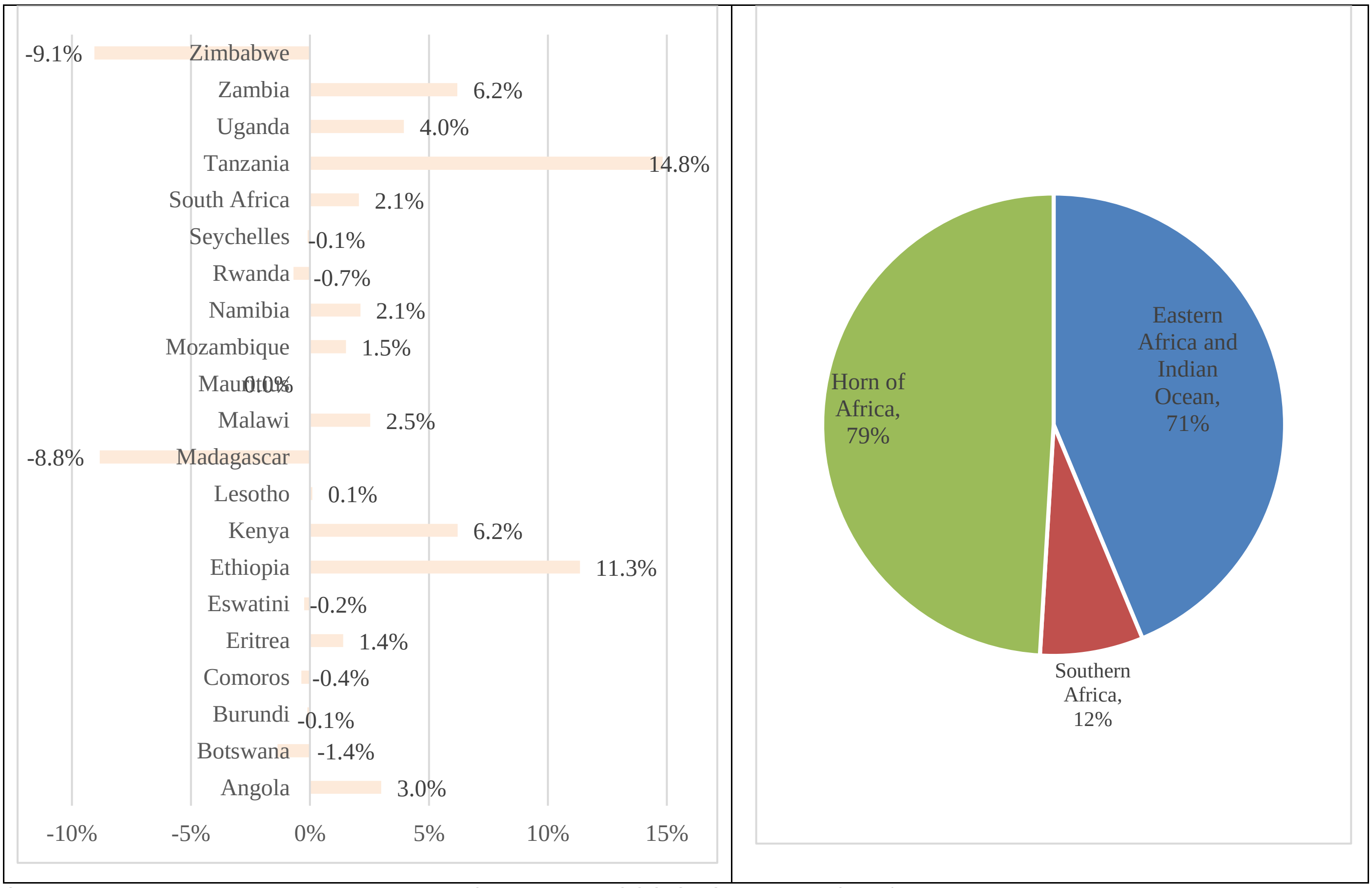
Countries' contributions to the ESA region's total (100 per cent) and AFOLU-related (38 per cent) net GHG emissions are shown in Figure 2 and **Error! Reference source not found.**, respectively. While for total emissions the sum of all countries' contribution is equal to 100 per cent, for the AFOLU emissions the sum of countries' emissions and removals amounts to 38 per cent – the total contribution of the AFOLU sector to regional emissions.

Figure 2. Contribution to economy-wide regional net GHG emissions, by country and sub-region (%)



Source: Authors' own elaboration using data from the UNFCCC GHG Data Interface (1990-2015).

Figure 3. Contribution to net regional GHG emissions from the AFOLU sector, by country and sub-region (%)



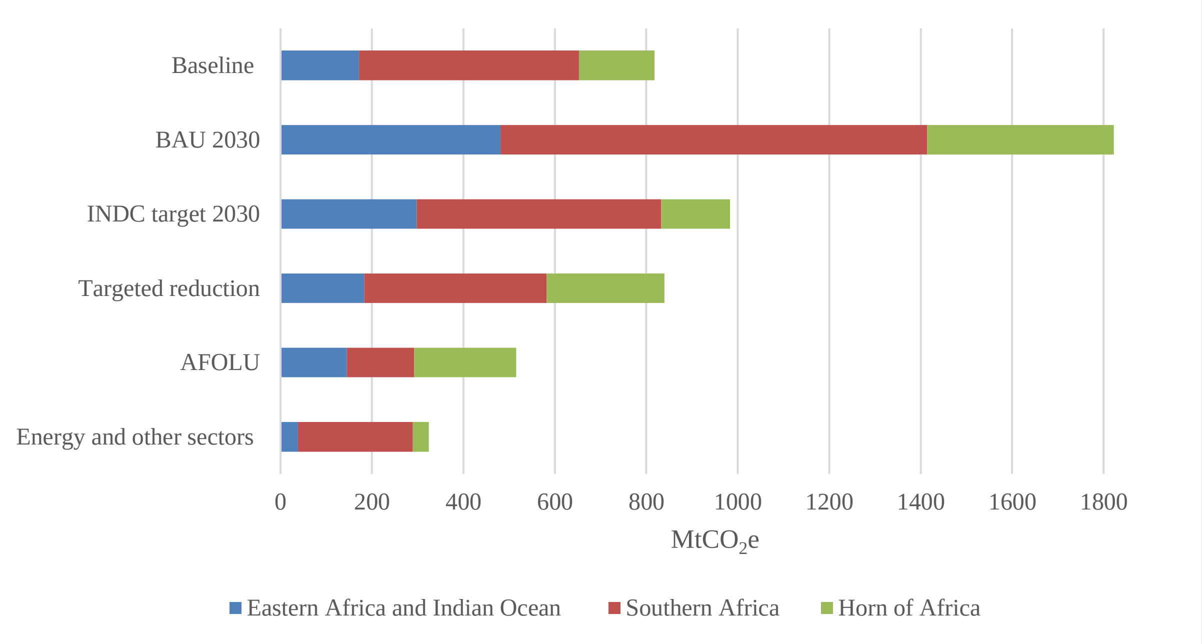
Source: Authors' own elaboration using data from the UNFCCC GHG Data Interface (1990-2015).

3.2. NDC mitigation targets: an economic perspective

We look now at the mitigation capacity of the ESA region (by region and country) which emerges from the analysis of the countries' NDCs, with specific attention to the economic implications. We also make both economy-wide and sectoral-level considerations, with the goal to compare the AFOLU aggregate with that for energy, IPPU and waste.

Error! Reference source not found. presents a picture of the baseline GHG emissions, the p rojected "BAU 2030" scenario, the overall mitigation targets computed as a sum of the national mitigation targets derived from the NDCs, and the target GHG reduction. The figure also reports information by regional hub (East Africa and Indian Ocean, Southern Africa and Horn of Africa) and by sector (AFOLU, energy and other sectors).

Figure 4. GHG emissions and mitigation targets, by region and sub-region



Source: Authors' own elaborations using data from the UNFCCC GHG Data Interface (1990-2015).

Of the 22 countries in the ESA region, 21 communicated their ambition to reduce net GHG emissions in their mitigation contributions through the NDCs (**Error! Reference source not f ound.** and **Error! Reference source not found.**). The baseline year indicated in the NDCs ranges between 2005 and 2020. At the aggregate level, economy-wide net emissions in the ESA region reported in the NDCs are expected to increase by 123 per cent between the baseline (2005-2020) and 2030 (from 818 $MtCO_2e$ to 1,823 $MtCO_2e$). Full implementation of both conditional and unconditional mitigation targets set forth in the NDCs would limit the increase in regional net emissions to about 20 per cent above the baseline – equivalent to a cumulative net emissions reduction of about 840 $MtCO_2e$ in 2030.[9] Ethiopia and South Africa have indicated the largest share of the expected reduction in net emissions in the region (**Error! Reference source n ot found.Error! Reference source not found.**).

[9] Note that not all NDCs include economy-wide GHG baseline and mitigation targets. In such cases, we have used information available from the National Communications instead.

Table 4. Unconditional and conditional 2030 targets

Country	Unconditional target	Conditional target
Angola	35% below BAU	Additional 15% is conditional
Botswana	15% below 2010 levels	
Burundi	3% below BAU	Additional 17% is conditional
Comoros	84% below BAU	
Eritrea	39.2% unconditionally below BAU	Additional 41.6% is conditional
Eswatini (Swaziland)		NDC sets out several sectoral measures
Ethiopia		64% below BAU
Kenya		30% below BAU
Lesotho	10% below BAU	Additional 25% is conditional
Madagascar		14% below BAU
Malawi	NDC sets out several sectoral measures	NDC sets out several sectoral measures
Mauritius		30% below BAU
Mozambique		Reduction of 67.5 $MTCO_2e$
Namibia	79% below BAU	Additional 10% is conditional
Rwanda		NDC sets out several sectoral measures
Seychelles		29% below BAU
South Africa	Emissions limited to 614 $MtCO_2e$	
Uganda		22% below BAU
United Republic of Tanzania		10-20% below BAU
Zambia	25% below BAU	Additional 22% is conditional
Zimbabwe		33% below BAU

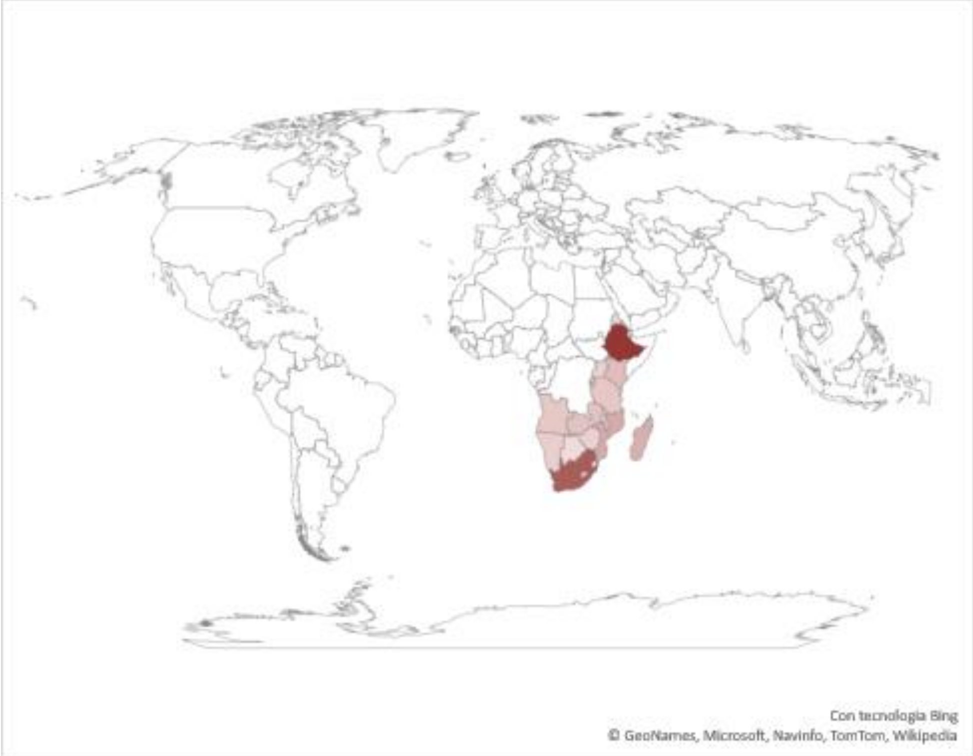
Source: Authors' own elaboration using data from countries' NDCs.

Table 5. Economy-wide net GHG emissions: baseline, BAU 2030 and mitigation targets, by country, region and sub-region

Country	Base year	Baseline	BAU 2030	INDC target 2030	Target reduction	Target yearly reduction	Energy and other sectors	AFOLU
		$MtCO_2e$/year				$MtCO_2e$/year	$MtCO_2e$/year	
Angola	2005	64	193	161	32	1.27	20	12
Botswana	2010	-4	8	7	1	0.06	0	1
Burundi	2005	0	75	60	15	0.60	11	3
Comoros	2015	-3	1	0	0	0.03	0	0
Eritrea	2010	12	8	5	3	0.16	0	3
Eswatini (Swaziland)	2010	4	5	4	1	0.05	1	0
Ethiopia	2010	121	400	145	255	12.75	35	220
Kenya	2010	71	143	97	46	2.29	13	33
Lesotho	2015	2	6	4	2	0.13	1	1
Madagascar	2010	-68	22	-45	68	1.81	4	64
Malawi	2015	25	42	27	15	1.00	3	12
Mauritius	2015	7	7	5	2	0.14	2	0
Mozambique	2020	16	19	-57	77	7.65	17	59
Namibia	2010	20	23	3	20	1.13	2	19
Rwanda	2015	-3	4	-1	5	0.31	2	2
Seychelles	2020	0	0	0	0	0.02	0	0
South Africa	2020	361	810	614	196	21.60	196	0
Uganda	2015	38	77	60	17	1.13	3	14
United Republic of Tanzania	2015	131	153	122	31	2.04	2	28
Zambia	2010	55	80	42	38	1.90	3	35
Zimbabwe	2020	-62	-57	-74	17	1.73	10	7
Total ESA		818	1823	983	840	56	325	515
East Africa and Indian Ocean		172	481	298	183	8.36	38	145
Southern Africa		481	933	535	399	36.53	252	147
Horn of Africa		165	408	150	258	12.91	35	223

Source: Authors' own elaboration using data from countries' NDCs.

Figure 5. ESA region's contribution to NDC 2030 mitigation targets (%)



Ethiopia	30.675%
South Africa	25.984%
Mozambique	9.203%
Kenya	5.505%
Zambia	4.571%
Madagascar	4.346%
Angola	3.820%
United Republic of Tanzania	3.681%
Namibia	2.724%
Zimbabwe	2.083%
Uganda	2.046%
Malawi	1.804%
Burundi	1.792%
Rwanda	0.553%
Eritrea	0.379%
Mauritius	0.253%
Lesotho	0.241%
Botswana	0.150%
Eswatini	0.113%
Comoros	0.053%
Seychelles	0.023%

Authors' own elaboration using data from countries' NDCs.

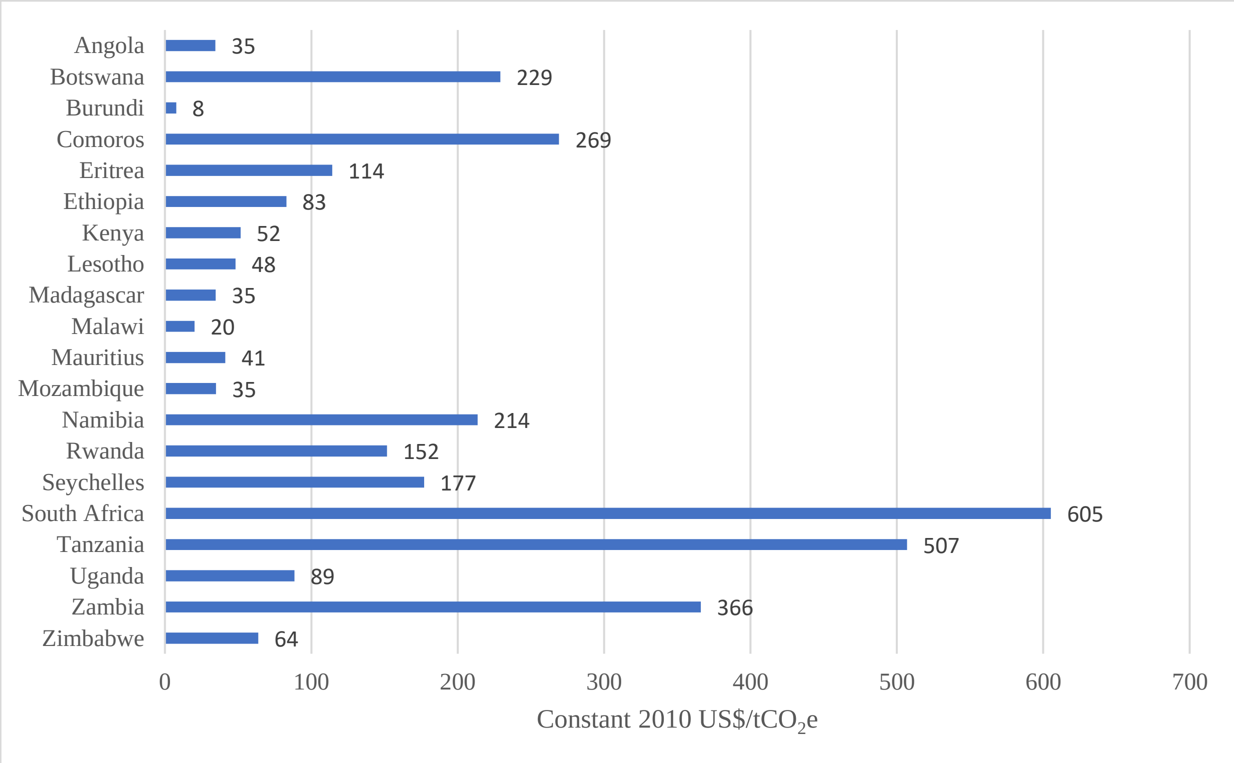
In the NDCs, countries also indicate the sectors potentially contributing to the mitigation targets reported, either by reducing emissions or by increasing carbon sinks. We observe that: (i) all countries explicitly identify the energy sector as a major mitigation source and list a wide range of measures, from hydropower to renewable energy, energy-efficient technologies and electric engines; (ii) 71 per cent of countries have identified a wide range of measures for both the agriculture and LULUCF sectors, such as climate-smart crop and livestock management, agroforestry, reduction in biomass burning and wildfires, soil and water conservation, afforestation/reforestation/improved forest management and improved wetland management; (iii) 67 per cent of countries have committed to invest in mitigation measures in the waste sector; and (iv) 43 per cent of countries have listed mitigation measures in the IPPU sector. A summary of such measures by country can be found in annex 1.

In preparing a strategy to exploit the regional and national mitigation capacity emerging from the NDCs, the first option is to guide the investments using a carbon-effectiveness criterion, prioritizing the results in terms of total mitigation targets. However, since here we look at the conditional targets, which would require a financing contribution from the international community, there is a need to optimize the use of funds and introduce a value-for-money criterion. Thus, we introduce cost-effectiveness of the proposed mitigation contributions, prioritizing the results in terms of MACs. While carbon-effectiveness considers the overall mitigation target, cost-effectiveness refers to reaching goals cost-effectively, therefore gaining social efficiency.

Thus, we estimate the GHG abatement cost by country by looking at the proposed budget reported in the NDCs[10] and computing the unit cost of abatement. The economy-wide national abatement costs resulting from this procedure are shown in Figure 6.

[10] The total budget is available for 20 countries.

Figure 6. Economy-wide GHG abatement costs, by country (constant 2010 US$/t$CO_2$e)[11]



Source: Authors' own elaboration.

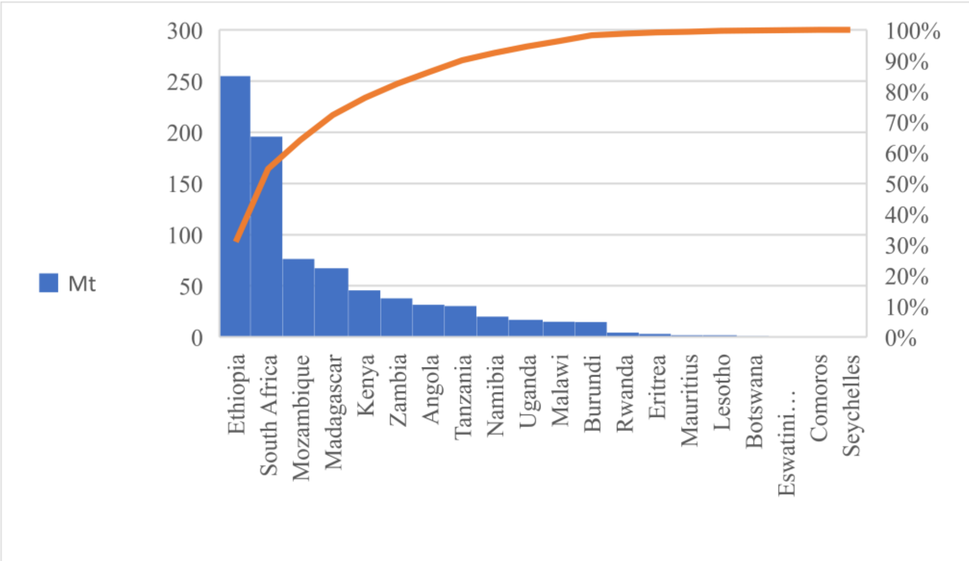
Prioritization of the investments to exploit countries' mitigation capacity can be based on both decision criteria, but with different outcomes, as shown in

[11] The data for Eswatini and South Sudan are not available.

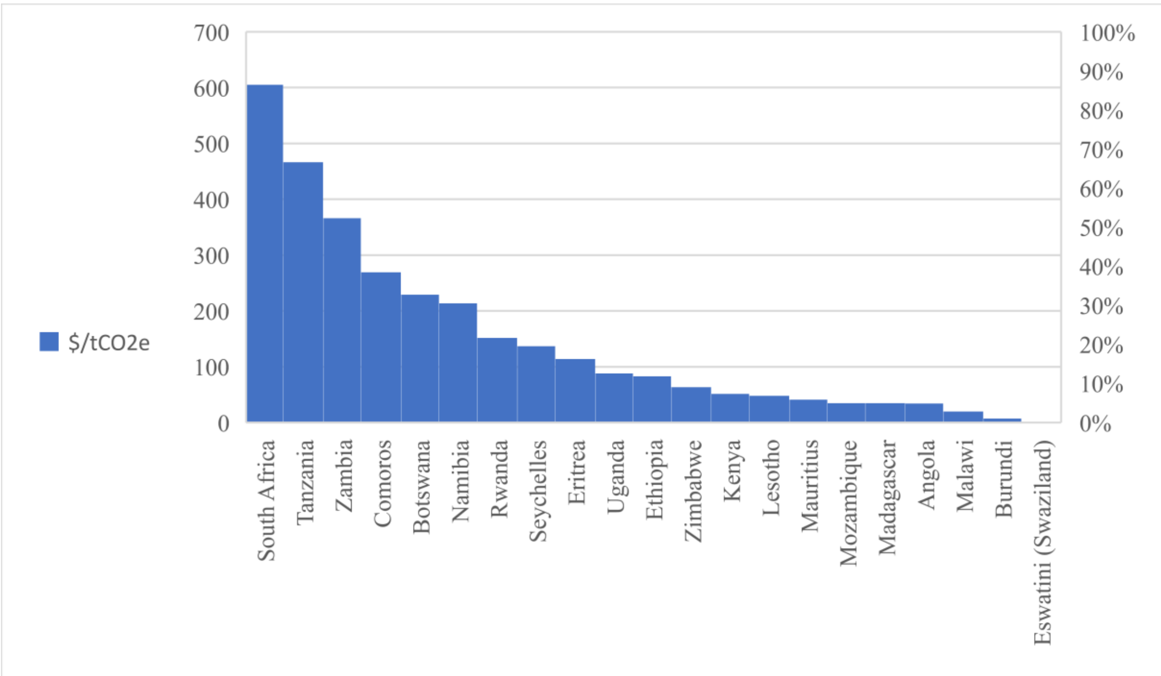
Figure **7Error! Reference source not found.**. By adopting the carbon-effectiveness criterion, it may be more effective to prioritize countries with the highest intended mitigation programmes (e.g. Ethiopia, South Africa). On the other hand, by choosing the cost-effectiveness criterion, it may be more effective to prioritize countries where the MAC is relatively lower (e.g. Malawi, Angola, Madagascar). **Error! Reference source not found.** shows a comparison of the results obtained u nder the different criteria. The figure relates the annual mitigation capacity (carbon-effectiveness) to the unitary abatement costs (cost-effectiveness). The annual abatement capacity controls for the different timeframes of the NDCs. The size of the bubbles reflects the total carbon savings. Among countries with higher total mitigation capacity (e.g. South Africa, Uganda, Ethiopia, Mozambique, Kenya), this would result in prioritizing countries with lower abatement costs (e.g. Ethiopia, Mozambique, Kenya). Also, priority should perhaps be given to countries which show higher annual mitigation capacity (e.g. Uganda, Ethiopia, Mozambique), as this may lead to faster accumulation of the expected mitigation benefits, again with advantages for the whole society. Countries with high mitigation capacity but high mitigation costs (e.g. the United Republic of Tanzania, Zambia) should probably be supported with development plans to improve production systems, introduce climate-smart technologies and improve overall sectoral economic efficiency.

Figure 7. Economy-wide carbon-effectiveness and cost-effectiveness, by country

a) Carbon-effectiveness (GHG reduction, Mt)

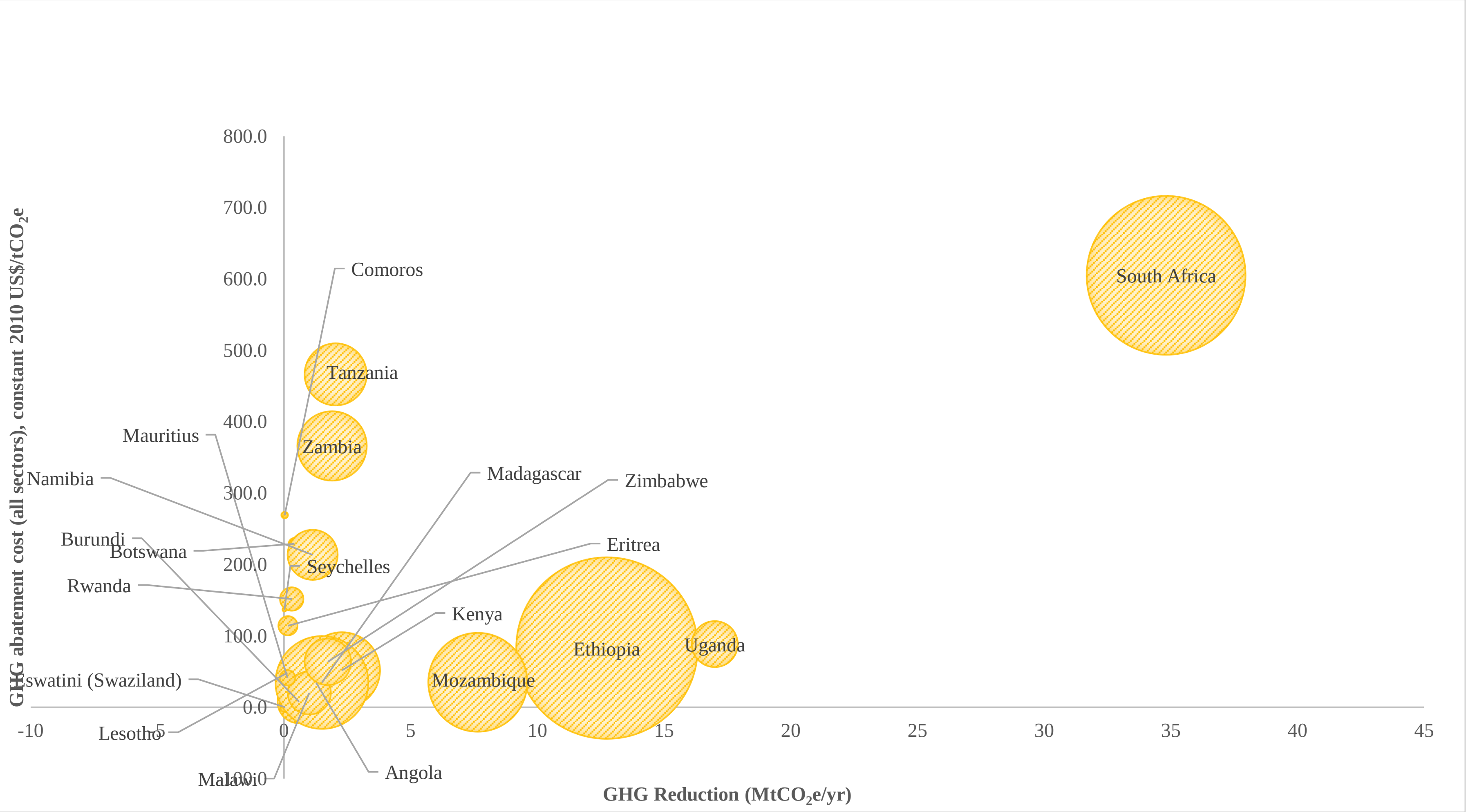


b) Cost-effectiveness (GHG abatement cost, US$/t$CO_{2e}$)



Source: Authors' own elaboration.

Figure 8. Distribution of countries' mitigation opportunities according to cost- and carbon-effectiveness



Source: Authors' own elaboration.

Note: The size of the "bubble" reflects total carbon savings.

A convenient way to visualize both criteria in the same picture is represented by the MACCs. Figure 9 reports the economy-wide MACCs for the countries in the ESA region. Each bar represents a specific country (and the mitigation commitments in its NDC). The height displays the on-country unit mitigation cost (on the y axis) and is expressed in constant 2010 US$/t$CO_2$e. The width represents the mitigation capacity – i.e. what the countries declared they would be willing to mitigate (on the x axis) – and is expressed in tCO_2e. The area displays the on-country total abatement cost (in constant 2010 US$). Since countries are ordered by increasing the MAC and volume of CO_2e abated, moving along the curve from left to right worsens the mitigation profitability of mitigation plans, as each ton of CO_2e mitigated becomes more costly. This indicates the country mitigation plans that should progressively be implemented to seek cost-effective climate change mitigation.

Prioritizing mitigation interventions in countries with lower abatement costs will save society's limited resources. Therefore, once the mitigation policy target is specified (i.e. the quantity of CO_2e to be abated) based on "technical" or political considerations, it would be possible to make the policy more cost-effective if such targets were systematically allocated among the countries which show the lowest abatement cost.[12] The figure allows countries with relatively lower abatement costs (e.g. Malawi, Madagascar, Mozambique, Kenya, Ethiopia, Burundi, Angola, Mauritius, Lesotho, Zimbabwe, Uganda) and those with relatively higher costs (e.g. Seychelles, Eritrea, Rwanda, Comoros, Botswana, Namibia, Zambia, the United Republic of Tanzania, South Africa) to be identified. The figure also provides guidance for selecting, within those groups, the countries with the highest mitigation capacity (e.g. Malawi, Madagascar, Mozambique, Kenya, Ethiopia, Zambia, the United Republic of Tanzania, South Africa).

Given that we are interested in investment opportunities in the agriculture and LULUCF sectors, we have specifically analysed the mitigation capacity of the AFOLU aggregate, which figures prominently in the region's commitments to a low-emissions development pathway. Its mitigation capacity is about 60 per cent (the remaining 40 per cent is from energy, IPPU and waste sectors). Such figures are only an approximation: we have estimated such mitigation capacity starting from the NDC targets. Unfortunately, only a few countries (Comoros, Ethiopia, Namibia and Rwanda) report reduction targets by sector; for the other countries, we have assumed that the expected AFOLU contribution to the economy-wide mitigation is proportional to the percentage contribution of the various sectors to the national level of net emissions, as reported in the GHG emissions inventory. We have used such percentage contributions as weights to estimate both the mitigation targets and the associated financial budget required under the conditional scenario. We are aware that this procedure assumes that the overall structure of the economy will remain unchanged, with respect to the baseline, in the timeframe of the current analysis. Also, some measures such as the use of renewable energy or ethanol production are often included in the energy sector-related options, even if they are clearly linked to the agriculture sector. The AFOLU mitigation capacity reported here is therefore underestimated. The detailed figures of the mitigation capacity for the two aggregates (AFOLU and energy, IPPU and waste), at both regional and national levels, can be found in **Error! Reference source not found.**. We compare the abatement costs of the two a ggregates in Table 6. It is evident that the costs are very different. The overall consideration is that the abatement costs in the AFOLU sector are lower than those in the energy, IPPU and waste sectors. This is due to the type of investments foreseen under the different sectoral plans described in the NDCs, since most infrastructure would be built to reduce emissions related to energy (see annex 1). This may have important implications in terms of mitigation strategies.

[12] Indeed, an approach for finding the lowest-cost means of accomplishing the policy objective is introduced. Nevertheless, according to neoclassical environmental economics theory, the least-cost means of achieving the environmental target will have been reached when the marginal costs of all possible means of achieving the target are equal. This is often known as the "Second Equimarginal Principle" or the "Cost-Effectiveness Equimarginal Principle" (Lewis and Tietenberg 2019). In our case, the MAC is different across countries. Therefore, the mitigation policy solution suggested by the adoption of the MAC approach is not the least-cost one, even though it would allow the policy target to be reached at the lowest possible cost, given the circumstances.

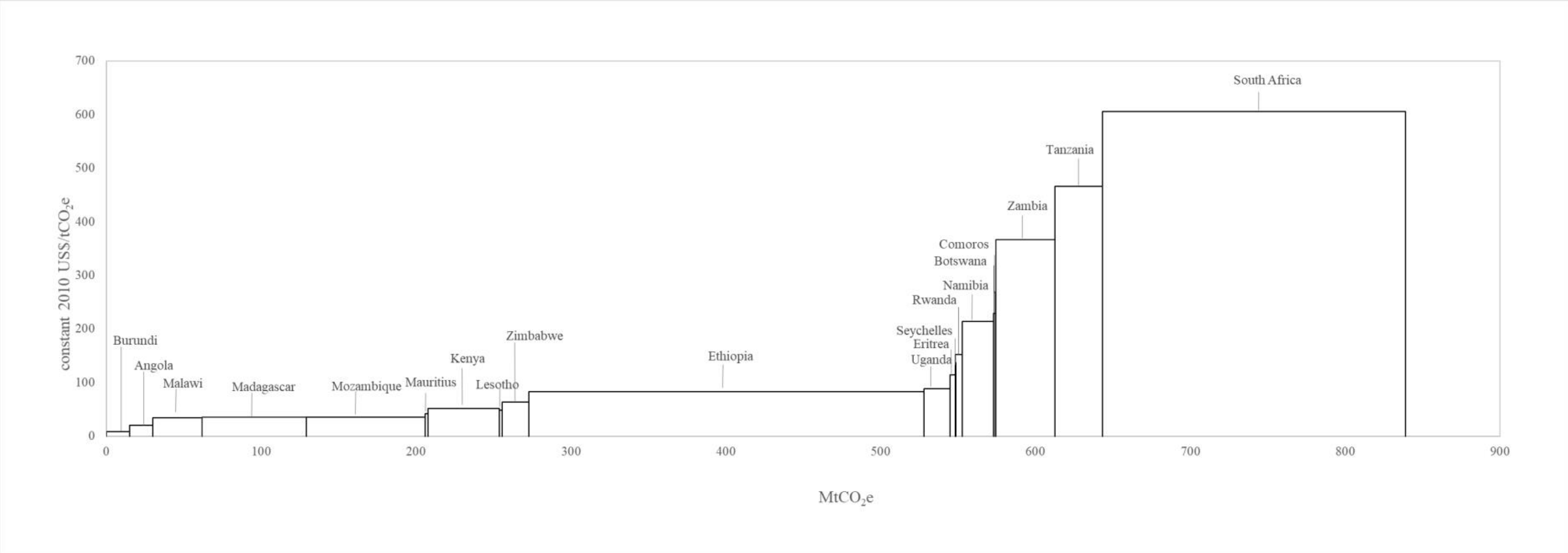
From the pure standpoint of economic efficiency it would be more cost-effective to first exploit the mitigation capacity of the AFOLU sector (about 515 Mt, corresponding to about 60 per cent of the regional mitigation capacity) and then to finance the (more costly) mitigation options in the remaining sectors of the economy. For example, mitigating a ton of carbon through investments in cropland reforestation would be more efficient than mitigating the same amount through a renewable energy project. This would enhance the efficiency of the overall mitigation programme. Of course, this is true without any consideration of the social equity and development trade-offs (including the opportunity costs of the foregone alternative), as well as the implementation and risk issues, which are not an object of this analysis. The resulting inputs to the strategic orientation of the potential mitigation investment plan are summarized by the MACC developed with reference only to the AFOLU sector and reported in Figure 10.

Table 6. Abatement costs, by country and sector (constant 2010 US$/tCO2e)

Country	Energy and other sectors	AFOLU
Angola	31.3	3.7
Botswana	229.7	1.9
Burundi	3.8	6.8
Comoros	540.8	33.2
Eritrea	0.0	2.6
Eswatini (Swaziland)	-	-
Ethiopia	133.8	5.1
Kenya	53.6	6.0
Lesotho	47.7	1.1
Madagascar	130.7	2.7
Malawi	28.5	2.2
Mauritius	25.6	117.0
Mozambique	42.0	3.6
Namibia	319.5	1.5
Rwanda	120.5	31.1
Seychelles	129.7	72.5
South Africa	579.7	0.0
South Sudan	-	-
Uganda	141.7	7.9
United Republic of Tanzania	1 294.2	28.1

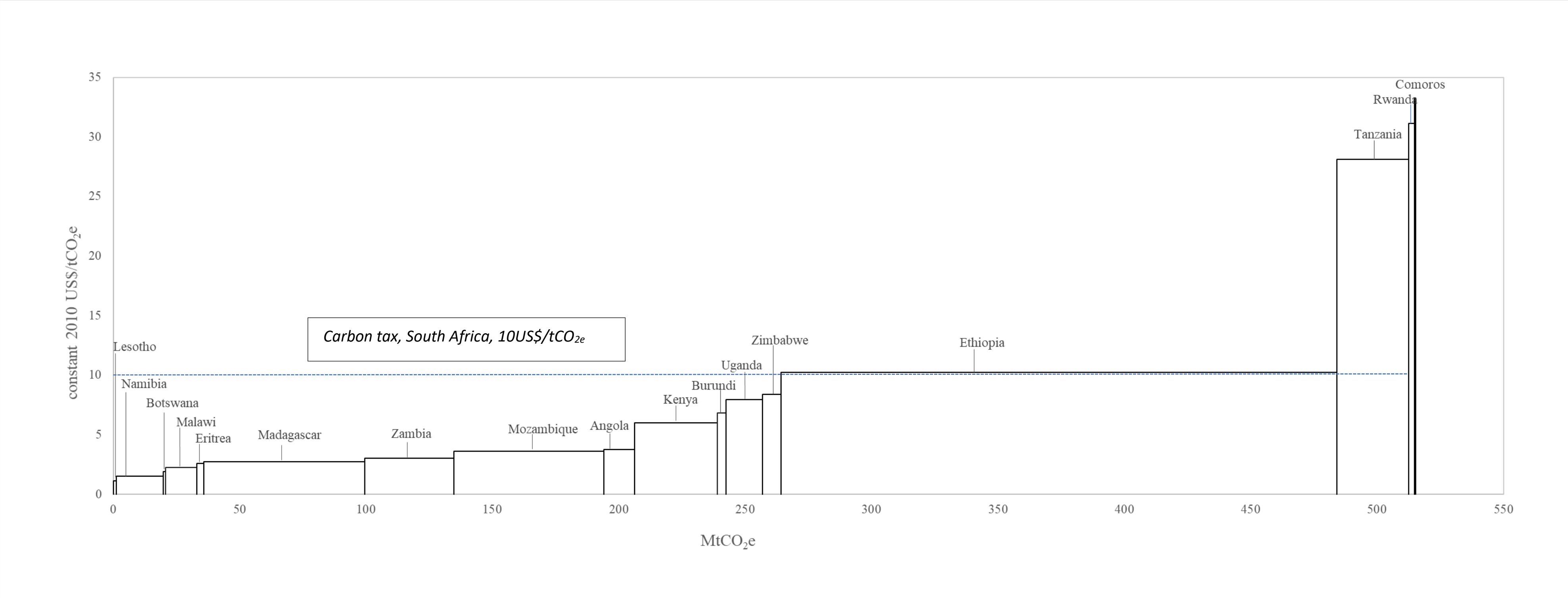
Source: Authors' own elaboration

Figure 9. Economy-wide marginal abatement cost curve for the ESA region



Source: Authors' own elaboration.

Figure 10. Marginal abatement cost curve for the AFOLU sector for the ESA region



Source: Authors' own elaboration.

By comparing the MAC with the carbon price on the existing carbon markets, it is possible to assess the profitability of investing in mitigation opportunities. In 2021, prices on the voluntary carbon market reached an annual global weighted average price of US$4/t$CO_2$e, but with many variations among sectors. Interestingly, the highest values are recorded for the AFOLU sector: US$5.40/t$CO_2$e for forestry and land use, and US$10.38/t$CO_2$e for agriculture (Forest Trends' Ecosystem Marketplace 2022).

Even if it is estimated that carbon prices of at least US$50–100/t$CO_2$e are required by 2030 to cost-effectively reduce emissions in line with the temperature goals of the Paris Agreement (CPLC 2017), and that less than 4 per cent of global emissions are currently covered by a direct carbon price in that range (World Bank 2022), carbon transactions and prices jumped after the COP 26 in Glasgow. For example, in 2021, the largest carbon market by traded value, the European Union Emissions Trading System (ETS), saw record trading activity and prices in both spot and futures markets (World Bank 2022). Also, in the same year, prices on the voluntary carbon market climbed by nearly 60 per cent over 2020. Credits from Africa represented 15 per cent of the total, with prices also increasing from US$4.24/tCO2e in 2020 to US$6.09/tCO_2e in 2021 (Forest Trends' Ecosystem Marketplace 2022).

However, in the ESA region, only South Africa applies a tax on carbon of US$10/t$CO_2$e (World Bank 2022), which is chosen as a proxy for the carbon market in the region. AFOLU abatement costs fall below this price in many countries, indicating the financial gain in investing in mitigation through the AFOLU sector in such countries. Indeed, the imposition of a carbon tax introduces an element of economic efficiency in the management of mitigation targets. The stakeholders are pushed to adopt innovative cost-saving technologies to increase abatement levels and avoid tax payments. The desired least-cost solution to achieve the mitigation target corresponds to an MAC equal to the tax level among all the countries. Besides, the Government of South Africa has recently announced a proposal to increase the carbon tax rate to US$30/tCO2e by 2030 (World Bank 2022), therefore enhancing the economic convenience of investing in carbon-related projects.

It is also possible to categorize countries based on the different abatement costs using the concepts of "economy of scope", which focuses on the average abatement cost, and "economy of scale", which focuses on the cost advantage that arises when there is a higher level of mitigation capacity. For example, countries to be prioritized according to the "economy of scope" approach in the AFOLU sector would include Lesotho, Namibia, Botswana, Malawi and Eritrea, given the relatively low abatement cost level. Under such an approach, prioritized interventions could be used to enhance country readiness. Following the "economy of scale" approach in the AFOLU sector would prioritize Madagascar, Mozambique, Kenya and Ethiopia, given the relatively high mitigation capacity.

Mitigation options within the AFOLU sector may vary, including sustainable soil and improved cropland management, improving livestock and grazing management, agroforestry conversion and expansion, avoided deforestation/forest conservation, afforestation, sustainable forest management and rewetting of organic soils. Due to data constraints, we cannot compute the abatement costs at this level of detail. The sectoral costs are derived using a top-down approach, as already described in the methodology section. Some information might be available in the literature at global (e.g. see McKinsey & Company 2020), regional (e.g. see FAO 2017 for Eastern Africa) or national (e.g. see Branca et al. 2020 for Malawi and Zambia) level.

In estimating the cost-effectiveness of the mitigation options, the abatement costs are computed in constant 2010 US$, and the comparison is therefore meaningful. However, countries in the region have different levels of economic development, as indicated by different GDP values. We have therefore reported the GHG abatement costs by GDP level, having divided the countries into two groups of below and above 1,000 constant 2010 US$ per capita and year, as shown in

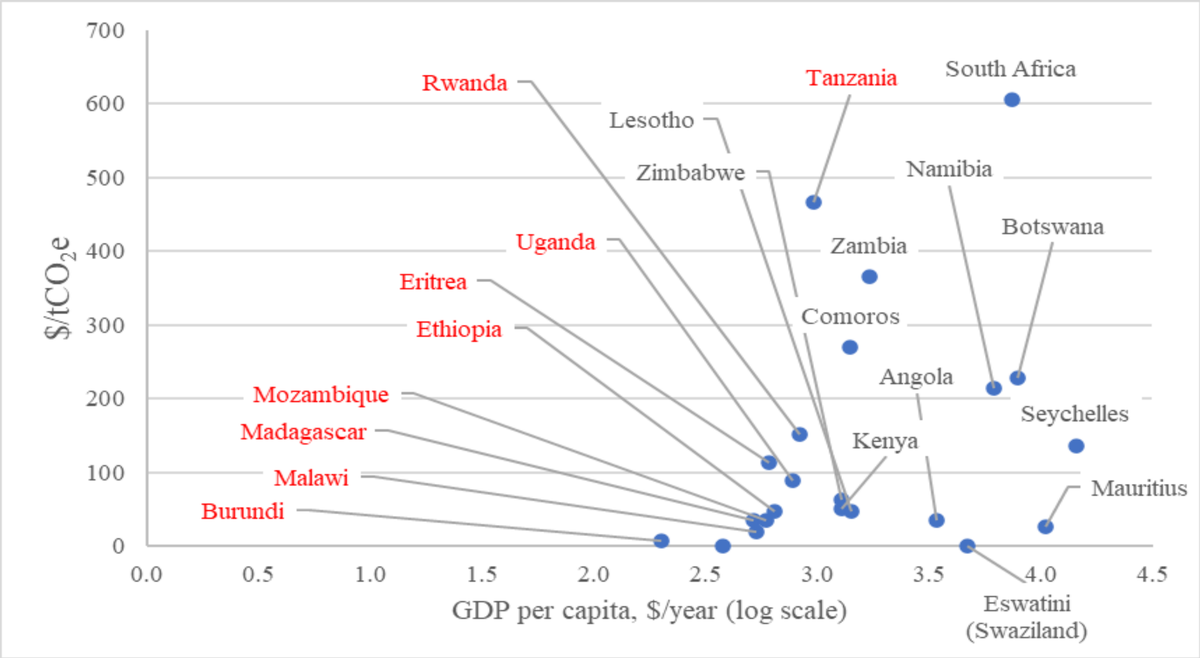
Figure **11**. By comparing countries with a similar GDP level, it is possible to say, for example, that the economy-wide abatement costs in Malawi, Mozambique and Madagascar are similar, and lower than those in the United Republic of Tanzania, or that the costs in Rwanda and Zambia are lower than those in Uganda.

Including GDP level in the analysis provides additional insights into the problem of the trade-off between carbon- and cost-effectiveness, extending it to the broader trade-off between mitigation and economic development. Indeed, while several mitigation alternatives deliver food security and income benefits as positive externalities, showing synergies between mitigation and economic development (e.g. minimum tillage, intercropping cereal with legumes), it is also true that some other options may result in trade-offs (even if only temporary). For example, reforesting croplands would have trade-offs with food security and generate opportunity costs in terms of foregone food production; conservation agriculture may bring about a decline in crop yields and food production during the first years of implementation and create an opportunity cost in the form of foregone farmers' income. Such trade-offs may limit the adoption of the mitigation practices and technologies, with negative implications for countries' capacity to achieve the mitigation targets set in the NDCs. However, since mitigation budgets reported in the NDCs only account for the direct costs to implement mitigation projects/activities, the abatement costs quantified here also include the same cost categories. Therefore, the costs associated with the trade-offs are not included in the present analysis, and this may limit its results.

In international climate policy (e.g. the Kyoto Protocol) and theory (e.g. the hypothesized Kuznets curve; see Azomahou et al. 2006), the assumption is often evident that climate change mitigation can only be afforded at a certain level of income. This suggests that, under BAU conditions, low- and middle-income countries will need to reach a tipping point at which low-carbon investment becomes affordable. Indeed, even if most of the mitigation commitments in the region are conditional on transfers of international funds and technologies, the private sector in the receiving country needs to play an increasingly important role to fill the funding gap (UNECA 2020).

This is confirmed by looking at Figure 12, in which GHG emissions per capita are plotted against GDP per capita. The size of the "bubbles" shows total abatement costs as a share of GDP, indicating the economic burden of the planned mitigation measures on the national economy (or, potentially, the economic benefits – for example, in the case of a country with an emissions reduction commitment implementing an emissions reduction project in a developing country through the Clean Development Mechanism). Countries with relatively low GDP per capita have in general a much lower level of emissions and relatively higher abatement costs, indicating the importance of international finance (in the conditional NDC scenario) to afford the costs for mitigation. Indeed, countries with high emissions and low GDP per capita show large differences from the conditional NDC scenario. Countries with high GDP show relatively small differences between the conditional NDC scenario and the unconditional one (see also Hof et al. 2017). Supporting the mitigation plan of low-income countries could be a priority to solve the trade-off between mitigation and economic development, decoupling economic output from carbon emissions also in the frame of fighting against poverty and food insecurity. In this context, there would be a need to identify a wide range of opportunities that are cost-effective on their own, also in low- and middle-income countries. Assuming that these can be deployed in a socially and environmentally responsible way, public authorities could reasonably be expected to invest in these measures purely on economic grounds, and this would coincidentally deliver real reductions in per capita emissions. Green strategies would represent a significant opportunity in this respect, as discussed in the following section.

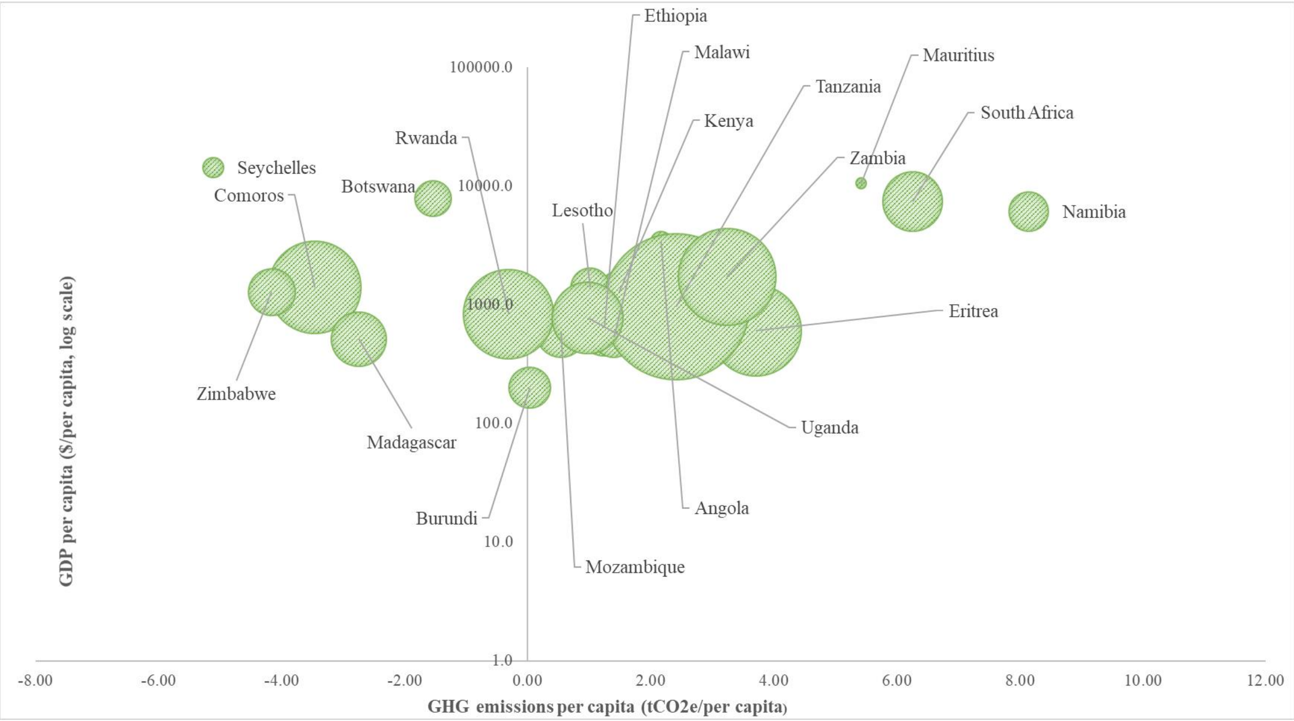
Figure 11. Economy-wide abatement cost, by GDP (2010 US$ per capita/year, log scale)



Source: Authors' own elaboration.

Note: Low- to middle-income countries (<US$1,000 per capita per year) are reported in red; middle- to high-income countries (>US$1,000 per capita per year) are indicated in black.

Figure 12. Net GHG emissions per capita plotted against GDP per capita (log scale)



Source: Authors' own elaboration.

Note: The size of the "bubbles" indicates abatement costs as a share of GDP.

3.3. Mitigation investment strategies

In this section we report the results of the analysis of the mitigation actions in the ESA countries' NDCs. We also compare such actions with the IFAD strategies as they emerge from the COSOPs and, when available, with national green growth strategies.

The NDCs are rooted in a variety of existing or in-progress plans, policies or programmes, including national development plans, climate change response policies, low-carbon development strategies, National Adaption Programmes of Action, National Climate Change Action Plans and Nationally Appropriate Mitigation Actions. Mitigation efforts focus mainly on the AFOLU and energy sectors.

The list of priority mitigation actions indicated in the NDCs analysed is summarized in annex 1. We consider only the priority measures – i.e. those contributing to the "conditional" mitigation NDC target and for which a budget is estimated. We exclude those indicated as measures with "additional" mitigation capacity. We report them by sectoral aggregate (AFOLU and energy, IPPU and waste), in line with the economic analysis conducted above. We specifically look at the eight priority areas most relevant to IFAD: agriculture; biodiversity, ecosystem conservation and restoration; renewable energy; fisheries; food security and resilience; LULUCF; social inclusion; and water and irrigation.

We find that most relevant intervention areas, in terms of number of proposed measures, relate to: (i) energy; (ii) LULUCF; and (iii) agriculture.

(i) Energy-related measures have to do with the enhancement of hydroelectric power and other renewable sources, energy efficiency, and reduced emissions from transport. As access to reliable electricity is a development priority for many countries, the energy sector is often predicted to be the sector with the greatest increase in emissions. Thus, expanded use of renewable energy is a common mitigation action.

(ii) Given the widespread deforestation and reliance on fuelwood in ESA countries, the LULUCF sector is often the largest GHG emitter. LULUCF mitigation options have a relevant mitigation capacity. They include all forest-related mitigation activities with a special focus on policies and actions under the Reducing Emissions from Deforestation and Forest Degradation (REDD+) programme,[13] mainly reduced forest degradation and deforestation on the emissions side, and improved forest management and afforestation/reforestation on the carbon sink side. However, the realization of such capacity is often constrained by economic and land use factors (UNEP 2015). Also, for developing countries to access results-based finance for REDD+, they need to have in place a national strategy or action plan, a national forest monitoring system, a safeguards information system and a summary of information on how the REDD+ safeguards have been addressed and respected, a forest reference emissions level and fully measured, reported and verified results in terms of emissions reductions/enhanced removals (UNEP 2015).[14] Needs include capacity-building, technology transfer, and assistance in inventory development (see ICF 2016).

(iii) GHG hotspots for emissions reduction in the agriculture sector are grassland biomass burning, enteric fermentation and poorly managed agricultural soils. Several countries refer to improved crop management to reduce their GHG emissions, mainly by

[13] REDD+ includes reducing GHG emissions from deforestation and forest degradation, conservation of forest carbon stocks, sustainable management of forests and enhancement of forest carbon stocks.
[14] These requirements place some constraints on the potential for REDD+ implementation in the short term – for example, the speed at which policies can be put in place and governance improvements can be implemented. The availability of finance, whether domestic or international, to cover the upfront costs of REDD+ measures will also be a determining factor. Results-based finance, by its nature, will be released only after success has been achieved. Many developing countries have expressed their interest in large-scale forest-related actions, in both their NDCs and a range of other statements (UNEP 2015).

addressing soil management on cropland, fertilizer use and rice cultivation. For instance, Ethiopia commits to improving crop production practices for greater food security and higher farmer incomes, while reducing agricultural emissions. Many countries also foresee policies and measures aiming to increase energy production from agricultural biomass, with potential mitigation co-benefits.

We screen the country COSOPs to analyse how IFAD's interventions can contribute to the country's NDC mitigation commitments.[15] The results of the screening are summarized in annex 2. We find that a wide range of measures with mitigation capacity fall within the IFAD strategies – for example, climate-smart agriculture, agroforestry, energy efficiency and renewable energy. Within the agriculture sector, measures include both improved crop management and livestock breeding, together with manure management.

In the NDCs, AFOLU-related measures are often not included in the mitigation priorities but are listed among the adaptation options. While adaptation is not directly considered in this paper, it is evident that there are synergies between mitigation and adaptation. Adaptation measures may generate important climate mitigation externalities, and vice versa. For example, the Climate Proofing Food Production Investments in Imbo and Moso Basins in the Republic of Burundi (see box 1) aims at upscaling activities prioritized in the adaptation section of Burundi's NDC and which are successfully increasing the resilience of the local population to the negative impacts of climate change, but also has an annual mitigation capacity of about 3 per cent of national annual GHG emissions as of 2015, resulting from reforestation and improved soil fertility interventions, in line with the mitigation section of the NDC (see annex 1) and the COSOP priorities (see annex 2). The Ethiopia Lowlands Livelihood Resilience Project (see box 2) has the objective of improving the livelihood resilience of pastoral and agropastoral communities in six regions and approximately 100 *woredas* (districts). It builds resilience by improving the communities' absorptive, adaptive and transformative capacities. However, it also constitutes a sizeable net carbon sink of 0.5 $MtCO_2e$ per year due to the introduction of improvements in rangeland management, agricultural practices, water conservation techniques and livestock productivity.

[15] Indeed, IFAD works at integrating climate and environment into its programme of work in the countries, starting from the very early stage of country strategies through COSOP design (IFAD 2020). However, only the most recent COSOPs (those referring to the PBAS 11 and beyond) explicitly refer to the mitigation targets in view of their anticipated contribution to the NDCs. Such information can mainly be found in the SECAP note. Indeed, with the aim of setting IFAD on a path to better supporting its client countries in meeting their climate commitments, as well as aligning IFAD country strategies with countries' NDC priorities, the new COSOPs use an analysis of priorities articulated in the NDCs for strategy development.

Box 1: Climate Proofing Food Production Investments in Imbo and Moso Basins in the Republic of Burundi

Objective: The project aims to scale up activities prioritized in Burundi's NDC and which are successfully increasing the resilience of the local population to the negative impacts of climate change. These activities consist in transforming the current agroecological land and water management practices in the upper and middle catchments of the Imbo and Moso basins (15,000 ha) towards more sustainable and productive land use practices. This will in turn reduce hillslope and instream erosion upstream and siltation and flooding risks for the irrigation schemes downstream and safeguard corresponding investments. The lessons learned from this project could support its scale-up to another 92,000 ha in the country at a later stage. The project will support farmers in reforestation, reducing soil erosion, improving fertility, better water management and reducing wood consumption (for household energy needs), among others.

Climate impact of the project: The project comprises climate change adaptation activities prioritized in the NDC and the National Climate Change Action Plan, which will increase the resilience of 240,000 direct beneficiaries and 333,540 indirect beneficiaries (irrigation scheme users) and protect their livelihoods and the agroecosystems they depend on. It will also ensure the sustainability of US$57 million of public investments in the face of climate change. The overall project beneficiaries include 153,280 households, who will gain knowledge on agricultural and nutrition best practices and/or benefit from the improvement of soil and water management infrastructure in the river basins.

Investment: US$31.7 million, of which a US$9.9 million grant from the Green Climate Fund

Mitigation potential: The annual mitigation potential of the project (143,998 tCO_2e) corresponds to 3 per cent of Burundi's annual GHG emissions in 2015.[16] The estimated abatement cost amounts to 6.9 constant 2010 US$/$tCO_2e$.

Source: Green Climate Fund. 2020. SAP017. https://www.greenclimate.fund/project/sap017.

Box 2: The Lowlands Livelihood Resilience Project in Ethiopia

Objective: The project aims to improve the livelihood resilience of pastoral and agropastoral communities in Ethiopia. Planned investments focus on: (i) improving the natural resource endowment and strategic infrastructure; (ii) improving public service delivery, skills, market access and diversification (to reduce pressure on natural resources); (iii) and building capacity in the institutional environment and supporting the delivery of basic social services to ensure the long-term sustainability of livelihoods. The project is expected to directly benefit 2.5 million people.

Climate impact of the project: The project generates climate benefits in the form of enhanced resilience and natural resource management. The project is aligned with the World Bank's Africa Climate Business Plan, Ethiopia's NDC and Ethiopia's Climate Resilient Green Economy Strategy.

Investment: US$451 million $, of which US$90 million from IFAD

Mitigation potential: The project constitutes a sizeable net carbon sink of 9.9 $MtCO_2e$ over 20 years (0.5 $MtCO_2e$ annually), due to the introduction of improved rangeland management, agricultural management practices, water conservation techniques and livestock productivity. The rangeland management activities constitute an absolute carbon sink with a carbon balance of 0.4 $MtCO_2e$ per year; the carbon balance for agricultural activities is 0.015 $MtCO_2e$ per year, and for livestock population growth the projection is 0.06 $MtCO_2e$ per year. The use of both electricity and fuel leads to an increase in emissions of 0.015 $MtCO_2e$ per year owing to increased transportation and processing because of improved market opportunities, and greater use of fertilizer and insecticides/herbicides leads to an increase of 0.003 $MtCO_2e$ per year. The estimated abatement cost amounts at about 39 constant 2010 US$/$tCO_2e$.

Source: Project Design Report, 25 July 2019.

[16] Mitigation potential figures are based on a preliminary analysis conducted with the Ex-ante Carbon-balance Tool (Ex-Act) and reported in the project proposal (www.greenclimate.fund/sites/default/files/document/sap017-ifad-burundi.pdf). Ex-Act allows the ex ante assessment of the net carbon balance consequent to the implementation of specific mitigation options compared to a counterfactual scenario (Bernoux et al. 2010), also at value chain level (see www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en/).

Both projects are expected to generate development co-benefits in terms of increased income for smallholders. This provides a good argument for promoting investments in climate change adaptation and mitigation. The relative cost-effectiveness of mitigating climate change in Burundi (the MAC is lower and below the regional average) makes the mitigation investments profitable and an option for providing farmers with the needed incentives to shift from BAU to more sustainable farming. Given the relatively lower abatement cost, Burundi could be a case of an "economy of scope" and eventually qualify for selling credits on the carbon market. Based on its high mitigation capacity but relatively higher abatement cost, Ethiopia could be a case of an "economy of scale" (indeed, IFAD projects in Ethiopia are scaling up activities based on previous successes).

The synergies between mitigation, adaptation and development are often reflected in the national green growth strategies, environmental policies and agriculture and rural development plans,[17] which provide the opportunity to integrate the scale-up of practices that potentially benefit development, food security and climate change adaptation and mitigation into an existing continental and country-owned sustainable agricultural development framework (Branca et al. 2012). In general, they aim to promote sustainable infrastructure (e.g. access to renewable/low-carbon energy and energy efficiency, sustainable transport, sustainable cities), efficient/sustainable management of natural assets (agriculture, forests and other land uses, water, minerals), and building the resilience of livelihoods (physical/climate, economic, social). The convergence of the proposed actions is reflected by the existing funding mechanisms: the Adaptation for Smallholder Agriculture Programme,[18] the Adaptation Fund, the Africa Fertiliser Financing Mechanism, the African Water Facility, the Climate Investment Funds, the ClimDev-Africa Special Fund and the Sustainable Energy Fund for Africa (AFDB 2012).

4. Summary and conclusions

The adoption of the 2030 Agenda for Sustainable Development and the Paris Agreement in 2015 represents a significant achievement. The Sustainable Development Goals (SDGs) and the NDCs carry a potential for synergies and complementarities. Countries can use NDC updates to align their climate activities more closely with their SDG priorities. To this end, the achievement of the goal of zero hunger by 2030 can be facilitated through green growth investments such as sustainable infrastructure, natural asset management and responding to climatic and economic shocks (AFDB 2012). This constitutes a strong justification for promoting more mitigation-related investments in the AFOLU sector, which would include the development of low-carbon and energy-efficient farming systems; the production of and access to renewable energy; efficient and sustainable management of land (agriculture, forests and other land uses) and water; and building the physical, economic and social resilience of smallholders' livelihoods.

Significant levels of finance are needed to support countries to implement such strategies and fulfil the commitments in their NDCs. Climate financing and investment for agriculture are far from sufficient to enable the transition to low-carbon development (IFAD 2020). Indeed, mitigation commitments in the NDCs are conditional on finance, capacity and technology transfer. The increased ambition in the revised NDCs highlights the need for support even

[17] For example, several African countries are preparing National Agriculture and Food Security Investment Plans within the Comprehensive African Agriculture Development Programme – which is owned and led by African governments – with the goal of reaching and sustaining increased economic growth through agriculture-led development that reduces hunger and poverty and enables food and nutrition security. To achieve these goals, more strategic and integrated planning and increased investment in the sector is recommended.

[18] Launched in 2012, the Adaptation for Smallholder Agriculture Programme channels climate and environmental finance to enable smallholder farmers who participate in IFAD projects to increase their resilience to climate change.

more. Given the current low level and unpredictability of public finance, private finance remains a key source of supporting such mitigation actions. However, attracting climate finance is still a challenge due to barriers such as weak governance systems, high-risk profile, lack of incentives and weak project bankability. Governments should create the environment necessary for the finance to flow at a scale needed (AMCEN 2019). More integrated policies are essential to bring together the green growth agenda and the low-carbon, resilient development pathway, including in rural areas.

The work presented here quantifies the mitigation capacity of the ESA region with a focus on the AFOLU sector and introduces cost-effectiveness criteria to exploit such capacity by attracting additional financing. It provides a useful guide for international donor investment, including by IFAD, in climate change mitigation actions in the region.

Results show that most emissions in the region come from the energy sector (52 per cent), followed by AFOLU (38 per cent due to poor agricultural practices, widespread deforestation and fuelwood use) and the waste and IPPU sectors (5 per cent each). Full implementation of both conditional and unconditional mitigation targets set forth in the NDCs would limit the increase in regional net emissions to about 20 per cent above the baseline, equivalent to a cumulative net emissions reduction of about 840 $MtCO_2e$ in 2030. This finding further justifies the analysis of NDCs that informs COSOPs, particularly the contributions towards meeting commitments and targets, and IFAD's rationale for the prioritization of investment in the AFOLU sector.

Including cost-effective low-carbon options in green growth strategies guarantees an economically efficient use of the available climate change mitigation financing. Indeed, the economic case indicates how mitigation investments should be prioritized to enhance the efficiency of available financing (economy of scope) and maximize the mitigation results (economy of scale). For example, on average, AFOLU is shown to be a profitable option for investing in climate change mitigation in the ESA region, being more competitive than energy and other sectors in attracting mitigation finance (21.3 versus 226.2 constant 2010 US\$/tCO_2e). Investing in mitigation through AFOLU in ESA is certainly more feasible given the low prices recorded on the regional carbon market. We find that in most ESA countries the average abatement cost is below US\$10/tCO_2e, which is the carbon tax applied in South Africa (the only country in the ESA region applying a carbon tax) and chosen as a proxy for the average price on the carbon market in the region. These findings present opportunities for IFAD, particularly in the ESA region, as investments are identified and articulated under the 12th replenishment cycle (IFAD12, 2022-2024). The increasing focus on climate change mitigation under IFAD12 can be quantified and realized through investment in the AFOLU sector, and buy-in from countries more likely to be secured based on the economic justification.

However, we acknowledge that important trade-offs associated with the implementation of emissions reduction activities may exist and that the prioritization of investments based on the economic efficiency of mitigation activities may conflict with other priorities targeted by international funding in developing countries, such as ending hunger and reducing poverty and social injustice. Thus, the range of returns expected by donors should also be considered in terms of broader development outcomes. In that case, prioritizing low-income countries would minimize the trade-offs and enhance the synergies between mitigation and economic development, therefore supporting socio-economic growth.

Investing in mitigation through AFOLU may represent an interesting solution for private financiers and investors as a "transition pathway" in view of the expected future increases in carbon prices in Africa. Revenues from the carbon market may provide the necessary resources to (at least partially) fill the funding gap, drive the transition of the AFOLU sector in ESA towards achieving the SDGs and restructure it in a more sustainable and "green" way, enhancing its competitiveness with respect to other sectors of the economy. Given the relatively low price and the relatively high start-up costs to put in place a carbon trading system (e.g. for the monitoring protocol and data management), this option would probably be feasible for the private sector only in countries with large mitigation capacity (economy of scale approach). For low-income countries with limited mitigation capacity (economy of scope), financial support from the public sector would probably be required.

More robust economic assessment will help release additional finance for climate action in agriculture and ensure a greater likelihood of positive outcomes for food security and emissions reductions. For example, estimating the cost-effectiveness of the different mitigation measures (see Branca et al. 2015; 2020) would help moving from the long list to the short list of options, providing a better-articulated range of options within the AFOLU sector. A more robust economic assessment is also critical to inform policies and strategies at national and regional levels.

African policymakers need to improve the enabling environment for access to climate-related finances and the carbon market by increasing investment in agricultural public goods and developing innovative financing instruments, such as through public-private partnerships (Braimoh 2020). Current use of climate finance across ESA indicates that all countries can access far more of the available funds, especially in the context of NDCs. Many countries have not exhausted their resource allocation from the three sources of climate finance available – the Global Environmental Facility, the Green Climate Fund and the Adaptation Fund – and many do not yet qualify for funding due to a lack of readiness (IFAD 2019a). As an accredited Entity to the Green Climate Fund and an Implementing Entity for the Adaptation Fund and the Global Environmental Facility, IFAD can support countries to access these resources and make the necessary climate change mitigation investments in the AFOLU sector.

There are several data limitations and uncertainties in our calculations which may affect the results. They are related to: (i) differences in data availability and metrics adopted in the pledges indicated in the National Communications and NDCs; (ii) the absence of specific budgets and mitigation targets for the different sectors; and (iii) heterogeneous methodologies used by the stakeholders involved to estimate the emissions and sinks in the various GHG inventories and databases, the current and projected level of emissions and the resulting mitigation capacity, and baseline assumptions. This calls for coordinated action from the scientific community to ensure coherence and harmonization of data collection, processing, benchmarking, reporting and knowledge-sharing. Facilitating the transferability of information into evidence-based policymaking is important, also in view of the next round of NDCs (new or updated) which will be submitted to the UNFCCC secretariat, and of the countries' needs to constantly update their plans to orient investments towards more cost-effective options.

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Annex 1. Priority mitigation actions indicated in ESA countries' NDCs

Country	AFOLU	Other sectors
Angola	Agriculture: stabilization of emissions (animal production and wildfires); LULUCF: forestry conversion; use of biomass; phase out harvested land	Energy: promotion of renewable energy (power generation from renewable sources), production of ethanol as an alternative to fossil fuels, industrial processes
Botswana	Agriculture: livestock sector (reduce emissions from enteric fermentation)	Energy (mobile and stationary sources) and transport sector infrastructural developments; waste
Burundi	Forestry: (i) reforestation of 8,000 ha/year for 15 years, beginning in 2016; (ii) replacement of 100% of traditional charcoal kilns and traditional home ovens by 2030; agriculture: gradual replacement of 100% of mineral fertilizers with organic fertilizer by 2030	Energy: building hydroelectric power plants
Comoros	Agriculture and agroforestry; forestry: reforestation, afforestation, forest conservation	Energy; waste
Eritrea	Agriculture and agroforestry (e.g. biogas on big farms; reforestation with agroforestry/silvopasture; biogas on rural farms; efficient wood stoves)	Energy, industry, transport, waste: waste heat recovery at steel plant, waste heat recovery at cement plant, efficient domestic lighting with LEDs, geothermal power, on-shore wind turbines, solar photovoltaics, large grid, off-shore wind turbines, composting of municipal solid waste, biodiesel from municipal solid waste, charcoal production, efficient wood stoves, LPG stoves replacing wood stoves, clinker replacement, bus rapid transit
Eswatini (Swaziland)		Renewable energy; transport (ethanol blend in petrol); phase out and substitute ozone-depleting substances
Ethiopia	Agriculture; forestry	Industry; transport; buildings
Kenya	Agriculture (climate-smart agriculture); forestry (afforestation and reforestation of 10% of tree cover)	Energy and IPPU: renewable energy (geothermal, solar, wind, biogas etc.) and energy efficiency; low-carbon and efficient transport systems; wildlife and tourism; waste: sustainable waste management
Lesotho	Agriculture: improving crop and livestock production practices for food security while reducing emissions; LULUCF: protecting and re-establishing forests for their economic and ecosystem services, while sequestering CO_2	Energy: expanding electric power generation from renewable energy, improving access to modern and energy-efficient technologies in transport; IPPU: industry and building sectors; waste
Madagascar	Agriculture: large-scale dissemination of intensive/improved rice farming techniques (SRI/SRA); large-scale implementation of conservation agriculture and climate-smart agriculture; dissemination of arboriculture (from 2018: 5,000 ha per year); LULUCF: large-scale reforestation for sustainable timber production and indigenous species for conservation; reduction of forest timber extraction; promotion of REDD+; large-scale adoption of agroforestry; enhanced monitoring of forests and grassland forests	Energy; waste

Malawi	Agriculture: support the development of market-based policies and legal instruments to shift decisions from financial to environmental decisions; develop appropriate extension and training materials for climate-resilient agronomic practices; scale up the dissemination of climate-resilient agronomic practices to over 10% of current cropland; build capacity to implement and monitor the agriculture Nationally Appropriate Mitigation Actions; LULUCF: afforestation, reforestation, forest conservation and protection of catchments	Energy supply and use; IPPU; waste
Mauritius	Agriculture: climate-smart agriculture (including smart use of marine resources); sustainable consumption and production in all sectors of the economy; climate-smart agriculture, including bio-farming; sustained tree planting programme within the context of the cleaner, greener and safer initiative	Electricity: cleaner technologies; transport, specific measures: expansion of solar, wind and biomass energy production and other renewable energy sources; gradual shift towards the use of cleaner energy technologies, such as LNG, among others; modernization of the national electricity grid through the use of smart technologies, which is a prerequisite to accelerating the uptake of renewable energy; efficient transportation system; sustainable and integrated waste management, including waste to energy; leapfrog to low global warming potential refrigerants
Mozambique	LULUCF: REDD+	Energy: electricity production, transport and other – residential, commercial and institutional; waste: solid waste disposal and treatment
Namibia	LULUCF: reduce deforestation rate by 75%; reforest 20,000 ha per year; restore 15 million ha of grassland; reduce removal of wood by 50%; afforest 5,000 ha per year; plant 5,000 ha of arboriculture per year; agriculture: fatten 100,000 cattle heads in feedlots; soil carbon	Energy: increase the share of renewables in electricity production from 33% to 70%, increase energy efficiency and demand-side management, mass transport in Windhoek, car and freight pooling; IPPU: replace 20% of clinker in cement production; waste: transform 50% of municipal solid waste into electricity and compost
Rwanda	Agriculture: crop rotation, improved fertilization, terracing, multi-cropping, conservation tillage; improved livestock and manure management	Energy; IPPU; waste
Seychelles	No agriculture; opportunities for emissions reductions in LULUCF are limited	Energy; waste; land transport
South Africa		Energy: expand the Renewable Energy Independent Power Producer Procurement Programme (REI4P), decarbonize electricity, carbon capture and storage, hybrid and electric vehicles
South Sudan	-	-
Uganda	Agriculture: climate-smart agriculture for cropping, livestock breeding and manure management practices; LULUCF: forestry management, improved wetlands	Energy (power supply): energy for buildings etc. and transport
United Republic of Tanzania	Forest sector: (i) enhancing and scaling up implementation of participatory forest management programmes; (ii) facilitating effective and coordinated implementation of actions that will enhance the contribution of the entire forest sector, including forest policies, national forest programmes and REDD+-related activities; (iii) strengthening nationwide tree planting programmes and initiatives; (iv) strengthening	Energy (and transport): energy diversification, clean technologies for power generation, use of natural gas, energy-efficient technologies, rural electrification, low-emission transport system; waste management: application of modern and practical way of managing waste, including the enhanced use of engineered/sanitary landfills, promotion of waste for energy programmes, promotion of co-generation activities

	protection and conservation of natural forests to maintain ecological integrity and continued benefit from service provisions of the sector; (v) enhancement and conservation of forest carbon stock	
Zambia	Agriculture: sustainable agriculture (enteric fermentation and manure management, rice methane, agricultural soils, burning of savanna and agricultural waste, agriculture farrow and plantations); LULUCF: sources (i.e. deforestation and forest degradation through land clearing for agriculture, uncontrolled fires, infrastructure, timber harvesting and charcoal production); sinks: regeneration of abandoned land from disturbed forests (firewood collection, charcoal production and timber harvesting), afforestation and reforestation	Renewable energy and energy efficiency: manufacturing, commercial, residential, agriculture, transport, mining and electricity; waste (i.e. solid waste disposal, solid waste open burning, domestic wastewater handling, industrial wastewater handling and human sewage)
Zimbabwe		Energy: ethanol blending, solar water heaters, improved energy efficiency, increasing hydroelectricity in the energy mix, electrification of the rail system

Source: Authors' own elaboration from NDCs.

Annex 2. Priority mitigation actions indicated in ESA countries' COSOPs

Country	Strategic areas of intervention/proposed actions related to climate change mitigation	Explicitly mentioned contribution to NDC	PBAS cycle
Angola	Promotion of conservation agriculture, soil fertility improvement, soil moisture conservation, water harvesting and drought-tolerant crops and varieties, particularly in the south. In the north, erosion and water management measures will be promoted, while interventions in the south will provide improved land and water management techniques, improved and more drought-tolerant crops and varieties, and access to reliable metrological data and climate information in support of vulnerable communities. Livelihood diversification opportunities will also be explored as an adaptation measure.	yes	11, 12, 13
Botswana	-	n/a	-
Burundi	Restoring and managing the ecosystem to ensure that priorities – such as a sustainable environment, rural social equity, and adaptation and mitigation of climate change such as land degradation and depletion, degradation of forest resources, the effects of climate change on agricultural systems, insufficient human and institutional capacities, and non-compliance with prevailing regulations – are effectively integrated into the strategic objectives of the new COSOP. The study is under way.	no	10, 11, 12
Comoros	-	-	-
Eritrea	To reduce the dependency on rainwater and promote water-efficient irrigation; to support land and water conservation measures; to identify and promote innovative technologies and build institutional capacity. Climate-smart practices and technologies include a broad range of technologies, including rainwater harvesting, drought-tolerant and early-maturing crop varieties, drought-tolerant forage and agroforestry fodder species, watershed conservation and management, afforestation, mangrove rehabilitation and conservation, solar and other forms of renewable sources of energy.	yes	11, 12, 13
Eswatini (Swaziland)	Short-term focus will include land use planning, rangeland management and complementary Climate-Smart Agriculture for Resilient Livelihoods (CSARL). Medium-term outputs will include increased farm productivity through access to inputs, improved water and land management, and climate-smart agricultural production practices to mitigate climate shocks, also under SMLP/CSARL.	no	-
Ethiopia	(i) promoting sustainable agriculture and land and water management; (ii) increasing economic productivity; (iii) strengthening and mainstreaming climate resilience and sustainable natural resource management activities; and (iv) promoting appropriate capacity-building to attain these goals at federal, regional and woreda levels	no	10, 11, 12
Kenya	Promotion of renewable energy use (biogas, solar, improved cook stoves etc.); promotion of afforestation, reforestation and agroforestry; integration of climate mitigation into CIDPs; capacity-building in carbon accounting and GHG monitoring; efficient livestock production systems	yes	11, 12, 13
Lesotho	Development of climate-proofing production systems: climate-smart agriculture (conservation farming and climate-resilient practices); afforestation of gullies, soil and water works to control water flows and erosion, grass strips, restoring the riparian vegetation and trees along streams, and removal of alien vegetation	yes	11, 12, 13
Madagascar	-	-	10, 11

Malawi	Alternative (renewable) energy sources and technologies for cooking and brick making at the village level; promoting afforestation, reforestation and vegetation cover as part of catchment restoration; and improving climate monitoring at the district and village level along with the regular dissemination of critical climate information to smallholder farmers	no	10, 11, 12
Mauritius	-	-	-
Mozambique	Promotion of the transfer and adoption of proven climate-smart and sustainable land and water technologies/practices for agriculture, livestock and fisheries; development or strengthening of early warning systems, weather information systems and integrated land and water management systems; strengthening of national and local capacities for sustainable land and water management	yes	11,12
Namibia	-	-	-
Rwanda	Agroforestry and land husbandry; improved pasture management practices through the adoption of drought-resistant forage and fodder varieties; water use efficiency; livestock waste management facilities; efficient use of fertilizer; manure management; and improving nutrient management and increasing crop productivity to enhance carbon sequestration	yes	11, 12
Seychelles	-	-	
South Africa	-	-	
South Sudan	-	-	
Uganda	Climate-smart production systems and energy-efficient technologies	no*	11, 12, 13
United Republic of Tanzania	Emphasis on climate-smart approaches/practices for agriculture, livestock, fisheries and forestry, which might include, for example, good agricultural/livestock practices, sustainable fisheries management and community forestry	no	10, 11
Zambia	Sustainable farming (e.g. conservation agriculture, climate-smart agriculture); sustainable forest management; renewable energy; and energy efficiency	yes	11, 12
Zimbabwe	Promotion of renewable energy use (biogas, solar, improved cook stoves etc.); promotion of afforestation, reforestation and agroforestry, and climate-smart agricultural practices (e.g. conservation agriculture, drought-tolerant crop varieties, stress- and disease-tolerant livestock varieties, hay and silage making, soil and water conservation, building climate and weather information systems, climate-proofing rural infrastructure, crop and livestock insurance, good agricultural practices, water harvesting, capacity-building and small-scale irrigation)	yes	11, 12, 13

Source: COSOPs (and annexed SECAP note).

Note: * The full document is not yet available for Uganda.

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