PBL Netherlands Environmental Assessment Agency

EVALUATION OF SELECTED COUNTRY CLIMATE AND DEVELOPMENT REPORTS OF THE WORLD BANK GROUP

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Colophon

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Contents

Findings 5

1 Introduction 8

2 General overview of the CCDRs 9

3 Overview of evaluated CCDRs 10
3.1 Tools and methods 10
3.2 GDP impacts of climate change 10
3.3 Emission reduction potential 12
3.4 Adaptation and mitigation investment needs 13

4 Evaluation 13

References 16

Appendices 17
Appendix 1: Detailed CCDR evaluation of China 18
Appendix 2: Detailed CCDR evaluation of G5 Sahel 25
Appendix 3: Detailed CCDR evaluation of South Africa 32
Appendix 4: Detailed CCDR evaluation of Vietnam 36

FINDINGS

Findings

The World Bank Group has recently published several Country Climate and Development Reports (CCDRs) that explore key transformations in various sectors to enable climate change mitigation and adaptation, while delivering on broader development goals. At the request of the Dutch Ministry of Foreign Affairs, PBL has evaluated the reports on China, G5 Sahel (i.e. Burkina Faso, Chad, Mali, Mauritania and Niger), South Africa and Vietnam. Our main findings are summarised below.

Appreciation

- The CCDRs are important as they identify crucial short- and medium-term measures that effectively reduce greenhouse gas emissions while improving adaptation.
- The CCDR on China effectively emphasises the importance of interrelated policy packages that prioritise urgent actions to reduce emissions and promote low-carbon development.
- The CCDR on the G5 Sahel is both timely and crucial, as it highlights the sustainable development challenges facing the region, emphasises both the urgent need for adaptation actions and the benefits of early and targeted actions to address the fragility and vulnerability to climate change of the G5 Sahel region.
- The South African CCDR's proposal to integrate mitigation, adaptation, and a just transition into the development paradigm is highly relevant, particularly given the current fragmentation of responsibilities and limited capacity for climate policy implementation.
- The CCDR on Vietnam emphasises the country's vulnerability to climate change, particularly along its long coastline, low-lying cities, and river delta regions. Moreover, the report comprehensibly explores synergies and trade-offs between climate change mitigation and adaptation actions and other development objectives.

Room for improvement

- More details on the scenario development process, the models used, and the method applied to calculate the impact on vulnerable assets could improve overall transparency and thereby the legitimacy and credibility of the recommendations.
- The CCDRs rely on a single model framework. Uncertainties in future projections could be addressed more effectively by presenting a range of values for the quantitative estimates of the damage from climate change and the investment needs, and/or by applying multi-model comparisons.
- The need for adaptation support for smallholders in China, who face potential yield losses and species range shifts due to climate change, is not clearly addressed.
- Climate change not only increases the likelihood of migration away from the Sahel region, but also exacerbates economic and physical conditions, and causes legal or practical barriers to access to support and protection, support networks, as well as other related factors that influence migration. The CCDR on the G5 Sahel does not adequately cover this topic.
- The CCDR on South Africa does not address the youth's vulnerability to climate change-related problems and the crucial role they could play in tackling climate change in South Africa.
- Vietnam's CCDR barely mentions the geographical challenges that the country is facing, such as those related to the implementation of a railway system to bridge the long distance between

the two largest cities, or around the expansion and integration of renewable energy into the national grid infrastructure.

FULL RESULTS

FULL RESULTS

1 Introduction

Climate change and development are intricately intertwined. On the one hand, since the Industrial Revolution, economic growth has been associated with greenhouse gas (GHG) emissions and environmental damages. IPCC's Six Assessment Report states that 'observed increases in well-mixed greenhouse gas (GHG) concentrations since around 1750 are unequivocally caused by human activities' [1]. Increased economic activities tend to rely on increased energy use and natural resource consumption. With the global energy mix being dominated by fossil fuels, energy consumption is directly related to GHG emissions, hence to climate forcing [2]. On the other hand, climate change can significantly harm economic development globally, with a large number of lower income countries being particularly at a high risk. Extreme weather events, such as heatwaves, droughts, and floods, damage infrastructure and other physical assets across the globe, having a detrimental impact on productivity and human health. In addition, changes in precipitation patterns can also affect water availability, which is crucial for many economic activities. Especially low-income countries lack sufficient resources to adapt to the effects of climate change, which can lead to decreased economic opportunities and increased poverty.

Tackling climate change calls for major transformations in social and economic development, which requires important decisions to be made in the very short term. Achieving sustainable development while promoting action on climate requires a clear understanding of high-impact interventions, the cost of these interventions, and the policy choices that need to be made. To help inform these decisions, the World Bank Group has published a series of diagnostic reports called Country Climate and Development Reports (CCDRs). These reports explore the complex and multifaceted linkages between climate change and development in several countries (at the time of writing, CCDRs had already been published on 24 countries, are forthcoming on another 5, and the process is initiated for a further 22) [3]. These CCDRs aim to assist countries in setting priorities by analysing synergies between climate change adaptation, climate change mitigation, and broader socio-economic development goals of different policy measures. The CCDRs reflect on the country's climate commitments, explore GHG emission trajectories, identify major climate change related vulnerabilities, and discuss interventions and pathways for sustainable and inclusive development. The CCDRs suggest concrete short- and medium-term actions for a transition towards a resilient low-carbon economy.

The CCDRs are a joint effort by the World Bank, the International Finance Corporation (IFC), and the Multilateral Investment Guarantee Agency (MIGA), in close coordination with the International Monetary Fund (IMF) [3]. The process involved active engagement with multiple stakeholders, including government, civil society organisations, non-governmental organisations, academia, the private sector, and development partners. These are also the target groups of the CCDRs. The goal of the CCDRs, which will be updated every five years, is to aid countries in better understanding the climate risk they face and to support prioritising actions to adapt to and mitigate climate change while achieving other development goals. In addition, the CCDRs will be useful in informing the World Bank Group's Systematic Country Diagnostic and Country Partnership Framework, identifying economic opportunities for private sector investment and markets, triggering conversations with the public and civil society around key priorities, trade-offs, and a just transition, and informing the global audience on pathways to achieve the global community's development and climate objectives. The CCDRs can also serve as a guide for countries while

preparing, updating, and implementing their own Nationally Determined Contributions (NDCs) and Long-Term Strategies (LTSs) [3].

At the request of the Dutch Ministry of Foreign Affairs, this note presents an evaluation of four CCDRs: China [4], G5 Sahel (Burkina Faso, Chad, Mali, Mauritania, Niger) [5], South Africa [6], and Vietnam [7]. The objective of the evaluation is to assess the methodology and the results in the context of other relevant studies and scientific standards. The target groups of the evaluation report are the World Bank, the Dutch Government (in particular, the Dutch Ministry of Foreign Affairs) and Dutch development partners.

2 General overview of the CCDRs

For each country for which the World Bank published a CCDR, diverse and complementary models, tuned to the context of the respective country, were employed to explore future developments and impacts of climate change under various scenarios. The scenario approach was used to explore country-specific development pathways. These pathways can be used to inform about i) synergies between climate action and development by analysing sectoral and macroeconomic policies and investments, ii) potential trade-offs between climate and other development objectives, and iii) opportunities, reforms, investments, and policy instruments for sustainable and inclusive development. The starting point for the CCDRs is each country's own development priorities and climate commitments.

The CCDRs that are already released cover countries that together account for 34% of global population, 22% of global GDP, and 34% of global GHG emissions [3]. The most ambitious mitigation scenarios in the CCDRs reduce combined emissions by 70% in 2050 relative to current policy scenarios, driven by bottom-up national emission reduction goals [3]. The CCDRs demonstrate the vulnerability of especially low-income countries and those with high levels of poverty to the impacts of climate change. These impacts are often local and severe for food security, human health, economic opportunities, and development outcomes.

The CCDRs also demonstrate that these major threats can be reduced by adaptation measures and climate goals can be achieved without compromising development, providing that certain key conditions are being met, such as well-designed climate actions, strong participation of the private sector, adequate international support, as well as appropriate complementary measures to manage unavoidable trade-offs, protect poor people's consumption and facilitate a just transition [3]. The economic impact of stringent climate change mitigation measures taken in the CCDR in deviation from the baseline scenario is estimated to be in the range of close to zero to a positive impact of 3.3% due to reduced fuel spending, efficiency improvements and health benefits. The impact on household consumption is higher, estimated in the range of -1.7% to +2.2%, due to the increased investment needs.

The main climate change impact indicators in the CCDRs include macroeconomic and distributional outcomes (GDP, consumption, poverty, inflation, exchange rates, fiscal impacts, debt), sectoral indicators (energy prices, industrial, agricultural and service sector output), and co-benefits (health and productivity improvements from reduced air pollution, and tax efficiency gains when carbon tax revenues allow a distorting tax to be removed).

3 Overview of evaluated CCDRs

The evaluated CCDRs present a balanced focus in climate adaptation and mitigation, except for G5 Sahel, where the focus lies on adaptation measures due to the low level of emissions and the high level of vulnerability to climate impacts.

3.1 Tools and methods

The CCDRs employ diverse and complementary models, chosen depending on the country-specific context, including local climate vulnerabilities and economic status and opportunities, to offer policymakers with actionable recommendations on several short- and medium-term climate change mitigation and adaptation policies (Table 3.1). For all evaluated CCDRs, economic models are applied to estimate the macroeconomic consequences of climate change damages and investment needs for adaptation and/or mitigation. For China and South Africa, in addition to a macroeconomic model, more detailed energy models are applied to project required changes in energy systems to reduce GHG emissions. The scenario approach is the key component of the methodology to explore how the future may evolve under a range of alternative conditions. Scenarios offer a framework for dealing with uncertainty and preparing for a wide range of plausible futures.

3.2 GDP impacts of climate change

According to the CCDRs, climate change has considerable economywide cost in all evaluated CCDR countries due to country- and region-specific impacts of climate change (Table 3.2). For Vietnam, if the threat is not averted, the agriculture sector could experience losses of up to 6.2% in 2030 relative to 2010 levels. In the G5 Sahel region, countries could experience a 5% to 10% fall in crop revenues and 11% to 20% fall in livestock yield by 2050, under the dry and hot scenarios, with up to 13.5 million people falling into poverty due to climate change-related shocks. Between 6% and 19% of South Africa's urban population could be vulnerable to flooding by 2050 if tackling climate change would not be an integral part of development programmes. China's densely populated coastal cities, which account for a fifth of its population and a third of its GDP, are at high risk to coastal flooding, storm surges, and coastal erosion resulting from sea level rise.

Table 3.1
Models and scenarios employed in the selected CCDRs

CCDR	Models	Scenarios

China	• TIMES is used to build an optimisation model based on bottom-up energy system linear programming for China's energy system, in partnership with Tsinghua University
	• The LEAP (Long-Range Energy Alternatives Planning) model was used to build a bottom-up transport sector model covering all subsectors, road, railway, waterway, and air transport, excluding international shipping and international aviation
	• MANGE and E3ME are used for macroeconomic analysis
		• Reference Scenario
		• NDC Scenario
		  ○ Carbon neutrality with revenue recycling to investment
		  ○ Carbon Neutrality with compensation
		  ○ Carbon Neutrality with flexible labour markets
		  ○ Carbon Neutrality with air pollution co-benefits
		• Accelerated Decarbonization Scenario

G5 Sahel	• The CC-MFMod is the extended version of the MFMod — the macro-structural model already used to do core macro-modelling for each of the G5 countries. CC-MFMod was used to model the linkages between damages caused by climate change, climate adaptation, and macroeconomic aggregates	• Climate scenarios
		  ○ optimistic climate scenarios
		  ○ pessimistic climate scenarios
		• Long-term growth scenarios
		  ○ low-growth scenario
		  ○ medium-growth scenario
		  ○ higher growth scenario

South Africa	• SATIM is a full energy sector model for South Africa
	• SAGE is a CGE model that incorporates the impacts derived from the SATIM on the country's main economic variables, especially the level of economic activity and GDP composition
	• The micro-simulation model captures the distributional impacts on households and jobs
		• A reference scenario
		• Net-Zero reference scenario
		  ○ With greater ambition
		  ○ With efficiency measures
		  ○ With green H_2 exports
		  ○ With efficiency measures and green H_2 exports
		  ○ With higher foreign savings and greater ambition
		  ○ With higher carbon tax

Vietnam	• MANAGE is a (recursive) dynamic CGE model designed to focus on energy, emissions, and climate change. The model includes a detailed energy specification that allows for capital/labour/energy substitution in production, substitution between fuels by producers, and a multi-output, multi-input production structure	• Currently proposed policy scenario • Accelerated Decarbonization Scenario • Net-Zero Pathway

Table 3.2
Estimated GDP losses due to climate change

CCDR	GDP losses	Remark
China	-0.5% to -2.3%	• Annual impacts from climate change in 2030, percentage of GDP. • The ranges correspond to alternative socio-economic and/or climate change scenarios (optimistic, intermediate and pessimistic)
G5 Sahel	-3.1% to -12.4%	• Percentage GDP deviation from the medium-growth baseline in 2050 • The ranges correspond to alternative socio-economic and/or climate change scenarios (optimistic, intermediate and pessimistic)
South Africa	-0.4% to -1.4%	• Projected economic damages between 2022 and 2050 as percentage of GDP under the pessimistic scenario: SSP3-7.0 dry • The range refers to maximum and minimum values over the 2022–2050 period
Vietnam	-9.9% to -12.4%	• Impacts of higher and more variable temperatures and precipitation patterns, rising sea levels, as percentage of GDP under RCP 2.6 and RCP 4.5 in 2050 • The ranges correspond to alternative socio-economic and/or climate change scenarios (optimistic, intermediate and pessimistic)

3.3 Emission reduction potential

The CCDRs explore low-carbon development pathways and show that, if the right conditions are met, emissions can be reduced without compromising development. Most of the low-carbon development pathways presented in the CCDRs are markedly more ambitious than existing NDCs (Table 3.3). These development pathways are context-specific and address the high emitting sectors in each country. The CCDRs conclude that if properly designed and executed, suggested short-term climate change mitigation measures can have a strong synergy with local economic growth and development.

Table 3.3
Projected emission reduction under various scenarios

CCDR	Emission change	Remark
China	-59% to -74%	Relative to the baseline scenario with an emission of 8946 million tonnes of CO_2e in 2050, the range covers the reduction potential of the NDC scenarios and Accelerated Decarbonization Scenarios in 2050
G5 Sahel	NA	NA
South Africa	-91% to -94%	Emission reduction potential in 2050 relative to 2022 GHG emissions, the range refers to the different net-zero scenarios
Vietnam	-70% to -74%	Percent change from baseline in 2040 in respectively the Net-Zero and Net-Zero with reforms scenarios

3.4 Adaptation and mitigation investment needs

Annual investment needs vary considerably per country and are higher as percentage of GDP in low-income countries compared to higher and lower middle-income countries. For higher and middle-income countries, the estimated adaptation and mitigation investment needs, on top of the baseline investment, are estimated at 1%–2% of GDP. This requires reallocating public resources, providing the right incentives to the private sector and managing interests from powerful actors, interest groups, and the public. For lower middle-income countries and low-income countries, the combined investment needs for mitigation and adaptation are much higher at an estimated 2%–6% and 8%–10% of GDP, respectively. Lower income countries are also much more vulnerable to climate risk, with climate change damage expected to often exceed 5% of GDP. These countries will need increased amounts of concessional finance and grants to manage climate change impacts and to develop themselves along a low-carbon path. As each CCDR applies methods and tools specifically targeted to the country, the reported investment needs are calculated differently and are therefore difficult to compare (Table 3.4).

Table 3.4
Example of differences in measurement of adaptation and mitigation investment needs between CCDRs

CCDR	Adaptation (USD billion, cumulative)	Mitigation (USD billion, cumulative)	Remark
China	n/a	13,800	Incremental investment over reference case Investment needs to achieve China's NDCs, in the 2022–2060 period Investment needs increase to about USD 17 trillion for Accelerated Decarbonization Scenario
G5 Sahel	33	50	Investments needed for mitigation and adaption based on G5 NDCs by 2030
South Africa[a]	431	996	Investment needs in the 2022–2050 period There is an additional investment of USD 368 billion required for just transition
Vietnam	483	218	Investment over the 2022–2040 period

a) The investment value is converted from South African Rand (ZAR) to USD using the 2019 exchange rate from OECD (2023), Exchange rates (indicator). doi: 10.1787/037ed317-en (Accessed on 24 January 2023)

4 Evaluation

The CCDRs explore key transformations in sectors to enable a resilient and low-carbon development. They offer several short- and medium-term actions to reconcile development objectives with climate change adaptation and mitigation, facilitating a just transition. At the same time, policy and institutional gaps are assessed, as well as required investments to finance the transformation from public, private and other financial sources. In some CCDRs, synergies and trade-offs between climate change mitigation and adaptation and other development objectives are explored, together with several proposals to minimise trade-offs. The CCDRs employ different kinds of models, mostly tuned to the specific context of the countries, which makes comparison of

the country results difficult. A summary of the evaluations is provided below; a more detailed evaluation of country CCDRs is presented in the appendix.

The CCDR on China explores key sectoral transformations that would enable the country to meet the commitments to peak emissions before 2030 and to become carbon neutral in 2060. The CCDR offers six interconnected policy packages that emphasise the urgency of actions needed given the still increasing emissions in the country, high vulnerability of the economic infrastructure and the crucial role that the country plays in global efforts to tackle climate change.

The CCDR on G5 Sahel (Burkina Faso, Chad, Mali, Mauritania, and Niger) focuses on adaptation, since these countries combined contribute less than 1% of global greenhouse gas emissions. The report discusses the potential for low-carbon development, the synergies between resilient and inclusive development and other development goals, and the benefits of early and targeted actions on policies and programs. The sustainable development challenges in the region, that include water stress, environmental degradation, competition for resources, conflict, rapid population growth, and high maternal mortality, are discussed in great detail.

South Africa's CCDR builds on the country's Economic Reconstruction and Recovery Plan (ERRP) and highlights the current fragmentation of responsibilities and limited capacity for implementation. It proposes mitigation, adaptation and the concept of just transition to be integrated in the development paradigm. The proposed measures and their expected impacts show that a more inclusive, resilient, and sustainable economy can be built while addressing climate change.

For Vietnam, the CCDR outlines policy actions aimed at reconciling development objectives with climate change adaptation and mitigation, with the smallest burden on the poor. The long coastline and many low-lying cities and river delta regions make Vietnam one of the most vulnerable countries in the world to climate change. The CCDR explores the synergies and trade-offs between actions to tackle climate change and other development objectives including suggestions to minimise trade-offs.

While all evaluated CCDRs do a good job in identifying important policy actions for mitigation and adaptation, there is room for improvement, especially in enhancing transparency of the model and presenting a range of uncertainty in the results. The overall transparency of the CCDRs can be improved by adding more information about the process of scenario development, the models employed, and the methodology used for determining the impact on vulnerable assets, both for policymakers and model experts. This would increase the legitimacy and credibility of the results. While some effort has been made to capture relevant uncertainties in future projections, this could be further enhanced by using a multi-model approach and considering uncertainties in the estimates of damages from climate change. Another important point is the use of discount factors. In the evaluated CCDRs, the role of discounting is not very clear and the projected investment numbers do not seem to depend on the chosen discount factor. As recognised in some of the CCDRs, the modelling exercise and the discussions could go beyond 2050 to capture the magnifying effects of climate change if action is delayed.

In addition to the model transparency and uncertainty concerns, there are also some country-specific shortcomings, as presented in detail in the annex. For instance, there is barely any attention for adaptation support for smallholder farmers in China who face potential yield losses and species

range shifts due to climate change [8]. In Sahel, very little attention is paid to migration, while climate change affects not only the likelihood but also the condition (e.g., economic and physical status, legal or practical barriers to access assistance and protection, support networks) in which people migrate from the region [9]. The CCDR on South Africa, where the youth account for a third of the population, neglects their vulnerability and role in tackling climate change, while this was highlighted in South Africa's 2nd climate change report [10]. Similarly, the CCDR barely touches the geographical challenges of Vietnam, such as the long distance between Hanoi and Ho Chi Minh City, to implement a rail infrastructure or expansion and integration of renewable energy in the national grid infrastructure [11].

There are a few similar studies that aim to assist countries to plan and prioritise actions to build resilience and respond to impact of climate change. One such report is the Climate Macroeconomic Assessment Programs (CMAP) of the IMF, which is especially focused on small and low-income countries. The CMAP report that is already published for Samoa [12] and Madagascar [13] explores the risks and impacts of climate change, assesses the strategic gaps in NDCs and other national climate plans, and provides key short- and medium-term recommendations. There are no CCDRs published for these two countries, though the process has been initiated for Madagascar. Hence, the two reports are difficult to compare — but in general, the CMAP reports seem to follow a similar approach as the CCDRs. Both employ computer models to explore the micro-economic impacts of climate change, evaluate climate change mitigation and adaptation strategies, and estimate the fiscal implications of mitigation and adaptation plans together with potential financial sources.

References

1. IPCC (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change, Cambridge (UK) and New York.
2. Lenaerts K, Tagliapietra S, and Wolff GB. (2021). Can climate change be tackled without ditching economic growth?
3. World Bank Group (2022). Climate and Development: An Agenda for Action — Emerging Insights from World Bank Group 2021–22 Country Climate and Development Reports. World Bank, Washington, D.C.
4. World Bank Group (2022). China Country Climate and Development Report. World Bank, Washington, D.C.
5. World Bank Group (2022). Country Climate and Development Report: G5 Sahel. World Bank, Washington, D.C.
6. World Bank Group (2022). South Africa Country Climate and Development Report. World Bank, Washington, D.C.
7. World Bank Group (2022). Vietnam Country Climate and Development Report. World Bank, Washington, D.C.
8. The World Bank Group and the Asian Development Bank (2021). Climate Risk Country Profile: China. World Bank, Washington, D.C. and Asian Development Bank, Manila.
9. United Nations (2021). Human Rights Climate Change and Migration in the Sahel.
10. Department of Environmental Affairs (2017). South Africa's 2nd Annual Climate Change Report.
11. Agarwal V, Deffarges J, Delteil B, Francois M and Tara K. (2022). By harnessing opportunities across sectors—particularly in power—Vietnam could potentially accelerate decarbonisation to achieve net-zero emissions by 2050. McKinsey.
12. IMF, Samoa: Technical Assistance Report—Climate Macroeconomic Assessment Program. 2022, Washington, D.C: International Monetary Fund.
13. IMF, Republic of Madagascar: Technical Assistance Report-Climate Macroeconomic Assessment Program. 2022, Washington, D.C.: International Monetary Fund.

Appendices

Appendix 1: Detailed evaluation of CCDR on China

Country details

- GDP per capita (2022, from CCDR): USD 11,761 (constant USD_{2020})
- Target GDP per capita in 2035 (from CCDR): USD 21,000
- GHG emissions per capita (2020): 9.9 tonnes CO_2e[1]
- Total GHG emissions (2020): 12.3 $GtCO_2e$[1]
- Electricity consumption (2020): 5,985 kWh per capita[2]
- Largest emitters (2018): Electricity & heat (45%), Industry (33%), transport (8%)[3]

General evaluation

Appreciation

- The CCDR explores key transformations in key sectors that would enable China to meet the commitments to peak carbon emissions before 2030 and become carbon neutral in 2060.
- The CCDR presents an evaluation of existing climate change mitigation and adaptation policies and identifies the gaps to reach the abovementioned targets.
- It suggests six interconnected policy packages for adopting climate actions that would help ease the trade-offs and maximise the potential synergies.
- The CCDR analysis presents a good balance of climate change mitigation and adaptation needs in China.
- The CCDR offers several recommendations for reducing emissions in the five major emitting sectors and shows the distributional impacts of decarbonisation in China.

Room for improvement

- There is barely any attention for adaptation support for smallholder farmers who face potential yield losses and species range shifts.
- Transparency could be increased by adding more details about the models applied and methodology used for determining the impact on GDP.
- Review of the uncertainties in the model used in this CCDR and a comparison with other model outputs could increase the robustness of results.
- An overview of scenarios assumptions would be helpful, as there are a set of NDC based and a set of Accelerated Decarbonization Scenarios (ADS) based scenarios, but it is not immediately clear what the assumptions behind these pathways/scenarios are.
- The role of discounting is not very clear (see below, for more details). The applied 6% social discount rate is within the high range of the literature.

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[1] Olivier J.G.J. (2022), Trends in global CO_2 and total greenhouse gas emissions: 2021 Summary report. PBL Netherlands Environmental Assessment Agency, The Hague

[2] https://ourworldindata.org/grapher/per-capita-electricity-generation

[3] https://www.climatewatchdata.org/data-explorer

Country commitments

The NDC target leads to an emission level of 13.4–14.7 $GtCO_2e$ excl. LULUCF by 2030 (270%–303% above 1990 level and 22%–33% above 2010 level). China also strives to reach a CO_2 emissions peak before 2030, and achieve carbon neutrality before 2060.

Comment

The level of ambition of NDCs has been reviewed by several institutes[4] and an evaluation of the ambitions and implementation progress of the NDCs in this CCDR is a useful addition.

Room for improvement

PBL evaluation and comments: A more critical value judgement of the country's long-term strategy to achieve the net-zero target could be a useful addition[5].

Models used

The CCDR uses two models:

- The World Bank's model on Mitigation, Adaptation, and New Technologies Applied General Equilibrium (MANAGE), a dynamic computable general equilibrium (CGE) model, that is designed to focus on energy and emissions.
- The CCDR also presents the results from an alternative macroeconomic model—E3ME—that allows for stimulus effects and induced technological change.

Appreciation

An illustration of the model architecture shows an overview of the framework. Some details are also presented in text boxes.

Room for improvement

A more detailed description of the model is given in a reference[6]. Adding more detail in the report itself could make the model methodology more transparent and accessible.

Discount rate

Six per cent is used by default, and net present values are also given based on the yield curve of China's treasury bonds, ranging from 2% for 1-year bonds to 3.4% for 50-year bonds.

Appreciation

The CCDR gives Net Present Value of the investment based on a discount rate and the yield curve of the country's treasury bonds.

Room for improvement

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[4] https://themasites.pbl.nl/o/climate-ndc-policies-tool/ (September 2021), https://climateactiontracker.org/countries/china/targets/

[6] https://www.oecd.org/gov/budgeting/integrating-climate-into-macroeconomic-modelling.pdf

Discount rates are mainly used in this CCDR for the present value of investment needs. The investment needs themselves do not seem to depend on the chosen discount rates. This seems to be inconsistent.

Carbon price

In the CCDR, the caron price is assumed to increase to USD 75 per tonne, by 2030

Appreciation

The applied carbon price demonstrates the considerable impact of carbon pricing on reducing China's emissions as an alternative to ETS.

Room for improvement

- It is unclear if any carbon price is applied in the reference scenario
- Presenting the methodology/model used to determine the carbon price could improve transparency of the results.

Comment

The applied carbon price is higher than the price implemented in China in the IEA announced pledges scenario (USD 30 per tCO_2e in 2030 and USD 95 per tCO_2e in 2040) but lower than the IEA Net-Zero Emissions by 2050 scenario (USD 90 per tCO_2e in 2030 and USD 160 per tCO_2e in 2040)[7].

Scenarios

A reference scenario and the following set of NDC based scenarios for the energy system are used:

- Carbon neutrality with revenue recycling to investment
- Carbon Neutrality with compensation
- Carbon Neutrality with flexible labour markets
- Carbon Neutrality with air pollution co-benefits

Furthermore, an enhanced policy scenario for the transport system is used as well as a set of 'Accelerated Decarbonization Scenarios (ADS)' to illustrate the potential benefits and costs of an accelerated emission reduction pathway.

Appreciation

- The diversity of the scenarios that are also aligned with China's 30/60 goals and its updated NDC allows simulating the impact of various policy sets on climate and economy.
- The scenarios cover a combination of economy-wide and sector-specific reforms in the key emitting sectors.

Room for improvement

- An extended explanation of the scenarios could aid better understanding of the results.

[7] IEA, 2021, World Energy Model Documentation, https://iea.blob.core.windows.net/assets/932ea201-0972-4231-8d81-356300e9fc43/WEM_Documentation_WEO2021.pdf

- A better explanation of the assumptions behind the ADS scenario before presenting results could increase readability

Mitigation policy packages

The CCDR recommends the following mitigation policy packages, grouped by theme:

- Accelerate the **power sector** transition with market reforms and investments in renewables:
    - Scale up solar and wind power generation capacity to 1,200 GW by 2030, in line with China's Nationally Determined Contribution (NDC)
    - Adopt international best practices in system planning, reliability regulations, and variable renewable energy (VRE) generation forecast and dispatch to reduce the need for additional coal-fired generation capacity
    - Accelerate the integration of provincial and regional power markets to optimise overall capacity usage
    - Expedite electricity market reforms
    - Promote demand management measures for electricity use and heating

- Decarbonise the key energy demand sectors **industry and transport:**
    - Advance electrification beyond public transport vehicles to include the private and commercial fleet
    - Combine regulatory measures with pricing instruments to encourage fuel and energy efficiency improvement by the private sector
    - Promote modal shifts from passenger vehicle transport to public transport, railway and waterway (for freight transport), through deeper integration across modes and pricing incentives
    - Promote technology development for alternative low-carbon fuels for harder-to-decarbonise sectors
    - A shift from traditional investment-led to more consumption-driven growth would reduce trade-offs between the government's short-term growth objectives and long-term climate targets
    - Greater attention for circular economy opportunities would reduce emissions intensity and help overcome material supply bottlenecks
    - In the longer term, there is a need to support direct and indirect drivers of technological advancement
    - Decarbonise the industrial sector, which may also induce relocation of industries toward provinces with higher renewable energy potential

- **Enhance climate resilience** and low-carbon development in rural landscapes and urban areas:
    - Elevate nature-based solutions within the national climate change planning process and use carbon credits to leverage new sources of financing
    - Reduce China's food system-related greenhouse gas (GHG) emissions by repurposing agricultural public support, reducing food loss and waste, and recycling
    - Promote denser, well-connected, and people-oriented urban growth

    - Combine grey and green solutions and engage local planning authorities to protect critical public assets against floods, storm surge, and sea level rise
    - Strengthen city-level GHG inventories and related analytics to help cities identify key emissions reduction potential and monitor progress toward achievement of carbon goals
    - Strengthen fiscal incentives and financial and building regulations to encourage private investment in more energy-efficient buildings

- **Harness markets** to drive cost-effective economy-wide abatement and innovation:
    - Expand the role of carbon pricing with forward guidance
    - Deepen state-owned enterprise (SOE) reforms to enhance competition, productivity growth, and emissions reduction
    - Foster market-driven green finance
    - Create an effective innovation ecosystem by correcting market and governance failures in innovation and early-stage technology diffusion
    - Reform trade and investment policies to encourage low carbon production and consumption

- Manage transition risks to ensure a **just transition:**
    - Enhance labour market flexibility and social safety nets to enable a more seamless labour market adjustment
    - Provide more targeted assistance that goes beyond social safety nets, to groups that will experience concentrated losses from the low-carbon transition

- Foster **global climate action:**
    - Create stricter rules for outward foreign finance
    - Assist emerging economies with low-carbon projects

Appreciation

- The CCDR provides concrete policy recommendations for decarbonising the different sectors and for increasing the capacity of the electricity sector
- The CCDR provides concrete policy measures to enhance climate resilience and low-carbon development in rural landscapes and urban areas
- The CCDR provides a set of economy-wide policies to facilitate cost-effective economy-wide abatement and innovation
- The CCDR provides policies to ensure just transition in sectors, occupations and regions that are unproportionally affected by the low-carbon transition
- Most of the policies in the scenarios show synergies with other development goals as discussed in a recent PBL report[8].

[8] Dagnachew AG, Hof AF, Van Soest H and Van Vuuren DP. (2021). Climate change measures and sustainable development goals. The Hague, PBL Netherlands Environmental Assessment Agency

Room for improvement

- A discussion of synergies and trade-offs (similar to Figure 42) with other measures and sectors could be a useful addition for policymakers.
- The scenarios provide concrete policy recommendations for decarbonising and increasing the capacity of the electricity sector.

Scenario results

The CCDR presents the following results for the different scenarios:
Reference scenario:

- Cumulative emissions 2022–2060: 405 $GtCO_2e$
- GDP per capita in 2060: USD 35,719
- Investment needs in power and transport for the 2021–2060 period: USD 14 trillion (0.97% GDP)

In all carbon neutrality scenarios, cumulative emissions in the 2022–2060 period are 28% lower than in the reference scenario. The results for cumulative output relative to reference are:

- Scenario 1: Carbon neutrality with revenue recycling to investment: -0.66%
- Scenario 2: Carbon Neutrality with compensation: -2%
- Scenario 3: Carbon Neutrality with flexible labour markets: +0.31%
- Scenario 4: Carbon Neutrality with air pollution co-benefits: -0.11%

Appreciation

The CCDR presents the impact of certain policy measures on the climate and the economy in the short and long term.

Room for improvement

Explaining the methodology including uncertainties could increase transparency.

Adaptation policy packages

The CCDR recommends the following adaptation policy packages, grouped by theme:

- Facilitate the adaptation capacity of people, firms, and local governments
    - Strengthen interinstitutional collaboration and vulnerability data access to households, firms, and local governments
    - Enhance local government capacity to address pluvial flooding and landslide hazards
    - Develop an adaptation effectiveness evaluation framework
    - Develop new financial tools to attract private funding for adaptation investments
- Integrate adaptation in land use and water use plans
    - Develop guidance and plan investments that promote science-based adaptation measures in agriculture
    - Invest in proactive water-related risk management
    - Strengthening the role of nature-based solutions in climate adaptation
- Protect critical public assets and services, particularly in urban areas
    - Combine grey and green infrastructure solutions in managing flood and drought risks to cities, settlements, and key infrastructure
    - Localise adaptation strategies against sea level rise and storm surges
- Help the most vulnerable manage residual risks and natural disasters

- Improve the targeting of social transfers to address climate vulnerabilities

Appreciation

The CCDR identifies adaptation policy gaps in priority areas and provides policy recommendations.

Room for improvement

- A summary of the Adaptation Principles framework[9] used for the analysis could improve readability.
- Estimation of damages from climate change and the cost of adaptation could be a useful addition to the CCDR.

[9] Hallegatte, S., Rentschler, J., Rozenberg, J., 2020. The Adaptation Principles A Guide for Designing Strategies for Climate Change Adaptation and Resilience. The World Bank Group, Washington, DC.

Appendix 2: Detailed evaluation of the CCDR on G5 Sahel

Country details

- GDP per capita (2021, from CCDR, USD_{2021})
  - Average G5 Sahel: USD 790
  - Burkina Faso: USD 839
  - Chad: USD 673
  - Mali: USD 887
  - Mauritania: USD 1,736
  - Niger: USD 570
- GHG emissions per capita (2019)[1]
  - Burkina Faso: 2.77 tonnes CO_2e
  - Chad: 6.63 tonnes CO_2e
  - Mali: 2.25 tonnes CO_2e
  - Mauritania: 2.92 tonnes CO_2e
  - Niger: 1.89 tonnes CO_2e
- Total GHG emissions (2019)[1]
  - Burkina Faso: 56.32 $MtCO_2e$
  - Chad: 105.68 $MtCO_2e$
  - Mali: 44.16 $MtCO_2e$
  - Mauritania: 13.21 $MtCO_2e$
  - Niger: 43.96 $MtCO_2e$
- Electricity consumption (2020)[2]
  - Burkina Faso: 77 kWh per capita
  - Chad: 17 kWh per capita
  - Mali: 158 kWh per capita
  - Mauritania: 379 kWh per capita
  - Niger: 17 kWh per capita
- Largest emitters (2020)[3]
  - Burkina Faso: Agriculture (42%), Land-Use Change and Forestry (43%), Energy (10%)
  - Chad: Agriculture (70%), Land-Use Change and Forestry (23%)
  - Mali: Agriculture (81%), Energy (15%)
  - Mauritania: Agriculture (74%), Energy (32%), Land-Use Change and Forestry (-8%)
  - Niger: Agriculture (72%), Waste (16%), Energy (7%)

General evaluation

Appreciation

- The CCDR has three clear messages that cover the potential of the countries for low-carbon development, the synergies between resilient and inclusive development and other development goals, and the benefits of early and targeted actions on policies and programmes.

- The CCDR presents the challenges of the region for sustainable development including water stress, environmental degradation, competition for resources, conflict, rapid population growth, and high maternal mortality.
- The CCDR also illustrates the potentials of G5 Sahel to tackle and cope with climate change: mineral resources that are critical for GHG emission reduction technologies, huge renewable energy potential, and large and growing labour force.
- The CCDR describes the consequences of climate change that is already being observed in the countries and assesses the existing policies and institutions for resilience and risk management.
- The CCDR outlines the need for building human capital and the capacity of the countries to do so, and awareness creation and capacity building of communities to stimulate locally led smart development.
- The CCDR presents a comprehensive picture of interacting factors of crisis in agriculture, violent conflicts, and weak governance in Sahel.
- A country-specific model was used to assess the poverty and distributional impacts of climate change-related shocks.

Room for improvement

- The quantitative analysis on agriculture, water, fisheries, and forest in Chapter 1 could be more transparent with clear explanation of the background methodology.
- The focus of the modelling exercise is the impact of and adapting to climate change, excluding mitigation policies while the combined financial needs for mitigation in the NDCs is higher than for adaptation.
- Modelling beyond 2050 (rather than stopping in 2050) could show the magnifying effects of climate change.
- There is little attention in the CCDR for migration, while, in the Sahel, climate change affects not only the likelihood but also the condition under which people migrate.
- There is little attention for the risk of stranded assets and nothing about the risk of stranded resources in the countries.
- Review of the uncertainties in the model used in this CCDR and a comparison with other model outputs could increase the robustness of results.

Country commitments

The CCDR presents a summary of the NDC commitments, and it also offers recommendations on financing the NDCs. The NDCs are estimated to lead to the following GHG emission levels:

- Burkina Faso: 55 $MtCO_2e$
- Chad: 105 $MtCO_2e$
- Mali: 44 $MtCO_2e$
- Mauritania: 13 $MtCO_2e$
- Niger: 46 $MtCO_2e$

Targets beyond NDCs that are considered include:

- All five have pledged to achieve net-zero emissions by 2050
- Burkina Faso, Chad, Mali, and Niger pledged to halt and reverse forest loss and land degradation by 2030

- Burkina Faso and Mali joined the pledge to reduce global methane emissions by at least 30% from 2020 levels, by 2030
- Mauritania agreed to phase out coal power

Comments

- The level of ambition of NDCs has been reviewed by several institutes and an evaluation of the ambitions and implementation progress of the NDCs in this CCDR is a useful addition.
- land use measures and reducing methane emissions through proper manure management and selective breeding, such as mentioned in beyond NDC targets, are identified as best practice policies in the region in a recent PBL report[8].
- halting the construction of unabated coal power plants is identified as best practice policy for Sub-Saharan Africa in the same PBL report because of high potential for emission reduction and several synergies with other SDGs.

Models and scenarios

The macro-structural modelling is done with a country-specific Climate Change Macro-Fiscal Model (CC-MFMod)[10]. Three growth scenarios (low, medium and higher growth) are implemented as baseline assuming no additional climate change impacts beyond what has already been experienced up to 2020. Six climate scenarios (three capturing emission uncertainties based on the shared socio-economic pathways and three covering model uncertainties) are implemented. Section 2.2 indicates that a set of growth and development scenarios was developed and presents the required investments according to these scenarios. The scenario results show that the investment needs of some of these countries are much lower than submitted in NDCs.

Appreciation

- A country specific model was used allowing capturing country-specific dynamics.
- Several scenarios were developed to capture uncertainties in emissions and models.

Room for improvement

- A description of the model would make the model methodology transparent and accessible.
- Better scenario description (of the growth scenarios) before presenting the results from the scenario analysis in Chapter 2 would increase readability of the CCDR.
- The scenarios presented cover adaptation activities only. Adaptation to changing climate is necessary but excluding mitigation could underestimate the strong synergy between adaptation and mitigation actions.

10 https://openknowledge.worldbank.org/bitstream/handle/10986/32217/WPS8965.pdf?sequence=4&isAllowed=y

Discount rate

A discount rate of 3% is used.

Appreciation

The discount rate is in the range of widely used social discount rates

Room for improvement

The only time the discount rate is used in the CCDR is to show the present value benefits and costs of clean cooking investment programme and benefit–cost ratio. In the annex, it is also used to show present value benefits and costs of the land restoration programme. It is not clear if the investment needs and the cost of inaction themselves depend on the chosen discount rates.

Important parameters

- Disability-adjusted life years (DALYs) are estimated at 5 times GDP per capita
- The cost of mortality or the cost of one death due to HAP is estimated at 70 times GDP per capita
- The opportunity costs of time spent is estimated at USD 0.54 per hour
- The social cost of carbon is set at USD 45.92

Room for improvement

The source for these parameters is mentioned in a footnote[11] but summarising the methodology used would increase transparency.

Macroeconomic and poverty impact

The following impacts are discussed:

- Rainfed crop yields: Expanded irrigation. Rehabilitation and construction of new irrigation for high-value crops and food crops to counter the impact of reduced water availability
- Heat stress and labour productivity: Two interventions to compensate for the productivity losses of pastures: (i) Purchasing crop residues from domestic crop production to use as animal feed; and (2) Investment in establishing fodder banks
- Heat-related human health shocks: Health shocks on labour productivity. Impact on total labour productivity from health shocks due to temperature changes
- Livestock yields: Livestock productivity shocks. Impact due to heat stress on animals and reduced availability of pastures to graze due to temperature and precipitation changes
- Inland flooding: Capital damages due to precipitation changes, considering floodplains, design flood events, spatial distribution of capital, and run-off dynamics
- Roads and bridges: Capital damages to road and bridges infrastructure due to temperature and precipitation changes, and flooding effects across paved, gravel, and dirt roads

Appreciation

[11] Enriquez, S., B. Larsen, and E. Sánchez-Triana, Good practice note 8- Local Environmental Externalities due to Energy Price Subsidies: A Focus on Air Pollution and Health. 2018

The impact channel modelling makes the results country- and sector-relevant.

Room for improvement

- The methodology and justification of the selection of the impact channels would improve transparency
- While the focus of the CCDR is on adaptation measures, Box 3.3 presents the Net-Zero Carbon Scenario of IEA. An explanations and description of the net-zero scenarios in Chapter 3 would improve readability of the CCDR.

Economic analysis

Economic analyses have been performed for two scenarios: one without adaptation and one with adaptation interventions. Without adaptation, the main results are:

- combined GDP losses from the six impact channels in the wet/optimistic scenario in 2050 range from -2.2% in Niger to -6.4% in Mali relative to the medium-growth baseline.
- combined GDP losses from the six impact channels in the dry/pessimistic scenario in 2050 range from -6.8% in Burkina Faso to -11.9% in Niger, relative to the medium-growth baseline.
- climate change increases poverty and inequality in Sahel.

Adaptation interventions are modelled for three impact channels:

- Rainfed crop yields: expanded irrigation
- Livestock yields: crop residues as feed and investment in establishing fodder banks
- Roads and bridges: make roads and bridges network climate resilient

The reduction in GDP losses in 2050 under the dry/pessimistic medium-growth scenario range from 2.1 pp in Mauritania to 4.8 pp in Chad, relative to no-adaptation scenarios.

Appreciation

- The results presented in Sections 3 for all impact channels under all scenarios give a comprehensive picture of the climate impact in G5 Sahel.
- The impact channel modelling makes the results country and sector relevant
- The CCDR emphasises the need for harnessing the power of the private sector

Room for improvement

- An extended explanation of the figures would aid better understanding of the results.
- A detail explanation of the methodology, data sources and assumption would increase the transparency and ownership of the results.

Recommendations

The CCDR lists the following recommendations, grouped by theme:

- Institutional capacity and delivery model
    - building essential institutional foundations for both development and climate action
    - clarifying the roles and responsibilities of agencies
    - identifying and supporting the need for expertise
    - building local inclusive institutional processes that support climate action
- Increasing Financing for Climate Action
    - using existing national resource more climate informed

    - accelerating the roll-out of mobile money and Digital Financial Services
    - leveraging large-scale private finance
    - increasing international climate finance
- Energy
    - adopting national electrification plans to expand low-carbon electricity access
    - facilitating access to independent power producers
    - strengthening governance mechanisms to improve operational and financial performance
    - recognising access to clean cooking as a climate agenda
    - making clean cooking an important part of national energy planning
    - developing and enforcing regulations and standards to promote clean cooking
- Landscapes: the importance of connecting the environment, water, and agriculture
    - support the professionalisation of local communities and vulnerable groups
- Environment: The fundamental Basis of Natural Capital
    - mapping different land uses and identifying the investments that would maximise natural capital and productive uses
    - availability of policy reforms and investments to scale up re-greening
    - funding for universities or specialised regional research centres
    - strengthening the key pillars of the landscape approach through participation, governance, and sustainability
- Agriculture, Livestock, and Fisheries
    - professionalising farmers and disseminate information and assistance (effective practices, irrigation technologies, crop selection, and early warning system)
    - reforming land tenure policies, strengthening women's formal land rights, securing land titles, and supporting inclusive land management and conflict resolution mechanisms
    - scaling up adaptation programs
    - investing in sustainable land husbandry, animal nutrition, vaccines, improved veterinary services, and fisheries practices
    - developing and strengthening agroforestry value chains
    - expanding efficient irrigation systems and water harvesting practices

Appreciation

- The CCDR recognises the critical role of strong intuitions in climate change adaptation
- The CCDR gives clear short- and medium-term policy recommendations
- the CCDR promotes climate change mainstreaming into sectoral interventions and highlights the need for mainstreaming climate considerations into existing budgeting and planning processes
- the CCDR recognises the critical role of energy for human development and offers concrete recommendations
- the CCDR pays attention to the vital role of regional integration
- the CCDR recognises the crucial role of natural capital in social, economic, and environmental sustainability
- the CCDR recognises the role of indigenous knowledge and participation of local communities for strengthening resilience
- the CCDR recognises unlocking the youth and women potential as a key priority
- the CCDR emphasises the role of regional trade in improving food security

Room for improvement

- an emphasis on the limited capacity of G5 Sahel to integrate climate change into sectoral policies, ministries, and local development plans would be useful
- highlighting not just mainstreaming but also integrating programs and processes could enable harness the synergies resulting in efficient uses of scarce financial resources
- the synergies and trade-offs of clean and modern energy access with other development programs is not well explored
- equity gender issues and women's empowerment are not covered in the recommendations
- the role of efficiency is not adequately covered
- proactive adaptation of roads, bridges, power grids, and other key infrastructure elements could be discussed in the section
- a clear summary of the methodology used to calculate the investment needs would increase transparency
- while some crop yields are projected to decline due to climate change others are projected to benefit from CO_2 fertilisation. This could influence adaptation strategies, which is not made clear in the analysis.

Appendix 3: Detailed evaluation of CCDR on South Africa

Country details

- GDP per capita (2021, from CCDR): USD 7,055 (USD_{2021})[12]
- GHG emissions per capita (2020): 9.3 tCO_2e, which is above the G20 average of 7.8 tCO_2e[1]
- Total GHG emissions (2020): 550 $MtCO_2e$[1]
- Electricity consumption (2021): 4,114 kWh per capita[2]
- Largest emitters (2018): Electricity & heat (85%), Agriculture, Industry (both 5%)[3]

General evaluation

Appreciation

- The CCDR proposes three interconnected transitions to be integrated in the development paradigm: i) Mitigating climate change—the low-carbon transition, ii) Adapting to climate change—the resilient transition, and iii) Protecting poor and vulnerable people—the just transition.
- The CCDR builds on the Economic Reconstruction and Recovery Plan (ERRP) and highlights the fragmentation of responsibilities and limited capacity for implementation.
- The CCDR presents a summary of the significant challenges and opportunities for South Africa's just transition to a low-carbon economy.
- The CCDR addresses climate risks for SMEs and provides recommendation on how to minimise the impacts.

Room for improvement

- The quantitative analysis could be more transparent with clear explanation of the background methodology.
- Modelling beyond 2050 (rather than stopping in 2050) could show the magnifying effects of climate change.
- Review of the uncertainties in the model used in this CCDR and a comparison with other model outputs could increase the robustness.
- The CCDR barely mentions the role of youth participation, even though the youth accounts for a third of the population and are largely affected by climate change[13]. This aspect is highlighted in South Africa's 2nd climate change report[14].
- There are substantial gas developments underway, with plans to import gas from Mozambique. The CCDR does not address risk of stranded assets and resources.

[12] https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=ZA

[13] https://www.unicef.org/southafrica/press-releases/80-cent-young-people-affected-climate-or-environment-related-event

[14] https://www.dffe.gov.za/otherdocuments/reports/southafricas_secondnational_climatechange

Country commitments

The CCDR presents a summary of the NDC commitments. The NDC of South Africa is estimated to lead to 350–420 $MtCO_2e$ GHG emissions by 2030 (a reduction of 22%–34% below 1990 levels) and South Africa has pledged to achieve net-zero emissions by 2050.

Comments

The CCDR states that the NDC commitments to reach net-zero by 2050 are unclear. The level of ambition of NDCs has been reviewed by several institutes and an evaluation of the ambitions and implementation progress of the NDCs in this CCDR is a useful addition. Halting the construction of unabated coal power plants is identified as best practice policy for Sub-Saharan Africa in a recent PBL report[7] because of high potential for emission reduction and several synergies with other SDGs.

Models used

A full energy sector model SATIM is used, which includes several primary energy options. The impacts of the energy sector transformation are assessed with SAGE model, and a third model is used to capture the distributional impact on households and jobs. A reference scenario and a variety of net-zero scenarios are presented.

Appreciation

- a country specific model was used allowing capturing country-specific dynamics.
- there are several scenarios to explore mitigation, adaptation and just transition.

Room for improvement

- a description of the model would make the model methodology transparent and accessible
- a better scenario description could increase readability of the CCDR
- The scenarios are based on the pessimistic SSP3 and do not show the range of results for other socioeconomic projections

Discount rate

Appreciation

The CCDR provides discounted and undiscounted investment needs for several scenarios

Room for improvement

It seems that discount rates are mainly used in this CCDR for the present value of investment needs. It is not clear if the investment needs and the cost of inaction themselves depend on the chosen discount rates.

Cost estimates

The CCDR concludes that the annual financing requirements to upgrade the country's assets are equal to 3% of their value.

Room for improvement

The source on which this result is based[15] is mentioned in a footnote but summarising the methodology would increase transparency.

Carbon price

There is an existing carbon tax of ZAR 144 or about USD 8.70 per tonne; a higher carbon tax is proposed in the Net-zero scenario (a rate converging toward ZAR 1,415 or USD 88 per tonne, by 2050).

Appreciation

The proposed carbon price could create additional revenue for the government for financing public investments and social programmes.

Comment

The applied carbon price is lower than the IEA Net-Zero Emissions in 2050 scenario[6] which has a carbon price of USD 90 per tCO_2e in 2030 and USD 160 per tCO_2e in 2040 in major emerging economies, such as South Africa.

Scenarios

The CCDR includes scenarios focusing on mitigation, adaptation and a just transition. The mitigation scenario (i.e. low-carbon transition) has an average GDP growth of about 2.3% per year, between 2022 and 2050, which remains short of the government's ambitions. The financial requirements could reach ZAR 4.2 trillion in net present value, between 2022 and 2050 (2.1% of GDP average per year). The adaptation scenario (i.e. resilient transition) focuses on Resilient water, Resilient agriculture, Resilient cities, and Resilient transport. It provides two estimates of adaptation costs. Top-down modelled adaptation cost would amount to about ZAR 1.8 trillion in net present value, over the 2022–2050 period, and bottom-up modelled adaptation cost would amount to ZAR 2.4 trillion (1.3% of GDP average per year). The just transition scenario manages the social impacts of the low-carbon transition by increasing labour mobility, skills development, MSME support, at a cost of ZAR 581 billion in net present value, from 2022 to 2050. The social impacts of increased climate change-induced shocks are managed by building resilience: identify who are the most affected and protect them, at a cost of ZAR 1.9 trillion in net present value over the 2022–2050 period (1% of GDP average per year).

Appreciation

- the CCDR presents various net-zero scenarios with varying ambitions and emission reduction potentials
- the impact channel modelling makes the results country and sector relevant
- the two methodologies of modelling adaptation costs provide relevant uncertainties
- the CCDR addresses the need for substantial just transition measures given the high workforce involved in the coal sector

[15] Hallegatte, S. et al. 2017. Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters: Climate Change and Development. Washington, DC, World Bank.

Room for improvement

- a detailed explanation of the methodology, data sources and assumption would increase the transparency and ownership of the results
- macroeconomic damages of climate risks and the costs of adaptation are presented under a pessimistic scenario; other variations of the Shared Socioeconomic Pathways would provide alternative pathways
- an extended explanation of the SAGE model and the scenario assumptions could aid better understanding of the results.

Appendix 4: Detailed evaluation of the CCDR on Vietnam

Country details

- GDP per capita (2022, from CCDR): USD 3,329 (constant USD_{2020})
- Target GDP per capita in 2045 (from CCDR): USD 12,695 (constant USD_{2020})
- GHG emissions per capita (2018): 3.8 tCO_2e[1]
- Total GHG emissions (2018): 364 $MtCO_2e$[1]
- Electricity consumption (2020): 2,745 kWh per capita[2]
- Largest emitters (2020): Energy (65%), Agriculture (19%)[3]

General evaluation

Appreciation

- The CCDR suggests actions to reconcile development objectives with climate change adaptation and mitigation, with the smallest burden on the poor.
- The CCDR assesses policy and institutional gaps, as well as public and private financing needs to meet climate and development objectives.
- Synergies and trade-offs between climate change mitigation and adaptation and other development objectives are well explored, and some suggestions to minimise trade-offs are provided.
- It recognises that the plan does not address all the climate-related challenged that the country is facing.

Room for improvement

- The CCDR can benefit from a systematic and comprehensive assessment of the climate risks faced by the financial sector in Vietnam, and evaluation of the risks for banks.
- Transparency could be increased by adding more details about the models applied to develop scenarios and methodology used for determining the impact on vulnerable assets.
- An overview of scenarios assumptions would be helpful, as there are different BAUs (BAU and CPS) and different mitigation pathways (NZP, ADS, Decarbonising Pathway) and it is not immediately clear what the differences between these pathways/scenarios are.
- A range of values for the quantitative estimates of damages from climate change would better represent the variability of the estimates in the literature. An explanation of the methodologies in estimating these damages could be helpful to put the results in context.
- The role of discounting is not very clear (see below, for more detail). The applied 6% social discount rate is very high.

Country commitments

The NDC of Vietnam is estimated to lead to 677 (conditional) to 844 (unconditional) $MtCO_2e$ GHG emissions by 2030 (Annex 1 of the CCDR). Vietnam is further committed to investing no longer in new coal power generation, scale up deployment of renewable energy, and phase out coal by the 2040s.

Comments

The emission estimates reflect the updated NDCs from 2020, in which the BAU projection has increased from 787 to 928 $MtCO_2e$ leading to higher emission target levels. The measures in the power sector are also identified as best practice policies for Southeast Asia in a recent PBL report because of high potential for emission reduction and several synergies with other SDGs[7].

Models used

The World Bank's model on Mitigation, Adaptation, and New Technologies Applied General Equilibrium (MANAGE), a dynamic computable general equilibrium (CGE) model that is designed to focus on energy, emissions, and climate change is used in the study. The model was run against RCP 2.6 and RCP 4.5. For agricultural losses, data is shown for RCP 8.5, as well. The climate change impacts are calculated by the difference between the results from a baseline scenario in which the impacts are ignored and an alternative scenario where the climate change impacts are included. A probabilistic catastrophe model is used to estimate the economic impacts associated with extreme weather events, such as typhoons and tropical storms.

Appreciation

- A brief description of MANAGE model is given in Chapter 3

Room for improvement

- A more detailed description of the CGE model, as given in the reference[5], would make the model methodology transparent and accessible.
- A summary of the catastrophe model would improve transparency and accessibility. There is no information in the CCDR about this model, but the references provided in the CCDR[16] gives a detailed explanation of the methodology supported by schematics and applied cases.

Discount rate

Six per cent is used by default, and results for 2% and 0% are also provided in Annex 3c of the CCDR.

Appreciation

The CCDR gives investment estimates under different discount rates.

Room for improvement

Discount rates are mainly used in this CCDR for the present value of investment needs. The investment needs themselves do not seem to depend on the chosen discount rates. This seems to be inconsistent. The CCDR mentioned that for evaluating projects, a social discount rate should be used instead of a market interest rate but estimates of social discount rates are generally in the

[16] https://documents1.worldbank.org/curated/en/773621468189559390/pdf/97447-WP-Box391476B-PUBLIC-PCRAFI-REPORT-WEB-Final.pdf; https://documents1.worldbank.org/curated/en/854961468184437420/pdf/WPS7717.pdf

order of 1% to 3%, which is much lower than 6%[17]. The 2% value would seem more appropriate, which would increase the present value of investment needs by about 50%.

Elasticity

It is assumed that a 1% decrease in air pollution augments labour productivity by 0.3%

Room for improvement

The number is based on unpublished WB report. The CCDR reader would benefit from better explanation of the methodology used.

Asset upgrading cost

The overall annual financing need for upgrading the country's assets is estimated at about 3% of their value.

Appreciation

A proxy value provided by a methodology developed by WB economists is used.

Room for improvement

Although a reference is given, a summary of the methodology in the CCDR would improve transparency.

Energy efficiency

It is assumed that the improvement of energy efficiency in industrial and services production gradually increases and reaches 5% by 2040.

Room for improvement

The reader could benefit from an explanation of the chosen rate of efficiency, which is at the lower end of the national energy efficiency programme target[18].

Scenarios

Several scenarios are used throughout the CCDR:

- Business As Usual (BAU)
- Resilient Pathway
- Decarbonising Pathway
- Resilient and Net-Zero Development Pathway (RNZP)
- Net-Zero Pathway (NZP)
- Currently Proposed Policy Scenario (CPS)

[17] Drupp MA, Freeman MC, Groom B and Nesje F. (2018). Discounting disentangled. American Economic Journal: Economic Policy 10: pp. 109–134, and Giglio, S., M. Maggiori, J. Stroebel and A. Weber (2015). Climate change and long-run discount rates: Evidence from real estate. Cambridge

[18] https://documents1.worldbank.org/curated/en/598851561961183317/pdf/Vietnam-National-Energy-Efficiency-Program-2019-2030.pdf

- Accelerated Decarbonization Scenario (ADS)

Room for improvement

The differences between the mitigation scenarios are not always clear, especially between the NZP, decarbonisation and ADS scenario. Also, the difference between CPS and BAU is not clear.

Carbon price

The applied carbon prices are as follows:

- BAU/CPS: Current carbon taxation levels are stated based on the Environmental Protection Tax in Vietnam: USD 0.50 per tCO_2e on coal, USD 77.60 per tCO_2e on petrol, and USD 32.90 per tCO_2e on diesel.
- Resilient Pathway: None indicated
- Decarbonising Pathway/ NZP/ ADS: Several options were analysed for an economy-wide carbon tax:
    - Current carbon tax: USD 12 per tCO_2e in 2022 (weighted average on coal, diesel, and petrol)
    - Option 1: increases to USD 40 per tCO_2e by 2040
    - Option 2: increases to USD 90 per tCO_2e by 2040 (this was used for the decarbonising pathway/NZP, as this would reduce emissions by more than 70% by 2040 if combined with sectoral investments (see measures below). Unclear whether this was also applied for ADS)
    - Option 3: increases go up to USD 120 per tCO_2e by 2040

Comment

There is considerable uncertainty in carbon prices needed to achieve NDCs: Perry (2019)[19], cited in the CCDR document, concludes that a carbon price of USD 35 per tCO_2 would exceed the level needed to meet mitigation commitments in Vietnam. However, Do and Burke (2021)[20] find that carbon price starting at USD 1.85 and 3.86 per tCO_2 on fossil fuels starting from 2022 and increasing at a real rate of 10% per year would already meet the unconditional and conditional NDC target for the energy sector, respectively.

Appreciation

Multiple options for carbon tax are analysed, indicating various plausible pathways. The applied carbon prices are in the same order of magnitude as implemented in IEA Announced Pledges and Net-Zero Emissions by 2050 scenarios.

[19] Parry, I. 2019. 'Putting a Price on Pollution: Carbon-Pricing Strategies Could Hold the Key to Meeting the World's Climate Stabilization Goals.' Finance and Development, December 2019

[20] Do, T. N. and P. J. Burke (2021). 'Carbon pricing in Vietnam: Options for adoption.' Energy and Climate Change 2

Room for improvement

Putting the chosen carbon tax in the context of previous studies could help justify the choices and assumptions made.

Policy packages

The CCDR recommends the following policy packages, grouped by scenario:
Adapting to Climate Change — The Resilient Pathway:

- Resilient agriculture and forestry: increased public spending on R&D, upgrading and expanding irrigation infrastructure, protecting and sustainably managing forests, promoting CSA, improving access to finance for smallholders, and afforestation and reforestation
- Resilient infrastructure: upgrade road and power assets, integrating different transport networks, and introducing a life-cycle asset management approach
- Resilient trade and manufacturing: policies and regulations for industry resilience and relocating the most climate-vulnerable industries
- Resilient Mekong Delta: water conservatory measures and innovative instruments to mobilise additional resources
- Resilient shores and cities: integrated coastal resilience investment programme, a systematic approach to using nature-based solutions, and restricting new developments
- Caring for the most vulnerable people: social safety net programs, information technology and other digital technologies for forecasting and early warning systems, and prioritise investments in infrastructure and social services

Decarbonising Pathway/ NZP/ ADS:

- Decarbonising energy: measures shifting away from coal power, rapid renewable energy deployment and accelerated implementation of energy efficiency plans
- Decarbonising transport: measures include shifting freight transport from road to waterborne transport, shifting urban passenger transport from personal vehicles to public transport systems, and improving the energy efficiency of motorised vehicles
- Decarbonising agriculture: measures include reducing fertilizer and pesticide, changes in cattle feed, herd health, and breeding practices, and increasing in subsidies for forest services
- Decarbonising trade and investing in new technologies: mainly involves technological shifts toward low-emitting activities

Appreciation

- Important adaptation measures are defined. Measures that reduce deforestation and increase afforestation also can contribute to mitigating climate change.
- The CCDR addresses the role of several climate change mitigation measures. The mitigation strategy submitted with the NDCs cover similar sectors (energy, agriculture and land use, waste, and industry). Synergies and trade-offs (for instance, increased electricity prices) are discussed and measures are proposed to limit these trade-offs.

Room for improvement

Explaining the methodology behind the choice of measures could increase transparency as previous studies show other effective measures as well. For instance, the use of CCUS[21] is not discussed in the CCDR.

Economic analysis

The Resilient Pathway:

- The climate change impact on the country's economy and national welfare was 3.2% of GDP (USD 10 billion) in 2020
- The costs of climate impacts could reach 9.8% of GDP under RCP 2.6, and 12.3% of GDP under RCP 4.5 by 2050, from 6% in 2022.
- At the same time, the costs of climate catastrophes could average around an additional 2% per year
- The required additional investments amount to USD 254 billion between 2022 and 2040
- Incremental climate change adaptation costs are estimated at USD 342–411 billion over the 2022–2050 period (equivalent to 4.5%–5.4% GDP per year)
- Total financing needs amount to USD 479–547 billion over the 2022–2050 period (equivalent to 6.3%–7.2% GDP per year)

Decarbonising pathway / NZP/ ADS

- The total cost of necessary investments is estimated at about USD 81.3 billion between 2022 and 2040 (80% for energy transition, and 20% for agriculture, transport, and industry) and an additional USD 33 billion for social programmes
- The investments alone reduce GHG emissions by 9% in 2030 and 21% in 2040 relative to a BAU scenario
- Adding a carbon price could reduce GHG emissions further by 70% in 2040. GDP would be 0.6% lower in 2030 and 2.2% lower in 2040 than in the BAU scenario, but this can be countered by policies that align decarbonisation and development objectives.

Room for improvement

- Putting the estimated costs in the context of financial requirements of the NDCs would make it easier to understand. The financial requirement of the resilient pathway (USD 14 billion per year, on average) is more than fourfold the climate adaptation cost estimate submitted for the NDCs (USD 3.5 billion per year).
- GDP impacts seem to exclude the impacts of climate change. The main reasons why GDP increases relative to BAU is i) less air pollution, ii) increased competitiveness, iii) higher energy efficiency

[21] IEA (2022), Southeast Asia Energy Outlook 2022, OECD Publishing, Paris, https://doi.org/10.1787/10bc5730-en

Vulnerability of assets and communities

The following vulnerabilities are discussed in the CCDR:

- Agricultural losses amount to 5.6% (RCP 2.6), 6% (RCP 4.5) and 6.2% (RCP 8.5) in 2030 and 7.6% (RCP 2.6), 7.9% (RCP 4.5) and 10.6% (RCP 8.5) around 2050 relative to what it would be without climate change.
- Road failure due to river flooding will increase by at least 40% by 2030
- For trade and manufacturing, the methodology employed a microeconomic and corporate finance approach
- The Mekong Delta contributes a third of Vietnam's agricultural GDP. Without adaptation measures, around 45% of the Mekong Delta area will be affected by salinity, at an economic cost of about USD 17 billion by 2030.
- The CCDR estimated that 11.8 million people in Vietnam are directly exposed to intense flood risks, and more than 35% of coastal settlements are on eroding coastlines
- Climate change impacts on low-income people could drive an additional 400,000 to 1 million people into extreme poverty by 2030

Appreciation

- For the Mekong Delta, the method is briefly summarised in the CCDR. More detail can be found in Kulp and Strauss (2019)[22]
- The impact on low-income people clearly emphasises the disproportionate impact of climate change on the poor and the vulnerable in Vietnam as previously reported by Rentschler et.al. (2020)l.

Room for improvement

- The methodology for determining agricultural losses is not explained in the document. Also, the reference mentioned in the CCDR does not adequately explain it. The cost could be compared to other similar studies[23].
- Explaining the methodology used for road failure and trade and manufacturing would increase transparency.
- For shores and cities, adding a description of the methodology would increase transparency and readability of the results. The accounting methodology is not discussed in the CCDR, but the methodology is clearly described in Braese et al. (2020)[24].
- The CCDR barely addresses the need for inclusive development, while just transition is limited to a few places. It could be a more integral part of the development process.

[22] Kulp, S. A. and B. H. Strauss (2019). 'New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding.' Nat Commun 10(1): 4844.

[23] For instance, with Li, S., Q. Wang and J. A. Chun (2017). 'Impact assessment of climate change on rice productivity in the Indochinese Peninsula using a regional-scale crop model.' International Journal of Climatology 37: 1147-1160

[24] Braese, J, de Vries Robbé, S and Rentschler, J. 2020. Technical Background Paper: A Multisectoral Risk Assessment for Coastal Vietnam. World Bank Group.

Synergies and trade-offs

The CCDR discusses the following synergies and trade-offs:

- Managing and expanding tree cover could deliver a range of livelihood and environmental benefits that help people and ecosystems adapt to climate change.
- The levelled cost of electricity would be 26% higher in the ADS relative to the CPS by the year 2040, and 16% higher on average between 2020 and 2040. A suggested solution is to use the revenue collected from carbon taxation for cross-subsidising electricity tariffs for poor consumers and mobilising concessional financing.
- The shift from coal to renewables will also have an impact on the labour market eliminating existing jobs and creating new ones.
- Prioritising actions to reduce air pollution can improve human health and labour productivity.
- The average age of coal-fired power plants owned by State-Owned Enterprise is 11 years, while the ones owned by the private sector have an average age of 5 years. The risk for the private sector due to the transition away from coal is disproportionately higher. The CCDR calls for the government to assess and prepare new contractual mechanisms for these.

Comment

- Similar benefits of afforestation are also presented in a PBL report[8]
- The need for targeted poverty alleviation policies to counter the impact of increased electricity prices due to the shift towards renewable energy technologies is a critical point raised in the CCDR.
- The IEA (2022)[25] also iterates the need for strong commitments and policies to phase out unabated coal-fired power plants, as well as deploy low-carbon fuels that could send long-term signals to investors.

Room for improvement

It is impossible to mention all synergies and trade-offs of measures but there are some important ones missing; see reference in Footnote 8.

[25] IEA (2022), Southeast Asia Energy Outlook 2022, OECD Publishing, Paris, https://doi.org/10.1787/10bc5730-en