Short Report

Analysis of fair mitigation contribution for South Africa

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Summary – In this short report, we aim to outline the implications of different effort-sharing criteria and metrics on emission reduction efforts for South Africa in the post-2015 agreement.

We defined a set of scenarios considering different sets of criteria (amongst historical responsibility, potential to mitigate, capacity) and their proxy metrics (the various possible numerical expressions for each of these criteria) and estimated emissions allowances for South Africa.

For a global 2°C pathway, the resulting effort-sharing ranges suggest for South-Africa a 2016-2050 cumulative carbon budgets of around 7.6-13.7 GtCO2 - for a scenario with a 50% chance of staying below 2°C - and 6.7-13 GtCO2 - for a scenario of 66% chance of staying below 2°C - and emissions being on a downward trajectory by the early 2020s (emissions excl. LULUCF).

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1 Methodology

Description of Equity Analysis Tool

The PRIMAP group at the Potsdam Institute for Climate Impact Research (PIK) developed the Potsdam Real-time Integrated Model for the probabilistic Assessment of emission Paths (PRIMAP model)[1]. The Emissions Module[2] has been developed as part of this model and allows for the flexible combination of data sources into composite datasets, and the calculation of national, regional and global emission pathways following various emission allocation schemes. At the core of the Emissions Module is a custom-built emissions database, the so-called PRIMAPDB.

Climate Analytics and the PRIMAP group developed an Equity Analysis Tool for the assessment of equity principles and indicators, embedded in the Emissions Module. Currently implemented in the tool we have the following published equity methodology proposals:

- South North Proposal (Ott et al. 2004[i]), with own methodology for downscaling emissions from groups to country level based on GDP and population projections (detail available upon request)
- Greenhouse Development Rights (Baer & Kartha, 2008[ii])
- Per capita convergence

Building on a range of methodologies and equity criteria put forward by the scientific community and parties for sharing the burden of reducing emissions, the PRIMAP equity tool also offers a modality that allows users to emulate equity regimes based on various equity criteria - and for each criterion a range of possible empirical metrics to quantify them is available. The equity criteria selected and the different empirical metrics available to evaluate them in the Equity Tool are:

Historical Responsibility: this remains the main argument often used by many developing countries that the greenhouse gas problem is primarily caused by emissions from industrialized countries. The metrics used as a proxy for historical responsibility in this exercise are based on per capita cumulative emissions i.e. the quotient of cumulative emissions for each country and its cumulative population within the pre-set time frame:

- Cumulative greenhouse gases emissions per capita, excluding deforestation emissions: starting and end years for accounting cumulative emissions are flexible
- Cumulative greenhouse gases emissions per capita, including deforestation emissions: starting and end years for accounting cumulative emissions are flexible

Capacity to mitigate: the overall capacity to mitigate in a country is often related to a country's wealth or degree of development, as these relate to the country's ability to pay for and

[1] https://sites.google.com/a/primap.org/www/the-primap-model

[2] Nabel et al. (2011). "Decision support for international climate policy - The PRIMAP emission module." Environmental Modelling and Software Vol. 26 Issue 12, p.1419-1433.

implement measures to reduce greenhouse gases emissions. Metrics available to evaluate this criterion are:

- GDP Purchasing Power Parity (PPP) per capita
- Human Development Index (HDI) at a certain year

Potential to mitigate is a measure of the actual room for improvement existing in a country. Among proposals that consider potential as a criteria are the Triptych methodology and the South North Proposal. The following intensities can be used to estimate a country's potential to mitigate:

- Emissions intensity: Energy related greenhouse gas emissions per unit of GDP
- Emissions per capita: Total national greenhouse gas emissions per capita, including deforestation emissions.
- Carbon intensity: greenhouse gas emissions per unit of energy production

Box 1: Data collection

Data availability and quality represents a major challenge for this exercise. Even though the Equity Analysis Tool is embedded in the PRIMAP database (Nabel et al. 2011), which offers a wide range of choices of data sources, a few restrictions prevent a free choice. First, as we are interested in the relative contribution of countries to a certain qualitative metric, top-down data provides a more adequate frame for comparison, as it usually implies that a set of requirements have been met to ensure quality and comparability of data (as opposed to data provided on a national level, following e.g. own – nonstandard – inventory methodologies). Second, for each metric resulting from two single metrics e.g. emissions per GDP, we consistently used data from the same data source. For the current exercise, we have used the following data sources: CRF data, World Development Indicators 2013, CDIAC, IEA data for energy, United Nations 2012 for population and HDI. For business-as-usual projections, we used RCP8.5 scenario downscaled to country level. The data used here are from state-of-the-art sources and are regularly updated in the PRIMAP database. We have consistently used the same datasets across all scenario runs, ensuring that the differences between emissions allowances across scenarios arise from criteria/metric choices alone and not by data divergences.

Weights can be attributed to each one of the criteria selected. This means that allocation regimes based on only one of the criteria, e.g. responsibility, or based on more than one criterion, and assuming either equal or different weighting among the different criteria can be studied. For each criterion, one or a set of empirical measures to evaluate them can be selected, also with different weights. Such an approach allows for full flexibility of assumptions in regard to criteria and metrics.

Another important feature of the tool is that is that it allows for the calculation of **ranges of responsibilities** for countries, based on the different indicators. To calculate ranges, (1) **random weights** are attributed to each indicator and measure, (2) resulting emissions pathways calculated and finally (3) calculations are repeated multiple times to define a range of possible pathways. Such an approach allows capturing the full range of emissions allowances of a country and to determine how different criteria and metrics influence its outcome. Results from this analysis are only provided in the Excel sheet accompanying this document.

Index Calculation: The selected quantitative measures are weighted, normalized and added, to obtain an interim index. The split of the mitigation burden is calculated proportionally to a final index, which is obtained by normalizing and weighting the interim index by the population share of each country. To avoid using projections, we calculated the index based on the last common historical year shared between all selected metrics, which was 2010. The index is calculated for as many countries as possible, which is the number of common countries available for all selected metrics.

Because the index is the result of the normalization of variables, we investigated the presence of extreme countries in each one of the metrics and exclude those countries to avoid the over or under-estimation of countries' share of responsibility.

Global mitigation burden: Equity methodologies often fit global emissions to levels that are in line with temperature targets. The scientific literature contains many different emission scenarios computed by integrated assessment models that limit global temperature rise to 1.5° C or 2° C above preindustrial levels, with a certain probability. The scenarios chosen here are consistent with maintaining temperatures below 2°C with a 50% and a 66% probability in 2100[3].

Based on the selected low-carbon scenario, an emissions mitigation burden (Figure 1) is calculated as the difference between global business-as-usual emissions (here, RCP8.5) and an emissions trajectory that avoids the worst effects of global warming (here consistent with a 2 or 1.5°C temperature target).

[3] Since the 2 and 1.5°C scenarios comprise total global emissions, they take into account efforts in all sectors, including international aviation and marine shipping and the land-use and land-use change (LULUCF) sectors. In this exercise, we have opted to treat these two sectors separately, because: first, addressing emissions from international aviation and marine shipping is challenging, as they are produced along routes where no single nation has regulatory authority (the Kyoto Protocol excludes international emissions from aviation and marine transport from developed countries' national targets, unlike all other sources of emissions. Secondly, emissions from the LULUCF sector add a very high level of uncertainty to the overall results of individual countries. Methodological details upon request. This approach implies that emissions reductions in these two sectors will be achieved.

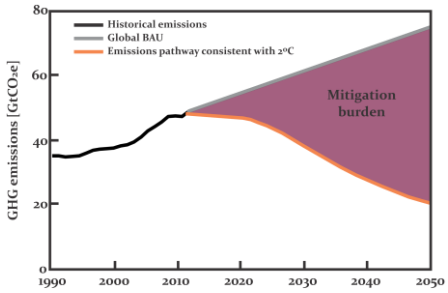

Figure 1 Mitigation burden

Calculation of emissions allowances: The index calculated using the methodology described above is then used to split the mitigation burden across countries, in such way that the country's index share of the sum of all indices will be proportional to its share of the mitigation burden. Countries with high indices will be attributed a high share of the mitigation burden and vice-versa. The share of the global mitigation burden of a country is subsequently subtracted from this country's business-as-usual emissions to obtain its final emissions allocations[4]. All final emissions allocations are for total national emissions excl. land-use, land-sue change and forestry (LULUCF) emissions. In the case of South Africa, this is of little importance as emissions from the LULUCF sector is a sink of on average 4% of national emissions for the period of 2000-2010. The 'peak, plateau and decline' (PPD) emissions mitigation trajectory is however assumed to include emissions from LULUCF[5].

[4] Such an approach allows for attribution of negative emissions allocations.

[5] If this is confirmed, the emissions allowances numbers produced in this report are not fully consistent PPD carbon budget. The latter would need to discount emissions from LULUCF, which depending on what is accounted for, are in the range of + to -5% of national emissions.

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2 Analysis for South Africa

Selection of scenarios

A wide variety of effort-sharing approaches exist and their different underlying criteria and assumptions can lead to very different outcomes and a large range of emissions allowances for a country. We defined multiple scenarios that differ in their set of criteria and metrics, and their weighting (please refer to Excel sheet accompanying this document for detail on chosen proposals). These scenarios were designed with the goal of capturing the widest possible range of variability arising from:

- different methodologies: GDR, per capita convergence, South North Proposal, South African proposal, proposal based solely on historical responsibility, proposal based on historical responsibility and capability, proposal based on potential, historical responsibility and capability.
- different starting years for historical period (1950, 1970, 1990):
- different weighing schemes for the criteria (e.g. 50/50 responsibility and capability vs 75/25
- different metrics for the criteria (e.g. capability measures in terms of HDI or GDPPPP and their different impacts for South Africa).

Carbon budget results

Chance of staying below 2°C	10-90th percentile	20-80th percentile	PPD
50%	7579-13669	8113-13267	12379-19666
66%	6683-13047	7748-12464	

Table 1: Range of carbon budget for the period 2016-2050 for South Africa (in GtCO2e, excl. LULUCF) resulting from the different equity-regimes scenarios

Emissions allowances ranges

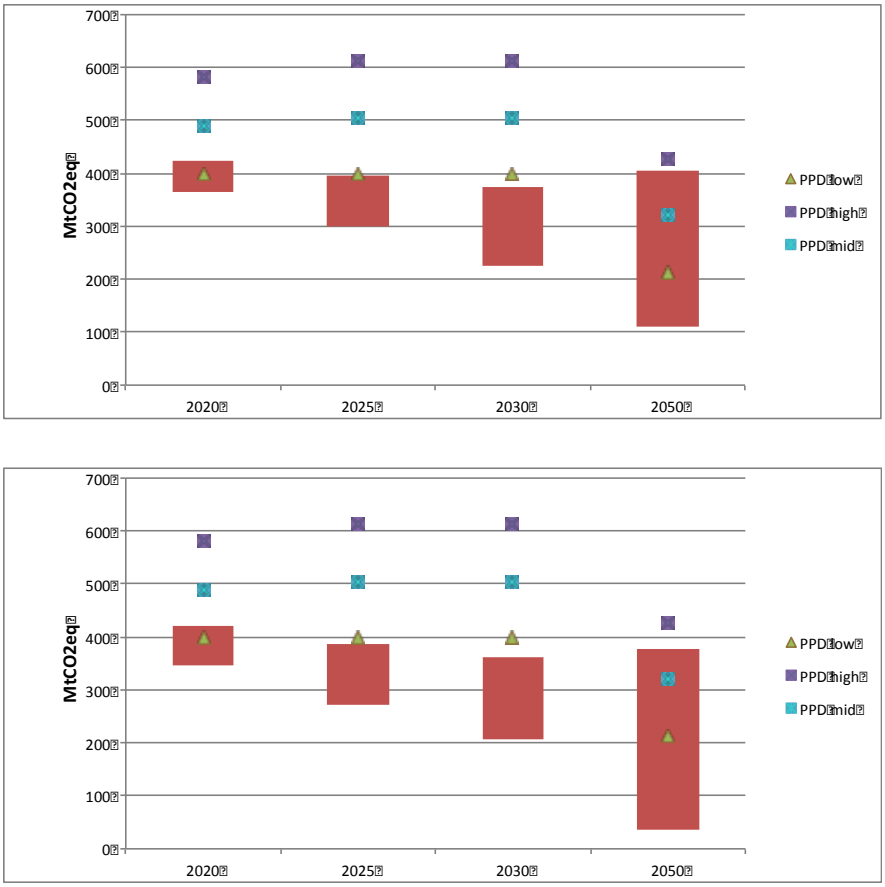

Figure 2: Bars represent emissions allowances range (10th to 90th percentile) for South Africa for 2020, 2025, 2030 and 2050 (excl. LULUCF emissions) resulting from different effort-sharing proposals in a world with a 50% (upper panel) and a 66% (lower panel) chance of staying below 2°C. Dots depict the PPD mitigation emissions trajectory defined by the Department of Environmental Affairs in 2011[iii]. For full effort-sharing range and detailed information on proposals, refer to Excel sheet accompanying this file.

[i] Ott, H. E.,Winkler, H., Brouns, B., Kartha, S., Mace, M. J., Huq, S.,… Rahman, A. A. (2004). South–North dialogue on equity in the greenhouse: A proposal for an adequate and equitable global climate agreement. Eschborn: Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, in cooperation withWuppertal Institute for Climate, Environment and Energy, Germany and Energy Research Centre (ERC), University of Cape Town.

[ii] Baer, P., Athanasiou, T., & Kartha, S. (2008). The Greenhouse Development Rights framework: The right to development ina climate constrained world. Berkeley, CA: EcoEquity and Christian Aid. Retrieved from http://www.ecoequity.org/docs/TheGDRsFramework.pdf

[iii] DEA 2011 National Climate Change response White Paper. Accessed March 2015. http://www.sanbi.org/sites/default/files/documents/documents/national-climate-change-response-white-paper.pdf.