Normalisation of Paris agreement NDCs to enhance transparency and ambition

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Normalisation of Paris agreement NDCs to enhance transparency and ambition

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Abstract

The Paris Agreement takes a bottom-up approach to tackling climate change with parties submitting pledges in the form of nationally determined contributions (NDCs). Studies show that the sum of these national pledges falls short of meeting the agreement's 2 °C target. To explore this discrepancy, we analyse individual pledges and classify them into four categories. By doing so, a lack of consistency and transparency is highlighted, which we correct for by performing a normalisation that makes pledges directly comparable. This involves calculating changes in emissions by 2030, using data for the most recent base year of 2015. We find that pledges framed in terms of absolute emission reductions against historical base years generally produce the greatest ambition, with average emission reductions of 16% by 2030. Pledges defined as GDP intensity targets perform the worst with average emission increases of 61% by 2030. We propose that a normalisation procedure of the type as we develop becomes part of the NDC process. It will allow to not only increase the transparency of pledges for policymakers and wider society, but also promote more effective NDCs upon revision as is foreseen to happen every 5 years under the 'ratcheting mechanism' of the agreement.

1. Introduction

The Paris Agreement (UNFCCC 2015) takes the form of a bottom-up approach to tackling climate change, reliant on voluntary commitments in the form of nationally determined contributions (NDCs), which are publicly accessible through the NDC registry. The NDCs are subject to regular review and updated every five years, implying a system of 'pledge and review' with civil society holding countries to account instead of employing direct enforcement mechanisms (Jacquet and Jamieson 2016). Under such a process, however, transparency and comparability of individual country pledges become paramount to the agreement's success. In response, online tools, such as the NDC Explorer (Pauw *et al* 2016), Climate Watch (Climate Watch 2018), the Climate Equity Reference Calculator (Kemp-Benedict *et al* 2017) and the Climate Action Tracker (Climate Action Tracker 2018) have appeared to make pledges more comparable. Yet the main lesson from using such tools is merely how much complexity and variance exists among NDCs. It remains challenging to compare what pledges really mean in emission and temperature terms. This job has instead fallen on scientists, requiring them to spend valuable resources analysing the impact of the pledges and judging their ambition (Aldy *et al* 2016, Jacoby *et al* 2017).

Initial studies suggest current NDCs are insufficient at meeting the top-down goal (Höhne *et al* 2017), implying a warming of 2.6 °C–3.1 °C, dependent on speculative negative emission technology (Anderson and Peters 2016, Schleussner *et al* 2016, Rogelj *et al* 2016a). Here we evaluate this discrepancy by performing a bottom-up assessment of the transparency and ambition of individual pledges. We identify four main categories of NDCs, and analyse the ambition of each category of NDC. In this context, we define ambition as producing emission targets that limit emission growth or lead to emission reductions in line with the overall goal of limiting global temperature rise to 2 °C. To compare the ambition of each pledge, we perform a

normalisation that makes their differences comparable and quantifies their effect on global emissions. This analysis is performed by grouping countries according to geographic region and by ranking them in terms of emission intensity per capita. On the basis of the findings we detect potential counterproductive systemic effects and suggest how transparency and ambition levels of NDCs can be improved.

The Paris Agreement states that the principles of transparency, accuracy, completeness, comparability and consistency (UNFCCC 2015) should be adhered to in accounting for emissions. We argue that these principles, particularly those of transparency and comparability need to be extended to the framing of NDCs themselves. Recent cooperation experiments have shown the need for greater transparency in achieving a fair climate deal (Hurlstone *et al* 2017). This will have the benefit of making the pledges easier to interpret and scrutinise by external stakeholders, including civil society, alongside having the psychological effect of inducing a behavioural change to increase ambition (Thaler and Sunstein 2008).

2. Methods

2.1. NDC differences regarding scope and gases covered

At the time of this writing, 147 parties had submitted their first NDC (including a joint submission for all 28 EU member states), the vast majority of which are unchanged from their intentions (Intended NDC or INDC) at the time the Paris Agreement was signed. A further 18 countries submitted an INDC but are yet to formalise an NDC. From here on NDCs is used to denote the combination of NDCs and INDCs, also as one may safely assume that for countries without an NDC yet it is likely that their INDC submission is representative for their future NDC submission.

Some large distinctions among the NDCs are immediately clear, such as whether targets are designated as 'conditional' or 'unconditional'. Around 80% of parties submitted conditional targets, which are subject to various stipulations, such as access to international finance, technology transfer and international cooperation. These are sometimes explicit, but often implicit or somewhat vague in their specific requirements. Meeting these conditions provides an additional challenge, but even if they are all met, a recent study indicates that emissions are unlikely to be on a substantially better trajectory for staying within the 2 °C target (Rogelj *et al* 2016a).

Several other significant differences between NDCs relate to emission scope and coverage. As countries can decide which Kyoto protocol gases are covered by the NDC, often we see them excluding HFCs, PFCs, SF_6 and NF_3, which is justified by their insignificant contribution to national emissions. However, some countries also exclude CH_4 and N_2O, which tend to make up a significant proportion of total national emissions. The importance of this is illustrated for China, which only includes CO_2 in its target. This means 2.5 $GtCO_2e$, or 4.9% of global greenhouse gas (GHG) emissions, is excluded from their commitment. Similarly, countries can choose which IPCC reporting sectors fall within the NDC, with perhaps the most important exclusion often being land use, land use change and forestry (LULUCF). Only around half of all countries fully and explicitly include LULUCF in their NDC or INDC submission. Hence, a further 1% of global emissions are not covered, and this conceivably gives license for LULUCF emissions to grow in these countries.

2.2. Normalisation of NDCs

More fundamentally, large differences exist among how countries express their individual targets. Based on analysing all NDCs (see section 2) we group them into four main categories:

2.2.1. Absolute emission reduction targets

Countries submitting these pledges present absolute emission reductions for a target year in percentage terms relative to a historic base year. The base year is set by the country and ranges from 1990 to 2014, while the target year is typically 2030, and in a few cases 2025.

2.2.2. 'Business as usual' (BAU) reduction (covering also trajectory targets)

Countries submitting these pledges present a percentage reduction in emissions relative to a 'business as usual' scenario, typically to 2030. This scenario is defined by each country itself, causing a large variance to exist in emissions growth among scenarios. Also included in this category are the few countries (Bhutan, Ethiopia, Oman and South Africa—representing only around 1.5% of global emissions) which submitted a fixed emission trajectory target. This approach effectively produces the same result.

2.2.3. Emission intensity reductions

Countries submitting these pledges present a reduction in emission intensity per GDP relative to a historic base year. Emissions targets are therefore dependent upon the historic GDP and emissions in the base year, and any future GDP growth.

2.2.4. Projects absent of GHG-emission targets

This final category includes countries presenting NDCs that did not include an explicit GHG emission target. These submissions typically offered details about projects aiming to reduce emissions, such as investment in renewable energy. However, these are difficult to convert into actual impact on emissions and do not provide a hard limit on emissions for the countries to be held accountable against.

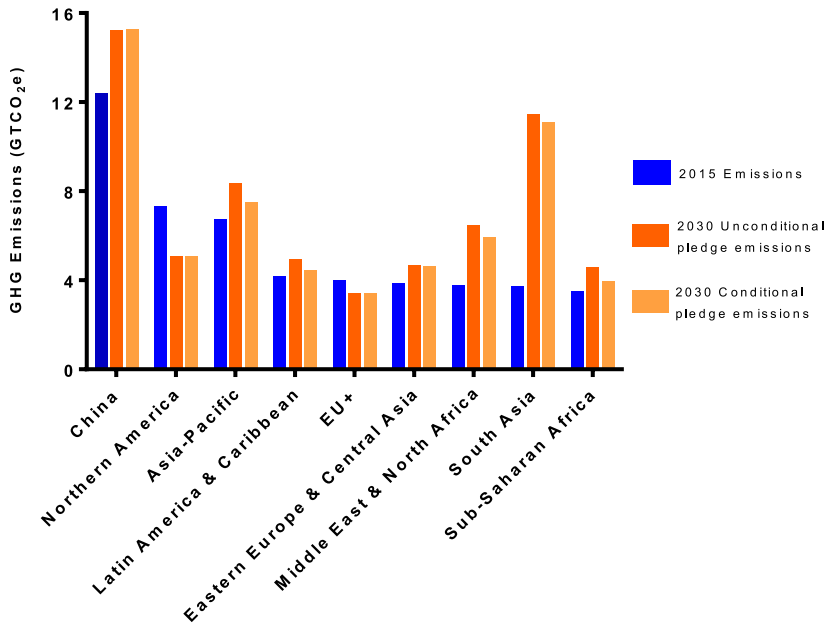

Figure 1. Historical and projected GHG emissions by region. Projected 2030 GHG emissions are shown for two scenarios: only unconditional pledges are achieved; and all conditional pledges are achieved. These therefore indicate the range of effects from current commitments. In the case of India (part of South Asia), we assume the emission intensity of GDP remains unchanged from 2015 if their conditional pledges are not met.

To analyse the ambition of each pledge type, we group countries by pledge type and perform analyses by region and rankings of emission intensity per capita. This allows for systematic comparison of countries of similar geopolitical characteristics, each covering at least 5% of global GHG emissions. The geographical groupings avoid having to report results for relatively small nations and thus assist in presenting the results in a concise way that allows for clear interpretations. Appendix A shows the resulting groups and countries within each. The PRIMAP database (Gütschow *et al* 2018) was used for historical GHG emissions because it is a peer-reviewed data source that covers all countries which have submitted an NDC. Countries' GHG emission projections to 2030 were calculated by individually assessing their NDC submissions. Where LULUCF or non-CO_2 GHG were not covered in the pledge, such emissions are forecasted using exponential smoothing methods applied to trends between 2006 and 2015. Of the seven countries submitting category iii targets, only India presented an explicit GDP projection in their NDC. Few long-term GDP projections provide complete information available at the country level. Among these, the most reliable are those provided by the OECD (2018), which we use to calculate the expected reduction in emissions. This involves applying world average growth rates for countries without individual GDP projections. In the case of India, we calculate an additional emission projection for 2030, based on the GDP projection that was included in its NDC. When growth in a country's GHG emissions could not be interpreted from the NDC (i.e. countries falling into Category iv), growth was forecast from trends between 2006 and 2015, again using an exponential smoothing method. Finally, the Bahamas and Belize show large changes in global emissions between 2006 and 2015 in the PRIMAP database. For these two countries, forecasts were made from trends between 2011 and 2015. Furthermore, in cases of the NDC pledge holding until 2025, such as for the United States, the trend extrapolated to 2030 by applying exponential smoothing on the data from 2016 to 2025. Appendix B shows the groupings of countries by emissions per capita in 2015, used to produce the calculations reported in table 2. Countries were ranked based on the absolute emissions of all GHGs, and then divided into five groups based on this ranking. For the production of all tables and figures, excluding figure 1, we assume that all requirements of conditional pledges have been fulfilled, thus we are working with conditional pledges rather than unconditional pledges.

3. Results

Table 1 shows the percentage of 2015 global emissions for the four groups. It also mentions weighted percentage changes of projected emissions by 2030 compared to 2015. Absolute values of the emissions in 2015 and 2030 are included in appendix C. In effect, we are normalising the emission pledges for all countries, by converting them into a format similar to category i pledges, but indicating actual emission change, whether positive or negative, compared with a consistent base year. Levels of ambition are more easily

Table 1. Normalised (I)NDCs by pledge type and region.

Pledge type / Region	i. Absolute emission reduction			ii. BAU reduction			iii. Intensity reduction			iv. Projects absent of GHG-emission targets			Regional Total
	Number of countries	Share of global emissions in 2015	% change by 2030	Number of countries	Share of global emissions in 2015	% change by 2030	Number of countries	Share of global emissions in 2015	% change by 2030	Number of countries	Share of global emissions in 2015	% change by 2030	% change by 2030
Asia-Pacific	8	3.7%	-20%	10	8.1%	23%	2	0.6%	61%	11	1.0%	1%	15%
China	0	0.0%	-	0	0.0%	-	1	24.9%	23%	0	0.0%	-	46%
Eastern Europe and Central Asia (EECA)	9	6.9%	17%	6	0.2%	10%	1	0.5%	52%	1	0.2%	28%	27%
Latin America and Caribbean (LAC)	6	2.9%	-10%	13	4.6%	10%	2	0.1%	386%[a]	11	0.8%	18%	7%
Middle East and North Africa (MENA)	0	0.0%	-	9	3.8%	68%	1	0.1%	0%	7	3.7%	47%	58%
Northern America	2	14.7%	-31%	0	0.0%	-	0	0.0%	-	0	0.0%	-	-31%
South Asia	0	0.0%	-	5	1.4%	125%	1	5.9%	219%*	2	0.2%	42%	174%
Sub Saharan Africa (SSA)	4	1.0%	-38%	32	5.0%	24%	0	0.0%	-	13	1.2%	4%	13%
EU+	34	8.1%	-14%	1	0.0%	-24%	0	0.0%	-	0	0.0%	-	-14%
GLOBAL TOTAL	**63**	**37%**	**-15.9%**	**76**	**23%**	**34.3%**	**8**	**32%**	**61.2%**	**45**	**7%**	**29.2%**	**23.8%**

Deeper green shades represent greater emission reductions and deeper red colours greater emission growth. For definitions of regions and details of calculations, see section 2.

[a] The 386% change in LAC intensity reduction countries is so high due to Chile having large negative emissions from LULUCF in the 2015 data, giving a very low overall emission total. This produces a very high percentage increase which is not representative of the change in emissions exclusive of LULUCF. Excluding Chile, this figure would only include the emission growth of Uruguay, which equals 104%. The 219% increase refers to that for India. In 2005, the base year for their intensity target, LULUCF emissions were much higher than in 2015. As with Chile, this large percentage increase seems largely related to LULUCF in the data used.

judged on the basis of such normalised pledges than for pledges in their original form.

The category i pledges generally prove to have the highest ambition in terms of tangible emission reductions. By contrast, categories ii–iv tend to produce low ambitions with significant emission increases of 29%–61% at global level. The effect of these changes on emissions at the regional level is illustrated in figure 1. Notably, we find that Northern America and EU+ are the only regions aiming for absolute reductions in emissions, while substantial increases are expected in MENA and South Asia. Since countries in the Global North (corresponding to the Annex I countries in the Kyoto Protocol) are more likely to submit category i pledges, it may not seem surprising that they produce the targets with highest ambition.

To control for the fact that these countries tend to have higher emission intensity and thus are more likely to submit category 1 pledges, we present results with countries grouped by their 2015 emission per capita in table 2. We see that category i pledges still tend to outperform the other pledge categories within the same emission intensity grouping. Additionally, it indicates that for the lowest 20% of countries in terms of emissions intensity pledge, type iv performs better in terms of emissions reduction than types i (−8 versus 64%) and ii (63%), while for the highest 20% countries, pledge type iii comes out lower than i (−49 versus −20%). Although this seems counter-intuitive, it is due to category iv pledges being based on recent trends; the more intense emitters are likely to have achieved high growth in emissions, whilst low-intensity countries are likely to have not. Overall, emission growth is lower under category iv pledges than under ii and iii. However, as the category iv pledges have been calculated by projecting recent trends in emissions, it is foreseeable that emission growth could accelerate and be higher than that seen in categories ii and iii countries, given that there is no fixed target which they are pledging to limit their emission growth to.

In terms of global emissions, we see a rise of 23.8%, from 49.8 $GtCO_2$ in 2015 to 61.6 $GtCO_2$ in 2030. Rogelj *et al* (2016b) calculate for a >66% chance of staying within 2 °C of warming, the remaining carbon budget has a range of 590–1240 $GtCO_2$. The cumulative emissions to 2030 from our analysis are 892 $GtCO_2$, suggesting that the 2 °C budget will quite likely have already been spent by 2030. It should be noted however that our emission projections are around 10% higher than Rogelj *et al* (2016a) and UNEP (2016). This is largely due to us trying to present the NDC pledges 'as is' rather than running them through complex modelling without making assumptions of how they translate into policies. Here we are presenting rather a maximum estimation of what the countries are actually committing to in emission terms. The effect on overall emissions, and why it may differ to other publications is also likely due to the

Table 2. Normalised (I)NDCs by pledge type and emission intensity per capita.

Pledge type / Ranking by 2015 emission intensity per capita	i. Absolute emission reduction			ii. BAU reduction			iii. Intensity reduction			iv. Projects absent of GHG-emission targets			Total for each rank of emission intensity per capita
	Number of countries	Share of global emissions in 2015	% change by 2030	Number of countries	Share of global emissions in 2015	% change by 2030	Number of countries	Share of global emissions in 2015	% change by 2030	Number of countries	Share of global emissions in 2015	% change by 2030	% change by 2030
Highest 20%	11	22.5%	-20%	9	5.8%	20%	1	0.2%	-49%	12	3.3%	52%	-5%
60%-80%	37	14.5%	-10%	13	7.3%	23%	4	25.9%	25%	6	1.0%	-2%	27%
40%-60%	7	0.1%	-42%	17	5.8%	36%	1	0.1%	0%	8	1.3%	16%	31%
20%-40%	4	0.1%	-19%	18	3.1%	74%	1	5.9%	219%*	10	1.0%	20%	134%
Lowest 20%	4	0.0%	64%	19	1.1%	63%	1	0.0%	2864%*	9	0.5%	-8%	56%
GLOBAL TOTAL	**63**	**37%**	**-15.9%**	**76**	**23%**	**34.3%**	**8**	**32%**	**61.2%**	**45**	**7%**	**29.2%**	**23.8%**

Deeper green shades represent greater emission reductions and deeper red colours represent greater emission growth. For definitions of ranking groups and details of calculations, see section 2.

[a] The 2864% change corresponds to the percentage change of Chile, the only country in the category. in intensity reduction is so high due to Chile having large negative emissions from LULUCF in the 2015 data, giving a very low overall emission total. This produces a very high percentage increase which is not representative of the change in emissions exclusive of LULUCF. The 219% increase refers to that for India. In 2005, the base year for their intensity target, LULUCF emissions were much higher than in 2015. As with Chile, this large percentage increase seems largely related to LULUCF in the data used.

sensitivity to the PRIMAP emission dataset and GDP assumptions used. This is particularly seen in the very high growth rate in emissions for India.

4. Discussion

We now explore the variance in transparency and ambition among different pledge types. Figure 2 illustrates emission projections for five sample countries varying in ambition: Australia, India, Mexico, Pakistan and Russia. These countries were chosen as they provide good examples of the difficulty in comparing level of ambition amongst individual countries. Australia and Russia both submitted seemingly similar category i pledges. Although we this appears to be the most effective pledge category, due to the explicit fixed cap on future emissions, we still find much variance in ambition, suggesting a need for achieving more consistency in the future. The choice of base year is particularly relevant. For instance, Russia aims to reduce emissions by 25% relative to the base year 1990, which at face value seems comparable to Australia's 26%–28% reduction relative to 2005. However, comparing both to 2015 emissions, we see Australia's emissions drop by around 9%, whereas Russia's increase by 13%, as it had considerably higher emission levels back in 1990. It is therefore clear that each country's level of ambition cannot necessarily be inferred from their NDC, even when submitting category i pledges.

Likewise, a similar issue occurs when trying to compare category ii 'BAU reduction' pledges. Mexico and Pakistan submitted Category ii, which give countries much freedom to define their business-as-usual scenarios. As a result of the scenarios being self-defined, the resulting differences amongst the emission changes for each countries are pronounced. At first sight, Pakistan's conditional BAU reduction of 20% may appear roughly comparable to Mexico's 22% unconditional GHG target. However, if we normalise both relative to 2015 emissions, we see a striking difference between how they translate into 2030 emissions. Mexico's GHG emissions decrease 11% from 2015 levels, while Pakistan's pledge would increase emissions by 182%. Despite producing only half of Mexico's emissions in 2015, Pakistan may emit twice as much as Mexico by 2030. The key difference is in the detail of the BAU scenarios; Pakistan's BAU scenario entails a 241% increase from 2015-level emissions while Mexico's is a more modest 38%.

Although few countries opted for category iii pledges, they include the major emitters China and India, which together account for around a third of global emissions. The outcome of these targets is more difficult to predict. Their greatest weakness is that they do not limit emissions: the more growth, the higher the emissions. These targets also suffer from needing economic data for interpretation. Using current long-term GDP growth forecasts from the OECD (OECD 2018) India's 33% reduction in intensity will likely translate to emissions growth of 229% from 2015 levels. India include a GDP projection for 2030 in their NDC, namely a 173% increase from their 2014 GDP. The OECD projections are very similar, namely a 178% increase in GDP, resulting in a comparable result in terms of CO_2e emissions with a 213%

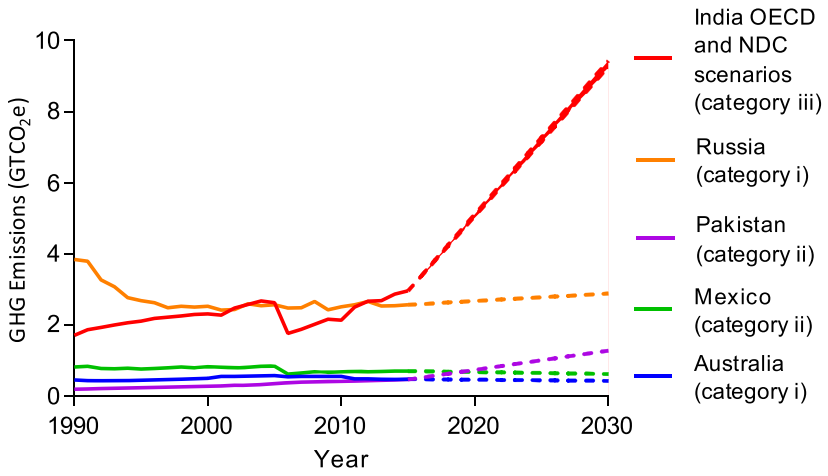

Figure 2. Historical and projected emissions for referenced countries under NDC. Dashed lines indicate projections based on current NDCs for: Australia (Category i pledge, 26% reduction from 2005 base year), Russia (Category i pledge, 25% reduction from 1990 base year); Mexico (Category ii pledge, conditional 36% BAU GHG reduction pledge); Pakistan (Category ii pledge, conditional 20% BAU reduction); and India (Category iii pledge, conditional 33% intensity reduction).

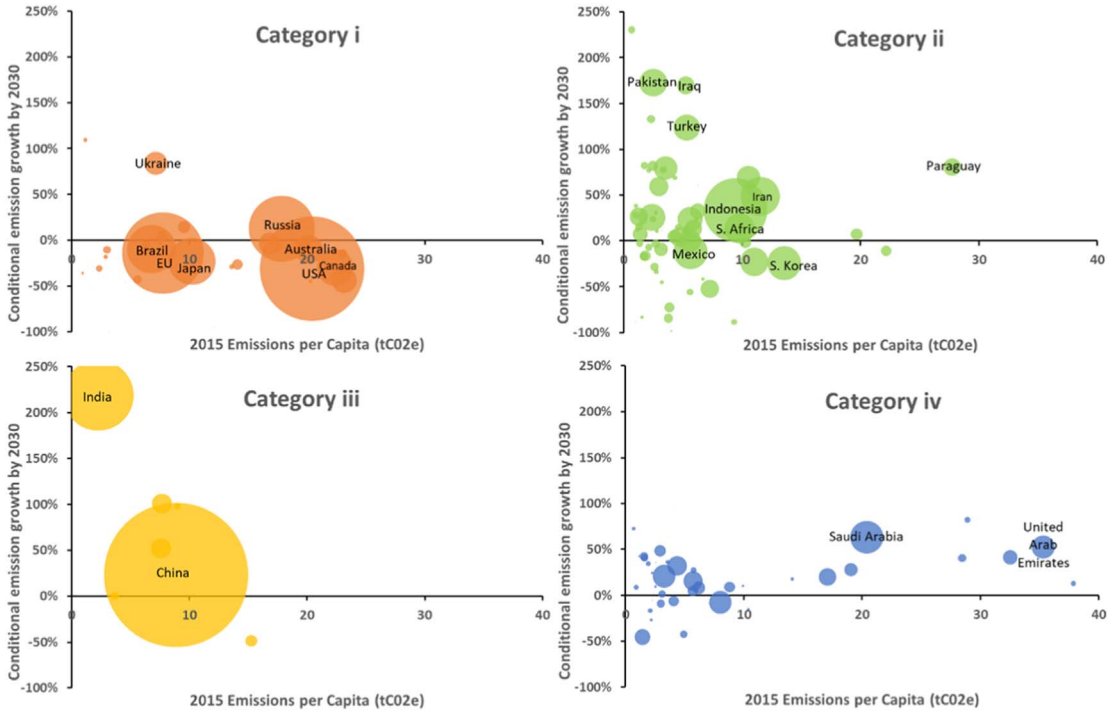

Figure 3. Normalised conditional NDC pledges for all countries. The size of each sphere represents total greenhouse gas emissions for each country in 2015. The top 15 emitters and some of the more significant outliers are explicitly mentioned (the centre of a country name coincides with the centre of the respective sphere). Extreme outliers in terms of conditional emission growth and emissions per capita, and those with negative emissions have been excluded from the graph to avoid that discernibility would be compromised. These are Bhutan, Burundi, Chile, Gabon, Fiji, Trinidad and Tobago and Qatar.

increase from 2015. This small range is shown in figure 2. However, it is important to note that the percentage increases are very high partly due to the accounting for LULUCF in the data. There was a large drop in LULUCF emissions between 2005 and 2006, the result of which can be seen clearly in figure 2. This is particularly significant given that 2015 was the chosen base year for India's intensity target. However, this further illustrates the difficulties in clearly assessing countries' pledges under the current framework. Note that it is not our intention with these illustrations to question goals agreed for developing countries, but to illustrate that in their current form even a simple comparison of NDCs requires careful analysis. Detailed analysis of mitigation effort or fairness will require more informative metrics (Aldy *et al* 2017).

Due to normalisation of all NDCs we are able to compare these now systematically. This results in figure 3, which shows the data of emission growth and emissions per capita for all individual countries, excluding a few outliers. While there is a large degree of variance among countries, category 1 targets generally lead to more ambitious emission targets, regardless of emissions per capita. The full data on normalised pledges for each individual country is presented in appendix D. The majority of countries fall into an area between −25% and 75% emission growth, and up to 10 TCO_2e emissions per capita. However, three groups of outliers exist. Firstly, there are countries with very high emission growth; most significantly Pakistan, India, Iran and Turkey. These countries have much greater growth in emissions compared to countries of similar emission intensity. Secondly, there are category 1 countries with already very high emission intensities, including Russia, USA, Canada and Australia. These countries are generally aiming for relatively significant emission reductions with the exception of Russia. Thirdly, there are several high-emission intensity countries, such as the United Arab Emirates and Saudi Arabia, which can be expected to continue to significantly grow their emissions due to having submitted category iv targets.

The calculations underlying the tables and figures assume that nations stick to, and successfully meet their stated pledge. There is a lot of potential for countries to meet or exceed their targets, particularly if economic growth turns out to be below current projections. However, one may expect the targets to be difficult to achieve due to systemic effects, such as carbon rebound (Druckman *et al* 2011, Antal and van den Bergh 2014), carbon leakage (Babiker 2005) and the green paradox (Sinn 2012). Of these, carbon leakage is of particular interest to our discussion as it is influenced by differences in national policy stringency, which can be connected to differences in NDCs. Carbon leakage arises when companies move production to countries with weaker climate policies or when imports from such countries increase due to products being cheaper than ones from other countries or produced domestically. This merely transfers emissions from one country to another. As we have seen, countries fall into four tiers of pledge ambition, which creates the problem of carbon leakage from countries with relatively ambitious NDCs to those with relatively non-ambitious NDCs. Although category iv NDCs theoretically lead to less emission growth than category ii and iii pledges in our analysis, one should expect considerable carbon leakage to these countries as they lack a target for emissions. This will make compliance of the latter countries with their NDCs more difficult, leading to higher cost of compliance—as more emissions have to be reduced than foreseen—which in turn may lead to efforts by such countries to reduce their NDC or to increase it less in the future than originally intended.

The current format of pledges presents two problems. Firstly, it is difficult to accurately assess and compare what the pledges will mean in actual emission terms. Russia, India and Pakistan all frame their NDCs in terms of percentage reductions; Russia relative to a base year, India relative to emissions per GDP and Pakistan relative to a BAU scenario. Not only does this make the associated pledges difficult to interpret and compare to other pledges without detailed analysis, but may produce a psychological effect of reducing ambition level. Psychology shows us that the framing of information is important in the decision-making process (Thaler and Sunstein 2008). Russia, for instance, might have been more ambitious in its pledge if it was unable to frame its actual 13% increase in emissions as a 25% decrease against a base year of choice. The same applies for all pledges in categories 1–3: here pledges are being framed as percentage reductions, although the actual effect of the reduction rarely corresponds to the actual effect on emissions. In view of this, our advice would be to prevent countries from presenting their pledges in a frame which appears more ambitious than its true effect. This is in line with experiments demonstrating how aversion from shame is a powerful motivator in public contribution (Samek and Sheremeta 2014). This would likely be challenging to achieve politically, as one of the factors that brought countries into the agreement was the freedom to be able to able to set their own targets in a format of their choosing. However, what we are proposing is not a radical change. For the majority of countries (those not in category iv), this would involve a simple conversion based on already available data, as we have done so in this analysis, so would not prove to be an undue burden on parties. Instead, it will be important achieving the goal of the Paris Agreement through the ratcheting mechanism. Alternatively, the countries could submit in a flexible format but their 'ratcheted pledges' would be immediately normalised by the UNFCCC. If known before, this would create healthy pressure on delivering ambitious updates.

5. Conclusion

The Paris Climate Agreement was undoubtedly a giant step in the right direction for international climate policy. However, studies have shown that, in its current form, it is at best inadequate and at worst grossly ineffective. Civil society has the right to be able to clearly understand and compare climate change commitments by countries, including whether they are fair, ambitious and add up to international climate goals. Moreover, providing consistent and easily comparable information about national climate goals has been found to contribute to their public

acceptance (Gütschow *et al* 2018). The current lack of transparency and consistency, which requires compensation by tools and models supplied by academic research, will hinder the NDC process. To move forward, we propose that the Principles of Transparency and Consistency from the TACCC framework are extended to the framing of the NDCs themselves. This would be easy to achieve, by having countries convert their pledges into clear emission targets relative to the most recent available year in the data, inclusive of all significant gases and sectors. Alternatively, countries could deliver pledges in a flexible format which then would be normalised by the UNFCCC. An important detail is that the base year should be consistent across all countries' NDCs. In effect, countries' NDCs would then be normalized as we have done in our analysis (table 1), according to a category i style target. In our analysis we accomplished this normalisation comparing emissions to a consistent base year of 2015, the most recently available base year in the PRIMAP dataset. Going forward, as countries update their NDCs this base year should be updated, to keep pledges relevant for the next period. Not only can this help produce targets of greater ambition that are more open to external scrutiny, but it also will assist in improving effectiveness through minimising counterproductive systemic effects. Normalisation of pledges will also put pressure on delivering ambitious updates of pledges every five years under the Paris Agreement's ratcheting mechanism.

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Appendix A. Definition of regions

Region	Countries	% of 2015 global emissions
Asia-Pacific	Australia, Brunei, Cambodia, Cook Island, Fiji, Indonesia, Japan, Kiribati, Korea (Democratic Republic), Korea (Republic), Laos, Malaysia, Marshall Islands, Micronesia, Mongolia, Myanmar, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Thailand, Timor-Leste, Tonga, Vanuatu, Vietnam	13.5%
China	China	24.9%
Eastern Europe and Central Asia	Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Georgia, Kazakhstan, Kyrgyzstan, Macedonia, Moldova, Montenegro, Russian Federation, Serbia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan	7.8%
Latin America and Caribbean	Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Panama, Paraguay, Peru, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela	8.4%
Middle East and North Africa	Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Tunisia, Turkey, United Arab Emirates, Yemen	7.6%
Northern America	Canada, United States	14.7%
South Asia	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka	7.5%
Sub Saharan Africa	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (DRC), Congo (Republic), Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, Zimbabwe	7.2%

(Continued.)

Region	Countries	% of 2015 global emissions
EU+	European Union (28), Switzerland, Iceland, Norway, Liechtenstein, Monaco	8.1%
No INDC submission	Libya, Nicaragua, Syria	0.4%

Appendix B. Definition of groups ranked by emission intensity per capita

Ranking group of 2015 emission intensity per capita	Countries	% of 2015 global emissions
Highest 20%	Qatar, Trinidad and Tobago, Brunei, Niue, United Arab Emirates, Kuwait, Guyana, Bahrain, Paraguay, Zambia, Botswana, Canada, Mongolia, United States, Saudi Arabia, Iceland, Australia, Oman, Turkmenistan, Russian Federation, Bolivia, Kazakhstan, Singapore, New Zealand, Suriname, Equatorial Guinea, Korea, Rep. (South), Palau, Iran, Argentina, Central African Republic, Venezuela, Belize	31.7%
60%–80%	Israel, Japan, The Bahamas, South Africa, Belarus, Indonesia, Namibia, Uruguay, China, Papua New Guinea, Bosnia and Herzegovina, Sudan, European Union (28), Serbia, Malaysia, Uzbekistan, Montenegro, Angola, Ukraine, Antigua and Barbuda, Brazil, San Marino, Mauritius, Norway, Seychelles, Cameroon, Saint Kitts and Nevis, Ecuador, Azerbaijan, FYR of Macedonia, Timor-Leste, Andorra, Peru	48.7%
40%–60%	Panama, Algeria, Liechtenstein, South Sudan, Mexico, Switzerland, Republic of Congo, Thailand, Tanzania, Cook Islands, Barbados, Turkey, Honduras, Iraq, Laos, Colombia, Dominica, Lebanon, Myanmar, Georgia, North Korea, Nauru, Zimbabwe, Solomon Islands, Cambodia, Marshall Islands, Chad, Tunisia, Jamaica, Vietnam, Saint Vincent and Grenadines, Maldives, Monaco	7.3%
20%–40%	Jordan, Egypt, Saint Lucia, Armenia, Morocco, Grenada, Cuba, Guinea, Somalia, Democratic Republic of Congo, Moldova, Morocco, Albania, Kyrgyzstan, Mauritania, Guatemala, Mali, Vanuatu, Swaziland, Pakistan, Benin, Madagascar, Nigeria, Dominican Republic, Tonga, Burkina Faso, India, Guinea-Bissau, Samoa, Lesotho, Togo, Senegal, El Salvador	10.2%
Lowest 20%	Sierra Leone, Djibouti, Tuvalu, Uganda, Niger, Yemen, Sri Lanka, Nepal, Eritrea, Micronesia, Philippines, Ethiopia, Cote d'Ivoire, Ghana, Bangladesh, Tajikistan, Cape Verde, Gambia, Liberia, Haiti, Afghanistan, Sao Tome and Principe, Comoros, Costa Rica, Malawi, Kiribati, Burundi, Rwanda, Kenya, Chile, Fiji, Bhutan, Gabon	1.7%

Note. Countries are ranked by 2015 total GHGs emissions per capita.

Appendix C. Absolute emission values for region and pledge type groupings

Pledge type	i. Absolute emission reduction		ii. BAU reduction		iii. Intensity reduction		iv. Projects absent of GHG-emission targets	
Region	2015 emissions ($MtCO_2e$)	Conditional 2030 emissions ($MtCO_2e$)	2015 emissions ($MtCO_2e$)	Conditional 2030 emissions ($MtCO_2e$	2015 emissions ($MtCO_2e$)	Conditional 2030 emissions ($MtCO_2e$	2015 emissions ($MtCO_2e$)	Conditional 2030 emissions ($MtCO_2e$
Asia-Pacific	1855	1486	4060	5012	321	517	499	502
China	0	0	0	0	12 400	15 255	0	0
Eastern Europe and Central Asia (EECA)	3433	4026	93	102	235	358	106	136
Latin America and Caribbean (LAC)	1432	1287	2299	2522	35	168	402	475
Middle East and North Africa (MENA)	0	0	1893	3183	41	42	1851	2726
Northern America	7345	5066	0	0	0	0	0	0
South Asia	0	0	703	1579	2960	9433	78	110
Sub Saharan Africa (SSA)	476	298	2502	3112	0	0	615	639
EU+	4017	3440	0	0	0	0	0	0
Global Total	18 558	15 603	11 552	15 512	15 991	25 772	3551	4588

Appendix D. Normalised conditional (I)NDCs for all countries.

Country	Submission	NDC category	2015 greenhouse gas emissions (GtCO2e)	2030 conditional greenhouse gas emissions (GtCO2e)	% change 2015 to 2030
Afghanistan	NDC	ii	33.3	42.7	28.2%
Albania	NDC	ii	8.1	9.0	10.8%
Algeria	NDC	iv	227.0	262.2	15.5%
Andorra	NDC	ii	0.5	0.4	−24.0%
Angola	INDC	ii	202.0	96.6	−52.2%
Antigua and Barbuda	NDC	iv	0.7	0.6	−8.5%
Argentina	NDC	ii	478.0	369.0	−22.8%
Armenia	NDC	ii	9.3	5.1	−44.9%
Australia	NDC	i	479.0	430.7	−10.1%
Azerbaijan	NDC	i	58.8	51.5	−12.3%
Bahamas, The	NDC	iv	3.8	4.2	10.4%
Bahrain	NDC	iv	39.0	54.9	40.7%
Bangladesh	NDC	ii	200.0	252.9	26.4%
Barbados	NDC	i	1.6	1.5	−5.6%
Belarus	NDC	i	90.6	103.7	14.4%
Belize	NDC	iv	3.7	3.2	−15.0%
Benin	NDC	ii	25.9	32.0	23.6%
Bhutan	NDC	ii	−1.3	−1.3	−6.7%
Bolivia	NDC	iv	183.0	219.7	20.1%
Bosnia and Herzegovina	NDC	ii	30.3	33.3	9.8%
Botswana	NDC	i	50.9	43.3	−14.9%
Brazil	NDC	i	1400.0	1,265.6	−9.6%
Brunei	INDC	iv	15.8	17.9	13.0%
Burkina Faso	NDC	ii	41.5	96.7	133.1%
Burundi	NDC	ii	8.2	60.3	633.8%

(Continued.)

Country	Submission	NDC category	2015 greenhouse gas emissions (GtCO2e)	2030 conditional greenhouse gas emissions (GtCO2e)	% change 2015 to 2030
Cambodia	NDC	ii	59.7	16.3	−72.7%
Cameroon	NDC	ii	142.0	188.1	32.5%
Canada	NDC	i	805.0	565.6	−29.7%
Cape Verde	NDC	iv	0.6	0.4	−38.9%
Central African Republic	NDC	ii	48.2	75.7	57.1%
Chad	NDC	ii	52.4	8.2	−84.3%
Chile	NDC	iii	3.6	135.0	7468.5%
China	NDC	iii	12,400.0	18,086.4	24.0%
Colombia	INDC	ii	225.0	234.5	4.2%
Comoros	NDC	ii	0.8	0.1	−89.1%
Congo, DRC	NDC	ii	224.0	356.9	59.3%
Congo, Republic	NDC	ii	27.8	12.3	−55.7%
Cook Islands	NDC	i	0.1	0.0	−93.2%
Cote d'Ivoire	NDC	ii	30.8	30.0	−2.6%
Cuba	NDC	iv	35.3	35.8	1.5%
Djibouti	NDC	ii	1.7	1.8	5.3%
Dominica	NDC	i	0.3	0.2	−45.5%
Dominican Republic	NDC	i	24.8	17.2	−30.7%
Ecuador	INDC	iv	99.7	107.8	8.2%
Egypt	NDC	iv	305.0	368.8	20.9%
El Salvador	NDC	iv	13.1	10.9	−16.6%
Equatorial Guinea	INDC	i	16.0	11.4	−29.0%
Eritrea	INDC	ii	7.3	1.2	−83.3%
Ethiopia	NDC	ii	135.0	145.0	7.4%
European Union (28)	NDC	i	3,930.0	3,378.0	−14.0%
Fiji	NDC	iv	−0.6	−1.2	84.5%
Gabon	NDC	ii	−85.2	65.0	−176.3%
Gambia	NDC	iv	2.3	3.3	42.6%
Georgia	NDC	ii	17.0	28.7	68.9%
Ghana	NDC	ii	35.2	40.7	15.5%
Grenada	NDC	i	0.3	0.0	−100.3%
Guatemala	NDC	ii	43.1	41.7	−3.3%
Guinea	NDC	i	36.5	32.6	−10.6%
Guinea-Bissau	INDC	iv	4.0	5.0	24.6%
Guyana	NDC	iv	22.2	40.4	82.1%
Haiti	NDC	ii	10.7	14.8	38.3%
Honduras	NDC	ii	47.2	52.6	11.5%
Iceland	NDC	i	6.7	3.7	−44.7%
India	NDC	iii	2,960.0	8,545.4	228.7%
Indonesia	NDC	ii	2430.0	3,245.2	33.5%
Iran	INDC	ii	913.0	1,355.2	48.4%
Iraq	INDC	ii	188.0	507.1	169.7%
Israel	NDC	ii	82.7	81.4	−1.6%
Jamaica	NDC	iv	10.2	13.9	36.1%
Japan	NDC	i	1310.0	1,007.1	−23.1%
Jordan	NDC	ii	30.3	53.9	77.8%
Kazakhstan	NDC	i	299.0	288.0	−3.7%
Kenya	NDC	ii	30.3	100.1	230.4%
Kiribati	NDC	ii	0.1	0.0	−73.0%
Korea, Dem. Rep. (North)	NDC	ii	107.0	112.2	4.8%
Korea, Rep. (South)	NDC	ii	684.0	518.1	−24.3%
Kuwait	INDC	iv	128.0	181.1	41.5%
Kyrgyzstan	INDC	ii	16.0	10.7	−33.4%
Laos	NDC	iv	32.7	18.9	−42.3%
Lebanon	INDC	ii	26.8	30.8	14.9%
Lesotho	NDC	iv	4.7	3.5	−26.6%
Liberia	INDC	ii	5.1	5.7	11.8%
Libya	No submission	N/A	87.6	95.9	9.5%
Liechtenstein	NDC	i	0.2	0.1	−30.4%

(Continued.)

Country	Submission	NDC category	2015 greenhouse gas emissions (GtCO2e)	2030 conditional greenhouse gas emissions (GtCO2e)	% change 2015 to 2030
Macedonia, FYR	INDC	ii	12.7	15.7	23.6%
Madagascar	NDC	ii	58.6	106.8	82.3%
Malawi	NDC	iv	15.5	16.9	8.8%
Malaysia	NDC	iii	236.0	661.2	107.0%
Maldives	NDC	ii	1.4	2.5	76.6%
Mali	NDC	ii	45.0	32.3	−28.3%
Marshall Islands	NDC	i	0.2	0.1	−51.3%
Mauritania	NDC	ii	11.2	14.6	30.7%
Mauritius	NDC	ii	8.4	4.9	−41.6%
Mexico	NDC	ii	707.0	622.7	−11.9%
Micronesia	NDC	i	0.2	0.1	−49.3%
Moldova	INDC	i	11.9	9.7	−18.1%
Monaco	NDC	i	0.1	0.1	−36.0%
Mongolia	NDC	ii	65.9	58.9	−10.6%
Montenegro	NDC	i	4.7	4.5	−3.7%
Morocco	NDC	ii	109.0	98.9	−9.3%
Mozambique	INDC	iv	81.1	120.6	48.7%
Myanmar	NDC	iv	228.0	301.0	32.0%
Namibia	NDC	ii	22.6	2.6	−88.6%
Nauru	NDC	iv	0.0	0.1	96.0%
Nepal	NDC	iv	44.3	63.2	42.6%
New Zealand	NDC	i	65.1	47.8	−26.6%
Nicaragua	No submission	N/A	16.7	19.4	16.4%
Niger	NDC	Ii	34.6	63.1	82.3%
Nigeria	NDC	Ii	430.0	540.0	25.6%
Niue	NDC	iv	0.1	0.1	38.3%
Norway	NDC	i	33.1	31.6	−4.7%
Oman	INDC	ii	82.6	88.7	7.4%
Pakistan	NDC	ii	470.0	1,282.4	172.9%
Palau	NDC	i	0.3	0.0	−94.2%
Panama	NDC	iv	22.8	29.1	27.6%
Papua New Guinea	NDC	iv	69.6	76.0	9.1%
Paraguay	NDC	ii	184.0	332.8	80.9%
Peru	NDC	ii	184.0	208.8	13.5%
Philippines	INDC	iv	145.0	79.3	−45.3%
Qatar	NDC	iv	186.0	314.7	69.2%
Russian Federation	INDC	i	2,570.0	2,887.5	12.4%
Rwanda	NDC	iv	8.0	13.7	72.6%
Saint Kitts and Nevis	NDC	ii	0.3	0.5	60.2%
Saint Lucia	NDC	ii	0.6	0.6	11.4%
Saint Vincent and Grenadines	NDC	ii	0.4	0.5	24.8%
Samoa	NDC	iv	0.4	0.4	−5.3%
San Marino	NDC	i	0.2	0.2	0.3%
Sao Tome and Principe	NDC	ii	0.2	0.2	−6.5%
Saudi Arabia	NDC	iv	643.0	1,050.8	63.4%
Senegal	INDC	ii	31.4	29.2	−6.9%
Serbia	NDC	i	68.1	70.8	4.0%
Seychelles	NDC	ii	0.6	0.5	−21.5%
Sierra Leone	NDC	iv	13.8	18.6	34.5%
Singapore	NDC	iii	84.5	50.5	−45.7%
Solomon Islands	NDC	ii	2.4	0.0	−98.4%
Somalia	NDC	iv	41.3	37.6	−8.8%
South Africa	NDC	ii	540.0	614.0	13.7%
South Sudan	INDC	iv	67.2	70.5	4.9%
Sri Lanka	NDC	iv	33.3	47.0	41.1%
Sudan	NDC	iv	309.0	285.6	−7.6%
Suriname	INDC	iv	7.8	9.2	17.9%
Swaziland	NDC	iv	3.3	3.6	9.7%
Switzerland	NDC	i	46.6	26.7	−42.8%

(Continued.)

Country	Submission	NDC category	2015 greenhouse gas emissions (GtCO2e)	2030 conditional greenhouse gas emissions (GtCO2e)	% change 2015 to 2030
Syria	No submission	N/A	78.5	23.5	−70.0%
Tajikistan	NDC	i	10.2	21.4	109.6%
Tanzania	INDC	ii	299.0	299.7	0.2%
Thailand	NDC	ii	382.0	471.0	23.3%
Timor-Leste	NDC	iv	7.6	8.5	11.9%
Togo	NDC	ii	15.6	27.6	77.1%
Tonga	NDC	ii	0.2	0.2	−21.6%
Trinidad and Tobago	NDC	ii	91.1	87.6	−3.9%
Tunisia	NDC	iii	41.4	56.4	1.9%
Turkey	INDC	ii	415.0	929.0	123.9%
Turkmenistan	NDC	iv	106.0	135.8	28.1%
Tuvalu	NDC	i	0.0	0.0	−79.8%
Uganda	NDC	ii	72.0	60.3	−16.3%
Ukraine	NDC	i	320.0	588.6	83.9%
United Arab Emirates	NDC	iv	323.0	493.4	52.8%
United States	NDC	i	6,540.0	4,497.8	−31.2%
Uruguay	NDC	iii	30.9	47.3	104.0%
Uzbekistan	INDC	iii	235.0	637.2	54.8%
Vanuatu	NDC	iv	0.7	0.9	35.8%
Venezuela	NDC	ii	328.0	556.0	69.5%
Vietnam	NDC	ii	329.0	590.6	79.5%
Yemen	INDC	ii	45.3	37.7	−16.8%
Zambia	NDC	i	373.0	210.4	−43.6%
Zimbabwe	NDC	iv	63.9	60.0	−6.0%

Note. NDC Categories: i Absolute emission reduction target, ii 'business as usual' reduction iii reduction of emission intensity of GDP, and iv projects absent of GHG emission targets. The percentage growth in emissions appear very high in some countries such as Burundi, Chile and Kenya (634%, 7469% and 230%, respectively) due to inconsistencies in the accounting of 2015 emissions in the PRIMAP dataset used and country's own accounting in the NDC. In particular, there seem to be irregularities in the accounting for emissions associated with land use, land use change and forestry (LULUCF) in the PRIMAP database.

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