Representative Concentration Pathways (RCPs) for Application

The adaptation gap defines the additional adaptation that will be required if the upper limit of anthropogenic global temperature change exceeds 1.5 C but is kept within the possible secondary target of 2.0 C (or higher). As a result of the COP21 in Paris a new initiative and focus on how this adaptation gap will be managed has emerged i.e. there is a global consensus that keeping global temperatures below 1.5 C is looking increasingly unlikely with each passing day and therefore action plans need to be made and implemented for adapting a wide range of sectors from food to water and health for a 2.0 C and possibly even warmer world by 2100 and beyond.

> Well, what the Paris Agreement specifies is that the goal should be to limit warming well under 2 C above preindustrial with efforts to ask whether it's possible to stabilize at 1.5 C. All of the available evidence says that the 2 C is within the realm of what's possible in a transition that protects the interests of people in poor countries, as well as the interests of people around the world and ecosystems. So I wouldn't say that the Paris Agreement is outside the realm of possibility, but what we increasingly see is evidence that being able to provide ambitious mitigation that holds us at the low range of the possible impacts, and 2 C or better is going to require action in the very, very near term with a very heavy foot on the accelerator pedal of the pace of that action to reduce fossil emission (Source: Stanford Field interview transcript 15 August 2016).

As risk and adaptation specialists with over 100 projects implemented in more than 50 countries, we are distinctly aware of the challenges that lie ahead. One of the most challenging aspects of any project that is limited in its scope and budget (and all projects are) is recommending to clients the Representative Concentration Pathway(s) (RCP(s) for application in risk assessments). The definition of any project parameters needs to consider this aspect as well as many others. The discussion of such parameters is paramount as early in a project scoping phase as possible and should be based on a consultative process. Given the latest Conference of Party (COP 21) discussions we have tried to make it as up-to-date as possible and bring to the discussion consideration of Intended Nationally Determined Contributions (INDCs) and potential limitations in societal capacity for achieving not only a reduction in greenhouse gas emissions but also the decarbonisation of the world economy. We have taken a pragmatic approach that explores the big picture issues rather than diving deeply into individual and nuanced aspects of each possibility that could impact change.

Representative Concentration Pathways (RCPs)

Is 2°C the Bottomline?

There is plenty of talk of limiting climate change and global warming to 2 °C or less from pre-industrial levels. One of the most influential global groups in the G7 +1 that when they met in June of 2015 made strong statements about the Conference of Parties (hereafter COP) negotiations.

The agreement should enhance transparency and accountability including through binding rules at its core to track progress towards achieving targets, which should promote increased ambition over time. This should enable all countries to follow a *low-carbon and resilient development pathway in line with the global goal to hold the increase in global average temperature below 2 °C* (G7 +1 Leaders Summit, emphasis added) .

The COP 21 negotiations concluded in Paris do relate and are linked by previous COP meetings. One of the strongest linkages is with the Copenhagen meeting (COP 15), where Member States agreed to a goal of limiting climate change to no more than 2°C. At the COP (21) there was considerable – but not universal – support for supplementing this goal with a long-term decarbonization goal, like that included in the G7+1 Leaders Statement in June 2015 and noted above, to provide a signal to business and investors. Many countries wanted to include a decarbonization goal in the Paris agreement, but as a consensus could not be reached to do so, a possible fall-back was to include the goal in the Conference of the Parties (COP) decision that adopts the Paris agreement, which would give the goal a slightly lesser political status (Bodansky 2015).

Limiting to 2.0 (or better) Degrees Celsius

One of the more critical pieces of country engagement in the COP process has been the development of Intended Nationally Determined Contributions referring to greenhouse gas trajectories (i.e. reductions but not in all country cases) that include: current policy projections; short-term pledges (up to 2030) and long-term pledges (up to 2050) with no explanation of post-2050 targets or implementation guidelines or clear statements on binding commitments.

As of the middle of 2019, 169 submissions to the UNFCCC, reflecting 187 countries (including the European Union member states), and covering around 98% of global emissions in 2010 (excluding LULUCF) and 97% of global population have been made. A further 3% of global emissions are coming from international aviation and maritime transport. Almost 1% of global emissions are covered by countries that are not Parties to the UNFCCC Climate Action Tracker, 2019).

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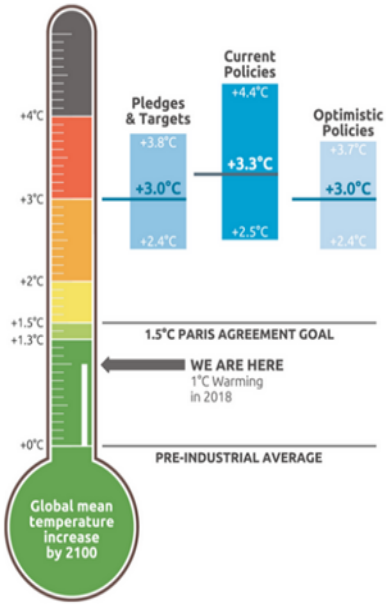


Various groups have been analysing the NDCs and what they could mean in relation to the achievement of the target global temperature. Given current commitments and on-going negotiations for decarbonising the global economy pledges look likely to fall short of the 2.0 °C target. Even if the global community were to reach the goal of limiting warming to 2.0 °C there would still be up to 30 cms of sea level rise and important shifts in climate and extreme events that must still be considered in adaptation planning (Wigley 2015).

Importantly there are sizable gaps between what is stated in the recently submitted INDCs and what history tells us. This is called the emissions gap and there are some very good reasons why this gap may persist for the foreseeable future and even if current pledges are fully realised will leave global temperatures at around 2.7 °C and perhaps higher depending on compliance and rates of reduction achieved.

However, the inertia in the energy system and emissions – e.g. the long lifetime of power plants and other fossil fuel powered technology – sets limits for how quickly nations can realistically slow their emission pathways. Highest emission reduction rates found in the mitigation scenario literature are in the order of 4% to 6% per year, importantly such rates have only been achieved over relatively short periods of time (van Vuuren and Stehfast, 2013). On a longer timeframe of 50 years, the maximal rates of reduction observed in scenarios has been only 3% to 4%. Therefore, it seems unlikely that most countries could sustain multiyear reduction rates exceeding 4% in the future (Elkholm and Lindroos, 2015).

The 2030 level can affect the achievable future emission levels: being on a higher level initially makes it more difficult to reach a low emission level in the future, as the rate at which emissions can be realistically reduced is limited. The 2030 level can exclude from reaching the target if the further cuts necessary to meet the 2°C target let along 1.5 °C have to be scaled up so fast. This seems highly unlikely given inertia in the energy system and other emission sources (Elkholm and Lindroos, 2015). Underlying such rates of possible emissions reductions beyond international and binding political agreements are national and local issues of politics, institutional capacity and mandates, regulations and standards not only of the UNFCCC but also International Organisation for Standardisation (ISO) and industry requirements. There are also issues of technological capacity and transfer, financial and development stages and goals and equity gaps and financing limitations.

For example, India alone through its submission of its INDC requires significant external financial support for capacity building, technology development and transfer. They noted a need for USD 834 billion to achieve moderate low carbon development up to 2030. The Green Climate Fund update at the COP20 noted a mobilisation of only USD 10.2 billion to date by contributing parties. The target is for USD 100 billion a year by 2020. Even if it were to achieve this level of donor country support India alone could consume eight of the next ten years of funding to meet its needs.

The Green Climate Fund was one of the most divisive issues at COP 21 and there are long standing disagreements on what has and will constitute donations to the fund. There remains a large gap between the expectations of developing countries for significant levels of climate finance, and donor countries, who already feel donor fatigue. A recent report found that $62 billion in climate finance was mobilized in 2014, up from $52 billion in 2013, although these figures are disputed because of the major methodological questions about what should be counted as climate finance (OECD 2015).

What is Best Practice?

Given the confluence of needs for a rapid reduction in greenhouse gas emissions, the slow onset of negotiations to effectuate such change, the move toward non-binding agreements on such reductions is the continued adaption of a worst-case scenario – RCP 8.5 ensemble of models and medium to high sensitivity approach justifiable? And is it even possible when countries or individual clients are not bound by any international standards or national regulations but are free to choose the level of risk they may wish to carry forward through the applications of one of many possible emission pathways. Is this ethical/ defensible given the new Intended Nationally Determined Contributions (INDCs)?

What if we try to estimate future scenarios from INDC commitments . . . theory and practice?

The 169 submissions to date representing 187 countries currently reporting representing about 90 percent of emissions. Clearly there is a greater than 50 percent chance that the global community is not going to make target temperatures and driving emission profiles. Do we therefore advise to plan for a worst case 4.4 °C or 2.5 °C (or 3.3 °C) world for durable 50+ year infrastructure?

Representative Concentration Pathways (RCPs)

Location	1995	RCP 8.5 (change) to 2030	RCP 8.5 (change) to 2060
Brasilia	21.04	22.66 (1.62)	24.49 (3.45)
Recife	25.87	27.07 (1.20)	28.43 (2.56)
Sao Paulo	17.63	18.94 (1.31)	20.41 (2.78)

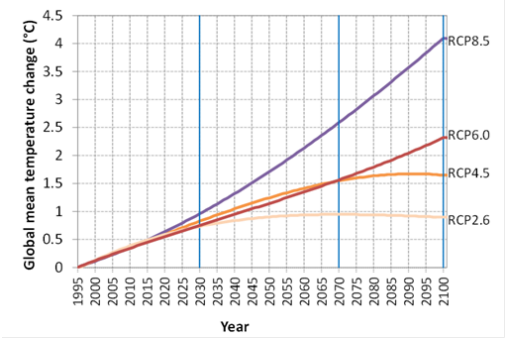
Mean annual temperatures and changes in °C to 2030 and 2060 from 1995 for RCPs 8.5 high sensitivity. Global mean temperature change to 2030 for RCP 8.5 is 1.39 °C and for 2060 is 2.97°C, both with high sensitivity (Warrick et al. 2013). Overall non-coastal Brazil is warming more quickly than the global mean hence the rationale for apply RCP 8.5 in the analysis.

In relation to the INDCs that have been submitted there is as shown a consensus that current pledges will fall short of achieving the 2.0 °C target (and almost certainly the 1.5 °C target suggested by SIDS). Ultimately, can the INDCs and the process be trusted? Monitoring and evaluation is critical and current negotiations are trending toward making it binding to reduce emissions, but actual targets be unbinding (Bodansky 2015; factorCO2 2015).

Given this review the Representative Concentration Pathway RCP8.5 medium sensitivity from IPCC Fifth Assessment Report (IPCC AR5, 2010) it is suggested for application in the village assessments with inclusion of RCP 8.5 medium sensitivity as a risk-based scenario. The natural systems under consideration can be considered lifelines and thus their resilience to climate risks needs to higher than other variables. Life and property losses could be catastrophic with loss or damage of these natural systems. Furthermore, the temperature profile for RCP 8.5 and the time frame for analysis (decadal) means that even the current goal of limiting temperatures to 2 °C Celsius will be achieved by 2050 (or sooner in the case of Chefornak) under the RCP 8.5 concentration.

In summary, the RCP8.5 is a greenhouse gas concentration (not emissions) trajectories adopted by the IPCC for its Fifth Assessment Report (AR5) with rising radiative forcing pathway leading to 8.5 W/m2 in 2100.

The figure below shows the global mean temperature change projected for RCP8.5, between 1995 and 2100. Global mean temperature changes projected range from 0.96 °C by 2030 and 4.10 °C by 2100.



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he global mean temperature change of the three selected RCP scenarios. The graph shows that up to 2030, global mean temperature is projected to increase by about 1.0°C (from 1995), irrespective of the RCP scenario and subsequently the future temperature change projections diverge by 2050 and even more by 2100, depending on the RCP scenario.

Representative Concentration Pathways (RCPs)

Summary

With the formation of the Adaptation Committee at COP21 and the ratification of the Paris Agreement the need for adaptation planning is becoming more pressing. There is movement across many fronts from insurance to national legislative requirements that development investments of all types will only be considered for projects that have been thoroughly reviewed for their potential risk and ultimately their resilience to future climates. There will be a very rapid growth in the need for high quality assessments of risk using the latest data and methodologies. Transparency and transdisciplinary approaches will be required, and lessons learned should and will inform future action. Defining risk and working collaboratively in its assessment and planning and implementing programmes to enhance resilience must grow enormously. The Adaptation Committee established at COP 21 will be watching and requiring examples from signatory countries.

List of RCPs

Overview of representative concentration pathways (RCPs) (van Vuuren *et al.* 2011; Moss *et al.* 2010; Rojeli *et al*. 2012)

Description[a]		CO_2 Equivalent	SRES Equivalent	Publication – IA Model
RCP8.5	Rising radiative forcing pathway leading to 8.5 W/m2 in 2100.	**1370**	**A1FI**	**Raiahi *et al.* 2007 – MESSAGE**
RCP6.0	Stabilization without overshoot pathway to 6 W/m2 at 2100	**850**	**B2**	**Fujino *et al.*; Hijioka *et al*. 2008 – AIM**
RCP4.5	Stabilization without overshoot pathway to 4.5 W/m2 2100	**650**	**B1**	**Clark *et al.* 2006; Smith and Wigley 2006; Wise *et al*. 2009 – GCAM**
RCP2.6	Peak in radiative forcing at ~ 3 W/m2 before 2100 and decline	**490**	**None**	**van Vuuren *et al.*, 2007; van Vuuren *et al.* 2006 - IMAGE**

[a] Approximate radiative forcing levels were defined as ±5% of the stated level in W/m_2 relative to pre-industrial levels. Radiative forcing values include the net effect of all anthropogenic GHGs and other forcing agents.