



# Differentiating regions for adaptation financing: the role of global vulnerability and risk distributions

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In the Paris Agreement, it is stated that country's vulnerability to climate change is a key factor to decide where and how to allocate adaptation funds. However, the distribution of available funds continues to be a controversial point of discussion. To inform this discussion, we look at how policy makers could be differentiating regions for financing countries adaptation needs. We synthesize the results of global vulnerability assessments and conclude that in spite of some agreement between global vulnerability distribution and current funding allocation based on income groups, climate vulnerability remains a nuanced and problematic concept. In a search for increased transparency to inform adaptation financing, we analyze the new risk approach brought forward in recent Intergovernmental Panel on Climate Change (IPCC) reports. A main advantage of this new formulation is a clearer distinction between physical hazards and vulnerability, where vulnerability is solely driven by societal factors. Notwithstanding, the risk approach comes with some shortfalls, not least in terms of scale mismatches. This confirms that more efforts could be devoted in exploring appropriate scales (from both climatological and societal perspectives) and methodologies for embedding the vulnerability approach in a risk framework. However, a prevalent disconnect between science and policy on issues of adaptation financing has so far impeded the shift from earlier formulation of vulnerability to a risk concept in the policy arena. The IPCC has a pivotal role to play in filling this gap by leading a country-level assessment that can serve as a basis for prioritizing adaptation financing. © 2016 Wiley Periodicals, Inc.

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## INTRODUCTION

Understanding the present and future distribution of different climate change impacts and vulnerability to climate change is a central subject in the context of climate justice and international climate policy.<sup>1,2</sup> The Conference of Parties of the United Nations Framework Convention on Climate Change (UNFCCC) calls for developed countries to mobilize

financial support to developing country parties, and in particular to those most vulnerable and at risk to the impacts of climate change as emphasized, for instance, in the 2014 Lima Call for Climate Action.<sup>3</sup> More recently, Article 7 of the Paris Agreement has reiterated the importance of adaptation efforts to take into account the needs of developing countries and especially of those that are particularly vulnerable to the effects of climate change.<sup>4</sup> The priority role of highly vulnerable countries is emphasized in the statements of the Paris Agreement that refers to the mechanisms for financing mitigation and adaptation. However, the distribution of available funds continues to be a controversial point of discussion. As repeated in numerous documents, the distribution of vulnerability to climate change, impact severity, or adaptive capacity of countries would typically need to be considered for funding allocation.<sup>5,6</sup> The Green Climate Fund (GCF), a primary financing vehicle under the UNFCCC, recently identified the vulnerability of a country as one amongst other criteria to decide on adaptation funding.<sup>7</sup> Scale and intensity of exposure of people and social or economic assets to risks from climate change are sub-criteria for funding in the GCF along with the social and economic development of the country. The GCF strives for a balanced geographic distribution of funding. However, funding allocation based on country income groups remains so far the dominant approach. This is not surprising considering that the GCF and similar financing instruments lack detailed guidelines on how vulnerability of a country to climate change impacts should inform funding allocation.

Different research institutions and disciplines as well as international NGOs have developed different assessment approaches on how to capture vulnerability. It has been shown that the methodological approaches for climate vulnerability assessments are so diverse that identifying and following prevalent directions are extremely challenging.<sup>8</sup> Some assessments translate vulnerability solely as linked to poverty, while other studies also consider the broader context, such as governance issues and elements of coping and adaptation.<sup>9,10</sup> This diversity has a value and shows that a universal concept might not be appropriate, however, as a consequence, the classification of countries most in need of adaptation financing remains controversial. The diversity of approaches is a major concern in view of the need to inform international climate policies, all the more if such assessments should contribute to the allocation of climate adaptation funds. It is interesting to note that in consultation rounds with the Intergovernmental Panel on Climate Change (IPCC), the Board of

the Adaptation Fund (another financing instrument under the convention) was concerned with the question whether vulnerability assessments could provide guidance on where to invest resources of the Fund.<sup>11</sup> However, the IPCC has so far failed to convene any knowledge synthesis on the status of global vulnerability and risk to climate change at a resolution relevant for policy makers and planners.

In this opinion article, we address the question of how policy makers could be differentiating regions for financing countries adaptation needs. The discussion is informed by critically looking at methodologies used to estimate vulnerabilities to climate change at the global scale and whether hotspots of vulnerability can be identified to provide guidance in view of questions of resources distribution. While the studies selected do not necessarily cover the full breadth of global vulnerability distribution, they exemplify the challenges that might be encountered when trying to operationalize a diverse concept such as vulnerability and its distribution for policy purposes. In view of recent shifts of the IPCC from a vulnerability to a risk framework, we then move to explore how and if the new approach can better inform the distribution of adaptation financing and the benefits and challenges of using a risk approach.

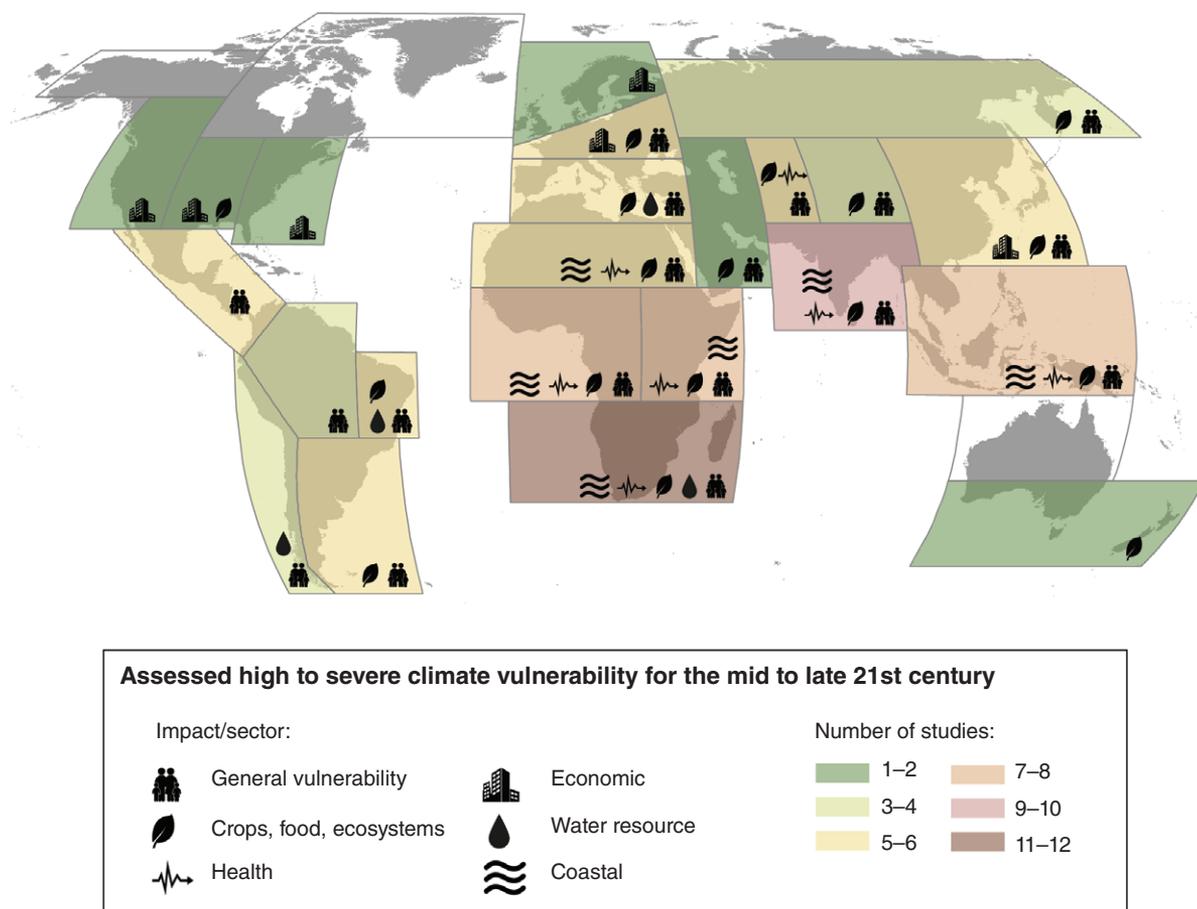
## A CRITICAL ASSESSMENT OF GLOBAL VULNERABILITY STUDIES

The IPCC in its Fourth Assessment Report (IPCC AR4)<sup>12</sup> conceptualized vulnerability as a function of exposure, sensitivity, and adaptive capacity. Exposure represents the natural and built environment that positions a system to be affected by the climate; sensitivity represents the degree a system is affected by climate stressors, and adaptive capacity is the capacity of a system to cope with such stressors. This approach to vulnerability has gained wide acceptance notwithstanding a lack of precision in the meaning of the three components of vulnerability.<sup>8</sup> A great deal of research to date has been dedicated to developing indicators underpinning these three components of vulnerability.

Considering that a synthesis of global scale studies of climate change vulnerability is currently missing, we looked at published studies having a global geographic focus.<sup>5,13–22</sup> We attempted to summarize their results and to conclude whether there is a convergence in the literature on where in the globe are the most vulnerable locations in spite of the different methods used to assess vulnerability to climate change. Half of the papers applied a vulnerability

concept in line with IPCC AR4.<sup>5,14–17,19</sup> The remaining studies analyzed specific components of vulnerability or applied other, typically index based, approaches. Figure 1 reflects the synthesis of our assessment and shows that most regions of the world are vulnerable to climate change, although the vulnerability profiles (i.e., a representation of the sectors that are vulnerable) vary across the globe. It is possible to say that there are several regions of the world where multiple studies converge to indicate high vulnerability across a range of sectors, that is, much of Africa and Southern regions of Asia; and in this regard, these regions may be considered as most strongly affected by climate change. However, few observations are granted here. South America and Central Asia show a certain degree of vulnerability across several sectors, but there are fewer studies to confirm this result relative to the hotspots of Africa and South Asia. Only one study considered the vulnerability of the economic sector to climate change

and reports high to severe vulnerability for some wealthier countries,<sup>18</sup> as illustrated in Figure 1. While this can be true for potential absolute or even per capita economic losses, the picture might change again if exposed wealth is characterized, for example, as the percentage of a nation's gross domestic product (GDP). Thus, the issue of differential vulnerabilities across the world and in different sectors suggests that vulnerabilities are more nuanced than a classification along poverty lines or GDP might provide. Similarly, the aggregation of results to a regional-scale means that country-level information (crucial for adaptation funding allocation) is lost, and some of the most vulnerable nations, such as Small Island Developing States, are not distinguishable at the scale. However, global studies of climate vulnerability conducted at the country-level are few. One such global vulnerability study is provided by the Notre Dame Global Adaptation Index (ND-GAIN)<sup>24</sup> where vulnerability is derived from the country's exposure,



**FIGURE 1** | Synthesis of the results from global vulnerability assessments. For each region, the impacts or sectors assessed as having high to severe levels of vulnerability are indicated. The number of studies supporting this assessment is also indicated. The figure represents vulnerabilities aggregated on a regional distribution of vulnerability. Regional geographic definitions are taken from Intergovernmental Panel on Climate Change Special Report on Managing Risks from Extreme Events.<sup>23</sup>

sensitivity, and ability to adapt to the negative impact of climate change. In comparison to our multi-study synthesis (Figure 1), there are notable differences. For example, in Africa, ND-GAIN shows greatest vulnerability over the countries of central Africa, whereas our synthesis points toward Southern Africa. Over South America, vulnerability in Northern and South-eastern regions is comparatively lower in ND-GAIN than depicted in our regional synthesis (Figure 1).

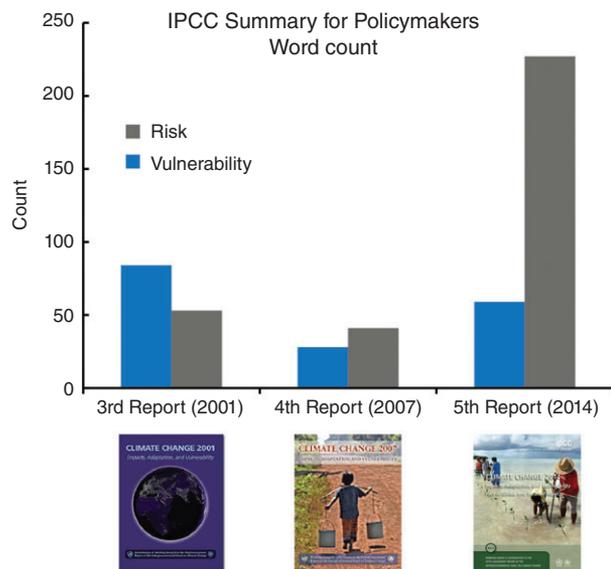
In synthesizing the results of the studies, we also noticed a plurality of assumptions made by this body of research in relation to the definition of exposure, sensitivity, and adaptive capacity. In addition to the issues raised above, such a plurality of assumptions is a drawback when attempting to operationalize vulnerability to inform policy processes. The boundaries of the concept of exposure and sensitivity are often blurred and the role of the two cannot be easily disentangled. Sensitivity should be ideally there to capture the biophysical impacts of climate change as part of the vulnerability equation, while exposure would underscore the link between impacts and geographical positioning of a human/natural system. However, in some studies, exposure directly includes climatic factors, that is, exposure equals the occurrence of certain climatic events or conditions (e.g., extreme temperatures) rather than the exposure of valued assets to such conditions.<sup>14,15</sup> In other studies, climatic conditions and drivers are part of the quantification of sensitivity.<sup>5,16,17</sup> Adaptive capacity embeds the notion of social vulnerability more systematically, but the plurality of indices contributing to the definition of adaptive capacity and the strong dependence on the chosen sector/region do not provide a firm indication on which indicators are more valuable for the classification of vulnerable countries.<sup>5,14,16,17</sup> Moving away from a strict definition of global vulnerability as a function of exposure, sensitivity, and adaptive capacity, some studies identify vulnerability with only one<sup>18</sup> or at most two of its three attributes.<sup>13,19,20</sup> This brings us to question whether more complex or more simplified definitions of vulnerability will result in the same outcome in terms of which countries are most vulnerable. Thus, the core challenge of assigning suitable indicators to each vulnerability component is hampered by a conceptual ambiguity in the definition and use of the components themselves.<sup>6,25</sup> The choice of which indicators to use to calculate the vulnerability components and the resulting vulnerability are highly dependent on the sectorial impacts the study is emphasizing.<sup>21</sup> As an example, the vulnerability of a sector, which is globally affected by negative impacts of climate change (low lying or coastal areas) is determined mainly by the adaptive capacity of the region and less by its sensitivity.

In conclusion, the importance of vulnerability profiles and a lack of agreement on the definition of vulnerability components, their usage, and choices of representative indicators fail to convene a robust guidance for policy makers when confronted with the delicate issue of deciding on the distribution of financing. Differences between our assessment and a global study of climate vulnerability conducted at the country level reinforce that no single study should serve as a basis for international policy decisions, and highlight the need for consensus based assessment results, which draw across multiple studies—a task for which the IPCC is best placed to deliver.

## THE EVOLUTION OF THE VULNERABILITY CONCEPT: TOWARD A RISK APPROACH

As seen before, the vulnerability concept based on exposure, sensitivity, and adaptive capacity is still a rather predominant approach found in the literature to date when considering a global scale. We have highlighted a number of conceptual inconsistencies and difficulties with this approach, which have been recognized by the research community for a while. In fact, the concept of vulnerability as proposed in IPCC AR4 and earlier assessments has been scrutinized and compared to risk concepts that were developed by the disaster research community. A first systematic comparison of the concepts was provided few years ago.<sup>26</sup> The IPCC Special Report on Managing Risks from Extreme Events (IPCC SREX)<sup>23</sup> represented an outstanding opportunity to integrate the concepts of vulnerability and risk as it brought together experts from the climate change and disaster risk communities. The IPCC Fifth Assessment Report (IPCC AR5)<sup>27</sup> then further refined the risk perspective. This paradigm shift from a vulnerability concept toward a concept of climate risk is reflected in the dialog between the IPCC and the policymakers, as evident from the wording used in the summary for policymakers' documents during the past three assessment cycles, where the concept of risk has come to dominate the messaging (Figure 2).

In the IPCC AR5, risk is defined as a function of the physical climate hazard (e.g., extreme temperature or flood), the exposure of people, asset values, ecosystems, and their vulnerability. One of the core differences to the former concept of vulnerability is the fact that in the new conceptualization vulnerability is clearly linked to the context of a society or system exposed, while changes in the climate system influence hazards and trends (floods, droughts, sea-level rise, changes in rainfall patterns, etc.).<sup>28</sup> A main



**FIGURE 2** | Prevalence of the terms 'risk' and 'vulnerability' within the Summary for Policymaker documents of the Intergovernmental Panel on Climate Change.

argument for differentiating vulnerability and changes in hazards or physical phenomena was outlined in IPCC SREX, which underscored that a vulnerability definition that makes physical causes and their effects an explicit aspect of vulnerability is misleading (Ref 27, pp. 32–33). In the more recent concepts, vulnerability is thus largely independent of the physical events and hence underlines that core drivers of human vulnerability are linked to societies and socio-economic, cultural, and governance factors. A main advantage of the risk framework is thus a clearer distinction between physical and societal drivers of risk. Accordingly, adaptation strategies have to improve the capacities to detect and monitor climate-related hazards (storms, droughts, and floods) as well as to enhance the capacity of exposed societies to cope with and adapt to these phenomena and changing environmental conditions, for example, through improved insurance regimes for the most vulnerable groups.

The IPCC AR5 systematically adopted the risk perspective and highlighted key and emergent risks in different socio-economic sectors and ecosystems.<sup>27</sup> At the time of the IPCC AR5, and basically still to date, few studies had integrated the concept of climate risk and the modified climate vulnerability perspective within a global study comparable to those using the former AR4 concept of vulnerability (as assessed in Figure 1). Two examples that go in the direction of a risk-based assessment at the global level are provided by the World Risk Index (WRI)<sup>9,29</sup> and the Disaster Risk Index (DRI).<sup>30</sup> The

WRI closely aligns with the conceptualization used in the IPCC AR5. The index has first been developed for geological and hydro-meteorological hazards but has now been extended to a version that captures solely climate-related hazards and slow-onset events, excluding geological hazards.<sup>29</sup> The WRI is based on the understanding that the risks and potential negative impacts due to climate-related hazards are not caused solely by external natural or climate influenced phenomena, such as floods or droughts or sea-level rise, but as well by the vulnerability as a predisposition of a society or community to be negatively affected by sudden and slow-onset hazards. The DRI aims at monitoring the evolution of risks related to extreme events by combining various types of hazards (floods, tropical cyclones, droughts, and earthquakes) with population distributions to derive physical exposures and then combining this with different levels of vulnerability established from socio-economic parameters.

The WRI and DRI provide a clearer definition and differentiation between hazard and exposure on one side, and vulnerability on the other side when compared to earlier formulations of vulnerability. This means that within the risk framework adaptation strategies should allow for reducing exposure on one side and societal vulnerabilities on the other. Differentiating the underlining social, political, economic, and institutional determinants of societal vulnerability is relevant for a sound adaptation strategy. Nonetheless, major challenges remain when trying to integrate an approach that has so far been used mainly in the context of the disaster risk management, now into the climate change adaptation domain.<sup>31</sup> One of the major challenges is the mismatch in terms of temporal and spatial scales.<sup>31,32</sup> Disasters are in general short-term events, while climate change is characterized by a combination of slow and fast onset events, where fast onset events can exacerbate the effects of slow-onset events or vice-versa (e.g., a storm surge from a tropical cyclone compounding the effects of global mean sea level rise). The WRI has moved toward integrating slow-onset events. However, processes such as ecosystem changes and loss of ecosystem species in relation to climate change have so far not been appropriately captured. Disasters are highly localized events, while climate change is supposed to have potentially large-scale impacts. As a result, policy approaches for climate change adaptation have been often top-down driven (e.g., NAPA) while the disaster risk management community used a prevalent bottom-up policy driven approach (community-based approaches).<sup>31</sup> We also noticed that in both the WRI and DRI, the focus is given to the direct risk

to human lives, whereas a full assessment of climate risk must be broadened to consider potential impacts and risks to economic, cultural, and ecological systems. For example, crop losses due to tropical cyclone damage may lead to famine and indirect fatalities far beyond those caused directly by the event itself, such that quantification of the vulnerability component must in this case be adjusted to include parameters such as a region's dependence or reliance on crops for sustenance.

## DISCUSSIONS AND CONCLUSIONS

To start with, we have raised the question of finding appropriate methods to support policy makers in the distribution of adaptation financing. Financing instruments under the UNFCCC such as the GCF and the Adaptation Fund invoke vulnerability, as a fundamental concept underpinning country needs for adaptation financing. From our assessment, it emerges that the vulnerability concept in its initial formulation as a function of exposure, sensitivity, and adaptive capacity has been widely used by the research community to assess global vulnerability distribution. Our synthesis of published global-scale vulnerability studies indicates that South and Southeast Asia, and south-central Africa are among the most vulnerable regions. This finding is in line with statements made in international climate policy and is generally consistent with the distribution of adaptation funding according to country income groups. Notwithstanding, the synthesis also shows how the vulnerability profiles of different regions (e.g., a representation of the sectors that are vulnerable) vary across the globe and scales suggesting that vulnerabilities are more complex and nuanced than classifications based on income groupings might be able to capture. It is worth adding that our synthesis of climate vulnerability studies was aggregated using the sub-regions developed in the IPCC's (2012) Special Report on extreme events. To avoid political sensitivities, these regions were defined climatologically, which may limit their usefulness in the vulnerability context, where social and cultural dimensions come to the fore. This represents both a challenge and conflict for the IPCC as they move into their sixth assessment cycle.

The IPCC AR5, and later the Structured Expert Dialogue under the UNFCCC in its final report, acknowledged the multi-dimensional nature of vulnerability where socially, economically, culturally, politically, institutionally, or otherwise marginalized people are particularly vulnerable to climate change.<sup>33</sup> Non-climatic factors thus play a critical role in defining the

level of people's vulnerability to climate change. The risk concept brought forward by the IPCC SREX and AR5 has an advantage over previous concepts focusing on vulnerability by representing a feasible framework to more coherently differentiate between physical and climatic factors, and characteristics akin to socio-environmental systems. Nevertheless, as seen, at a global scale, very few comprehensive risk studies exist and a meaningful synthesis of risk distribution is currently not possible due to limited availability of data. It is thus difficult to assess the extent to which the risk approach can inform the distribution of adaptation funds. Moreover, the mismatch in temporal and spatial scales between the disaster risk management community and the climate change community needs to be fully addressed for the climate change community to capitalize on the experience of the risk community. The issue of scale is not only linked to methods but also to data. Aggregation of uniform data of high spatial resolution is limited at the global scale, and the use and choice of vulnerability attributes, indicators, and corresponding data often bear a degree of judgment. Whether for instance health, development, economic, and education (and what type thereof) indicators are used to determine a country's vulnerability encompasses normative judgments about the importance of the different components that might influence or represent aspects and characteristics of vulnerability. While across various studies there is high agreement that poverty is one of the factors that contributes to the high vulnerability level of a country or society, it is still controversially discussed whether also governance issues, such as corruption or failed state parameters should also be considered. Eventually, these questions are fundamentally related to the purpose and scope of any vulnerability or risk assessment. Transparency in the definition of vulnerability components when informing policy is essential but often not fully achieved. And even then, some experts question whether there is a more preferential route to use for policy purposes.<sup>34</sup> However, looking at the present mechanism and country classifications, such as least-developed, middle-income, and high-income countries, used to define priority countries (i.e., least-developed countries) for global adaptation funds it is evident that such a classification is one-dimensional and solely captures GDP per capita and/or poverty, while newer global vulnerability and global risk studies also emphasize that other aspects of vulnerability need to be considered.

To prospect a way forward on the issue reviewed above, namely whether global-scale vulnerability and/or risk syntheses are appropriate at all to inform global climate policy on allocating funding for adaptation, we advocate for the full integration

of knowledge between science and adaptation policy in order to define methods that embed the multi-dimensional layers of vulnerability within a risk framework. We believe that such integration is crucial as we observe that the shift from vulnerability to risk concept, made during the IPCC SREX and AR5 process, has not yet been fully integrated in national and international climate policy. There is thus a fundamental disconnect between science and policy when it comes to issues of global adaptation financing. At this stage, the engagement of the IPCC is

pivotal. As the key scientific body informing the UNFCCC process, the IPCC should build on their concept of climate risk, and provide a global-scale assessment that can serve as a basis for prioritizing adaptation funding. To achieve this, the IPCC would either need to budge from their long-standing reluctance to provide country-level assessment results, or aggregate results to a scale that makes sense from both a climatological and socio-economic perspective—all the while navigating through the political challenges inherent in the IPCC and UNFCCC process.

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