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SPRINGBOARD COMMENTARY

Some extending thoughts on "thinking globally and siting locally—renewable energy and biodiversity in a rapidly warming world"

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Allison et al. (2014) is a provocative piece that highlights (1) the *risks* for ecosystems as the climate changes *and* (2) the tradeoffs that must be considered (i.e., the specific risks for one particular ecosystem against another) in the broader context of *the global implications of* (3) climate change and policy responses. In their abstract, they state that (selectively quoted with my emphasis in *italics*):

> Increasing greenhouse gas emissions are projected to raise global average surface temperatures by 3°–4 °C within this century, dramatically increasing the extinction *risk* for terrestrial and freshwater species and severely disrupting ecosystems across the globe. … Concerns about potential adverse impacts to species and ecosystems from the *expansion of renewable energy development* will play an important role in determining the pace and scale of emissions reductions and hence, the impact of climate change on global biodiversity. Efforts are underway to reduce *uncertainty regarding wildlife impacts* from renewable energy development, but such uncertainty cannot be eliminated. We argue *the need to accept some and perhaps substantial risk of impacts to wildlife from renewable energy development in order to limit the far greater risks to biodiversity loss owing to climate change*.

I write both to compliment and to complement their arguments; they are "right on the money," but did not go far enough. I therefore write to suggest how their adopting a risk-based framing of the ecosystem issue can be an exemplary and early example of how to organize broader thinking about risk and risk-based tradeoffs as we begin to contemplate how to respond to the complex menu of climate risks.

The risk-based framing adopted by Allison et al. (2014) was born in the Summary for Policymakers of the Synthesis Report of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007). In its final section, and in words that were authored by Steven Schneider and unanimously approved by all of the countries involved in the United Nations Framework Convention on Climate Change, the IPCC concluded that:

> Responding to climate change involves *an iterative risk management process* that includes *both adaptation and mitigation* and takes into account climate change damages,

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co-benefits, *sustainability*, *equity* and *attitudes toward risk* (IPCC 2007, pg 22; again, my emphasis).

Subsequent assessments have agreed (e.g. America's Climate Choices (NRC 2009), New York Panel on Climate Change (NYPC 2009), the Third National Climate Assessment of the United States (NCA 2014), and the "Risky Business" report (July, 2014) from such major financial players as Michael Bloomberg, Hank Paulson, Robert Rubin, George Schultz, and others). Allison et al. (2014) is a more specific example of the IPCC (2007) approach that thereby adds weight to that conclusion. They make it clear that there are tradeoffs embedded throughout any risk-based language. For example, interpreted from their text:

- adaptation and mitigation sometimes complement each other, but sometimes work at cross purposes;
- sustainability and mitigation and/or adaptation sometimes work at cross purposes, as well; and
- attitudes toward equity and risk can complicate the tradeoffs.

Historically, the most common way to assess tradeoffs in economics is to conduct careful cost-benefit analyses wherein damages and benefits are calibrated in currency; but this need not be the case. We now know that there are many other metrics, as described in IPCC (Chapter 19, 2014). My point is to support this fundamental insight – that adopting a risk-based framing helps organize thoughts around two components – likelihood and consequence.

Figure 1 replicates what has become an iconic image from the Fifth Assessment Report (Figure 19–4 in IPCC 2014)-itself derived from IPCC (2001) and confirmed in IPCC (2007) as well as Smith et al. (2009). Without unnecessary worrying about quantifying precise metrics (qualitative judgments are sufficient), these "burning embers" work from the two components of risk (likelihood and consequence) to suggest strongly that the tradeoffs highlighted effectively in Allison et al. (2014) need not be confined to ecosystems. Other "Reasons for Concern" are not restricted to economic indicators, but may include, for example, "Risk of Extreme Weather Events" and "Risk of (triggering) Singularities." My point here is that multiple metrics need to be considered to the extent possible when the tradeoffs highlighted in Allison et al. (2014) are to be considered.

I offer two examples to illustrate the possibility of using a risk-based framing to conduct rigorous and perhaps far more productive analyses of the tradeoffs, and thus as a means with which to organize ones thoughts to inform policy deliberation. The first example offers a qualitative take on a dramatic mitigation option – building a solar "farm" in the Mohave Desert to contribute to reductions in greenhouse gas emissions by the United States (perhaps in support of the 17 % reduction from 2005 levels in the next decade or so that was highlighted as a target that reported in the Sixth National Communication of the United States of America under the United Nations Framework Convention on Climate Change in January of 2014). The second example offers the potential of basing conversations based on the fundamentals of risk analysis that can, in fact, relate to rigorous economic estimates-in this case, for a wind farm to be located between Cape Cod and Nantucket Island. Both of these examples were met with narrowly focused resistance from environmental groups that were concerned about specific species, but seemed to ignore a broader context.

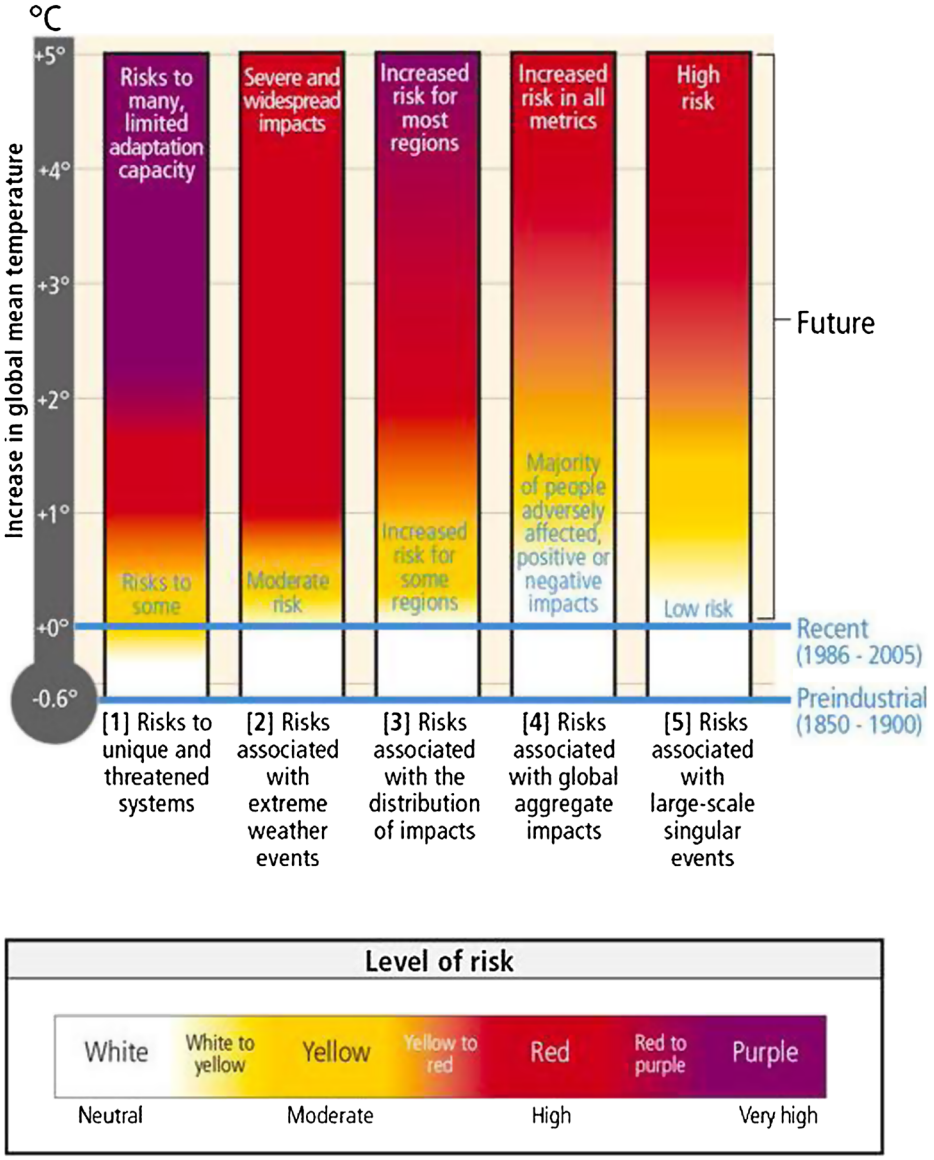

Fig. 1 (Replicating Figure 19.4 in IPCC (2014). The dependence of risk associated with the Reasons for Concern (RFCs) on the level of climate change, updated from IPCC (2001) and Smith et al. (2009). The color scheme indicates the additional risk. The shading of each ember provides a qualitative indication of the increase in risk with temperature for each individual "reason." The transition from red to purple, introduced here, is defined by very high risk of severe impacts and the presence of significant irreversibilities or persistence of climate-related hazards combined with limited ability to adapt due to the nature of the hazard or impact

1 Case one-the solar potential of the Mohave Desert

The Mohave Desert is obviously dry, so water is at a premium for species that rely on that limited water are therefore increasingly vulnerable in a warmer world. The Mohave Desert is

also obviously very sunny, so solar options are attractive-but they need access to some water and they need access to "the grid". Both of these points of access have been identified as sources of increased vulnerability to resident species, some of which are endangered. And so the question becomes-will the benefits in terms of reducing risk across the reasons for concern (through reducing the likelihood or pace of temperature change over the future and associated harm for other unique and threatened species, from extreme weather events, singular large scale events, and even aggregate or distributed economic consequences) outweigh the harm from additional vulnerabilities to specific local species. The answers depend on many factors and individual preferences, but Allison et al. (2014) argue that the concept of risk and other reasons for concern also play important roles, and they suggest ways to confront then. Indeed, Allison et al. (2014) is an excellent contribution because it demonstrates how these conflicting dependencies might be calibrated and evaluated.

2 Case two-the Cape Cod wind farm

The proposed wind farm off Cape Cod was criticized for the harm that it would do both to aesthetics and migratory birds as the farm would appear directly in migration paths for many species. Again, what would be the countervailing value in terms of more distributed (over time and space) reductions in risk? In this case, it is possible to report economic values under the assumption that wind power would replace (btu for btu) coal-fired power generation in New England. Yohe (2008) employed accepted measures of the social cost of carbon to suggest that the present value of global economic benefits would be in the order of $2 billion. The critical point here is that these benefits would not accrue to the rate-payers of New England electricity, nor would they accrue to the power company. These were discounted global social benefits (ecological, economic, and driven by extreme weather events, etc.…) that could be added to private economic value in comparison to increased vulnerabilities of migrating birds. Moreover, focusing on the likelihood component of risk offered the suggestion that wind farm "downtime" for maintenance could be timed to coincide with migration patterns (in the spring and fall) to ameliorate at least some of the risk to bird populations.

To reiterate, this brief intervention is not a critique Allison et al. (2014). It is a call to use their contribution to broaden the application of the perspective that they so clearly articulate so that many more metrics can be considered. In offering these thoughts, I am trying to illustrate how to use the underlying construction of risk (likelihood times confidence) to organize thoughts and thereby better inform tradeoff decisions of all types. These tradeoffs will be controversial across individuals with very good intentions. I am convinced that adopting a method for organizing thoughts will make the discussions between these individuals much more productive.

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