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Paper title

Reducing Climate-Sensitive Risks in the Medium Term: Stabilisation or Adaptation?

Keywords

Stabilisation, Adaptation, Mitigation, Millennium Development Goals, Sustainable Development, Adaptive Capacity, Mitigative Capacity

Reducing Climate-Sensitive Risks in the Medium Term: Stabilisation or Adaptation?

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Abstract

An evaluation of analyses sponsored by the predecessor to the U.K. Department for Environment, Food and Rural Affairs (DEFRA) of the global impacts of climate change under various mitigation scenarios (including CO_2 stabilisation at 550 and 750 ppm) coupled with an examination of the relative costs associated with different schemes to either mitigate climate change or reduce vulnerability to various climate-sensitive hazards (namely, malaria, hunger, water shortage, coastal flooding, and losses of global forests and coastal wetlands) indicates that, at least for the next few decades, risks and/or threats associated with these hazards would, by and large, be lowered more effectively and economically by reducing current and future vulnerability to those hazards rather than through stabilisation.

1. Introduction

Climate change is projected to add to existing, rather than create new, problems. Of particular concern are the problems of malaria, hunger, water shortage, coastal flooding, and threats to biodiversity [2,3,4]. This paper examines whether the total magnitude of these problems at the global level from both climate change (assuming unmitigated emissions) and non-climate change related factors would, in the foreseeable future, be reduced more effectively through stabilisation of atmospheric CO_2 concentrations, or through efforts to reduce the vulnerability of societies to these problems. The "foreseeable future" is limited to 2085 because socioeconomic scenarios are not credible beyond that [2].

In addressing this issue this paper will also shed light on: (a) whether, in the short to medium term, stabilisation would be the best approach to satisfying the twin goals of reducing climate-sensitive problems and advancing sustainable development, and (b) the efficacy of fully implementing the Kyoto Protocol (KP).

To the extent possible, and despite significant shortcomings [2,3,5], this paper adopts the results of recent studies [2,3] sponsored by the predecessor of U.K.'s Department for Environment, Food and Rural Affairs that compared the global consequences of unmitigated emissions (UE) against those of two stabilisation scenarios, namely, stabilisation at 750 ppm in 2250 and 550 ppm in 2150.

The magnitude of the problem under any emissions (or climate change) scenario at any time (t) is denoted by P(SCENARIO,t). For malaria, hunger, water shortage and coastal flooding, P(SCENARIO,t) is measured by the global population at risk (PAR) or suffering from the specific risk factor; with respect to biodiversity, it is measured by global losses in the extent of forests and coastal wetlands. The five scenarios examined in this paper are denoted by UE ("unmitigated emissions"), KP (Kyoto Protocol), 750 (stabilisation at 750 ppm), 550 (stabilisation at 550 ppm), and NCC ("no climate change" or "baseline"). Note that P(T,t) denotes the total magnitude of the problem in year t, assuming unmitigated emissions, i.e., P(T,t) = P(NCC,t) + P(UE,t), where P(UE,t) is the increase in P if emissions are not mitigated.

2. Contribution of climate change to populations at risk from various hazards

Table 1 provides estimates of ΔP(SCENARIO,2085) — the percent reduction in total global populations at risk (PAR) in the year 2085 — for malaria, hunger, water shortage and coastal flooding due to each of the four mitigation scenarios. (For these hazards, I will use P and PAR interchangeably.) To provide context for the changes in PAR for hunger, the table also indicates corresponding changes in global cereal production, a surrogate for global food production.

Table 1 shows that halting further climate change as of 1990, would at best reduce the total P for malaria in 2085 by 3.2% (see last column). Reductions from either stabilisation scenario would be even smaller, despite potentially costing trillions of dollars [6]. Reductions under KP would, at 0.2%, verge on the relatively trivial despite costing, according to the IPCC, anywhere between $25 billion and $500 billion annually in 2010 (in 1995 US dollars). (This discussion assumes that KP will cost of $125 billion annually, which is at the lower end of the above range.) But malaria's current annual death toll of a million could be *halved* with annual expenditures of $1.25 billion or less through measures designed to reduce present-day vulnerabilities to malaria, e.g., further development and better delivery of public health services for — and research targeted at — treatment and prevention of malaria [7].

Climate-Sensitive Risk Factor	**ΔP(KP,2085)** *% Reduction in P(T,2085) due to the Kyoto Protocol (KP)*	**ΔP(750,2085)** *% Reduction in P(T,2085) in 2085, assuming a stabilisation path toward 750 ppmv*	**ΔP(550,2085)** *% Reduction in P(T,2085), assuming a stabilisation path toward 550 ppmv*	**ΔP(NCC,2085)** *% Reduction in P(T,2085) if there is no climate change*
Malaria	0.2%	1.3%	0.4%	3.2%
Hunger	1.5%	16.6%	9.7%	21.1%
cereal production	*-0.1%*	*-1.5%*	*-0.6%*	*-1.9%*
Water shortage				
Method A	-4.1% to 0.8%			-58.6% to 11.8%
Method B	2.4%	4.0%	26.3%	34.1%
Coastal flooding	18.1%	62.8%	80.1%	86.2%

Table 1: Percent reduction in population at risk (P) in 2085 under various mitigation scenarios.
NOTE: P(T,2085) = P(NCC,2085) + P(UE,2085). Negative sign for cereal production indicates that yields would increase over levels under unmitigated climate change, while for water shortage it indicates a worsening situation. Except as otherwise noted, all the numbers are based on ref. [2]. Reductions due to KP are per ref. [5]. Numbers for water shortage, Method A, are calculated as the net change in the population under greater water stress [3]; Method B provides an estimate of only the population experiencing greater stress [2].

Such measures, i.e., technologies, practices and institutions, developed to reduce vulnerability to malaria today, will also help reduce malaria tomorrow, whether the disease is due to warming or non-climate change related factors. Thus, they would reduce risks to 100% of the PAR today and in 2085 (estimated at four and nine billion per year, respectively [2]), while, as noted, mitigation would at most address only 3.2% of the problem in 2085, and even less than that for the billions at risk annually between now and then.

With respect to hunger, Table 1 indicates that post-1990 warming would be responsible for 21% of the total PAR for hunger by 2085. This amount, seemingly large, is, in fact, the result of a small (1.9%) warming-related drop in future global food production between 1990 and 2085. In effect, unmitigated warming would reduce the annual growth in food productivity from 0.844% per year to 0.816% per year. But in the 1990s the world spent about $33 billion annually on agricultural R&D, including $12 billion in developing countries. Therefore a modest increase in R&D investments, say $5 billion per year, should help more than compensate for the 0.03% annual shortfall caused by unmitigated warming, particularly if that investment is targeted toward solving developing countries' current agricultural problems that might be further exacerbated by warming [5].

These problems include growing crops in poor climatic or soil conditions (e.g., low soil moisture in some areas, too much water in others, or soils with high salinity, alkalinity or acidity). Because of warming, such conditions could become more prevalent, agriculture might have to expand into areas with poorer soils, or both. Thus actions to improve current production under marginal conditions would alleviate hunger in the future whether or not climate changes. Similarly, since both CO_2 and temperatures will increase willy-nilly, cultivars should be developed to take advantage of such conditions as they come to pass. Notwithstanding current lack of confidence in location-specific details of climate change impacts analyses, substantial progress can be made on these approaches in the short to medium term [5]. Such focused measures should be complemented by measures that would broadly increase the productivity of the food and agricultural sector so that more food becomes available to consumers per unit of agricultural land or water [8].

By 2085, such measures would help reduce not only the 80 million increase in PAR due to unmitigated warming but also the 300 million at risk because of non-warming related factors [2]. Equally important, they would do more than any mitigation efforts to reduce PAR for hunger in the interim, estimated at hundreds of millions annually [2].

Remarkably, for both malaria and hunger, stabilization at 750 ppm reduces the total PAR in 2085 by a greater amount than stabilization at 550 ppm (Table 1).

Just as for malaria, reducing hunger would also boost adaptive capacity by improving public health, enhancing human capital and economic growth which then would reduce developing countries' vulnerability to any adversity, whether caused by warming or another agent. Other "co-benefits" associated with these approaches include reduced demand for additional agricultural land (because of increased food consumption per unit of land), which would limit habitat conversion. Such conversion is the biggest threat to global terrestrial biodiversity today and, as will become clearer below, probably in the foreseeable future. It would help reduce habitat fragmentation and loss of migratory corridors which, in turn, would help species adapt more "naturally" via migration and dispersion, and also conserve carbon stores and sinks and, thereby, aid mitigation [5].

The story for <u>water shortage</u> is similar to that for malaria and hunger: through 2085 the net effect of warming on PAR is relatively small, the effects of mitigation will be smaller, and measures that would reduce water shortages now will also help reduce shortages in the future.

Table 1 also indicates that warming might, in fact, reduce water shortages for some populations. Thus mitigation would make matters worse for these people, which would lower, if not eliminate, net water-related benefits from mitigation. This unfortunate outcome also holds for other hazards for which warming results in a mix of positive and negative outcomes, e.g., hunger and malaria. On the other hand, adaptation allows communities to capture the benefits while reducing, if not avoiding the downsides.

Measures that would help societies cope with present and future water shortages regardless of cause include institutional reforms to ensure that water is treated as an economic commodity, allowing water pricing and transferable property rights to water, supplemented by greater R&D into new or improved crops and techniques to increase agricultural water use efficiency. Because agriculture is responsible for 85% of global water consumption, collectively these measures would free up substantial water for household, industry, and in-stream uses, e.g., conservation of aquatic species and recreation. Notably, just as land conversion is the greatest threat to terrestrial biodiversity, so is water diversion the greatest threat to freshwater biodiversity. These measures would also help overcome what could be the major future constraint to meeting global food needs, i.e, insufficient water [5,8].

Finally, if there is one hazard for which emission reductions ought to be more cost-effective than adaptation, it is <u>coastal flooding</u>. Table 1 indicates that by 2085, unmitigated warming, estimated by the studies underlying this table to increase sea level by 0.4 m, would contribute 86 percent of the total PAR. By 2085, stabilisation at 550 ppm would reduce total PAR by as much as 80 percent at a cost of trillions of dollars [6]. But, the global cost for protecting against a 0.5 m rise in 2100 has been estimated at about $1 billion annually [9]. Thus significant emission reductions would not only cost more but could also provide less protection in 2085 than an adaptive approach that would protect against flooding.

3. Global forests & coastal wetlands

Table 2 compares projected changes in the global area of "potential" forests and coastal wetlands with and without unmitigated climate change. It shows that the effect of unmitigated climate change is small and/or positive compared to the effect of baseline (or non-climate change related) factors, at least through 2085. Whether increases in global forest area can be sustained beyond that is another matter.

Table 2 also indicates that unless baseline problems are addressed relatively quickly, a substantial portion of global forests and wetlands might be converted to other uses, and the benefits of mitigation may arrive too late to stem the loss of habitat (and biodiversity). Many of the adaptation approaches outlined previously for reducing vulnerability to both hunger and water shortage (e.g., enhancing food productivity per unit of land and water) would in fact decelerate, if not forestall, further diversion of land and water to human uses thereby fostering *in situ* conservation, and reducing the socioeconomic cost of setting any land aside for carbon sequestration [5,8].

Ecosystem	Change in baseline relative to 1990 (assumes no climate change)	Impact of unmitigated climate change, relative to 1990 (excludes land use changes)
Potential Forests (global area)	Decrease 25-30% in the 2050s ([10]	Increase by 5% in 2085 [2]
Coastal Wetlands (global area)	Decrease by 40% in 2085 [2]	Decrease by 13% in 2080s [2]

Table 2: Projected Changes in Extent of Various Ecosystems, With and Without Climate Change

4. Integrating mitigation, adaptation and sustainable development

The foregoing examined two approaches to address warming through the foreseeable future. The first, mitigation, would reduce impacts — positive and negative — across the board. This entails significant near term costs, and the pay-off will be delayed. The second approach, which I will call "focused adaptation", would reduce vulnerability to climate-sensitive effects now and through 2085 by focusing on one hazard at a time.

But developing countries are most vulnerable to warming because they lack adaptive capacity to cope with its impacts. Hence, a third approach to addressing climate change would be to enhance their adaptive capacity by advancing economic development and human capital, which, of course, is the point of sustainable development. Moreover, since the determinants of adaptive and mitigative capacity are largely the same [6], enhancing the former should also boost the latter.

Such an integrated strategy — simultaneously pursuing sustainable development while advancing the capacity to adapt to or mitigate climate change — can be accomplished by meeting the Millennium Development Goals (MDGs), which were devised to explicitly advance sustainable development. The MDGs' benefits — halving global poverty, hunger, lack of access to safe water and sanitation; reducing child and maternal mortality by 66% or more; universal primary education; and reversing growth in malaria, AIDS/HIV, and other major diseases — would generally exceed the benefits flowing from focused adaptation or even the deepest mitigation (see Tables 1 and 2). Yet, according to the World Bank, the additional cost of attaining the MDGs by 2015 is $40-60 billion annually [11], about half the cost of the barely-effective Kyoto Protocol.

Meeting the MDGs would directly or indirectly advance human well-being in its many dimensions, while broadly increasing adaptive capacity to cope with adversity in general and warming in particular. These benefits would be obtained sooner, at lesser cost, and, because of the uncertainties related to warming and its impacts, far more certainly than through mitigation alone. In addition, increased adaptive capacity would either raise the level at which GHGs would need to be stabilised to forestall warming from becoming "dangerous", or allow mitigation to be postponed, or both. In any case, costs associated with any eventual stabilisation would be reduced. And, as noted, it would advance mitigative capacity. In fact, such an approach would be entirely consistent with the UN Framework Convention on Climate Change's objectives outlined in Article 2, namely, "to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner."

5. Climate change and sustainable development

An argument advanced for mitigation is that otherwise climate change would hinder sustainable development and lock developing nations into poverty. However, through 2085, the impacts of unmitigated warming are, as shown, either smaller than the baseline problems that would exist in the absence of warming or it is more cost-effective to reduce the magnitude of the total problem via adaptation than through mitigation. Thus, even if in the longer term (i.e., beyond 2085) mitigation is inevitable, the problem through the foreseeable future is not that climate change will perpetuate poverty and hinder sustainable development, but that the lack of sustainable economic development will impede developing countries' ability to cope with all manners of adversity, including climate change.

6. Conclusion: solving today's problems without ignoring tomorrow's

Despite claims to the contrary [4], Tables 1 and 2 suggest that global warming is unlikely to be the most important environmental problem facing the world, at least for most of the remainder of this century.

For the next several decades, any mitigation scheme, whether it is as modest in its effect as the Kyoto Protocol or as ambitious as stabilising CO_2 concentrations, would expend scarce resources without commensurate improvements in global well-being. Despite the claim that such mitigation would help developing nations in particular, it would not cost-effectively reduce the risk to their populations from various climate-sensitive hazards that might be exacerbated by climate change. On the other hand, increasing adaptive capacity, through focused adaptation or, preferably, the pursuit of MDGs, is likely to reduce these risks faster, more cost-effectively and by a greater amount, while also improving other aspects of human well-being.

Some have argued for some mitigation as an insurance policy. But enhancing adaptive capacity is better than an insurance policy: unlike an insurance policy, it will, by addressing baseline problems, pay handsome dividends whether or not climate changes; if climate changes, it will also help reduce attendant risks much more contemporaneously with incurred costs than is possible through mitigation.

Assuming it takes 50 years to replace the energy infrastructure, that means we have at least 30 years (=2085-50-2005) before deciding on targets and timetables for emission cuts. In the meantime, we should focus on increasing adaptive capacity at all scales. This could raise the level at which GHG concentrations might become "dangerous" and/or allow mitigation to be postponed. Simultaneously, we should strive to make mitigation more cost-effective so that, if or when mitigation becomes necessary, net costs would be lower even if emission reductions have to be deeper.

Specifically, we should first and foremost pursue a broad adaptive strategy based on advancing sustainable development. Second, we should take measures to reduce vulnerability to today's urgent climate-sensitive risks (e.g., hunger, malaria, and water shortages) that could be exacerbated by warming. Together, these efforts would improve human well-being and enhance adaptive capacity of developing countries, which, it ought to be remembered, are most vulnerable to climate change. Not only will that advance sequestration, it would enhance mitigative capacity more broadly by augmenting economic resources and human capital.

Third, we should ensure that "no-regret" mitigation measures (e.g., elimination of fossil fuel and land conversion subsidies) are, indeed, implemented, while constantly expanding the universe of such measures through R&D designed improve their cost-effectiveness. Finally, we should continue to advance knowledge of climate change science, economics and responses to better evaluate and determine trade-offs and synergies between adaptation and mitigation, and continue to monitor trends to provide advance warning should the adverse impacts of warming occur faster, or be more severe, than currently projected.

Collectively, these approaches would solve some of the most critical problems facing the world today and tomorrow, while furthering the ability to deal with the uncertain problems of the day after tomorrow, of which climate change is merely one.

References and Endnotes

[1] Views expressed here are the author's, and not necessarily those of the U.S. government or any of its units.

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