Arbitrary Impacts and Unknown Futures: the shortcomings of climate impact models

Considerable effort has been devoted to the problem of predicting how climate change will impact society. Projections addressing this question come from complex models based on scenarios of physical and socio-economic processes that interact to reveal a wide range of societal impacts ranging from property loss, to the degradation of ecosystems, or even the compromise of human health. The IPCC third assessment report argues that the many uncertainties associated with these projections can be at least somewhat addressed by the use of wide ranging scenarios to explore multiple futures.

However, I argue that this strategy fails to remedy two fundamental shortcomings of the climate impact model approach. The first pertains to the relationships built into scenarios and models. In general, variables included in the models have known relationships with climate, but unknown relationships with each other. Thus, the "future" in these models is mainly driven by climate relationships, causing climate to appear to be more important to particular societal outcomes than is warranted.

The second shortcoming involves the relationships *not* built into impact models. Climate impact models are assembled based on known and quantifiable relationships among climate and societal factors. However there is no reason to believe that these identified relationships will prove most important. In an inexorably globalizing world, defined by increased interdependence and potentially fragile networks, the most significant societal impacts of climate may play out through complex and totally unpredictable pathways, based on relationships likely omitted from any present day climate impact model.

This argument is not intended to downplay the importance of climate change. Instead I suggest new approaches to thinking about climate impacts that focus on bottom-up, local understanding of how communities might be impacted. Furthermore, we should look for alternative framings of the issue that place climate change in the context of other types of global change, and that do not rely on guessing right about the important drivers and stressors related to climate change.

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What *can* climate change impact models tell us about the future?

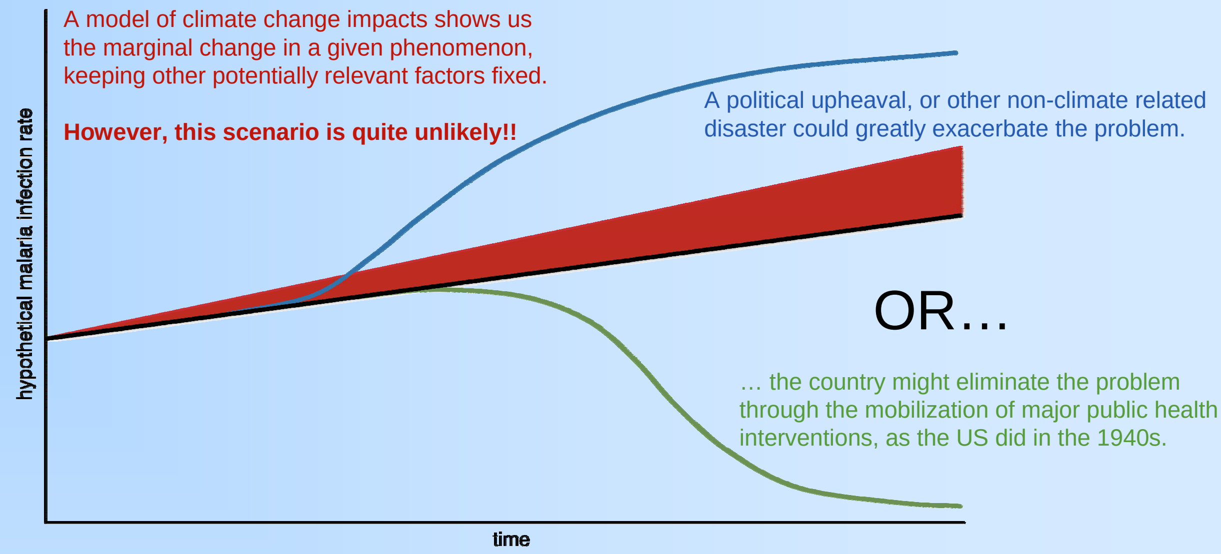
Studies of climate policy use Integrated Assessment Models to project ways in which society will be affected by, and react to, climate change. These assessments are meant to inform policy debates and other decision making processes.

To examine the future cost of climate change, modelers include phenomena with known links to climate, like property loss due to sea level rise, storm damage, or malaria (see example to the right).

But, as the right-hand figure demonstrates, the existence of a quantifiable link between, say, malaria and climate, does not mean that climate change will be an important factor determining malaria infection rates in the future.

Will climate change prove to be important to the various phenomena identified by climate modelers as being impacted by climate change? How can we know?

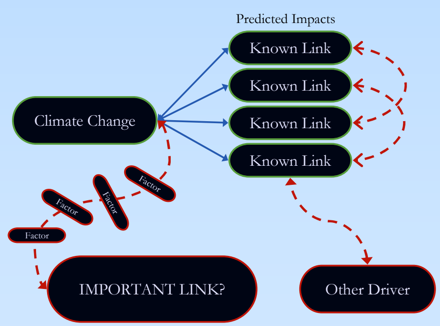
A global model of climate impacts may have little chance of telling us what the biggest impacts will be.



What *do* climate change impact models tell us about the future?

Modeling the impacts of climate change on society involves a huge range of uncertainties and value judgments. As economist Richard Tol states:

"In an economic system, the first order effect is dominant in the short run. In the long run, second, third, and even seventeenth order effects take over."



The table below shows the considerable variation in projections of impact models from different sources. These disparities stem from variation in the way modelers look at the world, value the future, interpret data, and deal with uncertainty.

Cost of climate change	Cost of limiting CO²	Optimal policies	Optimal instruments
Cost of Carbon per ton: mode=$2/tC; median=$14; mean=$93 (Tol review, 2005) 5-20% GDP/yr "now and forever" (UK Stern Review, 2006) 0.2-2% GDP in 2010 assuming Kyoto. (IPCC WGIII, 2001)	Betw ~$18 and <0.5 trillion. (IPCC WGIII, 2001) 1% GDP/yr (UK Stern Review, 2006)	"globally acceptable" target not possible. (IPCC WGIII, 2001) "strong and early action." (UK Stern Review, 2006 executive summary) modest short-term controls, increasing later (the "climate policy ramp"). (Kelly and Kolstadt review, 1999)	portfolio of policies, preferably integrated with "non-climate objectives." (IPCC WGIII, 2001) early action (C cuts, R&D, science) for flexibility in reaching future targets. (IPCC WGIII, 2001)

Climate is just one of many global changes

Starting with climate change as the central problem, and then building a model around variables that plausibly can be linked to climate, inevitably will yield a picture of the future in which climate change is the dominant problem. But climate is just one of many global changes important to the future of humans on Earth. **When modeling global dynamics, a broad perspective of global change may provide a far more useful (and balanced) context for specific global problems like climate change.**

Practical solutions must focus on local dynamics

A bottom-up approach to identifying and quantifying potential climate impacts is crucial to understanding the importance of climate change in socio-ecological systems. The marginal social cost of one ton of carbon emitted into the atmosphere - a number actively debated among environmental economists - is no more useful to the rural farmer in Zimbabwe than the knowledge that the global average temperature might rise by a few degrees. **Local dynamics must be incorporated into any realistic and usable account of climate impacts.**

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