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Earth System Dynamics
Discussions

Interactive comment on "Climate change as a driver of future human migration" *by* Min Chen and Ken Caldeira

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Formatted version is attached as supplement.

Referee #2 was somewhat less enthusiastic than Referee #1. Referee #2 states:

The manuscript, without any doubt, studies an interesting and very important question in the academic and policy worlds. It also shows a methodological sophistication and rigor, . . .

However, the referee goes on to say:

Unfortunately, I believe that this manuscript does not advance our understanding of the climate-migration relationship and as a result, it does not make any significant

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contribution to the relevant literature.

We are not sure what to say here. We have for the first time taken methods used by economists to estimate GDP changes and have applied them instead to predicting changes in population density, and using these predictions to infer possible incentives to migrate. We know of no other study that has attempted to quantify potential incentives to migrate quantitatively in this way. We are particularly surprised by this comment since the referee asks us to look at, because our treatment is much more nuanced than others cited positively by this referee. For example, Hsiang and Sobel (2016) assume examine a scenario in which people want to maintain the same global mean temperature, and use language like "tropical populations would have to travel distances greater than 1000 km" and "rapid evacuation of the tropics". We could have presented our study as a scenario and talked about all the people who would "have to migrate" under our scenario, but instead we chose to be more nuanced did not make any assumptions about people being tied to their current climates or whether they actually would migrate considering that there are many incentives not to move. We are somewhat perplexed in how to respond to a referee who cites a much simpler and less nuanced study to argue that we are not contributing anything new to the discussion. We are aware of no prior work that has performed a calculation like the one we are presenting in this work.

The referee writes:

However, at the end they chose to examine the climate-migration nexus in a direct and consequently deterministic manner, and make big and bold claims, which have huge implications of how the social consequences of climate change could be dealt with, based on false and naive assumptions.

Again, we are somewhat perplexed by the referee's remarks, as we are not aware of any big and bold claims that we are making and see nothing in our paper that could lead one to believe that we are treating "the climate-migration nexus in a direct and consequently deterministic manner".

The very first sentences of our abstract are:

Human migration is both motivated and constrained by a multitude of socioeconomic and environmental factors, including climate-related factors. Climatic factors exert an influence on local and regional population density. Here, we examine implications for future motivation for humans to migrate by analyzing today's relationships between climatic factors and population density, with all other factors held constant. Such 'all other factors held constant' analyses are unlikely to make quantitatively accurate predictions but the order-of-magnitude and spatial pattern that come out of such an analysis can be useful for thinking about the influence of climate change on the possible scale and pattern of future incentives to migrate.

Does this sound like the writing of people making big and bold claims "in a deterministic manner"?

Further, the very last paragraph of our manuscript reads:

Climate change is likely to induce a complex web of dynamical interactions at a range of spatial and temporal scales, and these interactions are not well represented by our model. For example, considerations of language, work, and family ties can provide strong incentive not to migrate. Projections of how climate change might affect migration are therefore fraught with uncertainty. Nevertheless, the results of our calculations may indicate areas that climate change can be expected provide large numbers of people, primarily in the tropics, an additional incentive to migrate, primarily to the middle and high latitudes of the Northern Hemisphere. This change in climate-driven incentives to migrate is one factor among many that need to be included in a comprehensive understanding of possible future migration flows.

Does this sound like the writing of people making big and bold claims "in a deterministic manner"? It is hard for us to understand what the referee is basing their comments on.

Usefully, the referee does point to some literature, which we now cite:

Black, Richard; W Neil Adger, Nigel W Arnell, Stefan Dercon, Andrew Geddes & David SG Thomas (2011) The effect of environmental change on human migration. Global Environmental Change 21: 3-11. Foresight Migration and Global Environmental Change. Final Project Report. London: The Government Office for Science, (2011). Available at: http://www.bis.gov.uk/foresight/ migration Hsiang, S.M. and A.H. Sobel (2016) Potentially extreme population displacement and concentration in the Tropics under non-extreme warming. Scientific Reports 6: 25697. McLeman, Robert & François Gemenne (2018) Environmental migration research: Evolution and current state of the science. In Robert McLeman & François Gemenne (ed.) Routledge Handbook of Environmental Displacement and Migration. London: Routledge, 3-16. Piguet, Etienne (2013) From "primitive migration" to "climate refugees": The curious fate of the natural environment in migration studies. Annals of the Association of American Geographers 103(1): 148-162. Rigaud, Kanta Kumari; Alex de Sherbinin, Bryan Jones, Jonas Bergmann, Viviane Clement, Kayly Ober, Jacob Schewe, Susana Adamo, Brent McCusker, Silke Heuser & Amelia Midgley (2018) Groundswell: Preparing for Internal Climate Migration, World Bank (https://openknowledge.worldbank.org/handle/10986/29461).

All of these references were easily incorporated into the existing text by adding an additional citation at the appropriate location. Because this is not a review paper, we did not attempt an exhaustive literature survey, so some sentences needed to be added to accommodate some of these suggested citations. The sentences we added are (to the Introduction):

Hsiang and Sobel (2016) examined consequences for migration if everyone moved to remain at the same annual global mean temperature under a climate change scenario.

And to the concluding paragraph:

A more complete treatment of migration, and not simply an examination of one possible set of incentives as we have done here, would require embedding our results in the

broader context of incentives that could influence migration decisions (Piguet, 2011)

And to the end of the Introduction:

When we report country-level results, we integrate across all grid cells within a country and report the net value, so our methodology would not predict incentive to migrate from a country that had some grid cells indicating incentives for out-migration but with other grid cells indicating even greater incentive for in-migration. Thus, internal migration is not considered in our study (Rigaud et al., 2018).

Please also note the supplement to this comment:
https://esd.copernicus.org/preprints/esd-2019-79/esd-2019-79-AC4-supplement.pdf

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