



What we do not know in terms of adaptation

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A **recent paper** by Oreskes *et al.* in the journal *Philosophy of Science* asserts that “there is a gap between the scale on which models produce consistent information and the scale on which humans act”. While the large scales, such as the global mean, provide the best indicators of the state of earth’s climate, it is on the *local* scales we feel a climate change, such as floods and extreme weather events. Extreme rainfall is usually *local*. So how is it possible then, as two new papers in *Nature* by Min *et al.* and Pall *et al.* (**discussed here**) have done, to attribute extreme precipitation and extreme UK floods to climate change?

First of all, Oreskes *et al.* emphasize that the reality of mean *global* warming is essentially undisputed, but that the future impacts on the scale for which humans would have to prepare are still the subject of considerable research, inquiry, and debate. Moreover, they argue that climate models *do not* give us the information we would need to accurately estimate the costs of adaptation and effectively prepare for the consequences of climate change – successful adaptation to *future* climate changes depends on whether the models produce realistic projections for regional and local scales.

We have already discussed why climate models are not well suited for providing detailed information about local climate on RC (**here** and **here**). It is important to keep in mind that models are only approximate representation of the real world, and that they are only meant to capture the essence of our climate – i.e. the larger picture. There will always be a limit to the degree of detail for which the models fail to produce reliable and useful information, and the interesting question is where this limit is. It’s a question of limitation rather than flaw.

There is a difference between the spatial scales associated with a local point measurement and statistics based on many local values. When looking at the statistics for a large region, one could argue that these studies do not rely on local scales. In fact, Min *et al.* used leading **empirical orthogonal functions** (EOFs; a type of principal component analysis) in their attribution analysis for extreme precipitation, implying large spatial scales. Hence, the points raised by Oreskes *et al.* may perhaps not be directly applicable to the attribution study done by Min *et al.*

Pall *et al.*, however, involved statistical downscaling to bridge the scaling gap between model and real world. Oreskes *et al.* paper argues that even with downscaling, our information about local scales is incomplete. Hence, the points raised by Oreskes *et al.* may be more relevant for the study of Pall *et al.* – and indeed for several of my own papers (e.g. **local temperature scenarios available for viewing in GoogleEarth** described in **a forthcoming publication**).

So, does that mean that downscaling is worthless? No! We already know that the local climate is systematically influenced by many factors, such as latitude, distance from the coast, and altitude. This information can also be utilized in the making of local climate projections – and this is exactly what is done in most downscaling exercises. The question is whether the additional information, such as that provided by the GCMs about future trends, is reliable. If the downscaling involves more than just getting a number for the future, but also evaluation over the past and other diagnostics, then I think there is some value in the downscaling.

I will **argue** that the uncertainties make it necessary to look at many different methods for downscaling (regional climate models and statistical downscaling) as well as the largest possible range of (sensible) GCMs. Nevertheless, the problems raised by Oreskes *et al.* are deeper than just looking at more models and more methods. Downscaling future climate involves uncertainties from a range of sources, some better known than others.

Another issue is the attribution of extremes to climate change, and the difficulties associated with these. We have already said that it is impossible to prove that one event is due to a climate change (**here**). A climate change involves a changing weather pattern, and if one event is part of an emerging new pattern – a trend – then one may with hindsight say that it fits the picture. Time will show.

Obviously, care must be taken, and downscaling studies that do not appropriately account for the real range of uncertainties may risk ‘over-selling’ the results. In the recognition of the uncertainties, the IPCC Good-Practice-Guidance-Paper on using climate model results offers **some wise advice** (first bullet point under section 3.5 on p. 10): the local climate change scenarios should be based on (i) historical change, (ii) process change (e.g. changes in the driving circulation), (iii) global climate change projected by GCMs, and (iv) downscaled projected change. By putting the local climate into the context of the larger picture, analyzing the uncertainties, and evaluating the methods in terms of past changes, I think that local climate projections can provide useful information. However, applied inappropriately, downscaling can also be deceptive.

In any case, Oreskes *et al.* make a strong case for the need of curbing the emission of GHGs. But I also think it is important to increase our efforts in making further progress in terms of our ability to get a clearer picture of how a global warming may affect the local climate and what that may mean for adaptation.

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