The scientific origins of the gradualist adaptation narrative and how to move beyond it

Roger Jones Professorial Research Fellow, Victoria University, Melbourne, Australia — Email roger.jones@vu.edu.au

Within limits, the impacts of gradual climate change should be manageable. Therefore, climate change adaptation can be understood as: (a) adapting to gradual changes in average temperature, sea level and precipitation. Gradual climate change allows for a gradual shift in the mix of crops and to alternative farming systems.

So why are Gauss and Newton in the bath and Ed Lorenz in the hot tub?

Physics says that climate change cannot be gradual

The First Law of Thermodynamics (conservation of energy) describes how much the Earth will warm. Greenhouse gases trap heat in the atmosphere but because air holds little heat, most goes into the ocean. This heat is re-released into the atmosphere as Earth warms towards equilibrium.

Under the simplest model, the ocean behaves like a bath that warms under the heat of a radiator. The warm bathwater then heats the atmosphere above until they are at equilibrium. Under the simplest model, the ocean behaves like a bath that warms under the heat of the Sun. The warm bathwater then heats the atmosphere above until they are at equilibrium.

The first law of thermodynamics describes how climate will change. The climate system evolves into a state where it can change into the maximum number of future possibilities. In a complex system, influenced by radiation imbalances, rotation, tides, gravity, wind, atmospheric friction and ocean-atmosphere interactions, the process of heat transfer is strongly non-linear, characterised by multiple state changes. The ocean-atmosphere system behaves more like a hot tub than a bath. (See the widespread non-linear behaviour in the diagram opposite.)

Why then, is adaptation dominated by a gradualistic narrative? It’s time to get out of the bath.

The gradualist narrative can be explored through the structure of a scientific paradigm, which consists of three main elements — theory, methods and values.

Theory forms the core of science and is justified by evidence. Methods are used to analyse and communicate evidence and are associated with a set of values. Scientific values include reproducible observations and experiments, objectivity, peer review and the development of models with predictive skill.

If theory suggests that climate change is non-linear, why is it so often represented as a gradual process? The reasons are in the historical development of scientific methods and their related values (see timeline below).

The origin of the gradualist narrative has its roots in scientific enlightenment. The subsequent development of methods and values have failed to address the non-linearity present in scientific theory and evidence (see 1963 on the timeline). The climate science community decides how their findings should be communicated and delivered. Critical information about changing climate risk is being discarded in the process.

Beyond gradualism

The following actions will ensure that theory, methods and values are more consistent with each other and can better address changing climate risk:

- Recognise the social constructions inherent in the scientific method and ensure that it accurately reflects theory and observations.
- Cease the scientific gatekeeping of climate information and develop communication strategies with the users of that information.
- Address risk more comprehensively in how climate data is prepared and communicated.
- Explore the set of adaptation options on the table in order to determine which information may be most relevant to decision making.
- Develop scenarios that anticipate rapid changes in risk but that are inherently unpredictable.
- Develop statistics for assessing the magnitude and likelihood of rapid changes in climate.
- Improve the scientific understanding of why and how non-linear changes in climate occur; to improve their detectability, and perhaps, prediction.

Table:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables involved</td>
<td>Ferrell and Pascal</td>
<td>Newton</td>
<td>Leistler</td>
<td>Gueiss</td>
<td>Caron and others</td>
<td>Cubasch, Harnik and others</td>
<td>Mani</td>
</tr>
<tr>
<td>Methodological development</td>
<td>Mathematical chance (bias)</td>
<td>The range of the distance between objects</td>
<td>Heat balance</td>
<td>Least squares analysis</td>
<td>Thermodynamic equilibrium</td>
<td>Conservation of heat (first and second in 20th century)</td>
<td>Signal-to-noise models</td>
</tr>
<tr>
<td>Scientific value</td>
<td>Predictability</td>
<td>Balance and order, irreversibility</td>
<td>Balance, measurement</td>
<td>Balance, order, management of uncertainty</td>
<td>Balance, irreversibility, harnessing of energy</td>
<td>Balance, order, separation into information from noise</td>
<td>Signal-to-noise models</td>
</tr>
</tbody>
</table>

Acknowledgments: This paper is based on Jones, R. W., Yang, E. K., Hetheron, J., Carling, A., Mallick, G. D., and O’Hare, P. (2013). Linking adaptation under rapid climate change: National Climate Change Adaptation Research Facility, Queensland, Australia. Non-linear attribution of climate change is described in Jones (2012). Detecting and attributing non-linear anthropogenic regional warming in southeastern Australia, Journal of Geophysical Research. 117, D04105. Calvin Young and Rod Smith are thanked for discussions and the team at Ascending Horse in Melbourne for design and protection. This work was supported by financial support from the Australian Government Department of Climate Change and Energy Efficiency and the National Climate Change Adaptation Research Facility (NCCARF).

References 1. www.pnas.org; 2. www.preventionweb.net; and 3. www.vms.unsw.edu.au