Modes of Uncertainty

Robert Soden

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I want to argue that we need to expand the cultural resources we can draw upon when engaging with uncertainty and that doing so might require unsettling or decentering the predominant techno-scientific mode of addressing the issue. Some background where I'm coming to these questions from – I study the knowledge infrastructures we use to understand and respond to environmental hazards including floods, earthquakes, and sea-level rise. In particular I want to understand how these infrastructures come to be the way they are, how the particulars of their construction shapes our understanding of the environment, with what consequence, and how things might be different. I use qualitative and design research methods and draw on human-centered computing, information science, and science and technology studies, as well as my own professional background as a software developer and cartographer. In my research and consulting practice I spend a lot of time working within the techno-scientific mode of thinking about uncertainty as it relates to disaster risk management – as a problem to be minimized or worked around. In this paper I will discuss this mode but also two others that I have been more recently been learning to think with – uncertainty as *generative* and uncertainty as *systematically produced*.

To ground this discussion I draw from research we did at the University of Colorado on the information standard that underpins the US National Flood Insurance Program (NFIP) maps – the 100-year floodplain (Soden et al 2017). This standard plays an important role both in how the federal government attempts to manage flood risk across a large and heterogeneous territory but also in the popular imagination of flood danger. As part of this study, I spent a year conducting research at a large engineering firm contracted by FEMA to update flood maps for the State of Colorado in the wake of the 2013 floods. While there I assisted in various tasks related to data preparation and map production, looked over the shoulder of experienced engineers as they went about their work, and interviewed many of the firm's employees about their perspectives on the process. At the same time, my colleagues at CU and I were interviewing members of the public about their understandings of flood risk and the floodplain maps. Based on the data collected through this process we argue that the 100-year standard, in presenting risk in a binary fashion, represents a problematic form of discursive closure in scientific understanding of flood hazard. We show how this closure serves to convey a certainty that the underlying science does not warrant and foreshortens public understanding of flood hazard in the region. We then looked at design opportunities for resisting this closure and helping the public develop a more engaged understanding of flood hazard.

Mode 1: Techno-Science

The first, most familiar, mode of thinking about uncertainty is that it is a problem to be overcome through advances in science and technology. The promise of the Enlightenment, after all, was about the triumph of reason over nature. Yet it's been widely argued that this effort will always come up a bit short. Hume's skepticism, for example, is rooted in his argument that all scientific claims are underdetermined, that they will always fail to take into account a functionally infinite number of potential states of the world. For many scholars, an asymptotic pursuit of certainty is in fact one of the defining characteristics of modernity (Beck 1992, Gandy 2014, Toulmin 1990). Otherwise put, modernity is a state of perpetual anxiety about uncertainty. Despite the ways in which quantum physics has complicated the matter even further (Barad 2007) and increased attention to so-called "wicked problems", this perspective continues to guide much of the practical work of scientists and technologists working in my field sites. Complex taxonomies of uncertainties are produced and used to identify tactics for managing or eliminating them (Bradley & Drechsler 2013, Spiegelhalter & Riesch 2011, Wynne 1992). Better sensors, higher resolution data, and more powerful algorithms will yield flood maps with less uncertainty. Sophisticated approaches to data visualization and risk communication will help the public navigate the remainder.

Our research in Boulder showed that residents who lived outside of the floodplain were unprepared for the possibility that their homes could experience flooding during the storm. Few bought insurance or took other protective measures. The lines on the floodmap, intended to delineate a 1% annual chance of flooding were taken as indicators of complete safety in the public imagination of risk. Further, the regulatory and insurance implications for property mapped inside the flood hazard zone, as well as the impact real estate values, have turned flood mapping into an intensely politicized processes, where home-owners with the resources to engage can tie up map updates in public comment processes that stretch on for months or years. At present, some 60% of NFIP rate maps are thought to be out of date due in part to this. Though we can imagine alternative data standards that would present more complex understandings of flood risk, some level of uncertainty will always remain. For example, during the flooding, everything from debris and small landslides in the canyons above Boulder to landscaping to attempts by residents to build makeshift defenses channeled the floodwater in unpredictable directions. Despite possible improvements in the science and technology of flood mapping, Hume's under-determination will always be with us. So let's look at some other ways to approach the question.

Mode 2: Uncertainty as Generative

Another mode of figuring uncertainty which is gaining traction in some design and STS circles is to treat uncertainty as something generative, or productive, rather than a problem to be isolated, reduced, and managed, So for Pink et al, uncertainty is a "technology" that can be usefully disruptive in overly determined contexts, allowing creativity and speculative practice to flourish in the cracks (Pink et al 2018). Similarly, Gaver et al write that ambiguity, an allied concept, supports "deep appropriation" of ideas and technologies "by impelling people to interpret situations

for themselves, it encourages them to start grappling conceptually with systems and their contexts, and thus to establish deeper and more personal relations with the meanings offered by those systems (Gaver et al 2003)". In this mode, uncertainty is not located in technologies of representation (e.g. maps, models, databases) but rather emerges in particular settings and during particular moments. We thus can seek to design encounters that allow the possibility for uncertainty to emerge in useful ways.

As part of our exploration of the 100-year floodplain standard in Boulder we undertook two very simple experiments on how to design encounters with flood risk information that would be more engaging. The first relied on serious games to support collective questioning and discovery of flood risk. This is in opposition to what we observed to be most Boulder residents' experience of flood data, if any, which was and individual question as to whether their home was inside the flood hazard zone or not. The second experiment used what is called *frictional design* (Korn & Voida 2015) to complicate flood maps by adding other kinds of risk information, most notably the extents of past flood events. Here simply showing residents that previous flooding had affected areas outside of the flood hazard zone provoked questions about how the maps are produced and what exactly they are meant to convey. Uncertainty in these examples became an invitation to look more closely, and promises rewards in the form of more in-depth understanding of the complex and collective aspects of flood danger. Rather than a problem to be solved, uncertainty in this mode is a resource that can support Anna Tsing's call to cultivate of the "arts of noticing" in a period characterized by increasing disruption and turbulence (Tsing 2015).

Mode 3: Systematically Produced

Third, we should ask about the ways in which uncertainty is systematically produced, or a result of particular historic constellations of ideology and power. In this mode, uncertainty is neither seen as a problem to be addressed or a resource to be leveraged, but instead the target of questions such as, how do the answers to some questions become seen as uncertain and in need of greater evidence? How is it that other potential uncertainties are not found problematic? How do political interests, such as those of the fossil fuel industry, deploy uncertainty strategically in order to influence policy around issues like climate change? How does scientific and technical expertise privilege some forms of uncertainty over others (Murphy 2006, Wynne 1989)? Here we might also look to an emerging body of work on *agnatology*, which is gaining attention in STS and Anthropology (Galison et al 2008). Agnatology looks at the ways in which ignorance of a cultural production, is ways that are similar to this third mode of thinking about uncertainty. We may be able to draw upon this area of work to support and clarify our own thinking here.

In the case of flooding this third mode might lead us to ask why we focus more on some uncertainties like how much rain will fall and where will it go over a given time period, while giving less attention (and research funding) to questions around the structural factors that yield certain kinds of vulnerabilities to flooding, or limit

some groups ability to recover in the aftermath (Rumbach et al 2013). This perspective might lead us to focus on different sources of uncertainty, for example by asking questions about the probability of residents ability to return to their homes following a major disaster, as one study related to earthquakes in San Francisco recently did (SPUR 2012). It might also mean moving even farther away from "solving" uncertainty from a technical perspective and toward a fuller critique of how uncertainty appears in our research sites, with what effects, at the expense of whose interests.

Conclusion

Flood management efforts would benefit from greater attention to definitional questions surrounding uncertainty. The term is currently used, even within the same fields, to refer to many different kinds of phenomena. This conceptual overloading reduces the tools that we have for thinking about the various sorts of uncertainties that arise in our work. Here I've argued that there are at least two modes of engaging with uncertainty that are distinct from the Modernist conception that typically prevails. This is not to say that further attempts to collect better data, develop better algorithms, or do better science isn't important, but that such efforts to address questions of uncertainty in our research and practice would do benefit from a much richer conceptual apparatus to work with. Part of this work will also be to develop a facility for moving between these modes, knowing when and where it might be profitable to deploy one versus another.

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