ESSAY THIRTY-FIVE

Science by and for Citizens

A HISTORICAL PERSPECTIVE

Deborah R. Coen

SUSTAINABILITY IN THE twenty-first century will depend on a reorientation of scientific research toward support for policy decision-making, particularly when it comes to climate change. The Intergovernmental Panel on Climate Change, for instance, was created to translate science into policy, but it has focused on long-term predictions of global temperature rather than on shorter-term, regional-scale predictions that could help guide local policies.[1] The climate change crisis calls on us to do science differently. How can scientists ensure that their work serves the needs of their communities? Generating actionable climate science will require incorporating the knowledge, experience, and values of those impacted by climate change into the process of producing and evaluating new research.

Several recent initiatives stake a strong claim to producing "usable" climate science. Among these are "climate services," or the provision of custom-made, local, seasonal forecasts, which can help agricultural communities and public health agencies plan for climate variability. Another example is "attribution studies," which evaluate the role of global warming in extreme weather events, useful to the insurance industry and potentially for decisions about legal liability. Some new endeavors go even further toward tailoring research to the needs of a given community. For instance, the American Geophysical Union's Thriving Earth Exchange pairs scientists with local communities and supports their collaborative efforts to achieve local goals. The organization has connected water managers with regional climate scientists, giving them access to locally detailed rainfall measurements that make it possible to plan for droughts. In another case, a community in the vicinity of a coal-burning power plant is seeking a scientist to help it quantify the impact of coal ash pollution by monitoring soil, water, and fish-tissue contamination.

As examples like these indicate, "usable" knowledge to support both climate-change adaptation and mitigation is increasingly emerging from research that is "collaborative" or "participatory," produced jointly by scientists and citizens. Thus the international research consortium Future Earth, which supports studies of global environmental change in relation to urgent social issues, now requires research to be "co-designed" by scholars and "stakeholders." When the consortium announced this policy in 2012, its leaders proclaimed it a "stepchange in making the research more useful and accessible for decision-makers."[2]

Indeed, strong claims are being made for the novelty of these modes of generating climate knowledge. If "normal science," following the historian of science Thomas Kuhn, refers to a highly technical, esoteric form of knowledge, one that is inherently resistant to public communication, then these new forms of research arguably constitute "post-normal science."[3] Jerome Ravetz, the sociologist who coined this term, has insisted that doing science in the age of anthropogenic warming "demands something rather different from scientists" than the responsibilities they bore in earlier periods. "Not only must scientific knowledge about climate change be publicly owned . . . but . . . the very practices of scientific enquiry must also be publicly owned."[4] Indeed, confronting climate change demands a more collaborative way of doing science.

However, these initiatives face pressing questions. Which areas of research will benefit from this grassroots approach, and which areas might instead need more centralized, top-down direction? What are the criteria for success when the goal is not truth but usefulness? What mechanisms of assessment are appropriate when evaluating knowledge made for and in part by non-expert users? What is to be done when users' goals or values conflict with those of the scientists they're partnering with?

These questions suggest that we should proceed with caution and in full cognizance of the lessons of history. In fact, the precedents for involving non-experts in scientific research date back to the very birth of professional science in the eighteenth century. If we want to reimagine science as a collaborative and publicly owned endeavor, we need to attend to the long and largely neglected history of non-expert participation in the Earth and environmental sciences—and to the sheer variety of ways in which collaboratively produced knowledge has, in fact, proved "usable."

THE ORIGINS OF USABLE EARTH SCIENCE

The turn to usable climate science has its immediate roots in the United States in the 1980s. In that era, calls for citizen participation in science tended to come not from scientists or the state but from grassroots movements concerned with issues such as women's health, carcinogenic waste, and the AIDS epidemic. Their legacies live on today, including achievements like the self-published women's health manual *Our Bodies, Ourselves,* the exposure of cancer clusters, and the reform of clinical trials. These were radical movements that pushed researchers to turn their attention to the concerns of neglected populations and that challenged scientists' claims to exclusive expertise.[5]

Yet those movements were a world apart from the Cold War–era Earth sciences, which were effectively shielded from public scrutiny due to their military value. The impetus for usable climate science came instead from U.S. development policy. By the mid-1980s, critics of development economics were increasingly drawing attention to social concerns like nutrition and health.[6] In that year, Steve Zebiak and Mark Cane announced that they had built a coupled atmosphere-ocean model that could produce reasonably reliable forecasts of El Niño events over a year in advance. It was not long before regional climate services were channeling this information to scientists, policy makers, and farmers in regions where agriculture, fisheries, water resources, and public health were highly sensitive to intraseasonal climate variability. The term "usable science" was first applied to this work in 1993.[7] The goal was to "link climate science with challenges associated with sustainable development and risk management in developing countries."[8] Subsequent experience convinced scientists that their work was not complete once they had produced accurate predictions; it was also necessary to study the social and cultural contexts in which local decision makers operated and to work closely with them to translate forecasts into policy. In the intervening decades, climate services providers have developed nuanced, interdisciplinary methods that are emphatically "iterative," incorporating feedback from users to producers of knowledge.[9]

In this context, "usable science" has come to be defined as knowledge that facilitates the management of risk, whether by planning for disaster or insuring against it. So firmly embedded were climate services in the paradigm of finance-based risk management that they tended to think of cultural difference primarily as a matter of variations in levels of risk aversion.

But the geosciences have not always worked with such a narrow definition of usable knowledge. Before their entanglement with military strategy in World War II, the Earth sciences were emphatically public-facing. The U.S. Weather Bureau relied on a network of volunteer observers that included not only physicians, teachers, and clergymen but also a significant proportion of storekeepers and farmers, as well as women, who typically took over when a husband or father was absent. Both the American Meteorological Society (AMS) and the Seismological Society of America (SSA) were founded in the Progressive Era around the turn of the twentieth century with the explicit goal of enlisting lay observers in the production and dissemination of socially useful knowledge. As the AMS's first bulletin explained in 1920, the "extension of meteorological knowledge and its applications require *cooperation* between amateur and professional meteorologists on the one hand, and teachers, business and professional meteorologists on the other hand."[10] The SSA, founded in 1906, turned to the public in order to supplement seismographic measurements with naked-eye observations. It hoped that the charge of reporting on tremors would build public support for seismic safety measures in the wake of the recent catastrophe in San Francisco. The group's president wrote to citizens across California, explaining with disarming humility that "none of us knows much about earthquakes, but if we all try to find out we hope to know something after a while."[11]

In the end, neither organization sustained this populist project for long. The AMS lost most of its amateur members after raising its annual dues from one to two dollars in 1922. And the SSA, following a series of false predictions of a major earthquake in the 1920s, turned from public outreach to backdoor lobbying in its campaign to influence local building codes.[12]

Still, this earlier era of participatory science has left an instructive legacy. By the late nineteenth century, rural Americans increasingly demanded forecasts of future weather and agricultural yields.[13] And yet predictive knowledge was not the only form that usable science took at the time. Alongside short-term forecasts, meteorological networks in Europe also generated information about regional climates over the long term and their characteristic variability. These forms of usable climate science were not tools for calculating risk; rather, they were guides to what contemporaries understood as the mutual influence between people and land. A climatic map, for instance, could be compared with a map of forest cover, highlighting regions where industrialization had depleted forest cover and raising questions about deforestation's climatic repercussions. Climatographies, or regional climatic descriptions, allowed readers to identify which crops a region could best support, as well as its suitability for health cures or seasonal recreation. Usable knowledge in these forms encouraged sustainable adaptations to long-term climatic constraints, as opposed to financial management of near-term risks.[14]

By the same token, seismologists of the late nineteenth and early twentieth centuries produced usable knowledge while hardly ever issuing predictions. Instead, in the wake of an earthquake, they examined the field site and interviewed eyewitnesses in order to produce thick descriptions of the impact of the event and its destruction. Their final output consisted of maps of historical seismicity, which the public could use to make decisions about future construction. With improvements in seismographs, seismic maps also came to serve as the basis for assigning moral responsibility for damages. Comparison between the distribution of "intensity" (a tremor's effects according to structural damage and subjective impressions) and the distribution of "magnitude" (the tremor's physical force) could reveal an unsuspected geography of vulnerability and exposure. In this sense, nineteenth-century usable science taught the lesson that "natural disasters" are always partly social in origin. In the 1930s, seismologists dropped their outreach campaign and began relying exclusively on instrumental measures of magnitude. The result was a knowledge vacuum when it came to the human-made determinants of seismic vulnerability.[15]

WHAT KIND OF CLIMATE SCIENCE DO CITIZENS WANT?

This history matters to the future of the science of climate change. In the course of the twentieth century, atmospheric science came to rely on automated instruments for its data, and its models and theories grew increasingly remote from ordinary experiences of weather and climate. Today, the Earth sciences are still feeling the effects of the abandonment of citizen-observers and the hardening of the risk-management paradigm circa World War II. This has recently become evident in studies of "detection and attribution." For the past decade, most such studies have posed the question: how does anthropogenic climate change influence the risks associated with extreme weather events? However, as the philosophers of science Elisabeth Lloyd and Naomi Oreskes have recently observed, there is no reason to assume that this is the question most citizens are asking.

After all, usable knowledge takes many forms besides calculations of risk. Lloyd and Oreskes draw our attention to an alternative approach to detection and attribution, known as "storylines," which seeks instead to make intuitive the causal (not merely statistical) relationship between a known effect of anthropogenic warming and the occurrence of a particular extreme event. For a given storm, for instance, this approach makes it possible to evaluate the relative significance of the factors that determined the event's human impact, including the added moisture in the atmosphere due to anthropogenic warming and the local geography of settlement that left some residents more vulnerable than others. The "usability" of this approach can be enhanced by allowing users' questions about the plausible impacts of climate change to guide the modeling of new scenarios.

And yet, as Lloyd and Oreskes suggest, environmental science today remains so firmly in the grip of the risk management paradigm that it has yet to recognize the value of the storylines approach. Instead, its proponents have been attacked for failing to do what they did not set out to do, namely to calculate risks.[16]

In fact, the virtues of storylines become all the more apparent when juxtaposed with the Earth sciences of the Progressive Era. Like the thick descriptions and maps generated by nineteenth-century climatology and seismology, the storylines approach foregrounds the mutual relationship between environment and society. Its scenarios illustrate not only how human-made warming can affect the toll of extreme weather but also how possible courses of action might allow a community to protect against future damage. By focusing on causal rather than statistical relationships, the storylines approach addresses a key concern of the Progressive Era: how to hold public and private authorities accountable for the harm that has resulted from their mismanagement or neglect. While the global scale of the Intergovernmental Panel on Climate Change's analysis diffuses moral responsibility, the storylines approach is an important step toward pinpointing it.[17]

BEYOND USABILITY

This history holds important implications for present-day efforts to draw users into the process of making policy-relevant science. Researchers tend to assume they know what kind of information users want. Thus, nearly all recent proposals to make climate science "usable" focus on the provision of seasonal forecasts. But history reminds us that there are many different ways for science to be useful. Useful knowledge should open up a new range of possibilities for action rather than merely propping up the status quo.

Above all, we need to reconsider what we mean by usability. Before the technocratic turn of the mid-twentieth century, collaborative research in the Earth sciences supported not only instrumental goals but also broad civic ideals—not only the management of risk but also principled resistance to unfettered industrialization. The storylines approach holds an analogous potential, precisely because it moves beyond the risk-management paradigm to support long-term, communal, and ethical decision-making. Today, most proposals for the assessment of participatory science ask about the uptake of knowledge by users and its application in foreseeable ways. Yet even very recent history reveals cases where the cause of sustainability was served instead by citizens who rejected scientists' conclusions and refused to act on them. Consider the Japanese citizen-scientists who measured their own radiation exposures after the Fukushima nuclear disaster in the absence of government data, or the citizens of Flint, Michigan, who trusted their own senses over official measurements of drinking water safety. In place of a model that prioritizes the smooth and efficient provision of information, these episodes suggest that friction is sometimes essential to producing actionable knowledge for sustainability. In cases like these, the most useful forms of knowledge might be those that serve ethical reasoning rather than calculations of self-interest. In short, we need a broader vision of what "usable" science will mean for the twenty-first century.

NOTES

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