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## **Thought piece for the Second Knowledge Infrastructures Workshop (Feb 2019)**

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### **What are the most urgent research questions to address about KI? Why?**

Maintenance, maintenance, maintenance. What is critical to maintaining and extending knowledge? What happens to knowledge systems that are not maintained – especially materially (not just data, but instruments, equipment, computers, and people)?

How can the connection between evidence/data and the knowledge they underlie be maintained? As knowledge systems become infrastructural, how is that connection retained and made available to users so that they understand the basis for knowledge claims? This is especially important as we move into an age of machine learning, where it is often impossible to truly understand the relation between a very large dataset and the conclusions drawn from it.

### **Identify a KI whose survival is under threat.**

Well — right now, just about all US federal government environmental knowledge infrastructures. I've been giving talks called variously “knowledge infrastructures under siege” and “truth under siege.” Climate science, water quality, and endangered species come immediately to mind. My talks focus mainly (but not only) on the Trump administration's attempts to go beyond previous political attacks on climate knowledge, which consisted of suppressing or altering conclusions delivered by independent scientists. The Trump administration attacks are worse and have much greater potential for long-term damage: de-funding (for example) satellite monitoring of carbon dioxide, even to the extent of defunding data analysis for a satellite instrument that is already in orbit and returning data to Earth — they will simply not record or analyze the data, even though other instruments on the very same satellite will continue to be recorded and processed. See the attached article for some further details.

#### **a. What led to these threats? Over what time frame?**

Threats to the climate knowledge infrastructure have been building since the 1980s, when policymakers began to get serious about carbon dioxide and fossil fuel companies saw climate science as a threat to their survival. Ironically, in the 1970s Exxon, Mobil, and other oil companies had their own climate scientists, who warned them about the problems with their product and even recommended strategies for anticipating the need to protect (e.g.) oil rigs from sea level rise. Politically, conservative administrations from Reagan on up used a strategy of “more research; not ready for action yet” to avoid unpopular restrictions on fossil fuels; this was actually salutary for the climate KI, which became enormous under the US Global Change Research Program, operating as an umbrella for numerous climate-related research efforts. The strong relationship of climate science to (popular and economically advantageous) weather prediction (whose infrastructure is overlapping and partially shared with climate science) helped a lot too.

Denialism replaced the fossil fuel companies' science in the 1980s, and by the 1990s there was a huge, heavily astroturfed, fossil-fuel-funded denialist machine in place. It began pumping out books, articles, and especially blogs and websites arguing (at best) that uncertainties were too great to support political action, and (at worst) that climate change was a giant conspiracy concocted by scientists in their own interest and/or to promote socialism. This happened especially in the USA and Australia, but also in Canada, and to a lesser extent in France, India, and elsewhere. It's moved to Brazil, once a climate champion, in the very recent past.

One way to see denialism is as a counter-KI, something like homeopathy vs. Western medicine, that created and promoted its own standards of evidence (often cherry-picking and repeating debunked misreadings of data and models). This is all treated in my article.

Now those groups are reaping the fruits of their labors, dismantling science advisory boards at the EPA, stripping the very phrase “climate change” from numerous government websites, and withdrawing from the landmark Paris Accord, even as evidence mounts that climate change has arrived and is already endangering agriculture, fisheries, forestry, and human habitation (e.g. the massive Australian and California fires of the last few years). This is way beyond head-in-the-sand or don’t-tell-me-about-it — it’s reached the point of “we will destroy major elements of your KI. It’s a waste of taxpayer money to even bother to measure what’s happening.”

Another, less direct threat to climate knowledge stems from increasing moves to privatize weather satellites, some led by governments seeking to save money, others by private corporations seeking to acquire their own independent capabilities. Privatization is not necessarily a terrible idea, but it does beg the question of who owns meteorological data, how much of it will be freely shared, and what will happen to the data if the corporations that collect go out of business or change their focus. World Meteorological Organization mandates and standards currently help to restrict the privatization of data recorded by such satellites, but as they proliferate, issues of calibration, data sharing, and coverage may become more prominent.

### **b. What actions or changes in circumstances might lead to its survival?**

Fortunately, since warming, ice melt, and sea level rise are global phenomena, many other countries play a part in the global climate knowledge infrastructure, and we can (for now) rely on European, Chinese, and Japanese scientists and scientific organizations (and others) to support the instrumentation, analysis, and modeling required to track climate change.

If the 2020 elections return a sane government to the USA, that will be a big help — but by then it may take years to restore the standards, legal principles, and scientific integrity of American environmental institutions. If the youth movement spearheaded by Greta Thunberg, or the Extinction Rebellion, or 350.org, or half a dozen other political movements succeed in focusing people on the gravity and urgency of the problem, maybe we’ll get some action.

Sea level rise is likely to be one cause of revived or extended KIs. In Fort Lauderdale over Christmas, I heard three different people spontaneously bring up the issue of where they will go, and when, as rising seas threaten South Florida’s coastline. People with houses only a few feet above sea level will soon start to see their property values decline, and at some point there may be a real estate panic that would destroy billions of dollars of value.

Another, less evident possibility is that one of the mega-IT corporations – Alphabet, or maybe Microsoft — could decide that climate projections could be marketed (perhaps as an adjunct to real estate), and decide to build their own KI for that purpose. These entities are capable of creating satellite networks quite rapidly, and with all the other data sources at their disposal they might build integrated pictures of climate change and its effects going well beyond what government agencies or the IPCC, with its rigorous but slow and plodding processes, could ever do.

### **c. What will be gained or lost, by whom, if this KI fails to survive?**

I won’t discuss the possibility that it would perish altogether; that’s not realistic.

I do think that the current loss of US scientific leadership, accompanied by outright hostility to climate negotiations and climate knowledge (the actual current stance of much of this administration), has worldwide ramifications. It emboldens deniers elsewhere (e.g. Bolsanaro in Brazil), and strikes at the relatively unified voice of the Framework Convention on Climate Change as manifested in the Paris Accord. It will be — already is — very difficult to ratchet up expectations for dramatic infrastructural change (emissions reductions, adaptation) in the face of even a few loud dissenting voices, not to mention governments renegeing on financial aid to developing countries and actually promoting MORE fossil fuel use.

### **How do KI spread information? Misinformation? Alone and in combination with other infrastructures?**

The Intergovernmental Panel on Climate Change (full disclosure: I'm serving on the 6<sup>th</sup> Assessment Report due out in 2021) is an interesting example of an attempt to spread consistent, well-vetted messages about climate knowledge around the world. It's had some notable failings, mainly related to mistakes (mostly minor) in its reports, and despite a lot of effort has enrolled fewer scientists from the developing world. The assessment process is massive, slow, and limited by the great difficulty of getting hundreds of scientists to adhere to consistent language, norms, and standards — but as such processes go, it's outstanding. The series of reports since 1990 has done a great deal to maximize awareness among policymakers, but at the same time, its messages have had less success reaching the public. I find that 9 times out of 10, random people I meet (even academics) don't know what the IPCC is.

Another problem is that the IPCC is an assessment organization which does not DO science, but only evaluates the quality and agreement of peer-reviewed literature. For most people, that's hard to distinguish from a scientific organization in the sense of a laboratory or institute, so the IPCC gets accused of all kinds of things it doesn't deserve.

Misinformation: my line on this for quite a while now has been that as commodity tools (spreadsheets, statistical software, modeling systems, mathematical aids, etc. etc.) roll out, and computer coding becomes a more widely shared skill, it's become possible for amateurs to produce graphs, charts, documents, videos, etc. that look almost exactly like professional scientific work. So it's easy to create misinformation or disinformation, and to pass it off as a genuine alternative to professional science. Some conservative think tanks have taken this on as a decades-long strategy, hiring scientists and “scientists” to produce confusing alternatives to mainstream science. We see this all the time with organizations such as the Heartland Institute, the George C. Marshall Institute, the Nongovernmental Panel on Climate Change, etc., which hold their own conferences, publish papers and journals, and disseminate “educational” materials by the millions to secondary school teachers, many of whom aren't well educated enough to tell the difference. Social media, of course, have only exacerbated the possibility for disinformation contagion, and one of the most striking findings in social media research is that both humans and bots retweet both true and false information, but humans retweet false information more often. False information is often more quirkier, stranger, more/less threatening – so also more interesting...

Analogies to alternative knowledge systems such as acupuncture, osteopathy, homeopathy, chiropractic are interesting to contemplate — because many of these do have some real value, and have developed alternative standards of evidence, instruments, and even theories (acupuncture). There are clearly major problems with some ways modern science has approached the world, for example the issues described by Michelle Murphy around “sick building syndrome” where multiple contaminants in widely varying concentrations cause clusters of related but not identical symptoms in different people, making it nearly impossible to tease out causality on the model of one chemical, one effect.