SOCIOLOGY

Drivers of climate change beliefs

Direct experience of global warming is expected to increase the number of people who accept that it is real and human-caused. A study now shows that people's perceptions about abnormal temperatures mostly match actual measurements but do not affect climate change beliefs.

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Climate change is expected to increase weather anomalies, including warming temperatures[1]. Some analysts expect that as such events escalate and climate change becomes increasingly apparent, more people will come to accept that anthropogenic global warming is occurring[2]. However, evidence from research on the effects of climate and weather on beliefs about climate change is mixed. Writing in *Nature Climate Change*, McCright and colleagues[3] find evidence that in the USA, weather abnormalities may lead to support for climate change adaptation, but not for mitigation, because many people remain unwilling to attribute abnormal weather to global warming despite experiencing its effects. More specifically, people do perceive abnormal temperatures but do not attribute them to human-induced global warming. In contrast, individual pre-existing beliefs about global warming, perceived scientific agreement, and political orientation impact both perceptions of actual warming and whether or not experienced warming is attributed to climate change.

This study combines the growing body of literature on actual weather and its impacts on global warming beliefs with work that looks at the influence of political orientation on belief that climate change is occurring. Research on the impact of weather is mixed, with some studies finding weather does not affect beliefs about climate change[4] and other studies finding that weather matters generally[5] or matters in specific contexts[6]. However, research consistently finds that not only does political orientation matter,[5] but that it matters over time[7] and influences a wide range of beliefs including perceived scientific agreement about climate change[8].

McCright *et al.*[3] build on such previous findings by using US state-level temperature data available from the National Oceanic and Atmospheric Administration's National Climatic Data Center and nationally representative US survey data from the 2012 Gallup Poll.

DIZ MÜNCHEN GMBH / ALAMY

Sunbathing in December 2011 in the Hofgarten, Munich.

The survey was administered shortly after the fourth warmest recorded winter in US history, and although abnormal warmth varied regionally, approximately 80% of respondents reported their local winter temperatures were warmer than usual. Of the respondents who perceived a warmer winter, however, only 35% attributed this to anthropogenic global warming. Although caution should be exercised in making direct links between specific weather events and climate change, the 'loaded dice' metaphor captures how climate change makes warmer winters more likely[9]. To measure a temperature anomaly the authors use deviation from the 30-year statewide average. They also examined deviations from average temperature over the past 1, 5, 10, 20, 50 and 100 years, and all yielded consistent findings.

Actual state-level temperature anomaly in part explains perceptions of a warmer-than-normal winter, but a number of factors at the individual level also explain perception of local warming, including perceived scientific agreement and beliefs about the current onset, human causation, threat and seriousness of global warming. Political views also play a significant role in explaining perceptions of anomalous temperatures. But when it comes to explaining whether or not respondents who perceive winter warming attribute it to global warming (versus year-to-year variation), state-level temperature deviation is no longer statistically significant. This suggests that experiencing the effects of climate change, such as anomalies in seasonal weather patterns, may not alter views on human-induced global warming. Cognitive

factors, instead, are important. Personal beliefs about global warming and perceived scientific agreement, as well as political party identification and political ideology, have a significant impact on whether or not respondents attribute perceived warming to climate change.

These findings have policy implications as political factors can influence whether or not people perceive actual warming. Importantly though, a majority of respondents do perceive winter warming, and this could translate into public support for adaptation policies. However, as attribution of winter warming to climate change is influenced by pre-existing beliefs and political orientation, this could affect the level of public support for mitigation policies, as accepting responsibility for mitigation requires acknowledging the human causes of climate change. This suggests that even experiencing the realities of climate change will not necessarily lead to acceptance that anthropogenic global warming is occurring.

The sociological approach taken by McCright *et al.*[3] emphasizes the role of political orientation in shaping perceptions and beliefs about climate change and thus analyses the social construction of such perceptions and beliefs. Using statistically appropriate empirical modelling techniques, this study both supports previous research that highlights the politicization of climate change and contributes by demonstrating the power of these findings even in the face of real experiences with warming temperatures[7,8]. Although every study has limitations, and this one is no exception, the researchers suggest many directions for future work on how social factors impact perceptions of weather patterns and acceptance of the reality of anthropogenic global warming. Research should continue to build theoretically in these two areas and test for these patterns at different scales and in a range of contexts, using indicators such as variation in rainfall and extreme weather events. Research should also look at different points in time, and at change over time, especially to see if political views — rather than actual experiences — remain a stronger influencing factor of beliefs about global warming. Such research is important for citizen support and pressure for policy decisions regarding adaptation and mitigation of anthropogenic climate change[10]. ❐

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SOIL CARBON

Microbes, roots and global carbon

Interactions between soil microbes, the physical soil environment and vegetation will determine the magnitude of the terrestrial carbon sink under climate change.

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Accurate carbon cycle projections are needed to inform climate change adaptation and mitigation strategies. Such projections require understanding of biological responses to environmental change, especially in the world beneath our feet. Globally, soils store more carbon than plants and the atmosphere combined. Soils also provide habitat for a stunning diversity of organisms that are largely responsible for the stabilization and decomposition of soil carbon. Writing in *Nature Climate Change*, Sulman *et al.*[1] present a fresh look at how soil microbial activity can be simulated at global scales and illustrate why such considerations matter. Their findings underscore the need to explicitly incorporate soil microbial response to environmental change in soil biogeochemical models.

Environmental change effectively reshuffles the deck of biological rules that determine how ecosystems function. Most current soil biogeochemistry models that are applied at ecosystem to global scales do not specifically consider soil microbial activity and so fail to represent the 'reshuffling' effect[2]. This raises concerns about the accuracy and certainty of the soil carbon projections derived from these models. Mounting evidence suggests that plants and soil microbes respond in unexpected ways to a variety of perturbations such as changing climate, land use and nitrogen load. For example, increased concentrations of CO_2 in the atmosphere change how and where plants use carbon for growth[3]. In many ecosystems, carbon–nitrogen interactions modulate plant and soil responses under increased CO_2 (ref. 4). These interactions directly influence soil microbial activity in ways that could attenuate potential gains in terrestrial carbon storage in a CO_2-rich world[5]. By omitting these insights, current models potentially misrepresent critical changes in the largest terrestrial carbon pool on Earth.

The work presented by Sulman and colleagues[1], therefore, marks an important development that could help to advance our understanding of the mechanisms that influence soil functioning. Their new model, Carbon, Organisms, Rhizosphere, and Protection in the Soil Environment (CORPSE), explicitly considers interactions between soil microbial activity and the physical soil environment. Microbial activity is simulated for bulk soil and for soil near fine roots, referred to as the rhizosphere (Fig. 1). Rhizosphere soils are characterized by accelerated microbial activity because they receive additional inputs of easily decomposed carbon supplied by fine roots. Experimental