

## Science and environmental sustainability

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## Environmental Research Letters



### EDITORIAL

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The past half-century has seen profound changes in environmental research and governance. Knowledge about environmental systems and human–environment interactions has expanded enormously; policies and institutions have proliferated at all levels; the dominant concerns have shifted dramatically in scale and scope; and ‘the environment’ has become one of the most visible arenas in which science interacts with politics and policy-making. It is timely, after a decade of *Environmental Research Letters* (ERL), to reflect on what we—as scientists, policy-makers and interested citizens—expect of environmental science. If our expectations are not always realistic, we might ask, in addition, what we *should* expect, if science is to occupy its proper place in policy-making for environmental sustainability.

### Expectations

Expectations have been high. We have looked to the environmental sciences for fundamental knowledge about Earth and environmental systems and for understandings of human impacts, hoping that scientific insights and predictive capacities might be brought to bear on societal choices. We have expected scientists to be dispassionate, or at least to draw lines between evidence and advocacy; and scientists themselves have often seemed confident that they can make this distinction. To take one of many possible examples, the architects of the ‘planetary boundaries’ framework see it as a task for science to identify critical Earth-system processes and assess the risks that they might be destabilized; but they argue for normative judgement in setting the boundaries to delineate a ‘safe operating space for humanity’ [1]. The implication is that science comes first, and politics follow. In practice, however, such tidy separation remains elusive.

### Realities

While achievements in science and governance have been transformative, the anxieties that rose to

prominence in the 1960s have intensified. Environmental degradation persists and, in significant cases, accelerates. While some of the ‘older’ problems have been resolved, new and more complex challenges have emerged. In refining the planetary boundaries analysis, Steffen *et al* estimate that proposed boundaries relating to climate change, biosphere integrity, biogeochemical flows, and land-system change have already been transgressed [2]. And human needs and pressures are growing: global population almost doubled, and world GDP more than trebled in ‘real’ terms, between 1972 and 2014 [3].

If such trends suggest that humanity is living dangerously, there is also a tangible frustration among scientists that ‘obvious steps’ to protect the environment are not taken [4], or worse, that political actors make critical choices *in spite of* scientific evidence and advice. Not surprisingly, relations among scientists, decision-makers and wider publics have sometimes become fraught, and the expectations vested in environmental science—as least as a basis for policy—have often proved difficult to meet.

### Complexities

There are a number of reasons for the shortfall. Environmental systems are complex, and the science and modelling through which they are interrogated are subject to deep uncertainties, as well as ignorance. Environmental conflicts often involve high stakes, economically and politically, and are beset by additional dimensions of ‘incertitude’ [5]. There can be disagreement (‘ambiguity’) about the nature of the problems, about what constitutes ‘harm’, or about the technologies advanced as causes, or solutions, or both. There is also an inherent unpredictability of outcomes when human, technical, epistemic and environmental systems co-evolve (‘indeterminacy’). These wider dimensions of incertitude implicate values, beliefs and worldviews in the framing of problems and potential solutions, such that ‘subjective judgement’ cannot be relegated to a political phase coming after scientific investigation. In deep controversies, intelligent people of goodwill can and do take different views—but

without falling neatly into the well-worn dichotomies of ‘experts’ and ‘lay publics’, or ‘scientists’ and ‘policy-makers’.

For these reasons, social scientists locate environmental concerns in the realm of ‘regulatory’ or ‘post-normal’ science [6], and have repeatedly observed that deep differences are rarely settled by ‘the facts’ [7]. Instead, divergent values become intertwined with the scientific uncertainties themselves: as Yaron Ezrahi put it in 1980, when uncertainties combine with ‘unsettled, ambiguous or contradictory’ human ends, science and politics ‘interpenetrate’ [8].

Even when uncertainties can be reduced on meaningful timescales—indeed, even when there is something close to scientific consensus—conflicting human ends must be negotiated through the political process. This is not to suggest that the evidence is irrelevant; on the contrary, careful analysis of science–policy interactions reveals that science is far from insignificant in policy-making, especially when we take the longer view [9]. But in the intricacies of the policy process, science (and other forms of specialist knowledge) are in dynamic interaction with power, interests, bargaining, institutions and events. Policy choices in pluralist societies are underdetermined by scientific evidence—and (overt politicization of science aside) this is as it should be, unless we prefer to be governed by technocracies. Even so, a failure to have immediate impact tends to be seen as a problem to be resolved by better communication and more energetic commitment to ‘evidence-based policy’.

## Hybridities

Communication is, of course, indispensable. But the instinct to shout louder and articulate the evidence more clearly (like the parody of an Englishman abroad) overlooks the complexities of science–policy relations and assumes that a failure to follow advice means that the science has not been heard (or understood). Equally unhelpful are exhortations to expert advisors that they should distinguish facts from value judgements, keeping the science ‘pure’, and political and other commitments out of the way. Historians, philosophers and sociologists of science have long argued that the idealized search for truth, shorn of all other considerations, is not even characteristic of ‘normal’ science [10]. In relation to contentious environmental issues, it is demonstrably unrealistic. Following this logic, it seems unlikely (for example) that critical thresholds in Earth’s life-support systems could be scientifically established prior to confronting political and ethical dilemmas in the delineation of planetary boundaries. In practice, the science and the politics would surely be ‘co-produced’—an example of ‘the ways in which we know and represent the world’ being ‘inseparable from the ways in which we choose to live in it’ [11].

## Towards a constructive encounter?

What, then, might it be reasonable to expect of science when confronting the complex and highly charged issues of environmental sustainability? First—and this point deserves emphasis—we should expect the environmental sciences to continue to play a crucial role. While policy is a product of many forces, it seems inconceivable that the transformations of the past half-century could have been achieved without scientific advances. This is cause for optimism, even if progress at particular moments can seem painfully slow.

There are, however, important lessons to be learned from fine-grained analyses of real-world interactions among knowledge, expertise and policy-political processes. Such studies show clearly that we should discard overly simplified conceptions of science, politics, policy-making, and the so-called ‘science–policy interface’, and accept instead that relations between science and policy are complex, contingent and played out over varying periods of time. It follows that we should expect neither too much *nor too little* of evidence and advice in ‘difficult’ science–policy arenas; nor should we be unduly impatient for knowledge to have tangible effect.

Recent studies have shown, too, that skilful advisors can play a crucial intermediary role in science–policy relations, even in the face of incertitude; they are especially effective in settings that allow for reflection on tacit assumptions and encourage robust ‘interdisciplinary deliberation’ [12]. Much research points to the need for serious engagement with the hybridity of science and politics, recognizing that the boundaries between these spheres are rarely fixed; if science ‘can never come *before* politics’ [13], insistence on separation may be counterproductive. Significantly, expert advisors have often had most impact when they have arrived at ‘serviceable truths’ [14], which are acceptable for scientists as well as meaningful in the world of policy.

In 1972, at the height of that earlier period of environmental revolution, the ‘Stockholm Declaration’ following the first UN conference on the human environment called for ‘an enthusiastic but calm state of mind’ and ‘intense but orderly work’ [15]. Despite the changes in the intervening years, this still seems an apt prescription for those engaged in the science and the politics of environmental sustainability.

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