Changing the intellectual climate

Noel Castree[1,2], William M. Adams[3], John Barry[4], Daniel Brockington[5], Bram Büscher[6], Esteve Corbera[7], David Demeritt[8], Rosaleen Duffy[9], Ulrike Felt[10], Katja Neves[11], Peter Newell[12], Luigi Pellizzoni[13], Kate Rigby[14], Paul Robbins[15], Libby Robin[16], Deborah Bird Rose[17], Andrew Ross[18], David Schlosberg[19], Sverker Sörlin[20,21], Paige West[22], Mark Whitehead[23] and Brian Wynne[24]

[1]Department of Geography and Sustainable Communities, University of Wollongong, New South Wales 2522, Australia, [2]Department of Geography, University of Manchester, Manchester M139PL, UK, [3]Department of Geography, University of Cambridge, Cambridge CB2 3EN, UK, [4]School of Politics, International Relations and Philosophy, Queens University, Belfast BT7 1PB, Northern Ireland, [5]Institute of Policy Development and Management (IDPM), University of Manchester, Oxford Road, Manchester M13 9PL, UK, [6]Institute of Social Studies, Erasmus University, 2518 AX The Hague, The Netherlands, [7]Institute of Environmental Science and Technology (ICTA), Edifici Z, Universitat Autonoma de Barcelona, Bellaterra 08193, Spain, [8]Department of Geography, King's College, University of London, London WC2R 2LS, UK, [9]Department of Development Studies, SOAS, University of London, London WC1H 0XG, UK, [10]Department of Science and Technology Studies, University of Vienna, Universitätsring 1, Vienna 1010, Austria, [11]Department of Sociology and Anthropology, Concordia University, Montreal, Quebec H3G 1M, Canada, [12]Department of International Relations, University of Sussex, Brighton BN1 9SN, UK, [13]Department of Political and Social Sciences, University of Trieste, Piazza Europa 1-34127, Trieste, Italy, [14]School of Languages, Literatures, Cultures and Linguistics, Monash University, Monash, Victoria 3800, Australia, [15]Nelson Institute for Environmental Studies, University of Wisconsin-Madison, Wisconsin 53706, USA, [16]Fenner School of Environment and Society, Australian National University, Canberra, Australian Capital Territory 0200, Australia, [17]Department of Philosophy, University of New South Wales, Sydney, New South Wales 2052, Australia, [18]Department of Social and Cultural Analysis, New York University, New York, New York 10012-2339, USA, [19]Sydney Environment Institute, University of Sydney, Sydney, New South Wales 2006, Australia, [20]KTH Royal Institute of Technology, SE-100 44 Stockholm, Sweden, [21]Institute for Advanced Study, Princeton, New Jersey 08540, USA, [22]Department of Anthropology, Columbia University, New York, New York 10027, USA, [23]Department of Geography, Aberystwyth University, Aberystwyth SY23 3DB, UK, [24]Department of Sociology, Lancaster University, Bailrigg, Lancaster LA1 4YN, UK.

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Abstract

Calls for more broad-based, integrated, useful knowledge now abound in the world of global environmental change science. They evidence many scientists' desire to help humanity confront the momentous biophysical implications of its own actions. But they also reveal a limited conception of social science and virtually ignore the humanities. They thereby endorse a stunted conception of 'human dimensions' at a time when the challenges posed by global environmental change are increasing in magnitude, scale and scope. Here, we make the case for a richer conception predicated on broader intellectual engagement and identify some preconditions for its practical fulfilment. Interdisciplinary dialogue, we suggest, should engender plural representations of Earth's present and future that are reflective of divergent human values and aspirations. In turn, this might insure publics and decision-makers against overly narrow conceptions of what is possible and desirable as they consider the profound questions raised by global environmental change.

The science of global environmental change (GEC) has played a vital role in alerting humans to the extraordinary bio-physical effects of their activities. Some practitioners now appear determined to take it in new directions, impelled by the gap between knowledge, namely, convincing evidence that the Holocene could soon be a thing of the past, and action, namely, the failure of world leaders to deliver policies adequate to the grand challenges this evidence implies. Three signs of change are apparent. First, several GEC scientists are enjoining the research community to be far more vocal and visible when communicating the key arguments[1] . Second, although much basic research into the functioning of the Earth system remains to be done, it is now widely recognized that the natural sciences cannot furnish us with all the knowledge or insight humanity will need to inhabit a post-Holocene environment[2]. Third, these calls to

make GEC research findings more prominent and less physical science-dominated have been accompanied by injunctions to make them more directly relevant to decision-makers and other stakeholders[3].

Many outside the world of GEC science will undoubtedly applaud the determination to both broadcast and stand by the evidence — notwithstanding the inevitable uncertainties about future GEC. Decision-makers will surely welcome the new emphasis on 'actionable knowledge'[4] . If it includes a richer understanding of how humanity can live with GEC, the benefits will be manifold. Societies worldwide will probably have to make changes that far exceed those associated with current mechanisms of global environmental management (such as international carbon emissions trading). Determining the range of possible values, means and ends that together might inform deliberations and decisions about future societal trajectories is something that GEC scientists can-not be left to fathom without assistance. Environmental social scientists and humanists have, over the past 30+ years, built a sub-stantial and diverse body of knowledge about these values, means and ends. Although some have long-standing involvement in GEC science (for example, through the Intergovernmental Panel on Climate Change (IPCC) Working Groups II and III), a deeper and wider engagement promises much.

In this Perspective, we argue that the potential fruits of interdisciplinary exchange are far greater than, and altogether different in character to, those implied by most recent clarion calls for the reformatting of GEC science. We write as representatives of work in the environmental social sciences and humanities (hereafter ESSH) that has so far registered weakly among both physical scientists and many non-academic constituencies. Given that the Future Earth initiative is now setting the terms for GEC research in the years immediately ahead[5], this is a key moment of decision for environmental investi-gators across the disciplines. The important question Future Earth in effect poses — namely, 'what kind of GEC research for what sort of Earth future?' — invites several legitimate answers[6,7]. Yet, in our view, this is insufficiently recognized by those calling for GEC researchers to change their *modus operandi*.

Their arguments (perhaps unwittingly) risk insulating research from those key 'human dimensions' that influence its very significance. For instance, they pass over how different conceptions of needs may frame plural notions about 'appropriate solutions' and 'relevant evidence'. If GEC scientists can expand their understanding of what the ESSH have to offer, it could greatly enlarge our sense of what 'broad-based, joined-up and useful environmental research' looks like. This could, indeed should, have formative implications for the choices that humans consider desirable and feasible as they enter what some are calling the Anthropocene.

The 'human dimensions' of GEC research

Although the study of GEC was pioneered by natural scientists, it was recognized early on that the systematic analysis of human actions was as important as understanding their biophysical effects. This is why the International Council for Science cosponsored the International Human Dimensions Programme from 1996, one of the four key GEC research initiatives antecedent to today's Future Earth endeavour. The International Geosphere–Biosphere Programme (established in 1987) also began projects factoring-in human dimensions soon after its creation. These programmes, combined with various national-level and other research initiatives, have both enlarged and filled with content the unduly small box labelled 'human activities' in Bretherton's famous diagram of the Earth System[8]. Over the years they have put a certain kind of social science flesh on the bones of the now familiar concept of 'coupled human–environment systems' — particularly through the use of Earth observation data, comparative fieldwork and quantitative modelling (evident in the Land Use and Land Cover Change project running from 1994). Coincident with this, the periodic IPCC assessment process has comprised a high-level milieu for interaction between climate scientists and several environmental social scientists. The relevance of global change science to human affairs has there been presented in terms of physical impacts on society along with transferable mitigation and (increasingly) adaptation measures. That United Nations-led attempts to reduce global greenhouse-gas emissions have so far proven ineffective is a key impetus behind those earlier mentioned calls for actionable knowledge that can transgress academic boundaries. In sum, over 30 years after its formal inception, GEC research is less dominated by natural science disciplines than before.

By virtue of this background, a particular framing of 'human dimensions' has arguably become normalized in those places where leading researchers are, today, discussing the future of GEC inquiry[9]. The frame's major presumption is that people and the biophysical world can best be analysed and modified using similar concepts and protocols (for example, agent-based models). A single, seamless concept of integrated knowledge is thereby posited as both possible and desirable, one focused on complex 'systems'. The frame positions researchers as metaphorical engineers whose job it is to help people cope with, or diminish, the Earth system perturbations unintentionally caused by their collective actions. Recent articles in this journal suggest its prevalence[10,11].

However, far from ensuring an 'objective' representation of human dimensions, this risks intellectual partiality and political complicity. Partiality because key concerns of many ESSH disciplines pertaining to human dimensions are absent (about which more below); complicity because, by refusing to explore the full range of values, means and ends that might guide human responses to GEC, researchers may implicitly endorse the societal status quo by neglecting to question it fundamentally.

Neither risk is acknowledged adequately in recent statements about the future of GEC research. Instead, the above-mentioned frame is deployed uncritically, even as it is finessed. Consider the following examples. The *State of the Planet Declaration* (2012), issued under the auspices of the Earth System Science Partnership and directed at policy -makers (including those who fund research), calls for a 'new social contract' with government, business and civil society. A central plank of this is the "need to link high quality, focussed scientific research to new policy-relevant interdisciplinary efforts for global sustainability. This research must integrate across existing research programmes and disciplines, across all domains of inquiry, as well as local knowledge-systems, across the North and South, and must be co-designed and implemented with input from governments…and [others]."[12]

Ruth DeFries *et al.* echo these sentiments [3]. They urge GEC researchers to renew their 'social contract with society' by providing "solutions -oriented research to provide realistic, context-specific pathways to a sustainable future." Finally, an *Earth Perspectives* review[13] advocates a social science complement to 'planetary boundaries' research[14]. It suggests that economists put robust monetary values on the cost of actions necessary to keep humans in a 'safe operating space' — a huge undertaking that requires pricing nature across multiple Earth subsystems. It then envisages interdisciplinary research teams identifying bespoke prevention strategies in dialogue with various social actors.

These three visions for future GEC research seek to adjust a well-established intellectual frame to ensure it is relevant to cur-rent circumstances. Specifically, there is a new emphasis on applied knowledge arising from more joined-up analysis across traditional intellectual divides. Physical science facts and forecasts, allied with social science evidence about prevalent patterns of human thought and action, here define the parameters for feasible interventions intended to steer humanity away from harmful practices. Applied research into new technologies and 'behaviour change' measures are seen to provide the know-how that can be used to close the yawning 'sustainability gap'. Given that interventions will need to be far-reaching, the frame — tweaked to suit the times — recognizes the need for 'actionable knowledge' to arise from stakeholder engagement and so be expert led, but not expert dominated.

This framing of how human dimensions are to be understood and modified appears intuitively right to many GEC scientists (natural and social) — indeed, imperative to create knowledge that might forestall runaway environmental change. If reality is seen to present nested local-to-global 'problems' with ramified causes and effects, the intellectual 'solution' seems to be 'applied synthesis' at a number of spatiotemporal scales. Certain social sciences are well placed to contribute to a GEC research endeavour so framed, building on previous involvements (Box 1). However, the frame's persistence belies the clarion calls for change among those physical (and certain social) scientists now arguing for broader engagement across the disciplines. For instance, not one of the three publications mentioned above makes any explicit reference to the envi-ronmental humanities, and exclude social sciences where a broadly positivist worldview is not the reigning paradigm. According to another recent publication on GEC science in *Ambio*, none of these are 'essential' disciplines[15], a view seemingly echoed in the pages of *BioScience*[16] . This contradicts a prominent statement in *Science* that "research dominated by the natural science [should] transition toward research involving the full range of [social] science and humanities"[17]. It also overlooks earlier calls for a new mode of GEC inquiry[18,19].

This may simply reflect a lack of understanding about what many ESSH scholars do. It may also reflect a sense among some GEC scientists that a lot of ESSH inquiry is simply incompatible with the frame and thus not relevant. We will challenge this view. First, though, we need to characterize the 'full range' of ESSH inquiry and so describe what is absent in current calls to reconfigure GEC research and why it matters.

The missing human dimensions

The ESSH have only come of age in the years when GEC scientists have shown, with increasing confidence, the breadth and depth of the human impact. Today, literally thousands of ESSH scholars can be found in universities worldwide. They range from ecological economists to environmental historians, from environmental news analysts to environmental law researchers, and from environmental ethicists to analysts of why and when people decide to 'vote green' in elections. They span virtually every social science and humanities discipline. Although not all of them study GEC directly or take a global view, the work of many bears substantial relevance to the subject (Box 2). Those environmental social scientists who have participated in the International Human Dimensions Programme, the International Geosphere–Biosphere Programme or the IPCC's second and third working groups represent only a small portion of ESSH inquiry. The same is true of those operating in the fields listed in Box 1.

What 'human dimensions' of GEC are missing in the particular sorts of social science thus far assumed to be most relevant to the subject? Indeed, is this term even appropriate? This science offers little or no sense of humans as diverse, interpretive creatures who frequently disagree about values, means and ends; and there is nary a mention of power, violence, inequality and the perennial desire of some people to replace one socio- environmental regime with an entirely different one. As German social theorist Jürgen Habermas long ago reminded us[20], scientific knowledge and its associated technologies are enormously successful when (1) they respect a society's existing norms, or (2) dominant social norms adjust in light of discoveries and innovations delivered by scientists. However, other forms of knowledge, discourse and under-standing must be properly acknowledged, precisely because they both affect, and are affected by, science and technology. These forms range beyond the cognitive to encompass the moral, spiritual, aesthetic and affective.

Habermas famously identified two forms: 'hermeneutic' knowledge, geared to understanding cultural specificity 'from the inside', recording cultural diversity, and facilitating understanding between people with different worldviews; and 'critical-emancipatory' knowledge, geared to challenging the status quo and creating a world predicated on new (or existing yet currently unrealized) ideals. To these we might add the ideas and products of the arts, which make manifest the human capacity to be deeply imaginative, creative and feeling. Such are the parts of the ESSH that fall outside the GEC human dimensions frame. Philosophical, methodological and normative diversity define the ESSH. ESSH inquiry suggests that once we broach the questions 'which values should guide us?' and 'what goals do we have in view?' the question ofappropriate 'means' is thrown wide open, and so too is the question 'what evidence matters?'.

Although many things in life seem non- negotiable (for example, protecting people from avoidable harm), numerous other things are — in principle — open to interpretation and a wide range of interventions. That should be writ large in any robust discussion of what 'sustainable development' might mean for humanity and non-humans [21–23]. For instance, what keeping additional average atmospheric warming below 2 °C should, in practice, mean for people raises profound questions for society that go far beyond those intimated in most calls for a new phase of GEC research. These questions rarely admit of 'best answers', let alone 'correct' ones, because agreed criteria for determining the relative influence of different data, arguments and policies is often lacking. They need to be addressed through broad and deep collaborations across the disciplines. Together, GEC researchers might then pre-sent a range of evidence-based, reasoned responses to these ques-tions. The responses could combine scientific, interpretive and critical knowledge in different ways that are reflective of life in a plural world where some worldviews are hegemonic, and others are notably less so.

A different social contract for GEC researchers

Some GEC scientists will worry that this social contract risks politicizing the sort of value-free knowledge that decision-makers and most citizens have come to expect from science and 'experts' more generally. The orchestrated attacks by climate change scep-tics, especially in the United States and Australia, have no doubt made many wary of being seen to 'play politics' with their find-ings. In this light, the prudent approach may appear to be one that restricts GEC research to factual and technical matters (that is, continues with the IPCC's 'policy relevant yet policy neutral' model of knowledge provision).

However, appearances deceive. As Daniel Sarewitz cogently argues, such an approach only serves to conceal the fact that GEC science is already political[24]. Pretending otherwise opens it to sev-eral misuses. One pertains to 'tornado politics'[25]. This is where cri-sis rhetoric ('we need to act now!') serves to suspend robust societal debate about future pathways. It leads researchers to focus only on the 'best' means necessary to reach given environmental goals in light of existing arrangements — thus leaving these arrangements relatively immune to questioning.

Unlike those areas of 'big research' that have been significantly directed by private investment (pre-eminently certain life sciences), GEC research remains government funded by and large and should seek to serve the widest public interest. It can better help decision-makers and those they represent by presenting a diversity of 'values–means–ends' packages. These are proposals about possible technical and behavioural pathways framed by different, although equally legitimate, conceptions of the 'good society'. In turn, these yield their own definitions of what 'problems' need to be addressed in the first place and what kinds of evidence can speak to them (Box 3). However radical, these conceptions and definitions are themselves conditioned by a keen awareness of how current arrangements curtail room for socio-environmental manoeuvre. Which facts are worth knowing, and which solutions worth pursuing, are partly a function of whose values (moral, spiritual, aesthetic) count and where the power to realize them lies. For instance, putting a price on 'under-valued' ecosystem services looks very different depending on whether one accepts — or seeks to challenge — the current socio-geographic distribution of monetary wealth on the planet[26]. It also varies — to the point of seeming utterly misplaced — according to underlying moral commitments[27].

Elaborating several values–means–ends packages would position GEC researchers across the disciplines as those who work together to open up the range of choice available to societies.

Rather than assuming that one form of broad -based, integrated, actionable knowledge 'fits' any given situation, researchers would together make visible a number of actual and possible realities. They could thereby seek to foster mature deliberation rather than short -circuiting it in the rush to inform the key decisions humanity must take as it negotiates GEC (Box 4).

Even assuming our argument for wider and deeper engagement is accepted, it may seem unrealistic to attempt so ambitious a reconfiguration of GEC research. Analysis of experiments designed expressly to foster new forms of inquiry reveal that old intellectual habits can die hard[28]. Furthermore, the divides between academia's 'three cultures' seem to be stubbornly enduring[29]. However, one useful basis for a new dispensation already exists. As Stirling notes, those sciences dealing with complex, multi-level systems are accustomed to cognitive deficits pertaining to 'possibilities' (risk and ambiguity) and 'probabilities' (uncertainty and ignorance)[30]. He argues that these deficits should encourage experts seeking to influence public affairs to offer "plural, conditional advice [that] helps enable mature and sophisticated policy debate on broader questions". It is not difficult to envisage GEC scientists and a wide array of ESSH scholars finding common ground here as risk, ambiguity, uncertainty and ignorance actively invite them to link (1) facts and values and (2) means and ends without pretending there is one present or a single preferred future awaiting 'objective' analysis if only we had more data or better models[31,32]. Its effective exploration awaits a reconfiguration of how university research interfaces with politics, economy and society in world of high-stakes decision-making[33].

Preconditions for a wider dialogue

Having argued for change to GEC research beyond that imagined by some physical and social scientists, we conclude with some suggestions that, if acted on, might sow the seeds of something new. Ultimately, cultivating that something requires an accurate under-standing of how novel habits can take hold[34,35].

First, many physical scientists in the GEC research community should acknowledge that they have grown accustomed to a certain 'style' of human dimensions research. This opens the door to them revisiting their conception of the nature and role of disciplines that study the human aspects of the human–environment drama. Second, the relatively small number of prominent GEC researchers who are not physical scientists — the late Elinor Ostrom was an influential one [36] — should openly recognize that they do not together speak for the ESSH *in toto*.

Third, still others in the ESSH who have sought to influence the thinking of GEC scientists should refrain from pulling their punches. Framing the 'offer' in terms that meet the above-mentioned expectations of many physical scientists will inevitably per-petuate the truncated perception we are questioning here. A recent *Nature Climate Change* paper on anthropology's contribution to the study of climate change is a case in point[37]. Terms that are part of natural science's *lingua franca* pepper the text — for instance, 'mechanisms' and 'drivers'. This hides the full range of anthropological contributions its authors are keen to advertise.

Fourth, it is time for more leading voices in the ESSH to get out of their comfort zones. Scholars who feel they are not part of the 'GEC conversation' beyond their home discipline must break in to the relevant meetings, conferences and journals. Currently, the wider ESSH do not have a Kevin Anderson, Paul Crutzen, Will Steffen, Nicholas Stern or Jeffrey Sachs. It has largely been left to non-academics, such as well-known environmentalist Bill McKibben or Inuit spokesperson Sheila Watt -Cloutier, to speak to key issues that many ESSH scholars are wont only to discuss in their lectures, writings and podcasts. Such figures, we suspect, are often seen as outsiders or idealists who can be safely ignored by many GEC scientists.

Finally, it might help if editors of the world's leading science publications would consider a wider range of submissions and use a broader spectrum of peer reviewers. Within the family of *Nature* periodicals, *Nature Climate Change* has arguably gone the furthest in this regard. But far more can be done to enrich the intellectual diet of those GEC researchers who have so far defined the field — after all, you are what you read, as much as what you eat.

Box 1 | Contemporary GEC research coupling physical and social science.

Inquiry into GEC crosses disciplinary boundaries. Courtesy of high-level funding and institutional support spanning many countries, the physical science aspects remain highly prominent but have been aligned with a number of social science approaches to human dimensions that share an elective affinity. These include environ-mental economics, which focuses on altering human behaviour by adjusting monetary costs of environmental 'goods' and 'bads'; behavioural psychology, which focuses on how individuals and groups register, process and respond to various signals (for example, informational); those parts of political science and legal studies that examine or propose rules and institutions that can engender sustainable activities from the local to global scales; those parts of management and business studies that analyse the preconditions for society-wide 'sustainability transitions' and the switch to 'green growth'; and environmental planning (both urban and regional), which operates at the 'coal face' where technologies and designs for real world change confront the specifics of locality and region. These approaches all feature in what is arguably the most prominent attempt to throw a rope around the coupled physical and social science of GEC, namely sustainability science[38]. They also intersect with what has been called vulnerability science and adaptation sci-ence[39,40]. In both sciences, and the wider field of GEC research, a number of shared terms and concepts have facilitated exchanges between physical and social scientists. These include 'variables', 'factors', 'stressors', 'feedbacks', 'thresholds', 'resilience', 'recovery', 'risk', 'probability', 'uncertainty', 'innovation' and 'vulnerability'.

Box 2 | The environmental social sciences and environmental humanities.

Broadly speaking, environmental social science has two aims:

(1) to study systematically the presuppositions, norms, perceptions, preferences, relations, regulations and institutions that together structure how humans value and use the non-human world; and (2) to identify and evaluate ways of altering human behaviour in light of one or more definitions of desirable or necessary ends. As part of this second aim, many environmental social scientists work with those effecting, or affected by, environmental change, rather than just conducting research on them. The environmental humanities have similar objectives. However, they place less emphasis on assembling and analysing large-scale (or long-run) data sets about people's thinking or actions. Instead, their work addresses fundamental questions of value, responsibility, rights, entitlements, needs, duty, faith, care, government, cruelty, charity and justice in a world marked by (1) significant differences in people's customs and aspirations, (2) manifest inequalities in people's living conditions and material prospects, and (3) complex material and moral interdependencies among people and non-humans stretched across space and unfolding through time. Addressing these questions involves reasoned argument predicated on sometimes starkly opposed principles, as long-standing debates over the moral significance of animals graphically demonstrate. The environmental humanities illuminate peoples' complex and divergent understandings of life — human and non-human — on Earth. They also pay close attention to human faculties beyond cognition and reason, dealing with such things as love, trust, fear, care, commitment, devotion and loyalty.

Box 3 | Interdisciplinary inquiry and values–means–ends packages.

In the widest sense, values are those fundamental beliefs that motivate people's behaviour (for example, love of nature, the right to free speech); means are those various practices, procedures, institutions and technologies by which values can get instituted; and ends are the concrete goals to which means are orientated and which provide a measure of how well values are being realized at any one time or place. Any body of scientific established or new evidence can be made relevant to more than one set of values, means and ends, so too can any established or new technology. Equally, some bodies of evidence and particular technologies speak better to certain sets than to others. It is thus important to reveal how science and technology can serve to internalize and reproduce certain values without seeming to. In this light, interdisciplinary inquiry into GEC must be plural in character and explicit about its political content, whatever the scale of analysis (local or global). If people value in ways that resist reduction to a common metric, then interdisciplinary research into human dimensions must elucidate the various 'packages' that represent alternative conceptions of how to respond to GEC. Packages will often be incommensurable and inspire debate about preferable future pathways[41].

Box 4 | Science, publics and democracy.

GEC researchers enjoy the privilege — but are also burdened with the responsibility — of representing contemporary and future trends in coupled human–environment systems at a range of scales up to the global and long term. The implications of their work stand to be far-reaching, and will unfold in two important contexts. One is the credibility crisis expert advice has suffered in many Western countries since the mid-1990s. The other is the hollowing out of democracy many perceive to be occurring in these same countries. Because of these two things, attempts have been made to foster public engagement with science using models of deliberative democracy 'upstream' of research and innovation not merely 'mid-' or 'downstream'[42,43]. This has been coincident with systematic new efforts to specify the role that publicly funded science should play in complex, large-scale representative democracies[44–46]. These attempts and efforts have thus far registered weakly in discussions of GEC science and this might usefully be rectified. Connecting scientific inquiry with a wider body of ESSH scholarship according to a model of 'plural, deep and wide interdisciplinarity' — our proposal here, inspired by others47 — promises to help GEC research avoid 'public values failures'[48,49] in two senses. First, it will serve a representative function by making visible several actual, probable and possible reali-ties that are relevant to different constituencies. Second, it will serve a deliberative function by encouraging decision-makers and other stakeholders to make what some have, affirmatively, called 'clumsy' choices among substantive options for change[50].

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