

Frontiers in Ecology and the Environment

Human behavior and sustainability

Joern Fischer, Robert Dyball, Ioan Fazey, Catherine Gross, Stephen Dovers, Paul R Ehrlich, Robert J Brulle, Carleton Christensen, and Richard J Borden

Front Ecol Environ 2012; doi:10.1890/110079

This article is citable (as shown above) and is released from embargo once it is posted to the *Frontiers e-View* site (www.frontiersinecology.org).

Please note: This article was downloaded from *Frontiers e-View*, a service that publishes fully edited and formatted manuscripts before they appear in print in *Frontiers in Ecology and the Environment*. Readers are strongly advised to check the final print version in case any changes have been made.



Human behavior and sustainability

Joern Fischer^{1*}, Robert Dyball², Ioan Fazey³, Catherine Gross², Stephen Dovers², Paul R Ehrlich⁴, Robert J Brulle⁵, Carleton Christensen⁶, and Richard J Borden⁷

Sustainability demands changes in human behavior. To this end, priority areas include reforming formal institutions, strengthening the institutions of civil society, improving citizen engagement, curbing consumption and population growth, addressing social justice issues, and reflecting on value and belief systems. We review existing knowledge across these areas and conclude that the global sustainability deficit is not primarily the result of a lack of academic knowledge. Rather, unsustainable behaviors result from a vicious cycle, where traditional market and state institutions reinforce disincentives for more sustainable behaviors while, at the same time, the institutions of civil society lack momentum to effectively promote fundamental reforms of those institutions. Achieving more sustainable behaviors requires this cycle to be broken. We call on readers to contribute to social change through involvement in initiatives like the Ecological Society of America's *Earth Stewardship Initiative* or the nascent *Millennium Alliance for Humanity & the Biosphere*.

Front Ecol Environ 2012; doi:10.1890/110079

The Ecological Society of America's (ESA's) *Earth Stewardship Initiative* seeks to reinvigorate the contributions that the ecological sciences can make in steering humanity toward a more sustainable future (Power and Chapin 2009). Like kindred initiatives, such as the *Millennium Alliance for Humanity & the Biosphere* (<http://mahb.stanford.edu/>), *Earth Stewardship* emphasizes that biophysical knowledge has to be coupled with insights into how, when, and why humans act on knowledge and deliberately adopt appropriate new behaviors. In this regard, a wealth of information exists from disciplines as diverse as sociology, public policy, economics, philosophy, theology, history, and other areas in the social sci-

ences and humanities (WebPanel 1). Here, we argue that the primary barrier to sustainability no longer lies in a lack of knowledge about biophysical or social problems. Instead, the main challenge now is to act on existing knowledge and to actively work toward a sustainable future (Ehrlich and Kennedy 2005; Fischer *et al.* 2007).

We propose five priority themes that focus on the nexus of human behavior and sustainability. For each theme, we briefly summarize existing knowledge and propose tangible steps that should be taken. Our priority themes range from pragmatic and fairly uncontroversial to foundational and contentious; they are: (1) reforming formal institutions at the level of nation states; (2) strengthening the institutions of civil society and fostering citizen engagement; (3) curbing consumption and reducing population growth; (4) routinely considering equity and social justice in decision making; and (5) reflecting on deeply held value and belief systems, which fundamentally shape behavior (Figure 1). We conclude with a discussion of how to break out of the current pattern of inadequate efforts to achieve sustainability.

We focus mainly on industrial societies because we see these as the primary origin of the sustainability crisis, and because, in principle, they are better equipped than poor countries to actively address unsustainable behaviors. Our paper is an overview of existing knowledge and potential solutions to the sustainability crisis – it is not a comprehensive review of the multiple bodies of scholarship on sustainability (WebPanel 1). Additional literature is suggested in WebPanel 4.

In a nutshell:

- Human actions and behaviors, both by individuals and societies, are resulting in the ongoing degradation of the biosphere
- The social sciences have generated useful knowledge on how to foster behavioral change
- Achieving large-scale behavioral change requires a powerful movement within civil society
- For sustainability science to be effective, it needs to engage with civil society and support appropriate initiatives, such as the Ecological Society of America's *Earth Stewardship Initiative* and the *Millennium Alliance for Humanity & the Biosphere*

¹Faculty of Sustainability, Leuphana University Lueneburg, Lueneburg, Germany *(joern.fischer@uni.leuphana.de); ²Fenner School of Environment and Society, The Australian National University, Canberra, Australia; ³School of Geography and Geosciences, St Andrews University, St Andrews, UK; ⁴Center for Conservation Biology, Department of Biology, Stanford University, Stanford, CA; ⁵Department of Culture and Communications, Drexel University, Philadelphia, PA; ⁶School of Philosophy, Research School of Social Sciences, The Australian National University, Canberra, Australia; ⁷Human Ecology, College of the Atlantic, Bar Harbor, ME

■ Reforming formal institutions

Sustainability is influenced by many societal actors, including governmental agencies, private companies, non-governmental organizations, local communities, and various interest groups. All are influenced by institutions



Figure 1. A pyramid of priorities for societal change. Changes that can be easily and rapidly implemented (at the top of the pyramid) are less profound than those that are more difficult to implement (at the bottom of the pyramid). Different sectors of society must work on social change at various different levels at the same time, with the possibility of momentum for social change spreading up and down the pyramid. Ultimately, profound changes will be necessary for human behavior to become sustainable.

– the underlying rules and structures that shape the social, economic, and political transactions within society (North 1990). Such structures can be formal or informal, and both are important for sustainability. Formal institutions offer considerable potential for immediate reform because they are shaped by political processes. Out of formal institutions emerge policy instruments that directly influence human behavior, including taxes, regulations, fines, educational programs, public disclosure, or threats of imprisonment (Dovers 2005).

Institutional reform at the level of nation states promises substantial benefits for sustainability because nations have a high degree of legal authority (whether they wield it well or corruptly). First, *environmental policy integration* is needed to incorporate sustainability as a core consideration across a wide range of policy sectors (Lafferty and Hovden 2003). Environmental problems originate from policy sectors – such as finance, trade, energy, transport, or urban development – whose primary accountability is not related to environmental performance, and it is in these sectors that action is most urgently needed. For example, following the 1992 Rio Earth Summit and Australia's adoption of the National Strategy for Ecologically Sustainable Development (also in 1992), sustainable development principles were inserted into the enabling statutes of over 120 Australian policy agencies whose primary responsibilities ranged from economic policy assessment and infrastructure provision to urban planning (Stein 2000). Through more frequent use of such mechanisms, sustainability considerations can become core business across a range of policy sectors.

Second, *systemic policy instruments and interventions* can address the causes, rather than the symptoms, of unsustainable behavior. Systemic instruments include market mechanisms (eg taxes on carbon), environmental review

of central budget processes and trade agreements, and curriculum-wide educational reforms (Dovers 2005). Many current policy approaches deal with the symptoms of environmental degradation, rather than providing incentives for sustainable practices.

Third, *legal change* is needed, both in its own right and to facilitate the two opportunities listed above (Connor and Dovers 2004; Richardson and Wood 2006). Statute law is often viewed simply as regulation, ignoring its crucial role in enabling other policy instruments, defining rights of access to decision making, defining agency mandates, and stipulating what must be considered in decision making. For example, a statutory basis is needed for strategic environmental assessment regimes and for environmental reviews of budgets. Similarly, re-allocation of

natural resources, for instance through regulation of fisheries, typically requires legal change, including new statutes (Connor and Dovers 2004).

While there are numerous opportunities for institutional reform within nation states, other societal actors are also important. For example, large cities have major impacts on sustainability but are governed not only by nation states but also by a variety of global economic actors (Sassen 2006), which subsequently must be considered when addressing sustainability problems. Similarly, institutional reform can be difficult in nation states where corruption is rife, formal institutions are weak, or powerful interests dominate political decision making. In such cases, civil society plays a particularly important role.

■ Engaging community in a stronger civil society

Many political and economic institutions are constrained by inherent obligations that limit their capacity to initiate social change. For political institutions, traditional imperatives include the provision of security, material well-being, and the maintenance of political legitimacy. For many established economic institutions (eg systems of investment, banking, trading, or stock exchange), traditional imperatives include maximizing return on investment and fostering economic growth. In both cases, environmental actions that are seen to impinge on these goals will not be fostered within the dynamics of the market or the state. Rather than transforming the relevant economic and political institutions to meet ecological requirements, environmental policies are thus forced to fit into existing institutional arrangements, even when these undermine sustainability (Brulle 2000).

In many cases, the problem is not that alternative insti-

tutional arrangements do not exist – they do. For example, sustainable resource use can result from economic institutions that follow certain design principles, related to, among other things, clear boundaries, collective choice arrangements, and graduated sanctions for those who violate agreed-upon rules (Ostrom 1990). Such rules can, for example, help to prevent the overuse of shared resources, such as communally used pastures. Similarly, political institutions can support sustainability if they are designed well – for instance, if they directly involve citizens and have high standards of accountability (Lebel *et al.* 2006). However, many existing economic and political institutions are narrowly focused on the traditional imperatives noted above, which limits their capacity to initiate change.

Civil society institutions, such as community groups, non-governmental organizations, foundations, and cultural groups, are less constrained than economic and state institutions. Consequently, they can play a major enabling role in establishing controversial reforms. They constitute a vital communicative link between citizens and government, and are key sites where large-scale social change originates (Calhoun 1993). A famous example illustrating the power of civil society to bring about social change is the uprising in the Love Canal community in New York State when it was discovered that the area was contaminated with toxic waste (WebPanel 2).

To effect social change, civil society institutions must engage people and provide opportunities for active participation. This enables individuals to join together with other community members to shape their own governance (Rochon 1998). It is also through participation in collective decision-making processes that citizens acquire the necessary technical and cultural knowledge to make more meaningful contributions to social change (Light 2002). Third, participating in deliberative, collective decision making involves a process of moral development, away from narrow individualism and toward a more encompassing notion of morality (Webler *et al.* 1994). Finally, decisions developed within participatory processes are more likely to be accepted, not only by those affected by the decisions but also by the broader community (see section on “Equity and justice” below). The benefits of participation have been documented in many case studies; for example, conservation volunteers in highly participatory projects report higher levels of learning about how to achieve conservation outcomes and how to work collaboratively than do those in less participatory projects (Evely *et al.* 2011).

Beyond the need for a participatory structure, sustainability messages need to be communicated in a way that people can relate to. This is particularly important at a time when “being heard” can be difficult for environmentalists, especially where powerful lobby groups have considerable influence over mainstream media outlets. Three types of messaging can be distinguished. *Reassuring messages*, such as might be found on disposable coffee cups

made from recycled materials, focus on encouraging low levels of behavioral change. Such messages are widely used by companies to market their green credentials but have limited ability to encourage fundamental change (Brulle 2010). Indeed, in some cases, a focus on supposedly green properties of food products (such as their organic production or their “freshness”) can even encourage overly consumptive lifestyles (Guthman 2004; Freidberg 2009).

The opposite strategy is *threat messaging*, such as forecasting the collapse of ecosystems or societies. There is some evidence that these kinds of messages can enhance the focus of individuals on collective action (Smith *et al.* 2010). However, if the threat is considered to be beyond the resources available to cope with it, threat messaging is not effective (Tomaka *et al.* 1993); people simply shut out threatening information, and important issues thus remain in the “too hard” basket.

Arguably, the best communication strategy for changing human behavior is *challenge messaging*, where fear of the danger being communicated does not exceed the perceived ability to achieve change (Tomaka *et al.* 1993). Fear arousal combined with information about effective actions can be strongly motivating (O’Neill and Nicholson-Cole 2009). There also may be benefits in the more widespread use of *social comparison strategies*. Energy use in different neighborhoods in San Francisco, California, for example, has been reduced by providing people with information on how much energy they consume as compared with their neighbors (Panel 1).

■ Curbing consumption and population growth

Two interacting drivers of environmental degradation are per capita consumption and human population growth (Ehrlich and Holdren 1971). Different challenges apply to rich countries, poor countries, and those with transition economies.

Disproportionate per capita consumption in rich countries is the largest current problem for global sustainability. Traditionally, scholars have focused on *conspicuous consumption*, which is motivated by its likely influence on other members of society. It has been suggested that conspicuous consumption serves socio-psychological functions, such as identity creation or peer recognition (Baudrillard 1998; McCracken 1998), and may include status symbols, such as expensive cars or certain brand-name clothing.

More recently, the focus has shifted toward *inconspicuous consumption*. This relates to everyday behaviors, such as bathing, laundering, or the use of air-conditioning and modern communication technologies (Shove 2003). Such activities do not play a status-signaling role but relate to everyday habits that are taken for granted or are expressed as “needs”. Investigation of how these practices have evolved into needs reveals that they shape and have been shaped by technological development. For example,

widespread implementation of air-conditioning in wealthier countries has led to expectations of comfortable indoor temperatures, irrespective of seasonal variation and geographic location. People now find it unreasonable to tolerate temperatures outside this artificial norm.

Inconspicuous consumption is pervasive and affects expectations of choice, comfort, cleanliness, and convenience – which feeds back to reinforce consumption. The belief that constant comfort and consumption is possible is encouraged and exploited by commercial interests, particularly through advertising – but it represents a form of blindness toward the biophysical and ethical limits of consumption. Efforts to address inconspicuous consumption will require a reorientation of economic life, particularly in rich countries, away from its current organization around providing consumables as constantly and easily as possible. Thus, an emerging priority is to understand whether and how consumers will adapt their expectations of everyday comfort, cleanliness, and convenience over time. New research is needed to understand how individuals can bring their preferences into better alignment with the requirements of ethics and sustainability (Christensen 2008).

Historically, poor countries have had very low levels of per capita consumption and thus have contributed less to current sustainability problems than rich countries.



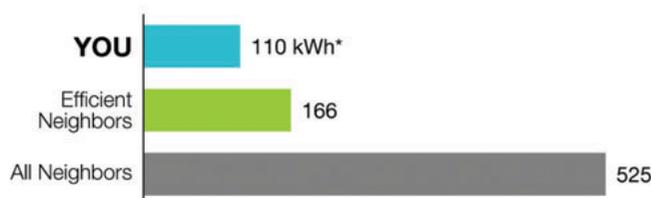
Figure 2. In the Solomon Islands, population growth presents a major challenge for sustainable development. Demographic momentum is high in many poor countries. Given the large number of children at present, populations will continue to grow for decades, even if average fertility per capita declines immediately.

However, even when per capita consumption is low, the environmental impact of additional members of society is non-linear and should not be underestimated (Figure 2). Rapid population growth in many poor countries is leading to farmland being used increasingly intensively and expanding farther into marginal areas. Moreover, although consumption patterns could be changed relatively rapidly, given appropriate incentives, it takes many decades to ethically reduce population size (Ehrlich and Ehrlich 2010).

Panel 1. Normative feedback and social comparison as means to reduce energy use

Opower is an energy advisory company that partners with utilities to make effective use of the natural drive people have to conform to the social norms of their peers. Home energy reports produced by Opower reveal the customer's own energy usage, descriptive messages about energy use in their immediate neighborhood, and practical suggestions on how they might further reduce energy consumption. In addition, bills also feature a simple symbol of social approval or disapproval; customers whose energy use is below the neighborhood average receive a smiley face on their bill (Figure 3), whereas the "More than average" label is highlighted for customers whose energy use is above the neighborhood average. Although a smaller energy bill provides a financial reward to the customer, research has revealed that the descriptive message in combination with the symbol of social approval actually is a major motivator to reduce energy use (Schultz *et al.* 2007). The use of this simple strategy, which draws on social comparison and social approval, has led 80% of customers to reduce their power usage, with lasting average reductions in energy use of between 1.5% and 3.5% (see www.opower.com/Results/Overview.aspx).

Last Month Neighbor Comparison | You used **34% LESS** electricity than your efficient neighbors.



* kWh: A 100-Watt bulb burning for 10 hours uses 1 kilowatt-hour.

How you're doing:

▶ **GREAT** 😊😊
 Good 😊
 More than average

Figure 3. Section of an Opower bill.

In addition to ecological reasons, there are compelling social reasons for stemming population growth in poor countries. Lower fertility rates correlate with improved gender equity and economic development (Lutz and Samir 2011). Improved female secondary education in particular – but also better access to family planning – can have a range of social, economic, and ecological benefits. Secondary education for women has, for example, effectively reduced population growth in Ethiopia, Nigeria, and Kenya (Lutz 2009). Culturally appropriate access to family planning in Thailand and Iran has also led to reductions in total fertility rates, from approximately seven to approximately two births per woman (Speidel *et al.* 2009). Such interventions are likely to bring a variety of benefits to poorer communities, including better survival rates among children, and improvements in health, well-being, and quality of life.

Countries with transition economies, such as India, present particular challenges: they have not only a growing population but also increasingly high levels of consumption per capita. These countries highlight most clearly of all that it is the combination of absolute numbers of people and per capita consumption that must be addressed. Notably, growing overall levels of consumption may still result in large segments of society consuming very little because of inequalities in the distribution of wealth within nations (Wilkinson and Pickett 2010). Major inequalities, in turn, contribute to social disharmony, loss of trust in institutions, and disenfranchisement. Consequently, these issues should be addressed through the more explicit consideration of equity and justice.

■ Equity and justice

Equity and justice must be routinely considered in decision-making processes concerning the natural environment. Although notions of justice and equity have been debated for centuries, they are still seen as being in the realms of theory and philosophy rather than of practical use in day-to-day decision making (Miller 1999; Barry 2005). Yet social conflicts over natural resources are common, and such conflicts can cause divisions within communities, prolonged disagreements with governments, and delayed decision making.

Conflicts resulting from a perceived lack of justice are played out in many different contexts. For example, the environmental justice movement emerged as a response to localized inequities in the distribution of hazardous waste, in that disadvantaged people are typically more seriously affected (WebPanel 2; Brulle and Pellow 2006). Similarly, the climate justice movement is concerned with the ethics of climate change, including questions of responsibility, blame, and the disproportionate impacts of some nations (Gardiner *et al.* 2010). Conflicts may also arise in infrastructure developments; for example, countries such as Australia have witnessed strong local opposition to proposed wind farm developments. The “not-in-my-back-

yard” syndrome is frequently touted as the cause of this opposition, but this broad-brush explanation glosses over a myriad of more subtle justice concerns. Such concerns frequently include a lack of consultation with stakeholders on the potential impacts of the wind turbines on individuals, communities, and wildlife (Gross 2007).

Many disputes regarding natural resources could be more effectively resolved through a better understanding of the theories and practical implications of justice and injustice (Shklar 1990; Simon 1995). The notion of justice itself includes three main constructs. *Distributive justice* is concerned with outcomes and includes three key distribution principles: need, equity, and equality (Miller 1999). *Procedural justice* is the fairness of decision-making processes, such as participation, voice, information, and consideration of impacts and issues (Lind and Tyler 1988). *Interactional justice* refers to the way people are treated during a decision-making process (Bies 2005). As illustrated in the case of water redistribution in Victoria, Australia (Panel 2), justice constructs revolve around processes as well as outcomes; that is, it is not only outcomes that can be perceived as just or unjust but also procedures and the way people are treated. Fair decision-making processes are critical in gaining widespread acceptance of outcomes (Panel 2).

A better understanding of justice, and its explicit consideration in decisions affecting natural resource distribution, will increase the political acceptability of bold sustainability reforms. A key challenge is how to systematically and routinely incorporate distributive justice, procedural justice, and interactional justice into relevant decision-making processes.

■ Value and belief systems

There is a critical need to understand how value and belief systems evolve, especially in relation to the way people interact with their environment. At the level of individuals, beliefs and values are influenced by age, life stage, gender, education, and social status (Hofer and Pintrich 1997; Rokeach 2000). At a societal level, socioeconomic development is associated with value shifts, such as from a focus on survival to a focus on self-expression (Inglehart 2000). Conceptual models of the development of values and beliefs suggest that there is gradual movement from low sophistication (eg being driven by desire) toward higher sophistication (eg exhibiting awareness and concern for how perceptions influence behavior; Cook-Greuter 2000; Commons and Goodheart 2007).

Spirituality and religion also have an important influence on values and human–environment relationships, but to date, few sustainability scholars have actively engaged with these themes (Tucker and Grim 1994). While some argue that religion has contributed to the sustainability crisis (White 1967), religion can also be part of the solution. Religion can provide metaphorical or experiential explanations for the underlying causes of unsustain-

able human behavior, sometimes complementing academic research findings. For example, Buddhist philosophy provides explanations for why increasing material wealth does not necessarily translate into an increase in human well-being, and suggests practical alternative measures to improve well-being (Daniels 2010).

While it is neither possible nor necessarily desirable to find clear relationships between the dominant belief system of a society and its environmental impact, metaphors and worldviews from non-Western belief systems are useful for reframing debates about sustainability. Examples include the Indonesian concept of *cukupan* (“enoughness”), the Thai notion of a “sufficiency economy”, or Bhutan’s focus on “Gross National Happiness”. Such non-Western worldviews may prove valuable in identifying pathways toward sustainability. Some of these pathways may seem “unreasonable” or “irrational” from a Western cultural perspective, but this may only highlight the difficulty of finding solutions to problems from within the same worldview that created them. Non-Western worldviews must not be seen as a panacea for solving global sustainability problems, and they pose serious epistemological challenges regarding how to conduct both research and environmental management (Berkes 2008). However, working through these issues is likely to provide fresh insights into how to tackle the sustainability challenge – a key point being that values and beliefs that offer real alternatives to a consumption- and growth-based society already exist in some human cultures (Lansing 1991).

It is our firm belief that the ultimate solution to the sustainability crisis hinges on a far greater emphasis on fur-

ther developing our understanding of the evolution of value and belief systems, at levels ranging from individuals to societies (Figure 1). Gaining such an understanding will require a new suite of transdisciplinary research that does not shy away from a spectrum of questions and approaches that natural scientists in particular have rarely engaged with in the past (Brown *et al.* 2010).

■ From knowledge to action

Our synthesis highlights clear priorities that need to be addressed to foster societal change (WebPanel 3). Specific measures are associated with these priorities, such as institutional reform in sectors not directly related to the environment or the education of women in poor countries (WebPanel 3). Even though our list is likely to be incomplete, if these priorities were addressed comprehensively, this would undoubtedly have major benefits for sustainability. The problem of unsustainability is therefore not due to a lack of knowledge; great advances are possible through existing knowledge and previously described reform proposals alone. Yet, progress is slow and inadequate, and aside from local exceptions, sustainability endeavors as a whole still lack the momentum to bring about large-scale societal change.

On the basis of existing experiences at smaller scales, we argue that the institutions of civil society should be strengthened because they are the origin of social change (WebPanel 2). In other words, sustainability requires a social avalanche of unprecedented proportions; to start this avalanche, enough momentum needs to be created for a snowball effect to develop, so that appropriate mea-

Panel 2. Justice and injustice in the case of water redistribution in Victoria, Australia

In 2007, the Victorian State Government initiated an infrastructure project to build a 75-kilometer pipeline to transfer water from the Goulburn River in the state’s north to Melbourne, the state’s capital city in the south. The rationale was that Melbourne could run out of water by 2010 if drought conditions persisted. The water diversion was part of a larger project, in which the Government would fund major upgrades to aging irrigation infrastructure in the state’s north, to increase efficiency and reduce water losses. The water thus saved was to be shared equally among the people of Melbourne, irrigators, and the environment. However, vehement opposition arose to the proposed initiative and was voiced through a broad-based grassroots movement called “Plug the Pipe” (Figure 4). Table 1 shows that there were a range of perceived types of injustice (Gross 2011).



Figure 4. Protest sign directed at the head of the State of Victoria, Premier John Brumby.

Table 1. Range of perceived types of injustice

Perception of injustice	Type of justice violated
(1) Disdainful treatment of affected communities	Interactional justice
(2) Lack of consultation with communities	Procedural justice
(3) Lack of information on pipeline and water savings	Procedural justice
(4) Impact on the environment: removal of water from a river system in drought	Distributive justice
(5) Unsatisfactory justification of “need” for Melbourne’s water supply; other options available	Distributive justice

tures will be widely adopted. The question is: who or what might start this avalanche? We are caught in a vicious cycle, where formal institutions and existing consumption habits reinforce disincentives for citizens to actively pursue sustainability. In the absence of more active demands for societal change by civil society, however, formal institutional change will continue to be slow.

An important research question for scholars working on sustainability is how to break out of this pattern, where institutions constrain behaviors, which in turn prevent institutional change. More importantly, as sustainability researchers, although we could just wait for community groups or non-governmental organizations to initiate major social change, many of us are also largely independent of formal market and state institutions in our everyday activities. A more honest strategy therefore is to turn to our own discipline of sustainability science and ask ourselves what we can do to initiate change. The alternative is to describe the world's fate ever more precisely, while doing nothing to avert it.

Initiating change challenges deeply held traditions of scholarly practice and demands different skills and activities than those conventionally associated with “good science”. First, sustainability is a normative concept, meaning it embodies a particular set of values. As sustainability scholars we cannot deny this dimension; advocacy toward the general goal of sustainability is essential for an effective, transdisciplinary sustainability science. Second, we must recognize that we are part of civil society, and we must engage with other institutions of civil society to actively promote change. Change is likely to require both high-profile champions of sustainability as well as grassroots involvement.

Third, we must confront the fact that sustainability science lacks the immediate excitement caused by traditional, discovery-oriented sciences. Sustainability science is all about addressing underlying variables and complex problems. Communicating the need to nevertheless face these issues requires extra efforts, which will need to go far beyond current standards.

Against these three challenges, the fourth challenge seems almost trivial: namely, to embrace interdisciplinary collaboration. Yet this is a recognized obstacle in its own right for several reasons, including clashing scholarly traditions and an often unsupportive institutional context. Put bluntly, we know what needs to happen to work toward a more sustainable future: we know that a social avalanche is needed. The challenge now is to get it started.

■ Acknowledgements

We thank D Carmichael, D Dumaesq, and J Schooneveldt for insightful early discussions, and C Folke, W Steffen, and P Matson for comments. JF was supported through a Sofja Kovalevskaja Award granted by the Alexander von Humboldt Foundation and

financed through the German Federal Ministry for Education and Research.

■ References

- Barry B. 2005. Why social justice matters. Cambridge, UK: Polity Press.
- Baudrillard J. 1998. The consumer society: myths and structures. London, UK: Sage.
- Berkes F. 2008. Sacred ecology. New York, NY: Routledge.
- Bies RJ. 2005. Are procedural justice and interactional justice conceptually distinct? In: Greenberg J and Colquitt J (Eds). Handbook of organizational justice. Mahwah, NJ: Lawrence Erlbaum Associates.
- Brown V, Harris J, and Russell J (Eds). 2010. Tackling wicked problems: through the transdisciplinary imagination. London, UK: Earthscan.
- Brulle RJ. 2000. Agency, democracy, and nature: the US environmental movement from a critical theory perspective. Cambridge, MA: MIT Press.
- Brulle RJ. 2010. From environmental campaigns to advancing the public dialogue: environmental communication for civic engagement. *Environ Comm* 4: 82–98.
- Brulle RJ and Pellow DN. 2006. Environmental justice: human health and environmental inequalities. *Annu Rev Publ Health* 27: 103–24.
- Calhoun C. 1993. Nationalism and civil society: democracy, diversity and self-determination. *Int Sociol* 8: 387–411.
- Christensen C. 2008. Redirecting affective dispositions: how philosophy can contribute to eco-political thinking. *Design Philosophy Papers* 2: 1–7.
- Commons ML and Goodheart EA. 2007. Consider stages of development in preventing terrorism: does government building fail and terrorism result when developmental stages of governance are skipped? *J Adult Dev* 14: 91–111.
- Connor R and Dovers S. 2004. Institutional change for sustainable development. Cheltenham, UK: Edward Elgar.
- Cook-Greuter SR. 2000. Mature ego development: a gateway to ego transcendence? *J Adult Dev* 7: 227–40.
- Daniels PL. 2010. Climate change, economics and Buddhism – part I: an integrated environmental analysis framework. *Ecol Econ* 69: 952–61.
- Dovers S. 2005. Environment and sustainability policy: creation, implementation, evaluation. Sydney, Australia: Federation Press.
- Ehrlich P and Holdren J. 1971. The impact of population growth. *Science* 171: 1212–17.
- Ehrlich PR and Ehrlich AH. 2010. The culture gap and its needed closures. *Int J Environ Stud* 67: 481–92.
- Ehrlich PR and Kennedy D. 2005. Millennium assessment of human behavior. *Science* 309: 562–63.
- Evely AC, Pinard M, Reed MS, and Fazey I. 2011. High levels of participation in conservation projects enhance learning. *Conserv Lett* 4: 116–26.
- Fischer J, Manning AD, Steffen W, *et al.* 2007. Mind the sustainability gap. *Trends Ecol Evol* 22: 621–24.
- Freidberg S. 2009. Fresh: a perishable history. Cambridge, MA: Harvard University Press.
- Gardiner SM, Caney S, Jamieson D, and Shue H. 2010. Climate ethics: essential readings. New York, NY: Oxford University Press.
- Gross C. 2007. Community perspectives of wind energy in Australia: the application of a justice and community fairness framework to increase social acceptance. *Energy Policy* 35: 2727–36.
- Gross C. 2011. Why justice is important. In: Connell D and Grafton RQ (Eds). Basin futures: water reform in the Murray–Darling Basin. Canberra, Australia: ANU E Press.

- Guthman J. 2004. *Agrarian dreams: the paradox of organic farming in California*. Berkeley, CA: University of California Press.
- Hofer BK and Pintrich PR. 1997. The development of epistemological theories: beliefs about knowledge and knowing and their relation to learning. *Rev Educ Res* 67: 88–140.
- Inglehart R. 2000. Globalization and postmodern values. *Wash Quart* 23: 215–28.
- Lafferty W and Hovden E. 2003. Environmental policy integration: towards an analytical framework. *Environ Polit* 12: 1–22.
- Lansing JS. 1991. *Priests and programmers: technologies of power in the engineered landscape of Bali*. Princeton, NJ: Princeton University Press.
- Lebel L, Anderies JM, Campbell B, *et al.* 2006. Governance and the capacity to manage resilience in regional social–ecological systems. *Ecol Soc* 11: 19.
- Light A. 2002. Restoring ecological citizenship. In: Minter B and Pepperman-Taylor B (Eds). *Democracy and the claims of nature*. Lanham, MD: Rowman and Littlefield.
- Lind AE and Tyler TR. 1988. *The social psychology of procedural justice*. New York, NY: Plenum Press.
- Lutz W. 2009. Sola schola et sanitare: human capital as the root cause and priority for international development? *Philos T R Soc B* 364: 3031–47.
- Lutz W and Samir KC. 2011. Global human capital: integrating education and population. *Science* 333: 587–92.
- McCracken G. 1998. *Culture and consumption: new approaches to the symbolic character of consumer goods and activities*. Bloomington, IN: Indiana University Press.
- Miller D. 1999. *Principles of social justice*. Cambridge, MA: Harvard University Press.
- North DC. 1990. *Institutions, institutional change, and economic performance*. Cambridge, MA: Cambridge University Press.
- O'Neill S and Nicholson-Cole S. 2009. “Fear won’t do it”: promoting positive engagement with climate change through visual and iconic representations. *Sci Commun* 30: 355–79.
- Ostrom E. 1990. *Governing the commons: the evolution of institutions for collective action*. Cambridge, MA: Cambridge University Press.
- Power ME and Chapin III FS. 2009. Planetary stewardship. *Front Ecol Environ* 7: 399.
- Richardson B and Wood S (Eds). 2006. *Environmental law for sustainability: a reader*. Oxford, UK, and Portland, OR: Hart Law Publishers.
- Rochon T. 1998. *Culture moves*. Princeton, NJ: Princeton University Press.
- Rokeach M. 2000. *Understanding human values*, 2nd edn. New York, NY: Simon and Schuster.
- Sassen S. 2006. *Territory, authority, rights: from medieval to global assemblages*. Princeton, NJ: Princeton University Press.
- Schultz PW, Nolan JM, Cialdini RB, *et al.* 2007. The constructive, destructive and reconstructive power of social norms. *Psychol Sci* 18: 429–34.
- Shklar J. 1990. *The faces of injustice*. New Haven, CT: Yale University Press.
- Shove E. 2003. *Comfort, cleanliness and convenience – the social organisation of normality*. Oxford, UK, and New York, NY: Berg.
- Simon TW. 1995. *Democracy and social injustice: law, politics, and philosophy*. London, UK: Rowman and Littlefield.
- Smith MH, Hargoves K, and Desha C. 2010. *Cents and sustainability: achieving our common future by decoupling economic growth from environmental pressures*. London, UK: Earthscan.
- Speidel JJ, Weiss DC, Ethelston SA, and Gilbert SM. 2009. Population policies, programmes and the environment. *Philos T R Soc B* 364: 3049–65.
- Stein P. 2000. Are decision-makers too cautious with the precautionary principle? *Environ Plann Law J* 17: 3–23.
- Tomaka J, Blascovich J, Kelsey R, and Leitten C. 1993. Subjective, psychological, and behavioral effects of threat and challenge appraisal. *J Pers Soc Psychol* 65: 248–60.
- Tucker ME and Grim JA. 1994. *Worldviews and ecology: religion, philosophy, and the environment*. Maryknoll, NY: Orbis Books.
- Webler T, Kastenholz HG, and Renn O. 1994. Can public participation in impact assessment enable social learning? *Seventh Meeting of the Society for Human Ecology*, 21–24 Apr, East Lansing, MI, Zurich, Switzerland: ETH.
- White Jr L. 1967. The historical roots of our ecologic crisis. *Science* 155: 1203–07.
- Wilkinson R and Pickett K. 2010. *The spirit level: why equality is better for everyone*. London, UK: Penguin Books.

WebPanel 1. Multiple understandings of sustainability

Sustainability is achieved when ecological, social, and economic conditions can be maintained at desirable levels over long periods of time. Sustainability is an issue that cuts across many academic disciplines (Pezzey 1992). For example, ecologists are concerned with the impacts of human activities on ecosystems. Institutional economists and public policy researchers consider that rules and structures are particularly important in governing human behavior, and that well-designed structures can substantially benefit sustainability. Sociologists attempt to understand the dynamics of societies, including patterns of behavior of people toward one another and toward the environment. Environmental philosophy is concerned with what the role of humans is, and ought to be, in relation to the non-human world. In addition to these disciplines, many others are relevant to sustainability, including human ecology, law, anthropology, psychology, and theology. Although the boundaries between different disciplines are often blurred, each body of scholarship has a different understanding of how the world works. No work on sustainability, including this paper, can be free from some inherent assumptions about which facets of sustainability are most important, or how they should be addressed. Here, we draw primarily on insights from institutional economics, sociology, and environmental philosophy.

WebPanel 2. Love Canal: an example of the enabling role of the institutions of civil society to bring about social change

In the spring of 1978, the residents of the Love Canal neighborhood in Niagara Falls, New York, discovered that their neighborhood was built on top of a toxic waste dump containing 21 000 tons of hazardous chemical waste. Through the door-to-door efforts of community residents, led by Lois Gibbs, the community organized around this issue and formed the Love Canal Homeowners Association (LCHA). This association, with local scientific assistance from volunteers at nearby universities, conducted health monitoring studies to document the disastrous health consequences of this situation on the people who lived in the Love Canal neighborhood. This group also advocated for evacuation of all residents from the hazardous area. Finally, after numerous political actions, including holding two US Environmental Protection Agency (EPA) officials hostage and demonstrating outside the 1980 Democratic National Convention, the US Federal Government funded the permanent relocation of the neighborhood's residents in 1980. The action by the LCHA placed the issue of toxic waste dumps on the national political agenda and gained widespread recognition of health issues associated with toxic waste disposal. Congress responded quickly to this situation and passed the Comprehensive Environmental Response, Compensation, and Liability Act in 1980, which established the EPA's Superfund program.

WebPanel 3. Summary of priority themes that should be addressed to foster more sustainable human behaviors

(1) Reforming formal institutions at the level of nation states

Reforms should prioritize non-environmental policy sectors, because that is where most sustainability problems emerge.

(2) Strengthening the institutions of civil society

Reforms of formal market and state institutions depend on sufficient political motivation or "political will". Fostering such political will, in turn, depends on the success of broad-scale social change movements. The institutions of civil society are the origin of social change and enable people to connect with formal market and state institutions.

(3) Fostering citizen engagement

Advocates of sustainability need to engage and challenge citizens, rather than threaten them, preach to them, or simply appeal to their self-interest. Peer comparison can be a useful complementary tool.

(4) Curbing consumption

Inconspicuous consumption relates to everyday comforts that are taken for granted in many parts of the world. An important research priority is to examine how people can be encouraged to change their consumption habits in response to the consequences for sustainability, including in everyday situations where excessive consumption is currently the norm.

(5) Actively supporting measures to reduce population growth

Family planning programs must be reinvigorated and supported both nationally and internationally, coupled with an emphasis on female education.

(6) Routinely considering equity and justice

Equity is about process as much as it is about outcomes. Distributive justice, procedural justice, and interactional justice must each be actively considered in sustainability reforms for such reforms to be accepted by relevant stakeholders.

(7) Reflecting on value and belief systems

The greatest challenge to sustainability is a systemic lack of deep reflection on the value and belief systems that underpin unsustainable behaviors. Spirituality and religion play central roles in shaping human behavior and can either encourage or discourage more sustainable human behaviors. A new suite of transdisciplinary research projects is needed to support a process of active cultural evolution in Western societies.

WebPanel 4. Further reading – Comments on selected key references are highlighted in bold.**Background**

- Ehrlich PR and Pringle RM. 2008. Where does biodiversity go from here? A grim business-as-usual forecast and a hopeful portfolio of partial solutions. *P Natl Acad Sci USA* **105**: 11579–86.
- Intergovernmental Panel on Climate Change. 2007. Climate change 2007: synthesis report. Contribution of Working Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland: IPCC.
- Jackson JBC. 2008. Ecological extinction and evolution in the brave new ocean. *P Natl Acad Sci USA* **105**: 11458–65.
- Kates RW, Clark WC, Corell R, *et al.* 2001. Sustainability science. *Science* **292**: 641–42.
- Millennium Ecosystem Assessment. 2005. Ecosystems and human well-being: synthesis. Washington, DC: Island Press.
- National Academy of Sciences. 1993. A joint statement by fifty-eight of the world's scientific academies. Population Summit of the World's Scientific Academies. New Delhi, India: National Academy Press.
- Pezzey J. 1992. Sustainability: an interdisciplinary guide. *Environ Value* **1**: 321–62.
- Rockström J, Steffen W, Noone K, *et al.* 2009. A safe operating space for humanity. *Nature* **461**: 472–75.
- Solomon S, Plattner G-K, Knutti R, and Friedlingstein P. 2009. Irreversible climate change due to carbon dioxide emissions. *P Natl Acad Sci USA* **106**: 1704–09.
- Steffen W, Sanderson A, Tyson P, *et al.* 2004. Global change and the Earth system: a planet under pressure. Berlin, Germany: Springer-Verlag.
- Union of Concerned Scientists. 1993. World scientists' warning to humanity. Cambridge, MA: Union of Concerned Scientists.
- Vitousek PM, Aber JD, Howarth RW, *et al.* 1997. Human alteration of the global nitrogen cycle: sources and consequences. *Ecol Appl* **7**: 737–50.
- Wake DB and Vredenburg VT. 2008. Are we in the midst of the sixth mass extinction? A view from the world of amphibians. *P Natl Acad Sci USA* **105**: 11466–73.

Reforming formal institutions

- Ahmad IH. 2009. Climate policy integration: towards operationalization. New York, NY: Department of Economic and Social Affairs of the United Nations Secretariat. DESA Working Paper No 73. ST/ESA/2009/DWP/73.
- Dovers S. 2006. Precautionary policy assessment for sustainability. In: Fisher E, Jones J, and von Schomberg R (Eds). The precautionary principle and public policy decision making. Cheltenham, UK: Edward Elgar.
- Dovers S and Hezri AA. 2010. Institutions and policy processes: the means to the ends of adaptation. *Wiley Interdisciplinary Reviews: Climate Change* **1**: 212–31.
- This review identifies the lack of connection between current climate-change debates with existing policy and institutional knowledge and capacities, and highlights a range of tangible opportunities for reforms.**
- Grimm NB, Faeth SH, Golubiewski NE, *et al.* 2008. Global change and the ecology of cities. *Science* **319**: 756–60.
- Gunningham N and Grabosky P. 1998. Smart regulation: designing environmental policy. Oxford, UK: Clarendon Press.
- McKay BJ and Acheson JM (Eds). 1987. The question of the commons: the culture and ecology of communal resources. Tuscon, AZ: University of Arizona Press.
- North DC. 1990. Institutions, institutional change, and economic performance. Cambridge, MA: Cambridge University Press.

Ostrom E. 1990. Governing the commons: the evolution of institutions for collective action. Cambridge, MA: Cambridge University Press.

This book is the basis for Ostrom's overall body of work, which earned her the Nobel Prize in 2009. It highlights how economic institutions can foster sustainability if they follow certain design principles.

Schneider A and Ingram H. 1990. Behavioural assumptions of policy tools. *J Politics* **52**: 510–29.

Most policy proposals are based on implicit assumptions regarding human behavioral motivation, preferable modes in social change, and the role of different groups in society.

Walker B, Barrett S, Polasky S, *et al.* 2009. Looming global-scale failures and missing institutions. *Science* **325**: 1345–46.

Engaging community in a stronger civil society

Anderies JM, Janssen MA, and Ostrom E. 2004. A framework to analyze the robustness of social–ecological systems from an institutional perspective. *Ecol Soc* **9**: 18. www.ecologyandsociety.org/vol19/iss11/art18.

Anderies JM, Ryan P, and Walker BH. 2006. Loss of resilience, crisis, and institutional change: lessons from an intensive agricultural system in southeastern Australia. *Ecosystems* **9**: 865–78.

Barber B. 1984. Strong democracy. Berkeley, CA: University of California Press.

Barry J. 2002. Vulnerability and virtue: democracy, dependency, and ecological stewardship. In: Minter B and Taylor BP (Eds). Democracy and the claims of nature: critical perspectives for a new century. Lanham, MD: Rowman and Littlefield.

Blühdorn I. 2000. Post-ecologist politics: social theory and the abdication of the ecologist paradigm. London, UK: Routledge.

Brulle RJ. 2000. Agency, democracy, and nature: the US environmental movement from a critical theory perspective. Cambridge, MA: MIT Press.

This book provides a theoretical, historical, and empirical analysis of the development and impacts of the US environmental movement.

Cialdini RB. 2008. Influence: science and practice. Boston, MA: Allyn and Bacon.

de Hoog N, Stroebe W, and de Wit JB. 2007. The impact of vulnerability to and severity of a health risk on processing and acceptance of fear-arousing communications: a meta-analysis. *Rev Gen Psychol* **11**: 258–85.

Eagly AH and Kulesa P. 1997. Attitudes, attitude structure, and resistance to change: implications for persuasion on environmental issues. In: Bazerman MH, Messick DM, Tenbrunsel AE, and Wade-Benzoni KA (Eds). Environment, ethics and behavior: the psychology of environmental valuation and degradation. San Francisco, CA: New Lexington Press.

Fritze J, Blashki G, Burke S, and Wieseman J. 2008. Hope, despair and transformation: climate change and the promotion of mental health and wellbeing. *Int J Ment Health Syst* **2**: 1–12.

Ostrom E. 2009. A general framework for analyzing sustainability of social–ecological systems. *Science* **325**: 419–22.

Putnam R. 2000. Bowling alone. New York, NY: Simon and Schuster.

Schlosberg D and Rinfret S. 2008. Ecological modernization, American style. *Environ Polit* **17**: 254–75.

Witte K and Allen M. 2000. A meta-analysis of fear appeals: implications for effective public health campaigns. *Health Educ Behav* **27**: 608–32.

WebPanel 4. Further reading – Comments on selected key references are highlighted in bold.**Curbing consumption**

- Blanchflower DG and Oswald AJ. 2004. Well-being over time in Britain and the USA. *J Public Econ* **88**: 1359–86.
- Campbell C. 1998. Consuming goods and the good of consuming. In: Crocker DA and Linden T (Eds). *Ethics of consumption: the good life, justice, and global stewardship*. Lanham, MD: Rowman and Littlefield.
- Christensen C. 2007. What is so sustainable about services? The truth in service and flow. *Design Philosophy Papers* **5**. www.desphilosophy.com.
- Douglas M and Isherwood B. 1979. *The world of goods: towards an anthropology of consumption*. New York, NY: Basic Books.
- Easterlin RA. 2001. Income and happiness: towards a unified theory. *Econ J* **111**: 465–84.
- Jackson T. 2009. *Prosperity without growth? The transition to a sustainable economy*. London, UK: Sustainable Development Commission.
- Sassatelli R. 2007. *Consumer culture: history, theory and politics*. London, UK: Sage Publications.
This book gives a comprehensive account of different theories of consumption, including a critical appraisal of the common view that consumers are manipulated by advertising.

Addressing population growth

- Bloom DE. 2011. 7 billion and counting. *Science* **333**: 562–69.
This is one of a series of papers in a recent special section in the journal *Science* on human population growth and demographic change.
- Cohen JE. 2008. Make secondary education universal. *Nature* **456**: 572–73.
- Ehrlich PR and Ehrlich AH. 2010. The culture gap and its needed closures. *Int J Environ Stud* **67**: 481–92.
- James KS. 2011. India's demographic change: opportunities and

challenges. *Science* **333**: 576–80.

- Lee R. 2011. The outlook for population growth. *Science* **333**: 569–73.
- Potts M, Pebley AM, and Joseph Speidel J. 2009. Editorial. *Philos T R Soc B* **364**: 2975–76.
This editorial opens a special issue on human population growth, which provides an authoritative overview of a wide range of key issues surrounding this controversial topic.

Equity and justice

- Gross C. 2010. *Water under the bridge: fairness and justice in environmental decision-making* (PhD thesis). Canberra, Australia: The Australian National University. <http://dspace-prod1.anu.edu.au/handle/1885/49419>.
This interdisciplinary PhD thesis relates ideas and theories about justice to the actual experience of fairness, justice, and injustice through empirically based research in current social conflicts.

Value and belief systems

- Ehrlich PR and Ornstein RE. 2010. *Humanity on a tightrope: thoughts on empathy, family, and big changes for a viable future*. Lanham, MD: Rowman and Littlefield.
- Orr DW. 2002. Four challenges of sustainability. *Conserv Biol* **16**: 1457–60.
- Perry WG. 1970. *Forms of intellectual and ethical development in the college years: a scheme*. New York, NY: Holt, Rinehart and Winston.
- Tucker ME and Grim JA. 1994. *Worldviews and ecology: religion, philosophy, and the environment*. Maryknoll, NY: Orbis Books.
This seminal book reviews and analyses the relationships between a wide range of religions and spiritual worldviews and the environment.