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Management for sustainability

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Much of the unsustainable activity that occurs in the world can be traced to organizations. Yet, because organizations are social systems, they cannot be managed for sustainability in the same way as ecosystems and natural resources. Using social systems theory, and employing the concepts of emergence, resilience and scale, I identify management principles for pursuing sustainability across an array of organizational contexts. These principles serve as a basis for an agenda to promote sustainability through logic models and experimentation. The UN Sustainable Development Goals provide an opportunity for putting these principles into action.

The archetypical organizations in the world — corporations, proprietorships, hospitals, schools, voluntary associations and others — rarely pursue sustainability as a primary objective, and are often rather indifferent to it, or in some cases even opposed[1,2]. This is unfortunate because many negative sustainability impacts, as well as opportunities to address them, reside in systems that are at their core organizational. Examples of ways in which some organizations engage with sustainability include a multinational conglomerate that embraces the circular economy as a business opportunity[3], a university divesting its financial holdings from fossil fuels to undermine the legitimacy of carbon-based energy sources[4] and the Girl Scouts conducting child-centred interventions to promote household energy-saving behaviours enacted by both the Scouts and their parents[5]. Clearly, organizations should be recognized as arenas where varied and meaningful action towards greater sustainability can originate.

To fully comprehend the possibilities and limitations of organizational engagement with sustainability requires a familiarity with management theory, a social science that examines organizations and organizing[6]. It is a 'big tent' academic enterprise, informed by psychology, sociology, economics and other disciplines[7]. Consequently, levels of analysis range from the micro — the individual inside the organization — to the macro — the way in which organizations interact with societies[8]. Researchers seek to understand a broad array of phenomena, including decision-making routines, innovation processes, forms of inter-organizational collaboration, modes of governance and gender diversity, to name but a very small number. Notably, these and other organizational phenomena are investigated as both independent and dependent variables, indicating researchers' interest in both their antecedents and their consequences.

From its earliest days, a primary research interest for management theory has been the structures, workflows and practices that promote efficiency and peak performance. In effect, management researchers often emulate engineers and model organizations after machines to provide guidance for managers on how to design and run them for optimal performance[9]. Management theory, however, is decidedly pluralistic, as opposed to paradigmatic[10]. Other approaches illuminate characteristics of organizations in a way that the machine model cannot[11]. Many researchers explore organizations as cultures or mini-societies, infused with values, norms and myths that are decidedly human and not mechanistic[12]. Some researchers conceptualize organizations as brains, drawing attention to information processing, decision-making and learning[13,14]. Yet another school of thought studies organizations according to principles of ecology. In it, researchers model differences in organizational forms as analogous to speciation, and examine how these species fit in organizational environments and what factors affect their survival[15]. Another approach equates organizations to political systems. Researchers in this stream explore power, control and interests at individual and group levels[16].

Common to most perspectives in management theory is their primary focus on the social aspects of organizing. Correspondingly, meager attention is paid to how organizations interact with physical and natural systems. The same is true for many organizations themselves. There are several reasons why both organizations and the researchers who study them often ignore sustainability. First, and most importantly, organizations — be they corporations, not-for-profits, government agencies or others — concurrently pursue multiple, and occasionally conflicting, goals, such as organizational survival, financial gain or some form of social impact. Sustainability may be one of them, but often it is not[17]. Second, organizations operate at different scales than sustainability challenges. Sustainability concerns are typically long-term and systemic, whereas organizations are generally oriented towards attaining short term, tractable goals such as producing a widget or providing a specific service[18]. Third, organizations tend to be particularly effective in domains where they are knowledgeable and over which they have control[19], whereas sustainability issues are not neatly bounded[20] and their complexity precludes full and complete comprehension.

Organizations and wicked problems

At first glance, this portrayal appears to provide meagre traction for orienting organizations toward sustainability in ways that are impactful. If organizations don't understand a problem, have little control over it and are not geared towards its resolution, how can they help solve it? In the context of natural resource management, theories of adaptive governance[21] and co-management[22] were developed to tackle precisely these types of situations. Adaptive management frameworks strive to reduce systemic uncertainties through diagnostic experimentation and hypothesis testing. Results from experiments inform subsequent rounds of policy formation in iterative 'plan–act–monitor–evaluate'[23] cycles, managed via carefully calibrated and inclusive governance arrangements. And yet, adaptive management implementations encounter obstacles in contexts that are highly uncertain, and particularly those enmeshed within social, political and institutional constraints[24]. In other words, when sustainability challenges present as multidimensional, wicked problems.

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Much has been written about wicked problems in management theory[25], natural resource management[26] and public administration and planning, where the term originated[27]. For social scientists, wicked problems are interesting not merely because they are intractable, but also because they are interpretive. Rittel and Webber, in their seminal article[27], captured this well: "The choice of explanation determines the nature of the problem's resolution". The climate crisis, for example, is understood by some to be a moral failure, by others to be a consequence of geopolitical deadlock and by yet others as a technological hurdle, with each explanation entailing divergent solutions[28]. Similarly, water can be understood contemporaneously as a human right, an economic good and a natural resource. None of these views is categorically incorrect — each conveys a kernel of truth — yet each also delineates a fundamentally different course of action. "Both the existence of a problem situation and its interpretation are human judgments."[29] Overall, for wicked problems, it is difficult for different actors to agree on the name and attributes of the problem that they are trying to solve, let alone agree on remedies.

Thinking of issues and systems in this 'soft'[30] way suggests that the managerial models we apply for sustainability are not so much objectively true as they are tools for making sense of reality and shaping the way we act. The way we understand problems is not merely descriptive; it delineates the solution space, and provides the language and coordinating mechanisms for addressing them[31,32]. Although this depiction might seem to be at odds with the 'hard' systems science of natural resource management, there is much to be gained by having the two approaches inform each other, mainly through closer examination of concepts such as emergence, resilience and scale.

Emergence

When managing, one's tendency is to impose hierarchy, knowledge and order[33]. In this idealized form of management, highly trained experts amass relevant expertise and, through analysis, prescribe optimal paths for attaining clearly specified outcomes. An exemplar is the Apollo programme, whose goals John F. Kennedy succinctly set forth in 1961: "Before this decade is out, of landing a man on the moon and returning him safely to the earth." An organization — the three-year-old NASA — was assigned the task and set about attaining the goal with best managerial practices, to great effect. The success of the Apollo programme makes it a common reference point for sustainability challenges, which seem to require the same level of urgency and resolve.

This managerial approach is the standard model taught in business schools today, for organizational problems large and small. Often forgotten is that this approach can also yield spectacular failure, as evinced by the Space Shuttle programme, particularly the horrific losses of Challenger in 1986 and Columbia in 2003, outcomes which suggest that the deliberate, hierarchical model of management can fail even in contexts to which it is ostensibly well-suited[34]. Similar failings of 'command and control' are well documented in the natural resource sciences[35]. More interestingly perhaps, in situ management in organizations is rarely enacted this way. Good managers realize that strategy and planning are not synonymous[36]. Often, they allow strategies to emerge as part and parcel of organizational members' efforts to solve pressing, quotidian problems, rather than through policy directives promulgated by the head office. Emergent strategy embraces bottom-up decision-making but is not synonymous; it entails the recognition of patterns and opportunities that become visible in unexpected ways[37,38]. Many actors are involved, anywhere in the organizational hierarchy or outside it, and they do not necessarily follow structured decision-making processes[39].

An instructive example is the emergence of wind turbine technology. The dominant design — slow-moving blades revolving around a horizontal axis — most emphatically did not originate through top-down planning and cutting-edge engineering expertise[40]. Rather, it evolved in Denmark over several decades beginning in the 1970s, in what can be described as a process of 'path creation'[41]. Several tradesmen in the Jutland peninsula, operating independently, began tinkering with a 1950s design, which had been developed and later scrapped by a Danish utility. Local farmers installed these small turbines for on-site use, enabling further innovation. As they began to receive positive press coverage and public interest in wind power grew, politicians began framing this novel technology as a way to promote energy independence. A national test and research centre was established, and it explicitly prioritized building bridges between existing knowledge communities rather than conducting ivory-tower research. A cluster of firms — including Vestas, Micon and Bonus — enacted a mix of competition, collaboration and risk sharing that led to industry growth. They identified international opportunities, and Danish exports increased dramatically, making the country a global leader in wind energy. This precise mix of bottom-up organization, technological bricolage, industry–government collaboration and managerial recognition of emergent opportunity could never have been predicted, let alone planned. Rather, managers and policymakers identified 'building blocks'[42] to success, perceived patterns, possibilities and intentions and created paths for pursuing them.

Resilience

In the sustainability sciences, resilience is used to describe the state of a system and measures its capacity to absorb change without altering fundamental properties[43]. Resilience is often a desirable attribute, supporting the vitality of ecosystems and their capacity to withstand degradation[44]. And yet, a system will also be resistant to change when in a less desirable state. Collapsed fisheries, degraded coral reefs and poverty traps are examples. The same is very much true of organizations and other social structures, which can get mired in inertial dynamics that make them unresponsive and uncompetitive — unhelpfully resilient. This is why 'change management' is such a difficult organizational endeavour.

To move people and organizations out of undesirable resilient states, typical remedies suggest that explaining the current situation and its shortcomings, articulating a vision for a better one and providing resources and guidance on how to transition will provide enough of an impetus to create such a shift. Change management processes in organizations proceed along this temporal sequence[45], highlighting the importance of a compelling vision to orient organizational strategy (for example, around sustainability[46]). These templates are founded upon the 'information deficit' model of action, which contends that lack of awareness and knowledge explain why people behave undesirably or illogically[47]. The model predicts that providing people with a convincing explanation about 'the' (singular, well-defined) problem will impel them to act to solve it. Yet, in the context of sustainability, it is becoming increasingly clear that resistance to change does not stem from ignorance. Rather, individuals prefer to interpret information and messages in ways that reinforce their cultural predispositions[48,49]. This tendency can keep organizations and individuals mired in a resilient state characterized by inertia and irresponsiveness.

In contrast, acknowledging the interpretive nature of sustainability challenges, and wicked problems more generally, suggests that there is not 'a' problem around which to build consensus and momentum. Rather, each of us frames our understanding of issues based on cultural underpinnings and value systems, which tend to be stable and resistant to scrutiny. This does not mean that people who are not interested in or aligned with scientific understandings of sustainability are indiscriminately opposed to it. Simply, certain narratives about sustainability do not resonate for them or inspire them to act. Hence, obtaining support obliquely[50] can be a more

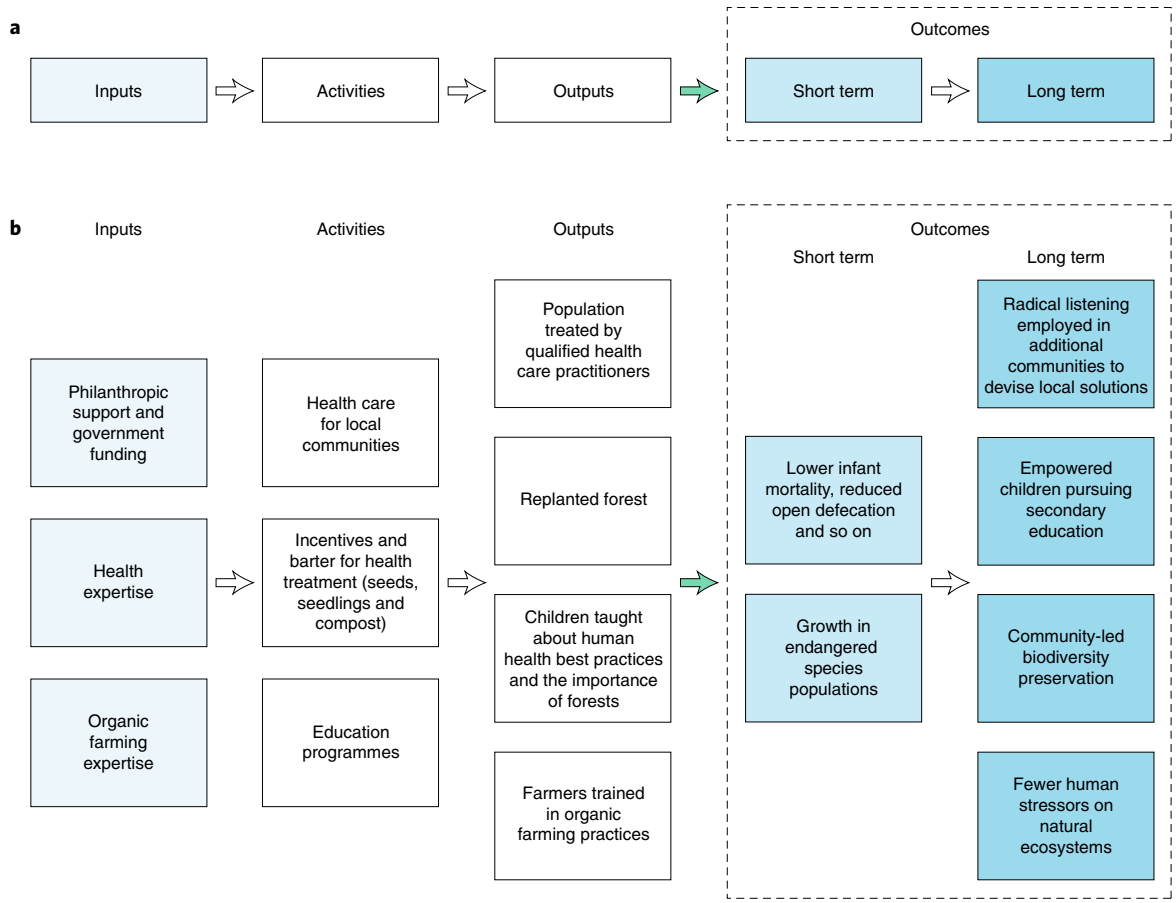

Fig. 1 | Logic goals. a, Stylized logic model. Darker shading indicates increasingly diffuse organizational control and influence. The green arrow indicates where leverage points should be sought. **b**, Logic model for habitat preservation in Indonesia, using information from ref. [67].

effective approach for enlisting people and organizations to engage with sustainability concerns.

This is the key insight behind the managerial concept of 'robust action': the accomplishment of short-term objectives while preserving long-term flexibility[51]. As befits its name, robust action is predicated upon action that is resilient, not systems[52]. Robust action recognizes that interpretations and understandings may differ, but do no not necessarily preclude common objectives. Indeed, a key feature of robust action is multivocality, a form of communication that permits audiences to make sense of meaning in more than one way[53]. Multivocality helps engage a variety of audiences and avoids contestation by not trying to teach, explain or convince. It mobilizes without asserting a coherent, complete worldview. Instead, it provides linguistic anchors and shared goals for individuals to latch on to, according to their distinct needs and values. Often, this approach yields strange bedfellows characterized by ideological incongruence[54]. Such alliances are found in Midwest American states, whose populations support renewable energy installations because they reduce energy costs and provide employment opportunities, even though the majority of residents in these 'red states' do not identify with the climate movement[55]. Similarly, although conservationists and conservatives have worldviews that are ideologically at odds, hunters and fishers, many of who lean conservative, can find common ground with conservationists on the issues of natural habitat preservation. Placing monetary value on ecosystem services produces a similar result, aligning the actions, but not the beliefs of supporters[56]. In all these contexts, agreeing is not an antecedent to doing. Rather, through interpretative flexibility[57], individuals and organizations find the fit between avenues for action and their belief systems.

Scale

Emergence allows many ideas to flower, but local, focused efforts will often be limited in their impact. As such, scaling up is perceived as crucial. A rule of thumb from management theory, however, is that strategies that are particularly effective in a specific context cannot be assured of success when replicated elsewhere. In particular, scaling up is hindered when cause and effect relationships are difficult to identify[58], which is perhaps the defining characteristic of complex systems and wicked problems. Usually, solutions that have proven themselves in a certain location are precisely those that have — through robust action and other forms of iterative learning — conformed to the unique contingencies in which they were conceived[59]. Any attempt to mimic such a solution in a different context inevitably requires adjustments[60]. This means that the exquisitely calibrated 'business model' that proved so effective in the original context must necessarily be altered as it expands. Such is the case of microfinance, which was pioneered in Bangladesh, but failed conspicuously when transplanted to India, Bosnia and elsewhere without much modification. In Bolivia, however, where it was re-envisioned, and not replicated in cookie-cutter fashion, microfinance has flourished[61].

Other efforts to scale emphasize scaling out, or expanding the scope of successful organizations — 'diversification' in management-speak. One example is Grameen, which has expanded from its roots as a microfinance organization to the telecom and food sectors, among others, with varying levels of success[62]. Diversification is notoriously difficult for the same reason that replication is: competence in one context is not easily transferable to others and additional layers of management typically reduce emergence and

Table 1 | Linking the 17 Sustainable Development Goals

Initiative	Goal	URL
SDG Compass	To provide guidance for companies on how they can align their strategies as well as measure and manage their contribution to the realization of the SDGs	https://sdgcompass.org
Sustainable Development Goals: Interlinkages and Indicators	To support policy integration for SDG implementation and monitoring by providing a practical tool on the analysis of the interlinkages between SDG targets	https://sdginterlinkages.iges.jp
Global Opportunity Explorer	To help business leaders, entrepreneurs and investors connect with new partners, projects and markets to foster more partnerships for the SDGs and a greener and fairer world by 2030	https://globalopportunityexplorer.org
Better Business, Better World	To bring together leaders from business, finance, civil society, labour and international organizations to map the economic opportunities available to business if the SDGs are achieved	http://www.businesscommission.org
SDG Interactions: from Science to Implementation	To identify the interactions between the various goals and targets, determining to what extent they reinforce or conflict with each other	https://www.icsu.org/publications/a-guide-to-sdg-interactions-from-science-to-implementation

agility[63]. Not without reason are organizations exhorted to stick to their knitting — their 'core competencies'[64,65].

Sustainability contexts may require us to think of scale in other ways, and in particular by identifying leverage points — "places within a complex system (a corporation, an economy, a living body, a city, an ecosystem) where a small shift in one thing can produce big changes in everything"[66]. Leverage can be attained by identifying and activating latent pathways between issues typically perceived as unrelated. For example, the non-profit partnership Health in Harmony, working with local non-profit ASRI (Alam Sehat Lestari), used a radical listening approach to understand what impelled rural populations in Indonesia to log critically endangered habitat[67]. They discovered that high medical costs were forcing people to turn to logging to pay for health care and that conventional agricultural practices were depleting the soil of nutrients, leading to slash-and-burn agriculture in the vicinity of natural parks. Consequently, the organizations began to offer low-cost health care and training in organic farming, thereby allowing residents to refrain from logging local forests for income. In a nutshell, the Health in Harmony model uses accessible heath care as a mechanism for preserving orangutan habitat.

In another NGO-led initiative, Gram Vikas works in Indian villages to improve water quality[68]. The organization emphasizes that clean water is attainable only if all community members agree to stop polluting water through open defecation. In fact, Gram Vikas refrains from implementing its programme in a village until each and every single household agrees to participate. When agreement is secured, Gram Vikas enforces a formal contract that binds all the village's residents to the programme and requires them to engage in direct dialogue with each other, regardless of class and gender. Meetings to discuss water and sanitation turn into a space for breaking taken-for-granted patterns of interaction. In essence, Gram Vikas strives to erode the caste system and fight inequality through community-wide dialogues about water.

The surprising nature of the linkages between disparate sustainability outcomes in these two examples highlights the key to their success. Such pathways to effectiveness are nearly impossible to plan, require intimate local knowledge and can most effectively be uncovered through emergence and nurtured through robust action.

Finding leverage

There are tools that can benefit managers intent on pursuing sustainability based on an appreciation of robust action and path creation. One such tool is logic modelling, which has proven effective for developing and evaluating public programmes and philanthropic efforts[69]. Logic models are a visualization of a causal chain that describes how specific resources are transformed into activities to produce desired results (see Fig. 1a). Logic models make an important distinction between outputs — the actual deliverables that an organization has control over (for example, health care services provided by Health in Harmony; Fig. 1b) — and outcomes — the desirable results that the organization believes its outputs will promote, at shorter and longer temporal scales (for example, growth in orangutan populations in the short term and biodiversity preservation in the long term; Fig. 1b). Similarly, consider an organization rolling out a technology that provides clean water to households in the global south. The number of litres of clean water provided is an output. The amount of time freed up for women and girls who would otherwise be fetching it is a short-term outcome, and likely long-term outcomes are higher levels of female education and stronger families and communities[70].

The value of logic models is that they force their designers and evaluators to explicitly identify leverage points: specific outputs that will generate meaningful outcomes. It is precisely at that interface where a more meaningful manifestation of scale can be realized, focusing on 'expanding impact' rather than 'becoming large'. Often, organizations look inward to identify opportunities for lowering their negative environmental impacts. Organizations might, in parallel, try to have greater positive impact by looking outward and thinking rigorously of the outcomes that they are producing. In particular, organizations should explore impact at scale not only via pathways of scaling-up but also by scaling-out, aspiring to be "catalysts of policy innovations and social capital, creators of programmatic knowledge that can be spun off and integrated into government and market institutions and builders of vibrant and diverse civil societies"[71].

Of course, logic models run the risk of oversimplifying cause and effect dynamics of complex adaptive systems. They may not capture the simultaneous efforts of multiple actors in a system and cannot anticipate emergent outcomes. Consequently, guidance for using logic models emphasizes robustness, meaning that they must be iterative and should evolve as organizational environments change and actual outputs and outcomes become available for analysis[72]. Researchers can endeavour to enrich logic models with agent-based capacities, in which each agent has a set of rules guiding their behaviour, to allow the models to generate outcomes that are difficult to otherwise foresee[73].

Additionally, researchers can explore the application of logic models at larger scales, even at the level of the United Nations' Sustainable Development Goals (SDGs). The seventeen SDGs are in effect a set of desired outcomes that equate with global

sustainability. The SDGs are systemic, meaning that together they constitute a network of interconnected issues[74,75]. Table 1 describes several thoughtful initiatives that engage deeply with the complex nature of the SDGs by mapping interlinkages, thereby identifying potential leverage points while at the same time uncovering trade-offs that may be necessary.

Consider food waste, one wicked problem where interlinkages among the SDGs can be generative. Food waste is explicitly listed under SDG12, which focuses on sustainable consumption and production patterns. Under SDG12, the desired outcome set forth in Target 12.3 is "By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses."[76] The UN estimates that food waste contributes to 3.5 Gt CO_2-equivalent of greenhouse gas emissions per year, and 3×10^{11} m of irrigated water loss[77]. Reducing food waste will therefore contribute to combating climate change (SDG13) and attaining water availability for all (SDG6). Through additional linkages in the food–water–energy nexus[78], reducing food waste will also help ensure healthy lives and promote well-being (SDG3) and contribute to halting land degradation and biodiversity loss (SDG15).

Efforts to reduce food waste must be attuned to local context, because the causes vary dramatically. A major driver of food waste in less-developed countries occurs in the post-harvest phase and is attributable to poor storage facilities, suggesting that effective outputs are likely to involve improved physical infrastructure[79]. In developed countries, however, roughly half of food losses occur much later in the value chain, at the consumption phase. Successful efforts in these countries are more likely to revolve around interventions such as changing societal norms and expectations regarding the appearance, provenance and consumption of food. Organizations strive to change societal norms all the time. They call it marketing, and are very good at it[80,81]. Norm transformation can have profound effects, giving rise to 'new ways of seeing', which can lead to profound systemic change[66]. New norms around the consumption of food can then be leveraged to other forms of consumption, or engagement with sustainability more broadly.

An experimenting society

Needless to say, sustainability's complexity implies that many initiatives employing sound logic models will inevitably fall short of creating meaningful impact. Given the likelihood of this outcome, it is worth remembering that a logic model is analogous to a hypothesis: if a programme is implemented, then certain results are expected to follow[72]. This is important because hypotheses are routinely falsified and not all experiments yield expected results, but the failure of specific experiments is part and parcel of the scientific enterprise, and defines its uneven progress. Of course, experiments in real-world change are not identical to controlled experiments conducted in labs. Yet, a more expansive definition of experimentation, which views managerial initiatives as activities conducted with an 'intent to learn', is a powerful idea in both the social[82] and ecosystem management[22,83] sciences. Fully embracing experimentation calls upon us to truly appreciate that sustainability concerns are wicked and that failures are in fact a good measure of effort and ambition. An 'experimenting society'[82] acknowledges that experimentation should be evolutionary and that from a probabilistic perspective, more variation and selection increases the likelihood that beneficial paths will be created. It recognizes that we cannot plot a direct course to sustainability and manage our way to that goal in the most-efficient manner possible, because such a course is at odds with how social systems function. A policy promoting ambitious experimentation will in some regards be similar to the venturing model that provides resources to an array of entrepreneurial organizations in information technology. This resilient model recognizes the difficulty of identifying winners when uncertainty prevails. It does not discountenance failure and at the same time emphasizes learning and adaptation[84,85].

Pursuit of sustainability through robust action is motivated by a belief that "through individual and collective experimentation … humans can learn to navigate their environments skillfully"[86]. Sustainability problems are daunting because they are complex, interpretive and multifaceted. Yet, at the very same time, complex, interpretive, multifaceted problems provide a multitude of entry points for tackling them, making them particularly suited to experimentation at all levels of scale and effort. A compendium of plausible experiments is Paul Hawken's 2017 book *Drawdown*[87], which set forth 100 solutions to global warming, based on peer-reviewed science. Their appeal lies in their systemic nature, all encompassing social, political and technological components. They are also remarkably diverse; among the top 10 are educating girls, reducing food waste and rooftop solar. Each of the 100 solutions is in effect both a business opportunity and a grand challenge[88,89]. Transforming them into reality entails experimenting with emergent ideas, the harnessing of diverse participants in robust action and thoughtful scaling. A more worthy application of management theory is hard to envision.

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References

1. Strike, V. M., Gao, J. & Bansal, P. Being good while being bad: social responsibility and the international diversification of US firms. *J. Int. Bus. Stud.* **37**, 850–862 (2006).
2. Banerjee, S. B. Corporate social responsibility: the good, the bad and the ugly. *Crit. Soc.* **34**, 51–79 (2008).
3. Fleming, T. & Zils, M. Toward a circular economy: Philips CEO Frans van Houten. *McKinsey Quarterly* (February 2014).
4. Stephens, J. C., Frumhoff, P. C. & Yona, L. The role of college and university faculty in the fossil fuel divestment movement. *Elem. Sci. Anth.* **6**, 41 (2018).
5. Boudet, H. et al. Effects of a behaviour change intervention for Girl Scouts on child and parent energy-saving behaviours. *Nat. Energy* **1**, 16091 (2016).
6. Hatch, M. J. *Organization Theory: Modern, Symbolic, and Postmodern Perspectives* (Oxford Univ. Press, 2018).
7. Scott, W. R. & Davis, G. F. *Organizations and Organizing: Rational, Natural and Open Systems Perspectives* (Routledge, 2015).
8. Tsoukas, H. & Knudsen, C. *The Oxford Handbook of Organization Theory* (Oxford Univ. Press, 2003).
9. Shenhav, Y. A. *Manufacturing Rationality: The Engineering Foundations of the Managerial Revolution* (Oxford Univ. Press, 2002).
10. Davis, G. F. Do theories of organizations progress? *Org. Res. Meth.* **13**, 690–709 (2010).
11. Morgan, G. *Images of Organization* (Sage, 1986).
12. Scott, W. R. *Institutions and Organizations* (Sage, 1995).
13. March, J. G. & Simon, H. A. *Organizations* (Wiley, 1958).
14. Argyris, C. & Schon, D. A. *Theory in Practice: Increasing Professional Effectiveness* (Jossey-Bass, 1974).
15. Hannan, M. T. & Freeman, J. The population ecology of organizations. *Am. J. Soc.* **82**, 929–964 (1977).
16. Pfeffer, J. & Salancik, G. *The External Control of Organizations* (Harper and Row, 1978).
17. Etzion, D. Research on organizations and the natural environment, 1992–present: a review. *J. Manag.* **33**, 637–664 (2007).
18. Bansal, P., Kim, A. & Wood, M. O. Hidden in plain sight: the importance of scale in organizations' attention to issues. *Acad. Man. Rev.* **43**, 217–241 (2018).
19. Williamson, O. E. Comparative economic organization: the analysis of discrete structural alternatives. *Admin. Sci. Q.* **36**, 269–296 (1991).
20. Ostrom, E. *Governing the Commons: The Evolution of Institutions for Collective Action* (Cambridge Univ. Press, 1990).
21. Folke, C., Hahn, T., Olsson, P. & Norberg, J. Adaptive governance of social-ecological systems. *Ann. Rev. Env. Res.* **30**, 441–473 (2005).
22. Berkes, F. Evolution of co-management: role of knowledge generation, bridging organizations and social learning. *J. Env. Manage.* **90**, 1692–1702 (2009).
23. Stankey, G. H., Clark, R. N. & Bormann, B. T. *Adaptive Management of Natural Resources: Theory, Concepts, and Management Institutions* Report PNW-GTR-654 (USDA, 2005).

24. Rist, L., Felton, A., Samuelsson, L., Sandström, C. & Rosvall, O. A new paradigm for adaptive management. *Ecol. Soc.* **18**, 63 (2013).
25. Edmondson, A. C. Wicked problem solvers. *Harvard Bus. Rev.* **94**, 52–59 (2016).
26. DeFries, R. & Nagendra, H. Ecosystem management as a wicked problem. *Science* **356**, 265–270 (2017).
27. Rittel, H. W. J. & Webber, M. M. Dilemmas in a general theory of planning. *Pol. Sci.* **4**, 155–169 (1973).
28. Verweij, M. et al. Clumsy solutions for a complex world: the case of climate change. *Public Admin.* **84**, 817–843 (2006).
29. Checkland, P. Soft systems methodology: a thirty year retrospective. *Sys. Res. Behav. Sci.* **17**, S11 (2000).
30. Checkland, P. *Systems Thinking, Systems Practice* (Wiley, 1981).
31. Weick, K. E., Sutcliffe, K. M. & Obstfeld, D. Organizing and the process of sensemaking. *Org. Sci.* **16**, 409–421 (2005).
32. Daft, R. L. & Weick, K. E. Toward a model of organizations as interpretation systems. *Acad. Man. Rev.* **9**, 284–295 (1984).
33. Simon, H. A. *Administrative Behavior* (Macmillan, 1947).
34. Vaughan, D. *The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA* (Univ. Chicago Press, 1997).
35. Holling, C. S. & Meffe, G. K. Command and control and the pathology of natural resource management. *Conserv. Biol.* **10**, 328–337 (1996).
36. Martin, R. L. The big lie of strategic planning. *Harvard Bus. Rev.* **92**, 3–8 (2014).
37. Mintzberg, H. & Waters, J. A. Of strategies, deliberate and emergent. *Strat. Man. J.* **6**, 257–272 (1985).
38. Mintzberg, H. Crafting strategy. *Harvard Bus. Rev.* **65**, 66–75 (1987).
39. Plowman, D. A. et al. Radical change accidentally: the emergence and amplification of small change. *Acad. Man. J.* **50**, 515–543 (2007).
40. Garud, R. & Karnøe, P. Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship. *Res. Pol.* **32**, 277–300 (2003).
41. Karnøe, P. & Garud, R. Path creation: co-creation of heterogeneous resources in the emergence of the Danish wind turbine cluster. *Eur. Plan. Stud.* **20**, 733–752 (2012).
42. Sabel, C. F. & Victor, D. G. Governing global problems under uncertainty: making bottom-up climate policy work. *Clim. Change* **144**, 15–27 (2015).
43. Holling, C. S. Resilience and stability of ecological systems. *Annu. Rev. Eco. Sys.* **4**, 1–23 (1973).
44. Biggs, R. et al. Toward principles for enhancing the resilience of ecosystem services. *Annu. Rev. Env. Res.* **37**, 421–448 (2012).
45. Stouten, J., Rousseau, D. M. & De Cremer, D. Successful organizational change: integrating the management practice and scholarly literatures. *Acad. Man. Ann.* **12**, 752–788 (2018).
46. Broman, G. I. & Robèrt, K.-H. A framework for strategic sustainable development. *J. Clean. Prod.* **140**, 17–31 (2017).
47. Pidgeon, N. & Fischhoff, B. The role of social and decision sciences in communicating uncertain climate risks. *Nat. Clim. Change* **1**, 35 (2011).
48. Nisbet, E. C., Cooper, K. E. & Garrett, R. K. The partisan brain: how dissonant science messages lead conservatives and liberals to (dis)trust science. *Ann. Amer. Acad. Polit. Soc. Sci.* **658**, 36–66 (2015).
49. Kahan, D. M. et al. The polarizing impact of science literacy and numeracy on perceived climate change risks. *Nat. Clim. Change* **2**, 732–735 (2012).
50. Kay, J. *Obliquity: Why Our Goals are Best Achieved Indirectly* (Profile Books, 2011).
51. Eccles, R. G. & Nohria, N. *Beyond the Hype: Rediscovering the Essence of Management* (Beard Books, 1992).
52. Ferraro, F., Etzion, D. & Gehman, J. Tackling grand challenges pragmatically: robust action revisited. *Org. Stud.* **36**, 363–390 (2015).
53. Padgett, J. F. & Ansell, C. K. Robust action and the rise of the Medici, 1400–1434. *Am. J. Soc.* **98**, 1259–1319 (1993).
54. Whittier, N. Rethinking coalitions: anti-pornography feminists, conservatives, and relationships between collaborative adversarial movements. *Soc. Prob.* **61**, 175–193 (2014).
55. Gillis, J. & Popovich, N. In Trump country, renewable energy is thriving. *New York Times* (6 June 2017).
56. Costello, C., Gaines, S. & Gerber, L. R. Conservation science: a market approach to saving the whales. *Nature* **481**, 139–140 (2012).
57. Pinch, T. J. & Bijker, W. E. The social construction of facts and artefacts: or how the sociology of science and the sociology of technology might benefit each other. *Soc. Stud. Sci.* **14**, 399–441 (1984).
58. Seelos, C. & Mair, J. Profitable business models and market creation in the context of deep poverty: a strategic view. *Acad. Man. Persp.* **21**, 49–63 (2007).
59. Duke, D. Why don't BOP ventures solve the environmental problems they initially set out to address? *Org. Env.* **29**, 508–528 (2016).
60. Ehrenstein, V. & Neyland, D. On scale work: evidential practices and global health interventions. *Econ. Soc.* **47**, 59–82 (2018).
61. Gonzalez-Vega, C. & Villafani-Ibarnegaray, M. in *The Handbook of Microfinance* (eds Armendáriz, B. & Labie, M.) 203–250 (World Scientific, 2011).
62. Yunus, M., Moingeon, B. & Lehmann-Ortega, L. Building social business models: lessons from the grameen experience. *Long Range Plan.* **43**, 308–325 (2010).
63. Mintzberg, H. *The Structuring of Organizations: A Synthesis of the Research* (Prentice-Hall, 1979).
64. Prahalad, C. K. & Hamel, G. The core competence of the corporation. *Harvard Bus. Rev.* **68**, 79–91 (1990).
65. Porter, M. E. From competitive advantage to corporate strategy. *Harvard Bus. Rev.* **65**, 43–59 (1987).
66. Meadows, D. H. Places to intervene in a system. *Whole Earth* **91**, 78–84 (1997).
67. Salisbury, C. Paying for health care with trees: A win-win for orangutans and communities. *Pacific Standard* (4 April 2017).
68. Mair, J., Wolf, M. & Seelos, C. Scaffolding: a process of transforming patterns of inequality in small-scale societies. *Acad. Man. J.* **59**, 2021–2044 (2016).
69. Poister, T. H. *Measuring Performance in Public and Nonprofit Organizations* (Jossey-Bass, 2003).
70. *The Water for Life Decade 2005–2015 and Beyond* (UN Water Decade Programme on Advocacy and Communication, 2015).
71. Uvin, P., Jain, P. S. & Brown, L. D. Think large and act small: toward a new paradigm for NGO scaling up. *World Dev.* **28**, 1409–1419 (2000).
72. McLaughlin, J. A. & Jordan, G. B. in *Handbook of Practical Program Evaluation* (eds Wholey, J. S., Hatry, H. P. & Newcomer, K. E.) 55–80 (2010).
73. Rogers, P. J. Using programme theory to evaluate complicated and complex aspects of interventions. *Evaluation* **14**, 29–48 (2008).
74. Weitz, N., Carlsen, H., Nilsson, M. & Skånberg, K. Towards systemic and contextual priority setting for implementing the 2030 Agenda. *Sust. Sci.* **13**, 531–548 (2018).
75. Le Blanc, D. Towards integration at last? The sustainable development goals as a network of targets. *Sust. Dev.* **23**, 176–187 (2015).
76. *Transforming our World: The 2030 Agenda for Sustainable Development* (UN, 2015).
77. *Food Wastage Footprint: Full Cost Accounting* (FAO, 2014).
78. Weitz, N., Nilsson, M. & Davis, M. A nexus approach to the post-2015 agenda: formulating integrated water, energy, and food SDGs. *SAIS Rev. Int. Aff.* **34**, 37–50 (2014).
79. Gustavsson, J., Cederberg, C. & Sonesson, U. *Global Food Losses and Food Waste* (FAO, 2011).
80. Wilkie, W. L. & Moore, E. S. Marketing's contributions to society. *J. Market.* **63**, 198–218 (1999).
81. Ewen, S. *Captains of Consciousness: Advertising and the Social Roots of the Consumer Culture* (McGraw-Hill, 1976).
82. Ansell, C. & Bartenberger, M. in *New Perspectives on Technology in Society: Experimentation Beyond the Laboratory* (eds van de Poel, I., Asveld, L. & Mehos, D. C.) 36–58 (Routledge, 2017).
83. Rist, L., Campbell, B. M. & Frost, P. Adaptive management: where are we now? *Env. Cons.* **40**, 5–18 (2013).
84. Gordon, A., Becerra, L. & Fressoli, M. Potentialities and constraints in the relation between social innovation and public policies: some lessons from South America. *Ecol. Soc.* **22**, 2 (2017).
85. Kemp, R. The Dutch energy transition approach. *Int. Econ. Econ. Pol.* **7**, 291–316 (2010).
86. Gross, N. Pragmatism and the study of large-scale social phenomena. *Theory Soc.* **47**, 87–111 (2018).
87. Hawken, P. *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming* (Penguin, 2017).
88. George, G., Howard-Grenville, J., Joshi, A. & Tihanyi, L. Understanding and tackling societal grand challenges through management research. *Acad. Man. J.* **59**, 1880–1895 (2016).
89. Reid, W. V. et al. Earth system science for global sustainability: grand challenges. *Science* **330**, 916–917 (2010).

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Competing interests

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Additional information