ENVIRONMENTAL RESEARCH
LETTERS

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To cite this article: Angela Wilkinson and Esther Eidinow 2008 *Environ. Res. Lett.* **3** 045017

Environ. Res. Lett. **3** (2008) 045017 (11pp) doi:10.1088/1748-9326/3/4/045017

Evolving practices in environmental scenarios: a new scenario typology

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Received 10 March 2008
Accepted for publication 20 August 2008
Published 15 December 2008
Online at stacks.iop.org/ERL/3/045017

Abstract

A new approach to scenarios focused on environmental concerns, changes and challenges, i.e. so-called 'environmental scenarios', is necessary if global environmental changes are to be more effectively appreciated and addressed through sustained and collaborative action.

On the basis of a comparison of previous approaches to global environmental scenarios and a review of existing scenario typologies, we propose a new scenario typology to help guide scenario-based interventions. This typology makes explicit the types of and/or the approaches to knowledge ('the epistemologies') which underpin a scenario approach.

Drawing on previous environmental scenario projects, we distinguish and describe two main types in this new typology: 'problem-focused' and 'actor-centric'. This leads in turn to our suggestion for a third type, which we call 'RIMA'—'reflexive interventionist or multi-agent based'. This approach to scenarios emphasizes the importance of the involvement of different epistemologies in a scenario-based process of action learning in the public interest. We suggest that, by combining the epistemologies apparent in the previous two types, this approach can create a more effective bridge between longer-term thinking and more immediate actions. Our description is aimed at scenario practitioners in general, as well as those who work with (environmental) scenarios that address global challenges.

Keywords: scenarios, planning, environment

1. Introduction and aims

It is understandable that environmental changes in the 21st century are considered to be one of the more significant challenges of modern civilization, given that failures to appreciate and address environmental changes in the past have resulted in the collapse of civilizations (Diamond 2005). However, whereas historical environmental changes were localized and tangible in nature, global environmental changes in the 21st century can be characterized by their seeming intractability, their impact across many scales (local–global) and their persistence. For example, global environmental changes are inextricably linked with social and technological changes. Addressing one aspect of change impacts the other two: technological change can exacerbate or restore environmental degradation, environmental degradation impacts social change, etc. For these reasons, some of those who work in the field of global environmental change, or related areas, view it as a 'wicked problem' (Rittel and Webber 1973)—and this is the perspective adopted by this paper.

Wicked problems are aggressive challenges that are both messy and circular. By messy, we mean that there is no definitive statement of a wicked problem. Instead the different perspectives of diverse stakeholders will result in contradictory definitions. Meanwhile, changing resources and political ramifications are constantly shifting the problem-solving context so that there are often competing solutions to any wicked problem. Possible solutions to any aspect of a wicked problem are likely to reveal or create an even more complex problem—this is the circular aspect of wicked problems.

Wicked problems do not lend themselves to well-bounded, linear problem-solving approaches, nor to the design of interventions based on historical and empirical evidence alone. Attempts to 'tame' wicked problems and identify simple solutions fail. These problems require approaches that

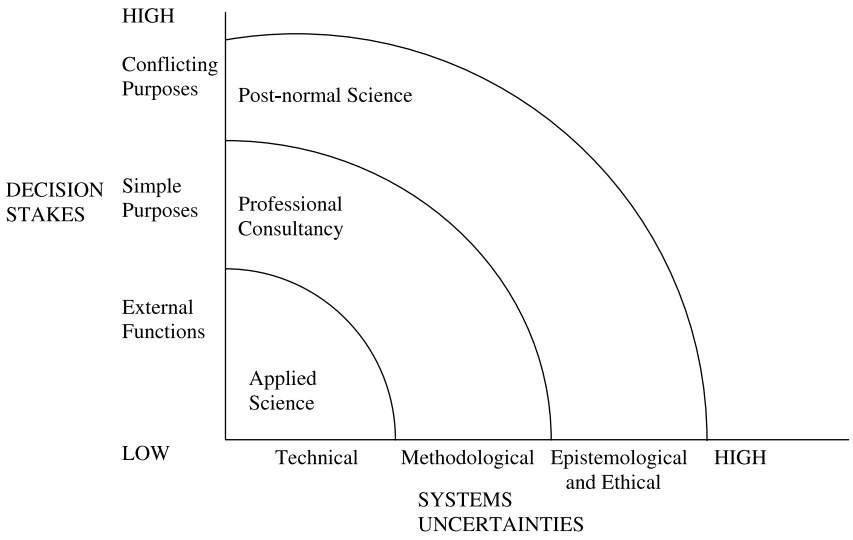

Figure 1. Increasing decision stakes and systems uncertainties create a new context for scenarios (based on a diagram by Funtowicz and Ravetz to illustrate the need for post-normal science).

enable collaboration across multiple geographical scales, using multiple types of knowledge. They are likely to require people to change both mindsets and behaviors. Uncertainty needs to be considered as more than a lack of knowledge, scientific or any other type. If we are to tackle wicked problems effectively, we need to pay attention to the co-evolution of different types of knowledge and ignorance. This is as important as questions of the scale (both temporal and geographical) of the problem, and the identification of its relevant stakeholders.

Global environmental changes are potentially too urgent and too 'wicked' to be resolved by conventional methods of scientific inquiry. Instead, we suggest, they demand the extended processes of a post-normal science methodology that reaches beyond the traditional scientific facts and experts into the wider communities affected by an issue (Funtowicz and Ravetz 1993). Figure 1 was originally used by Funtowicz and Ravetz to illustrate how post-normal science is needed, in addition to traditional scientific strategies, to deal with increasing systems uncertainty and decision stakes (Funtowicz and Ravetz 2001). We use it here to show how high decision stakes and high levels of uncertainty create the need for a new scenarios approach. In what follows we will describe a scenario approach that is appropriate and useful in this context.

The ability of groups and organizations to appreciate and take action in relation to 'wicked' environmental change and challenges can benefit from the anticipation of future possibilities. The messy present can be clarified by looking at it from two perspectives: from the past and from the future. But despite the persistence and proliferation of futures studies, methods and service providers, there is limited evidence supporting what works, when and why (Ramirez *et al* 2008). Many foresight activities, in particular scenarios, remain under-theorized. Anecdotal evidence suggests that environmental scenarios are produced with enthusiasm but deployed with limited effect. One explanation for this is that whilst the scenario literature makes explicit the methodological differences and similarities of various approaches, it tends to pay little attention to the underlying epistemological assumptions of different scenario approaches.

As we shall see in the next section, environmental scenarios practices can trace their lineages to different so-called 'schools' of scenarios (Bradfield *et al* 2005) and fall into two basic approaches. These approaches can be classified according to existing scenario typologies, variously organized around the aims of the approach (e.g. exploration, prediction, decision support), the methods involved (e.g. intuitive or formal modeling, inductive or deductive scenario building techniques, etc) and/or the worldviews of those building the scenario. However, these existing typologies pay little attention to wider, philosophical assumptions, e.g. ontological, epistemological, etc.

For scenario work to enable groups, organizations and societies to better appreciate and manage global environmental change, we suggest that practitioners and participants need to consider the wider philosophical assumptions of everyone involved. This should be part of the planning of any scenario project, as well as shaping its ongoing conduct. It is also important to try to take account of the philosophical assumptions of those who will be involved in the project's intended realization—that is, the implementation of policies intended to arise from the project—and this may include groups or individuals who are not directly participating in the scenario process itself.

With the aim of encouraging consideration of epistemologies in scenario processes, this paper introduces a new way of thinking about scenarios, in the context of a new scenario typology, and is primarily aimed at scenario practitioners and those who work with (environmental) scenarios that address global challenges. The new typology makes explicit the types of and/or the approaches to knowledge ('the epistemologies'), which underpin a scenario approach. Drawing on previous environmental scenario projects, we distinguish and describe two main types in this new typology: 'problem-focused' and 'actor-centric'. This leads in turn to our suggestion for a

third type, which we call 'RIMA'—'reflexive interventionist or multi-agent based'.

In the next section, we provide some context for this new typology by describing the nature and use of scenarios, and providing a brief overview of the development of approaches to scenario thinking and planning.

2. A brief history of scenario practices

A scenario is a story, describing potential future conditions and how they came about, produced for a variety of purposes, e.g. to enable sense making, to inform decision making. Scenarios have several characteristics that differentiate them from other futures practices, such as projections, predictions and forecasts. They are holistic (i.e. multi-dimensional); they are schematic; they come in sets of two or more; and they claim less confidence than other types of future statements (Parson *et al* 2007).

The discursive-analytical nature of scenario processes can help ensure attention is focused on different types of knowledge and uncertainty. This is particularly useful in the context of challenges that are too uncertain to be resolved by conventional methods of inquiry that depend on assimilating expert knowledge. Forecasting and modeling methods work with what is known and what is unknown. This can encompass 'what is likely', in terms of probabilities for example, but it is still essentially working in terms of the same basic dichotomy, which does not acknowledge the varied nature of 'knowledge'. In contrast, scenarios can help us to work with different kinds of knowledge, ignorance and uncertainty, for example, socially constructed ignorance or 'uncomfortable knowledge' (Rayner 2006), i.e. what others know about but cannot be known here/by us/in this country/organization.

The development of scenarios has been undertaken by intergovernmental and governmental agencies, think tanks, companies, and NGOs for almost half a century. During this time, a diversity of environmental scenario approaches (and resulting 'schools') have emerged. In what follows, we explain this by means of a brief historical overview. This is not intended to be a comprehensive history of scenarios, but to describe to the reader the different contexts in which the scenario approaches to be discussed in this paper have developed. We draw the reader's attention to the development of three main approaches to scenarios.

- Rational/objectivist, e.g. the cross trends impacts approach.
- Social constructivist, e.g. an approach inherited and developed by the Shell Intuitive Logics school of scenarios.
- Normative/deterministic, e.g. developed by the school of *La Prospective*.

We go on to discuss two different approaches to environmental scenarios—which will become the basis for the discussion of a new scenario approach.

By the mid-20th century forecasting, war gaming, scenarios and systems models were all flourishing. Today's environmental scenario practices can trace their origins from developments within different regions (e.g. US and Europe), different domains of practice (e.g. public and private sector), along with developments in other futures methods, such as systems modeling.

The development of scenario planning as a methodology for making public policy decisions probably started in the US, in the 1950s in the field of war game analysis. The Rand Corporation in the US became one center for scenario thinking, using this approach to help the US Dept of Defense grapple with the question of which weapons systems it should fund. Herman Kahn, who joined Rand as a physicist and mathematician and went on to become a renowned strategic thinker, explored the application of systems analysis and game theory to military strategy, in order to encourage 'thinking the unthinkable'. He later founded the Hudson Institute, where he used his methodologies for exploring the future of economics, politics and public policy questions. In 1967, he described how scenarios, '· · · serve to call attention, sometimes dramatically and persuasively, to the larger range of possibilities that must be considered in the analysis of the future · · ·. Scenarios are one way to force oneself and others to plunge into the unfamiliar and rapidly changing world of the present and the future' (Kahn *et al* 1967).

The US-centric activity gave rise to the so-called *Probabilistic, and Cross Trends Impacts* approach to scenarios which harnesses the promise of expanding computational power for calculating, simulation and modeling. Such approaches emphasize continuity with the past, identifying the most critical uncertainties. It approaches the future environment as an objective context, about which it is possible to collect sufficient and sufficiently exact information to create accurate scenarios.

Meanwhile, at about the same time, in France, Gaston Berger, a French Philosopher, was starting to use scenarios to explore the long-term political and social future of France. He founded the *Centre d'Etudes Prospectives*, and called his methodology *La Prospective*. This approach to scenarios was primarily normative, that is, scenarios were intended to provide a guiding vision of the future for policy makers to work towards and through which to harness the promise of scientific and technological progress in the service of humanity.

During the late 1960s and 1970s, these scenario-based approaches to planning continued to evolve and filter into the business community. Under Michel Godet, the school of *La Prospective* began to use a probabilistic approach to building scenarios for use in industry (Godet 2004a, 2004b). Meanwhile, influenced heavily by a combination of Kahn and eastern mysticism (Kleiner 1996), Pierre Wack, a planner at Shell Française, began to experiment with scenarios as a way to improve strategic planning in response to his concerns about the dependency on forecasting, which had became the dominant approach. He saw scenarios as a way to improve the attention of decision makers to systemic, environmental changes, eventually giving rise to the so-called *Intuitive Logics* approach. Peter Schwarz worked with Wack, went on to lead Shell's scenario planning team and became a celebrated futurologist himself. He explained that Wack's approach was aimed less at evoking the external environment and more at

enabling learning and unlearning by revealing and changing the mind-set of those within an organization (Dearlove 2002). This is intended to draw attention to the possibility of discontinuities (breaks with the past), exploring the importance of predetermined elements as well as critical uncertainties (van der Heijden 1996). It emphasizes the plausibility of the scenario set to the intended users, and stresses the importance of strategic conversation. Those creating and using the scenarios are encouraged to see themselves as part of the future—one of the elements shaping the environment as it evolves.

Scenario approaches have continued to evolve: during the 1970s they were widely adopted, and their use now seems to be increasing again (Bradfield *et al* 2005). Whilst there is no agreement as to why this might be, one explanation is that it is acceptable for key decision makers to attend to uncertainty, and even to recognize unpredictability. This concurs with an earlier observation by Pierre Wack that in the 1950s and 1960s, to admit uncertainty in management decision making and taking was regarded as 'incompetent' or 'unprofessional' (Wack 1985a, 1985b). Another explanation suggests that the more effective use of alternative futures methods, such as scenarios, has created a pronounced change in capacity for 'designing organizations and their internal processes from a command-and-control point of view to that of learning and responding to emerging elements in the environment' (van der Merwe 2008). The persistence and growth of scenarios has also been, we believe, shaped by the clear inadequacy of systems modeling when applied to wicked problems such as environmental change: for example, the Club of Rome's *Limits to Growth* (Meadows *et al* 1979).

Since then, theoretical analyses of scenarios have included how they affect organizational group-think and decision-making biases and enable organizational learning (De Geus 1997). More recently, scenario practices have been explored through the lens of social ecology. Their effectiveness has been explained in terms of their ability to shift strategy, at the organizational level, from notions of competition and the search for equilibrium and adaptation to strategy as continuous change, a search for emergence and improvisation and collaboration (Selsky and McCann 2008). However, there has been limited examination of how scenario thinking or planning works in contexts of multi-actor and inter-jurisdictional challenges, such as global environmental change.

2.1. Environmental scenarios

This paper takes 'global environmental scenarios' as referring to scenarios focused on environmental concerns, challenges and changes, e.g. water stress and shortages, climate change, ecosystem functioning, urban air quality, etc, that have significance on a 'global' scale, either common to several regions or relevant worldwide.

The different schools of scenario practices outlined in the previous section are reflected in the different approaches to global environmental scenarios. We suggest that they fall into two basic approaches.

- Approach 1: rests on an assumption that accuracy guides decision making and emphasizes the possibility of enhancing knowledge *about* the future. There is a bias towards empirical evidence: accuracy is largely determined in terms of fit within the range described by historical trends. Gaps in knowledge are resolved by building consensus around what is certain and uncertain. This approach assumes the role of the scenario builders as objective experts. The process of scenario building tends to put more stress on research and less on direct engagement with intended users. Decisions and decision makers tend to be excluded from the building process, although they may be consulted once the scenarios are built. The scenarios are the product of new learning. Examples of this approach are the suite of scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2000).
- Approach 2: involves a range of stakeholders involved in building scenarios that are specific to the context of a specific organization(s). It is designed to gather and utilize many different views on past and current trends in order to see the present situation more clearly. This approach emphasizes the role of plausibility of the scenarios in influencing decision making. The focus is the co-production of practical, rather than accurate, knowledge: creating scenarios as a basis for learning through strategic conversation. The WBCSD Water scenarios provide an example of this approach (WBCSD 2006).

We can describe these two approaches in terms of the relationship between systems uncertainties and decision making, mapping them as follows. The first approach places an emphasis on identifying technical knowledge, in a context in which facts will determine correct policy. The second approach describes a process of co-production as a basis for further learning, in a context in which strategy is a matter of adaptability.

These two approaches represent two conventional ways of thinking about knowledge (and its relationship to decision making for simple purposes). In figure 2 we illustrate how these scenario approaches relate to system uncertainties and decision stakes in a planning context.

3. Existing typologies of scenarios

There are an increasing number of typologies of scenarios. For example, the project goal characteristics delineated by van Notten *et al* (2003) in their updated scenario typology, include the inclusion of norms; vantage points; subject of scenario study; timescales and spatial scales. Process design characteristics, such as the nature of the data, or the nature of institutional conditions, are then discussed as a list of separate characteristics. This typology is helpful for cataloging scenarios in retrospect rather than as a way of thinking about scenario design, but the authors do express the wish that it 'will encourage scenario analysts to reflect on the scenario past and present with a view to improving scenario methodology' (van Notten *et al* 2003).

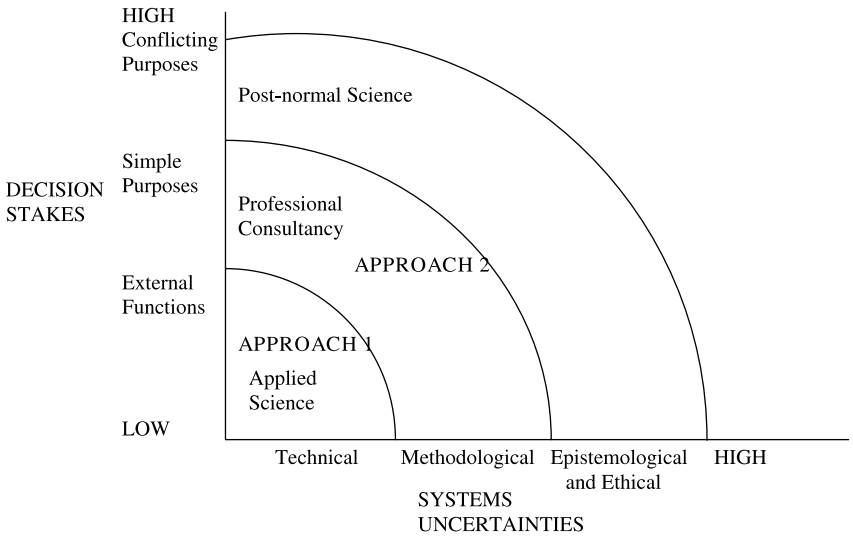

Figure 2. Existing scenario approaches and their relation to the context of decision stakes/uncertainty.

The identification of the motivation behind any scenario project appears to underpin the scenario typology described by Borjeson *et al* (2006), which reviews many other typologies before suggesting an alternative comprising three categories and six types. The categories arise from the kinds of question that a scenario user might use about the future: what will happen? What can happen? How can a specific target be reached? Each of these questions can be seen to evoke the motivation of a particular approach to scenarios.

For example, in this typology *What will happen? scenarios* lead to predictive scenarios, in effect, forecasts, which look at what will happen as the likely development occurs. By contrast, *What can happen? scenarios* are normative scenarios—concerned with achieving particular future objectives—which lead to preserving and transforming scenarios. *Preserving scenarios* are used when the target can be met within an existing structure, while *Transforming scenarios* feature a form of back-casting, asking what would need to be changed for the target futures to be achieved.

This typology makes an important distinction between scenario types and the techniques used for building them. The criteria suggested for selecting the desired type of scenario does include the type of information available (alongside the time-frame of the project, the system structure and whether the focus should be on internal or external factors, [736]), although this is limited to qualitative and quantitative data. There is also a brief but stimulating discussion of the importance of attitudes to different kinds of data. This paper notes that it is important to consider the user's worldview, perceptions and aims for the study' and adds that these 'can be even more important for the choice of approach', but suggests that different approaches to different types of knowledge will not pose a problem 'as long as the user is aware of it, and states the starting points of the study clearly'. It sees more problems inherent in tension 'between the aim and the perspectives on the possibilities of influencing the future and the possibilities of predicting the future' (Borjeson *et al* 2006)—that is, between desire to influence and the action necessary to achieve it.

Another typology introduces the archetype approach to categorizing scenarios, which identifies environmental scenarios according to the kinds of futures that they describe. Again, although these are categories made to describe scenarios *post-eventum*, they are, as Rothman notes, 'often used to guide the development of scenarios' (Rothman 2008). These can include some acknowledgment of epistemology, since they involve, more or less explicitly, assumptions about the nature and development of social attitudes and actions. Rothman (2008) observes how the Global Scenarios Group make such assumptions, and how these, in turn, are rooted in 'worldviews or myths defined by different schools of thought throughout history'.

Whilst any of the three typologies described above could be used to analyze existing global environmental scenarios, in none of them is there a suggestion that the project includes an explicit exploration of the intentions and epistemologies of the process or of the actors. In terms of the latter, most of the typologies do not mention the types of knowledge or approaches to knowledge that may be involved in a scenario process. As for the intentions behind constructing scenarios, the implicit assumption of the typologies seems to be that scenario projects are intended simply to structure and reduce uncertainty about future changes, by using the scenarios to develop a set of strategies that can provide an effective response to an event or events in that environment. The scenarios seem to be regarded as products of research, rather than as tools designed to function in particular sorts of inquiries.

4. A proposal for a new typology—and a new approach

The combination of the wickedness and urgency of global environmental concerns requires interventions that mobilize and sustain collaboration across different jurisdictions and worldviews. Scenario practices, with their emphasis on shared sense making, strategic conversation, narrative and

collaborative action can, we suggest, make a contribution to appreciating and addressing the challenges of global environmental change. However, this requires a revised approach to the process of scenario development: as well as paying attention to the question of who is involved and the need to maintain a requisite variety of worldviews throughout the process, it is essential to consider explicitly the aims, intentions and underlying epistemological assumptions of those participating in the process.

The emergence of a new generation of scenario thinkers, who take stock of different perspectives has been discussed elsewhere (Neumann and Overland 2004), as has the potential value of the scenario method as an effective method for bridging the gap between different epistemologies (Bennett and Zurek 2006). In what follows, we build on these ideas. Emphasizing the role of different epistemologies in the process, we describe not only a new typology to describe scenarios for tackling problems of public interest and concern, such as global environmental change, but also suggest a new approach to scenarios.

Our typology distinguishes three types of scenario approach used to build scenarios: they are 'problem-focused', 'actor-focused', and 'reflexive interventionist or multi-agent based'. (We provide an overview summary of the three approaches in table 1.)

4.1. Type 1: problem-focused scenarios

Image: setting out to create accurate maps of the future that will enable others to reach a destination as reliably and efficiently as possible.

Problem-focused scenarios tend to involve an approach to the environment that casts it, or some aspect of it, as an objective and quantifiable entity, divorced from the values judgments and impacts of actors or stakeholders. In essence, it involves the idea that the future is comprehensible and knowable. As a result, such approaches are generally conducted in the form of mode 1 research, which can be summarized as 'the pursuit of 'scientific truth' by 'scientists' (Huff 2000).

This is the form of knowledge production supported through the hierarchical infrastructures of traditional higher education and concepts such as 'sound science'. It involves experts working in particular disciplines to produce scholarly output that is validated by their peers. There is an assumption that accuracy guides decision making and a bias towards evidence-based research, with an emphasis on quantifiable data, rigor and excellence in a particular branch of learning. The epistemological philosophy underlying this approach is that it is possible to assemble a set of reliable facts that is built up through an inductive process of inquiry.

In the production of problem-focused scenarios, mode 1 research provides the reliable basis for the extrapolation of historical trends into alternative futures. Both the research and the scenarios it produces tend to focus on events in the environment, looking to describe clear (and in some instances, linear) chains of causality. This approach to futures research is well suited to the legalistic decision-making cultures associated with environmental policy making in the US, and the evidence-based culture of the UK. Dominant decision cultures establish an *a priori* bias towards what constitutes legitimate knowledge and evidence, while rational choice is taken to be the dominant logic in strategic decision making. As a result, even though practitioners involved in such scenarios acknowledge that facts do not determine correct policy, we suggest that the combined decision tool (i.e. scenario set) and decision context tend to conspire in an implicit assumption that more accurate and scientific knowledge about the future is essential to making better choices. The legitimacy of the scenarios depends on the accuracy of the formal modeling elements and the rigor of the evidence. These are illustrated by the problem-focused scenarios approaches deployed by IPCC.

4.1.1. IPCC special report on emissions scenarios (SRES).

The IPCC SRES (special report on environment scenarios; IPCC 2000) produced four storylines (describing socio-economic conditions) and used these as the basis to develop families of scenarios—in total, 40 scenarios were developed by six modeling teams. Six groups of scenarios were selected from across the families—and the IPCC chose an 'emissions scenarios' to represent each group. These emissions scenarios were then fed into climate models (general circulation models) to produce estimates of global average temperature increases and sea level change, and assess the associated impacts.

Such scenario building has been invaluable for enabling global, long-term outlooks (100 years plus, global average changes), with a strong focus on interdisciplinary research to deliver scientifically rigorous quantitative outputs. However, they are less valuable in translating this information into effective decision support tools. As the IPCC itself notes (IPCC 2000), the SRES emissions scenarios did not include any additional (explicit) policies or measures directed at reducing GHG sources and enhancing sinks, although they could be used as 'reference cases for the introduction of specific policy interventions and measures in new model runs that share the same specifications for the other principal driving forces of future emissions'.

The decision to work in this way was due in part to the uncertainties involved in translating global outlooks into more localized impacts, and difficulties in securing effective traction between such long-term possibilities and today's shorter-term decision-making horizons. Again, to quote from the IPCC report: 'Since the scenarios focus on the century timescale, tools are used that have been developed for this purpose. These tools are less suitable for the analysis of near-term developments, so this report does not intend to provide reliable projections for the near-term'.

Underlying these scenarios is the assumption that knowledge production and problem framing are and can be separated from decision making and problem-solving (a linear societal learning model). The projects were intended (more or less successfully) to provide input for a wide range of possible needs ('potential users vast, diverse, unidentified' (Parson *et al* 2007)), rather than enabling decisions or facilitating action from any particular group. The IPCC SRES process was intended to be 'more open', but this was still limited to those

Table 1. Summary and comparison of problem-focused, actor-centric scenario and reflexive interventionist, multi-agent-based types.

	Problem-focused	Actor-centric	RIMA
Focus	Objective	Specific to organization	Specific to 'wicked problems' that involve sustaining collaborative action in the public interest/common good
Foreground	Factors, and their continuity	Relationship of a system of actors to their strategic environment; discontinuity and predetermined elements	Interactions between agents and between agents and their common environment
View of environment	Objective and continuous	Causal and discontinuous	Causal and turbulent[a] environments
Research approach	Often mode 1	Often mode 2	Relevance and rigor
Approach to uncertainty	Mapping and reducing uncertainty. Emphasis on knowledge and ignorance as lack of knowledge	Mapping and embracing uncertainty. Also attending to social construction of ignorance (unknown–knowns)	Continuously navigating knowledge, uncertainty and ignorance as they co-evolve across society
Decision culture/context	Credibility of experts building scenarios Rigor	Representative of system of actors Relevance to mental models of intended users of scenarios	More effective rather than just more participation
	Accuracy of scenarios	Plausibility of scenarios	Plausibility across a requisite variety of worldviews
	Influence of evaluation on choice	Influence of interpretation on choice[b]	Procedural fairness
	Assumes problem framing and solving separable and separated Insights derived before use of scenarios	Assumes problem resolving rests on reframing current reality Insights enabled in use of scenarios	Usability of knowledge
Information context	Often biased towards quantitative analysis ad 'fit' with historical and empirical evidence	Emphasis on predetermined elements. Balance future possibilities with past (historical rooting) Often led by qualitative inquiry	Abundance of information, void or crisis of leadership and institutional capacity
Purpose	Contingency planning/risk management/'future-proofing'	Shaping the future	Mobilizing and sustaining collaboration in the public interest to enable institutional innovation and/or renewal
Strategy and innovation[c]	Strategy as 'agility'; innovation as 'exploitation'	Strategy as 'adaptability'; innovation as 'exploration'	Balancing/right timing for social innovation/change in terms of adapt and/versus agile, exploit and/versus explore
Scenario building method(s)	Usually deductive (see van der Heijden 1996)	Varies but usually a single method: inductive, deductive, or normative	Multiple: inductive and deductive and normative. Rapid prototyping via iteration
Storytelling	Stories of the future Often used to simplify/translate complex ideas into simpler concepts	Stories of the context of the scenario 'client(s)' i.e. intended users An effective mode of systems thinking and engagement	Not designed to be told but experimented with
Process	Usually one-off linear learning	Often sustained iterative—double loop learning	Sustained and iterative assumes need to attempt to change a system in order to understand it
Time matters	Single time horizon Emphasis on continuity of past and present	Single time horizon Anticipation of predetermined elements and discontinuities	Multiple time horizons Anticipation of predetermined and discontinuities
Emphasis of scenarios	Scenarios as a product, an output of new learning	Scenarios as a basis for strategic conversation learning process	Scenarios as a basis for unlearning as well as learning; scenarios need combining with other tools, e.g., weak signals/horizon scanning and early warning signs
Example scenario projects	MEA/IPCC	Shell/WBCSD	

[a] According to Emery and Trist (1965): 'causal texture theory' describes how systems try to survive in their environments in a sustainable way. A system and its environment co-evolve, mutually and systematically influencing each other. 'Turbulence' refers to a distinctive, field-based environmental texture in which links between elements in the environment of the system, which are independent of the system, are more salient, than those between the system and its environment.

[b] Weick *et al* (2005).

[c] March (1991).

working in the same field, with appropriate modeling skills. This affected attitudes to epistemological uncertainties, which were poorly addressed.

4.2. Type 2: actor-focused scenarios

Image: setting out on a journey and inviting the whole crew to help draw a map of the route that they need to take.

These are scenarios produced with a focus on the actors involved, and their relationship to the environment, drawing attention to their interpretation of events. The scenarios are used to shape organizational strategy, renewal and planning. The process of production of these scenarios tends towards a model of mode 2 research, which means that content is produced by heterarchical and cross-disciplinary groups, who are responding together to a perceived and transitory need. As a result, the bias of the data can be towards qualitative, rather than quantifiable evidence, turning on the interpretation of any particular input. But since knowledge is deemed to emerge primarily from the consensus of the group, this may result in the idea that debate is the most effective method for acquiring wisdom.

The WBCSD water scenarios provide an example of this type of global environmental change scenarios. Practitioners of this scenario approach, assume and explore a causal, strategic environment, rather than the environment *per se*, pulling in data from a wide variety of different sources, with the aim of enabling collaboration and action through a process of shared learning and the forging of a shared vocabulary for strategic conversation (Ramirez *et al* 2008).

4.2.1. World business council for sustainable development (WBCSD) water scenarios (WBCSD 2006). In this approach, the focus is on a 'strategic environment', i.e. the environment specific to a group of actors that will use the scenarios, and an assumption of 'causality', i.e. that the actor and its environment affect each other. The fundamental aim is to create a shared strategic language for thinking, talking about and shaping the future. This new vocabulary is essential to making collective action possible, by allowing individuals and groups to (re)align their understanding of the plausible future.

Similar to scenario building at Royal Dutch Shell, the WBCSD approach works with external drivers of change, but pays particular attention to the mental models of the scenario users. Scenario building starts by surfacing and mapping the 'intuitive logics' of the scenario 'clients' i.e. user organizations. Data and evidence is then deployed to provide challenging and usable strategic insights. These are derived by bringing the different possibilities of the future back to the present. The aim is to enable a re-perception of the current reality and help develop options for action.

The WBCSD water scenarios is an illustration of the actor-centric, 'intuitive logics' approach developed by Pierre Wack at Shell and applied to global environmental change scenarios. The set of scenarios were developed to reflect developments in the strategic landscape of a specified group of actors: 20 of the 170 companies comprising the Council. In an attempt to recognize the variety of mental models (or in this case different worldviews) on the role of business in water, the scenario building process involved almost 200 individuals drawn from business, government, intergovernmental and non-governmental organizations in a series of five workshops. In an attempt to address multi-scalar effects and identify issues of global and local relevance, workshops were held in Panama, China and Switzerland to develop regional scenarios before constructing a global scenario set.

There were multiple rounds of scenario building in each workshop, as well as two iterations of scenario building between different scales, i.e. regional-to-global scenario sets followed by global-to-regional scenario sets. The scenarios sets were also further refined during their initial use by the WBCSD member companies before being public communicated and any further engagement. Furthermore, the WBCSD invested in building capacity for using scenarios amongst their member companies in parallel with building the scenarios themselves, i.e. there was an assumption that not all organizations were predisposed to, or had experience with, scenario thinking and planning and furthermore might have a decision culture that would reject an intuitive logics approach to long-term, environmental research.

The WBCSD process, similar to that of Shell, began by exploring the worldview of the intended users of the scenarios and wider stakeholders involved in the process. In both cases, the key deliverables were not just a set of products (e.g. a scenario book) but rather a shared vocabulary and capacity for using scenarios in strategic conversation (van der Heijden 1996).

4.2.2. Looking forward: the continued evolution in environmental scenario practices. Both of these scenario-based approaches have strengths and limitations in their application to appreciating and addressing global environmental change and challenges. For example, the problem-focused approach with its implicit emphasis on rigorous analysis and knowable futures tends to focus the scenarios to 'known-knowns' and 'known-unknowns'. This approach struggles to incorporate and untangle the many context-based, qualitative and evolving, dimensions of a wicked problem. Furthermore, there is an implicit assumption of linear learning and decision making. Meanwhile, the actor-focused approach, although it encourages engagement with worldviews of scenario users in order to deliver usable knowledge, may under-attend to the diversity of worldviews that characterize environmental concerns.

4.3. Type 3: reflexive interventionist/multi-agent-based (RIMA) scenarios

Image: setting out on a journey in which environmental scenarios help to shape not only the route, but also the ship, its crew and the ocean itself.

This third and new approach aims both to bridge and enrich the first two approaches, recognizing uncertainty and variety in the processes and products of scenario building. In this approach, scenarios are a mode of action research: many forms of knowledge are sought—from

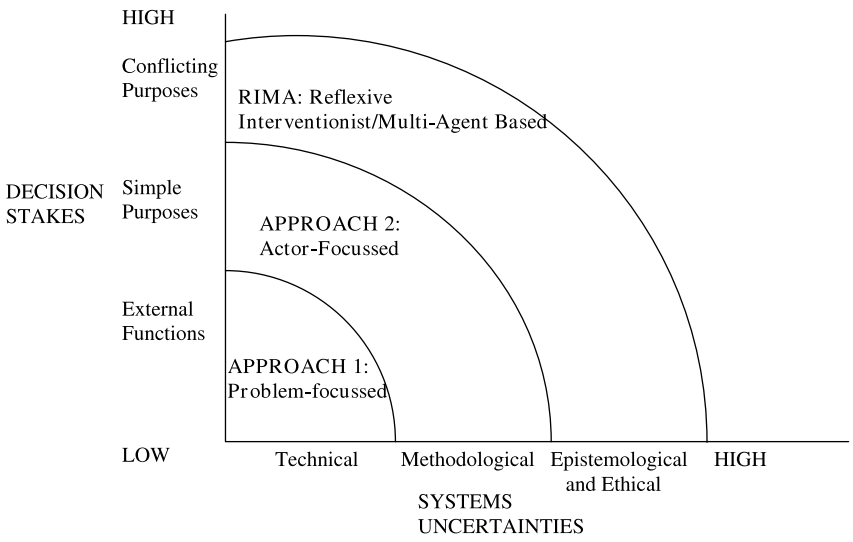

Figure 3. The reflexive interventionist/multi-agent-based ('RIMA') scenario approach in a context of increasing decision stakes/uncertainties.

explicit knowledge generated through formal modeling, to tacit local know-how, from quantitative data to qualitative input. Similarly, this approach necessitates clear descriptions of both the environment itself, and the relationships of many different actors to that environment, weighting each of those relationships equally, and acknowledging contradictions.

This third approach is substantially more than just a sum of these components. It does not seek to construct consensus around a single understanding of current reality, but acknowledges that knowledge is multiple, temporary and dependent on context—with different points of view providing a constant challenge to any existing viewpoint or system. This approach does not seek simply more participation, but to ensure that participation is more effective.

Where the first two processes are intended to help those involved anticipate and respond to future changes in their environments, the aim of this third approach is not responsive but creative. The metaphor that we used above to describe problem-focused and actor-centric projects described how we used maps to move through an environment, in the former case creating reliable maps that help us get to a destination as efficiently as possible; in the latter case, the participation of a group is essential in drawing maps. It is not a question of more maps, or more accurate mapping, but of the requisite variety in the set of maps and their plausibility to a range of worldviews that matters most.

In the third space, the metaphor of the map is still relevant, but our relationship to it has changed. Now the very act of map making itself is recognized as shaping the environment. Moreover, the scenario users are reflexive in their activities: prepared not only to change their route and destination, but also to remodel their ship and its crew. As this suggests, the methodology is iterative and may occur in parallel streams. The aim is not to produce definitive input that charts the continuity of past trends, nor to embark on a process of co-production in shaping what might happen. Instead, it seeks to change the participants' approach to future thinking, encouraging attendance to both what will catch up with us from the past (continuity) and what is coming at us from the future (possibility), and continually mobilizing and sustaining collaborative thinking and action. To this end, practitioners in this mode will supplement their scenario-based research method with other tools: 'early warning systems', used to track/monitor indications that any particular scenario is developing, a system to look for 'weak signals', in order to maintain vigilance to developments that fall outside the existing scenario set. The scenarios process is iterative and sustained, rather than a one-off event. The learning from each intervention informs the next round of scenario building. In effect, the scenarios become temporary scaffolding for an ongoing strategic conversation, establishing and re-establishing common ground amongst an evolving set of stakeholders, as the problem-context continues to evolve.

In figure 3 we revisit the previous diagram to show how the new scenario approach relates to system uncertainties and decision stakes, as well as previous scenario approaches, in a planning context. This new approach is intended to recognize and work with high systems uncertainties, epistemological and ethical, as well as methodological and technical. It is aimed at highly difficult decision-making contexts that involve conflicting perspectives and purposes.

We believe that this approach, although we describe it as new, in fact reproduces processes that already occur when groups of people try to create a future together. That is, each creates a scenario of the future, which the members of a group negotiate on the fly in order to create a shared future. If that is the case, then this approach can be considered a formalized and methodical way to collaborate around a process in which we all already participate.

One possible challenge of this approach is how to surface and involve all relevant worldviews, not only acknowledging multiple worldviews at the start of a project, but to find a way to involve them explicitly and sufficiently throughout the process (Elkington and Trisoglio 1996). Moreover, this needs to be done in a manner that avoids a polarization of perspectives

or the reduction of archetypes to stereotypes, and encourages learning between worldviews across different scales.

The authors imagine one way might be to design a series of processes—workshops, interviews, surveys, for example—occurring throughout a project, designed specifically to elicit different worldviews, followed by processes for disseminating and involving the information collected. This method would also allow for the inclusion of voices that might not be present among more directly involved participants. Such an approach demands not only time, which would need to be built into all stages of the project, but also new skills for hearing, recording and incorporating what could become overwhelming amounts of information.

We would like to suggest that scenario practitioners draw on other disciplines that explore different worldviews and have developed nuanced tools for their exploration. As a recent review of UK environmental scenarios (Eames and Skea 2002) notes, Cultural Theory may provide a basis for ensuring environmental scenarios contain sufficient diversity of worldviews (i.e. requisite variety) and that these interventions are powerful mechanisms for social learning and for anticipating surprise. In this respect, we propose there should be an experiment in global environmental scenario practices, involving the use of Cultural Theory to enable attention to 'more effective' rather than just 'more' public or stakeholder participation. Other elements of the proposed RIMA approach are listed in the right-hand side column of table 1.

Other than this initial suggestion, at this stage, the authors draw back from setting down specific methods and processes for this new approach. Our introduction of the RIMA scenario approach, is just that, an introduction: it is not intended to provide the definitive new methodology, but to start a crucial reflection and conversation among practitioners, scenario thinkers and users, about the wider epistemological assumptions underpinning global environmental scenarios and how these might affect the methods and effectiveness of their scenario-based interventions. How to do this is a matter for reflection and experiment: it may be that little is needed in terms of new processes or it may fundamentally alter existing procedures.

In the RIMA approach attention to analytical challenges in integrated assessments, such as scale effects, interdisciplinarily and stakeholder interests, is matched by attention to different types of knowledge and ignorance. Problem and context, knowledge and ignorance are recognized as co-evolving. We hope that consideration of the RIMA approach will better enable societies and organizations to navigate knowledge, ignorance and uncertainty, and to survive and flourish in the face of the wicked problems that characterize the 21st century.

Acknowledgments

We are grateful to Professor Rafael Ramirez and Dr Jerry Ravetz for sharing ideas and commenting on earlier drafts.

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