



A critical review of the application of environmental scenario exercises



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ABSTRACT

Scenario exercises have become instrumental across multiple fields, from their original usage in business and military planning, to being ubiquitous in environmental planning and policy formation. This article critically reviews whether there are explicit and imminent divisions between how scenario exercises are used and discussed, with particular focus on the literature of qualitative scenarios concerning environmental challenges. The authors interrogate what scenario exercises are in actual practice, in the context of what they are used for and how they are designed, before then considering the criteria for determining 'success' for a scenario exercise. The particular focus of the literature analysed is in the emergence of the discipline of 'environmental scenarios', being scenarios concerned with 21st Century environmental challenges such as the influence of climate change on the notion of natural hazards.

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1. Introduction

Scenario exercises have become instrumental across multiple fields, from their original usage in business and military planning (Lakoff, 2007), to being ubiquitous in environmental planning and policy formation. This article critically reviews whether there are explicit and imminent divisions between how scenario exercises are used and discussed, with particular focus on the literature of qualitative scenarios concerning environmental challenges. The authors question what scenario exercises are in actual practice, in the context of what they are used for and how they are designed, before then considering the criteria for determining 'success' for a scenario exercise. The particular focus of the literature analysed is in the emergence of the discipline of 'environmental scenarios', being scenarios concerned with 21st century environmental challenges such as the influence of climate change on the occurrence and consequences of natural hazard events.

The term 'scenario' has particular properties in the context of 'environmental scenarios', although the core criteria retain the earlier definitions of 'scenario' found in the broader literature (Börjeson, Höjer, Dreborg, Ekvall, & Finnveden, 2006; Bradfield, Wright, Burt, Cairns, & van der Heijden, 2005). The properties particular to 'environmental scenarios' have been most comprehensively determined by major multi-year, multi-governmental international projects about environmental challenges, as these organisations have established the main properties in order to conduct the scenario exercises for their projects. The United Nations Environment Programme's (UNEP) 3rd Global Environmental Outlook (GEO-3), for example, defines scenarios as 'descriptions of journeys to possible futures' which 'reflect different assumptions about how current

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trends will unfold, how critical uncertainties will play out and what new factors will come into play.' Furthermore, GEO-3 argues that 'it is now generally accepted that scenarios do not predict. Rather, they paint pictures of possible futures, and explore the differing outcomes that might result if basic assumptions are changed' (UNEP, 2002: 320). The UN's Millennium Ecosystem Assessment (2001–2005) added the additional criteria that scenarios should be 'plausible and often simplified descriptions of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces and relationships' (Carpenter, Pingali, Bennett, & Zurek, 2005). Similarly, the Intergovernmental Panel on Climate Change (IPCC) has placed an emphasis on the importance of coherency and plausibility, as it defines a scenario as 'a coherent, internally consistent and plausible description of a possible future state of the world.' The IPCC (2013) also aligns with UNEP's argument that 'scenarios do not predict,' as the former further defines a scenario as 'not a forecast; rather, each scenario is one alternative image of how the future can unfold'. A scenario would seem to be, on this account, a credible possible future; predictive, but not a prediction.

While these definitions clarify central tenets of 'scenarios,' they avoid defining the term once it is joined with its main associated terms: 'exercise', 'development' and 'analysis'. When 'scenario' is used in conjunction with these words the meaning becomes much less clear. Environmental scientist Joseph Alcamo, who has contributed more to disambiguating these terms than any other writer, reasons that this arises since 'scenario development is the discursive procedure by which a scenario or a set of scenarios is conceived, formulated, and elaborated' such that scenario development becomes synonymous with 'scenario building'. In relation to this distinction, he defines 'scenario analysis' as 'a broader concept encompassing both scenario development and the analysis of scenarios' whereby scenario analysis is 'a procedure covering the development of scenarios, comparison of scenario results, and evaluation of their consequences' (2008: 16). However, Alcamo himself nevertheless perpetuates the inconsistent terminology, arguing in one instance that since the terms 'scenario exercise' and 'scenario-based assessment' are often used interchangeably with 'scenario analysis,' the authors in the accompanying volume 'therefore use the three terms interchangeably' (2008: 16). Bishop, Hines, and Collins (2007) also found these persistent 'confusions' around such key terminology and techniques. In line with Alcamo, they argue that the three fundamental 'confusions' in the scenario literature stem from terms being used interchangeably: namely, equating 'scenario development' with 'scenario planning,' equating the term 'scenario' with 'alternative future,' and equating the terms 'methods' and 'techniques' (2007: 6).

The following paper synthesises a wide-ranging review conducted as part of an Australian research project funded by the Bushfire & Natural Hazards Cooperative Research Centre, a government-funded not-for-profit founded to explore the causes, consequences and mitigation of natural disasters (see Wodak, 2014). The project, 'Scientific Diversity, Scientific Uncertainty and Risk Mitigation Policy and Planning', explores the utilisation and management of scientific knowledges and scientific uncertainties in bushfire and flood risk mitigation practice in Australia (see Neale & Weir, 2015). Project researchers identified scenario exercises as an effective possible method to inquire into the knowledges and uncertainties of risk mitigation professionals. To complete this review, approximately 250 sources on scenario exercises, methodology, analysis, and design were reviewed, including from academic journals, white papers, grey literature, industry guidelines, governmental and NGO reports, training manuals and coursebooks. A mixture of highly practical and applied guidelines were incorporated into the analysis in conjunction with more theoretical academic articles. For instance, sources were collected through a review of the journals which extensive history in analysing scenario exercises, including from *Futures*, *Foresight*, *Environmental Modelling & Software*, *Environment & Planning*, and *Environmental Research Letters*. Case studies and projects discussed in these journals were then reviewed, to obtain more primary material on actual scenario exercises. These were then cross-referenced with NGO and governmental reports, drawing on the outreach dimensions of such projects, where formal reports were published as part of the respective projects, including self-reflexive reviews of the 'success' of their scenario exercises.

2. How are scenarios used?

To define the term 'scenarios' when conjoined with its associated terms 'exercise', 'development' and 'analysis' requires applying these terms to their context of actual practice. However, examining scenario practice reveals two broad meanings, defined by two dominant approaches to scenario exercises. In the first, scenario exercises involve the generation of predictive models of possible future events through quantitative analyses. Scenarios in such cases may be produced across levels of probability, as in Monte Carlo simulations, but always within parameters selected to give meaningful insight into the future. In the second, scenario exercises involve participants of various kinds responding to possible future events in order to pay attention to how knowledge of such futures is produced. The authors are here more concerned with this second meaning of 'scenario exercise'.

Exploring these terms in practice, there is broad consensus in the literature that there are two principal types of scenario exercises, comprising five specific subcategories of scenario exercise design. This does not imply that there are not alternate models and typologies, for instance Bishop et al. (2007) argue for the existence of 'eight general categories (types) of scenario techniques with two to three variations for each type, resulting in more than two dozen techniques overall' (2007: 10). While their typology presents a comprehensive overview of these 'more than two dozen techniques,' this article is principally concerned with the aforementioned two principal types of scenario exercises that emerge in the literature pertaining to 'environmental scenarios'.

The first type are categorised here as including Normative/Anticipatory methods (driven by an interest in the conditions required to get us to given end), Exploratory/Descriptive methods (driven by an interest in the consequences of a change in a given input) and Predictive methods (driven by an interest in the consequences of a specified event). The second type are categorised as Actor-focused and Reflexive Interventionist/Multi-Agent-Based (RIMA) methods. These are distinctively different, in that while they 'bridge and enrich' the Normative and Exploratory approaches to produce future forecasts (Wilkinson and Eidinow, 2008: 8), their predictive quality is fundamentally secondary. Their interest is foremost in who is involved, the forms of knowledge they employ, and how decisions are made within the scenario exercise. This investment in the socially produced character of knowledge and categories of thought bares striking parallels with the 'actor network theory' developed by French sociologist Bruno Latour (2005).

In reviewing these sources, we are now able to critically provide a synthetic account of how scenarios are used, as well as providing insights into the subsidiary questions of how scenario designers build a framing question, how scenarios are developed and how they should be run, including recommendations for how to design, coordinate, convene and facilitate scenarios.

2.1. Scenario framework

At the outset, a scenario is informed by framing questions, which determine the following stages of determining the type, narrative, form and function of a scenario. Framing questions can be presented as a series of related 'conflicts,' like those posed by Fahey & Randall (1998), which are resolved through an effective framing. In applying this approach to the framing of scenarios, Ratcliffe (2000: 13–14) suggests that framing questions concern where a scenario should be situated on the spectrum between the following eight binaries: present versus future; closed versus open-ended; grounded versus imaginative; intellectual versus emotional; advocacy versus dialogue; scepticism versus expertise; quantitative versus qualitative; and, probability versus plausibility.

The UNEP's (2007b) Training Manual on Integrated Environmental Assessment and Reporting ('IEA Training Manual') recommends one method to 'solve' these conflicts and determine where each scenario should be positioned on each scale, though it is nonetheless a prescription with contradictions.¹ Since defining the key issues is the most difficult and foundational question, this training manual offers four additional questions to clarify the key issues: (1) what are the key themes upon which the scenarios should focus; (2) what, if any, are the key targets and/or goals that should be considered in evaluating the scenarios; (3) what are the most useful indicators for describing the system of interest; which can help us to see if targets are being met; and, (4) what, if any, are the key policies we wish to explore as part of the scenario exercise (UNEP, 2007b: 24)? However, the combined answer to these four questions is made problematic by the caveat that 'there is no correct answer' as to which of these questions should actually be addressed first, if they should be done together, or if they should be taken separately on the basis that the four questions are best treated 'at the same stage' because they are 'intricately related' (UNEP, 2007b: 24).

The ambiguity of such scenario design recommendations is broadly representative of the wider ambiguity in the literature of scenario exercises. In light of this, the following section outlines the considerable variation in the literature around developing scenarios, principally in terms of when to bring participants or stakeholders into the process of designing and/or staging a scenario exercise, or even whether to bring them in at all. In line with the order of stages in the IEA Training Manual above, Alcamo also recommends that one 'establish [the] focal issue' as the first stage in scenario design. Importantly, he recommends this specifically for qualitative scenarios that intend to involve scenario exercise participants in the later stages of the scenario design. For this stage, Alcamo recommends phrasing the focal issue 'as a crisp and clear question' which can range from being as 'precise as a question requiring a yes/no decision' to 'as general as the exploration of an emerging issue' (2008: 24). In keeping with the intention to involve participants later on in the scenario design process, Alcamo recommends already interviewing the 'different parties having interests in the scenario exercise' to refine this focal issue question by incorporating their feedback. The subsequent stages are, in order: identify driving forces; label critical uncertainties; determine scenario logics; and, elaborate scenarios (2008: 24). In two articles on participatory scenario development, environmental planner Christian Albert (2008a, 2008b) advocates a similar pattern of steps based on his own use of Jager et al.'s (2007) 'simple framework of four main steps for developing scenarios.' The first step – 'Clarifying the Purpose and Structure of the Scenario Exercise' – consists of defining the scope and issue of the scenarios, selecting the stakeholders and participants, and identifying themes, targets, indicators, and potential policies. 'Laying the Foundations for the Scenarios,' the second step, is comprised of identifying the driving forces and critical uncertainties, and creating a scenario framework. Third, the 'Development and Testing of the Actual Scenarios' involves elaborating the scenario narratives, quantitative analysis, and an exploration of policy options. Finally, the fourth step of 'Communication and Outreach' requires researchers and participants to distribute their findings to other parties (Albert 2008a; Albert 2008b).

The persistence of ambiguity and variation in the literature on the four stages for defining the key issue is demonstrated by how Albert, in line with the IEA, also acknowledges that these four steps do 'not need to be carried out in this order and

¹ The IEA Training Manual is from the Integrated Environmental Assessment Training Manual series, by the International Institute for Sustainable Development and the UNEP. The stated aim of this highly practical document is to 'help you develop scenarios and analyse them, either in terms of the impact they would have on existing policies, or the kinds of policies that would be needed in order for a particular scenario to unfold' (2007: 1).

that some of the aspects may be forgone in particular scenario processes' (2008a: 5). To determine whether to go through the four stages outlined above in chronological or non-chronological order, environmental scientist Thomas Henrichs recommends another sorting method. This involves establishing the most appropriate approach out of three principal kinds of scenario development: deductive, inductive, and incremental. Deductive approaches to scenario development are the most linear of the three and can be broken down into four main stages: identifying the main concerns about future developments; discussing the main uncertainties, driving forces and actors that might be expected to shape future trends and their interactions, and thus identifying the underlying scenario logics; elaborating the actual scenarios; and, analysing the scenarios and their implications.

Only in the deductive approach does Henrichs actually advocate the linear or chronological progression through the four stages. In the alternative two approaches, Henrichs recommends iterative and non-linear development of the scenario. Inductive approaches, he argues, require similar steps as a deductive approach but apply a different method to developing scenario logics. Rather than systematically discussing and deducing driving forces, this variant of scenario development starts off by describing individual events or plot elements, and spins larger stories around these 'seeds'. This approach calls for a greater degree of creativity that may be difficult to structure, but may also result in more 'out-of-the-ordinary' scenarios and insights. Finally, there is the incremental approach, which Henrichs defines as built on expanding and questioning a 'reference scenario'. A reference scenario is the future that scenario developers really believe, either explicitly or implicitly, will occur. This is usually a relatively non-threatening scenario, featuring no surprising changes to the current environment. Then, following a Monte Carlo based method, alternative iterations of this reference scenario are explored by first identifying key threats to this pathway and varying those driving forces that appear most influential (Henrichs, 2007: 12). Select drivers can thus be tested both in regards to their influence on outputs and their relative importance to participants.

In a similar iterative process to the four-stage process as advocated by Alcamo and Albert, Mahmoud, Liu, Hartmann, Stewart, Wagener, Semmens, and Stewart (2009: 802) advocates 'a formal scenario development framework for use in environmental studies' although his process contains five stages. The order of steps broadly follows those above, moving from definition, to construction, analysis, and assessment. Mahmoud's additional stage is also the final stage, risk management, which he argues is critical. This judgement stems from his locating the ultimate responsibility for assessing the value and outcomes of scenarios not with 'the scientists involved in a scenario development study,' but rather primarily with decision-makers and stakeholders. This is because they are charged with 'the implementation of strategies for reducing vulnerabilities to risk, increasing resiliency to problematic conditions, and positioning resources to exploit opportunities' identified by and analysed through the exercise (2009: 804). Of course, Mahmoud et al. do not argue that stakeholders should be relegated to participation only in this final stage of the development process. Rather, they suggest that 'continuously involving stakeholders throughout the entire process can be important and desirable' due in part to their ability to provide feedback and insights during all phases of scenario development (2009: 802).

Uncertainty operates across the phases of Mahmoud et al.'s framework, as they maintain that it is an essential consideration in order to 'fully understand the implications of scenarios.' Due to the range of causes of uncertainty – such as lack of basic knowledge, errors in data, model structures, and model parameters, inadequacy in condition approximations, subjective judgment, inappropriate assumptions, ambiguously defined concepts, and errors in projections of human behaviour – they recommend that uncertainty is incorporated into the following three ways for his five-stage development framework. First, those in the scenario definition and scenario construction phases must *understand* uncertainty by considering what sources of uncertainty are to be included or excluded. For those in the second and third phases – scenario construction and scenario analysis – a primary task must be to *estimate* uncertainty, asking themselves about the magnitudes of the included uncertainties and their propagation from one phase of the scenario development process into another. In the final stages of scenario assessment and risk management, those involved should *communicate* uncertainty (2009: 807). How uncertainty can be effectively communicated to stakeholders and decision-makers is, itself, a matter of significant and extended debate amongst social scientists (see Fischhoff, 2012, 1995; Stirling, 2007).

2.2. Number of scenarios

In contrast to the intentional and unintentional ambiguities and inconsistencies which pervade the literature reviewed thus far, the literature is far more consistent and coherent with regard to determining how many scenarios should be used, and the details of their scope and scale. For planner John Ratcliffe, how scenarios explore distinct and plausible futures which may eventuate is consistently undermined in actual practice by limited scenario design. The limited design typically stems, he argues, from drafting several scenarios that are simply 'slight variations on the same theme', with the result that these often amount to a 'good', a 'bad', and an 'average' iteration, encouraging a latent tendency for participants to drift towards the middle and mistakenly 'treat it as the "most likely" single-point forecast' (2000: 12; see also James et al. 2015: 226). Alcamo acknowledges these same limitations, although he does not advocate a 'more-is-more' approach to the scale, number and duration of scenarios, on the basis that more options increases both the difficulty of communicating the scenarios and the effort and resources required for the exercise. In response, Alcamo both emphasises the relationship between the number of scenarios and 'the greater the variety of views and possibilities of the future that can be represented by the scenario set' (2008: 26), while also pressing for a trade off between the minimum and maximum number of possible scenarios, concluding in this regard that 'since these factors vary from project to project, no fixed number is recommended here' (2008: 26). However, the literature reveals that in practice, two to four scenarios is the most common compromise between these

constraints. Ratcliffe finds these numbers ‘sufficient to explore the possible futures within which decisions will have to be taken’ (2000:12). O’Brien, like Albert (2008a: 10), concurs that ‘current evidence suggests that two or four scenarios work well with any greater number leading to levels of complexity that potentially dampens engagement’ (2012: 3). Like Ratcliffe, O’Brien also cautions against using three scenarios as he finds that this number ‘inadvertently promotes the idea that the ‘middle’ scenario is the most likely most probable future’ (2012: 3).

2.3. Scale of scenarios

Importantly, the number of scenarios is also determined by their parameters or scale. Scale refers here to metaphorically ‘mapping’ issues and content from different temporal, spatial, and topical dimensions. Scale, in this instance, does not refer to mathematically scaling data, as that applies to quantitative scenarios, not the qualitative/narrative scenarios that are our concern here. For instance, is an environmental scenario generated from global climatic trends to be dealt with at a national, regional or local level? Will these scenarios contemplate the next ten or twenty years as a progression or simply focus on a bracketed year or years iteratively, such as 2025, 2035 and so on? Will they focus on one bounded environmental concern, such as wildfire risk to life and property, or a multiple and complex concern, such as climate change? To determine if and how scaling should be used, Alcamo (2008: 32) provides four criteria and the questions they raise for scaling in scenarios analysis. First, ‘purpose and potential users of the scenarios’ should be considered. What are the particular spatial and temporal scales of interest to the potential users of the scenarios? Second, the ‘factors/processes’ will guide development. Are the key relationships in the scenarios operating at a local, regional, national, or global scale? At which scale can the driving forces of the scenarios be influenced? At which scale do processes affect the scenario development? Third, ‘actors/institutions’ should be assessed. At which scale can institutions influence developments in the scenarios? At which scale do actors impact the developments analysed in the scenarios? Finally, ‘quantification/data availability’, meaning attending to the scale at which tools of analysis and modelling are available to quantify developments. At which scale is data collectable or available? Scenario design should be more productive and credible if guided by the intersections between these four aspects.

Unfortunately, there is little coverage of the issue of scaling in the literature. One reason this is a problem in the field is because, as the IEA Training Manual found, scaling is often predetermined in ways that are both problematic and difficult to resist. Scales are applied due to the common practice of using ‘existing scenario studies as the starting point for developing new scenarios,’ through which existing data from a prior and potentially separate project gets ‘scaled’ onto the new scenarios. One typical example of this practice, given by the IEA, is when a national scenario process builds on an international one, such as the UNEP Global Environment Outlook 4 (GEO-4) scenarios. What follows is that the main drivers of change identified in the global stories, such as those created for the GEO-4 scenarios, are assumed to be those most relevant and applicable to the new national-level scenarios. As a consequence, the IEA advises against using any existing scenarios, such as the GEO-4, because such scaling ‘might inhibit the recognition of other relevant signals of change, leaving the policy-maker vulnerable to developments that were not anticipated in the scenarios adopted’ (UNEP, 2007a: 20–21). Nonetheless, borrowed scaling in scenario design is a common fix to the widespread problem of limited resources and time. Such scaling was used by Ratcliffe in several of his scenario exercises, for example, such that ‘existing scenarios prepared for previous projects were employed, sometimes with slight reorientation’ (2012: 29).

To minimise this vulnerability caused by scaling, Alcamo (2008: 33) recommends that scenario developers should keep scaling methods as simple as possible and ‘make scale implications and restrictions as transparent as possible to scenario users’ as this will facilitate scenario users being able ‘to interpret or reinterpret scenarios at the scale they are most interested in’. He further advises including an explicit definition of procedures and an analysis of the possible drawbacks of the given scaling process. For Alcamo (2008: 33), clearly communicating this scaling process creates four additional requirements for those publishing their findings. First, and most critically, developers should note in scenario storylines where scale implications may affect scenario outcomes, as this is a necessary limit in any instance; second, they should provide detailed descriptions of the methodologies used to transform information between different scales; third, they should report the scale of the original data/information used in the scenarios; and, fourth, they should endeavour to graphically present overviews of major linkages between scales.

2.4. Scenario participation

Alcamo’s edict here – to make the implications and restrictions of scale as transparent as possible – highlights the challenges for such transparency of the ‘process’ (scenario development) and ‘product’ (scenario staging) to what he and others term as ‘scenario users’, a category which arguably should include participants. Such transparency is widely held to be instrumental in forming scenarios which are credible, salient, and legitimate in the eyes of participants (see Albert, 2008: 10; Henrichs, 2007: 31; Rounsevell and Metzger, 2010: 614). At the centre of such transparency is whether participants are incorporated into the scenario process *as well as* its ‘product’, and if so, how this should be done. The motivation that Alcamo draws attention to, that of enhancing the legitimacy and impact of scenarios, is common to scenarios whether they involve a great deal of stakeholder participation, or little or no participation. The motivation to achieve these qualities is all the more pronounced in environmental scenarios, where the aim is more likely to be to inform policy or change practice in response to environmental challenges; a ‘deeper level of involvement is necessary’ if the aim is plan strategically for a nation or region’s

future, in part to enhance the legitimacy and impact of the enterprise (Alcamo, 2008: 28).² Reed accounts for the qualities that motivate stakeholder participation in environmental scenarios as stemming from how environmental problems are typically complex, uncertain, multi-scale and affect multiple actors and agencies. Meeting the challenge of such problems requires transparency in decision-making which is, at the same time, flexible to changing circumstances and receptive to a diversity of knowledges and values. As such, stakeholder participation is increasingly being sought and embedded into environmental decision-making processes, across different geographic scales, to meet a variety of ends. As Reed notes (2008: 2418), the widespread acceptance and promotion of participation is driven not only by thinking regarding the complexity of environmental problems, and the need for politically and socially sustainable responses, but also by pragmatic considerations such as the increasing public scepticism about environmental science, increasing public interest in environmental decisions, and the rearticulation of stakeholder participation as a kind of democratic right (see: Alexander, 2000; Cleaver, 2001; Wright and Cairns, 2011).

In the context of this widespread desire for transparency and impact, Reed (2008: 2426) proposes seven principles for stakeholder participation, centred around equity, trust and learning between participant–participant and participant–facilitator. He places the skillset of the facilitator(s) as being integral to establishing and maintaining these principles, but does not address the issue of whether there can be too much participation expected, or required, of stakeholders. Alcamo addresses this issue, in arguing that the first consideration in determining stakeholder participation is for the scenario designers to decide the most suitable manner of stakeholder participation. This ranges from the ‘weakest form’ of participation, wherein stakeholders are ‘users’ limited to being provided with the findings of the scenario exercise, to a ‘middle-level’ consultative process of engagement in the scenario exercise itself and, finally, to being ‘actual participants’ in the scenario exercise to the extent that they ‘co-produce’ them, contributing to scenario design and providing input to scenario development and comments on the final results (2008: 27).

However, reflections from scenario designers who have incorporated Alcamo’s tiers of stakeholder participation into their designs have found that stakeholder participation was fraught with difficulties (for parallels in policy planning see Hajer and Wagenaar, 2003; Healey, 2006a,b). One such instance, outlined by Ratcliffe (2002), centred on twelve scenario exercises conducted on built environment futures. The ‘middle-level’ of participation was used in two of the scenario projects, while the other ten utilised the favoured ‘low-level’ of participation within a process completed by a small in-house project team of three or four, with one person, the researcher, remaining ultimately responsible for the final product (2002: 29). For the two ‘middle-level’ exercises, Ratcliffe writes, the scenario ‘story-lines’ were written up by a professional journalist who had been present during group meetings and workshops concerned with the previous stages. In these two instances, an iterative process was developed wherein the participants identified the scenario logics of three or four different futures, alternative draft scenarios were then written-up by the journalist, and then these were circulated back to the group for discussion, amendment and refinement. This was repeated twice in both cases. Collaborative in design, this process actually gave rise to considerable contention, and, at times, open conflict. In one study it almost led to a breakdown of the process (2002: 29).

To minimise the likelihood of such divisive situations, Alcamo recommends a careful screening process when selecting stakeholders, attentive to their respective institutional ties and the interests of these institutions, as well as of their personal backgrounds and, importantly, their ‘potential unwillingness to be open to new and unexpected outcomes’ (2008: 28). He argues that participant selection should be guided by considerations of their function, scale and network. That is, first, what function will the stakeholders have and what role do they play in decision-making, planning, or other aspects of the issue being analysed? Second, what scale are they interested in and what is their sphere of concern and influence with regard to the issue analysed? Third, and finally, which group do they belong to and are they part of a particular thematic or political network? Once these criteria have been worked through, Alcamo advocates clearly defining the roles of stakeholders and the ownership of the final scenarios, ensuring transparency with stakeholders (2008: 28). There are, of course, possible objections to such screening. It might be argued, for instance, that actively defusing the tensions of a given context will compromise the process, or, alternately, that some bias in participant selection is inevitable. It is quite possible that too much screening by practitioners would hinder stakeholders’ ability to feel they are co-creators and co-owners in the scenario process.

Angela Wilkinson and Esther Eidinow see the broader issue of collective ‘ownership’ as requiring practitioners and participants to ‘consider the wider philosophical assumptions of everyone involved’. They argue that this consideration, addressed by both practitioners and participants, ought to be part of the planning and conduct of any scenario project, carrying through to ‘the implementation of policies intended to arise from the project’ (2008: 2). George Wright and George Cairns suggest that this may occur through guiding the participants’ involvement prior to, during, and following the scenario exercise for two different scenario types. For a ‘basic level’ scenario, such as a one-day exercise to explore the ‘limits of possibility’ for a known and predetermined uncertainty, they recommend that participants be asked to ‘do homework’ or

² Participation, Alcamo states (2008: 27), can also help scenario developers ‘tap into the expertise and creativity of stakeholders or experts that would otherwise not directly contribute to the scenario exercise. Moreover, involving stakeholders can guide emergent (social) learning processes within public, research or policy communities. Yet involving stakeholders in scenario analysis can also complicate the scenario development process. In particular, broad participation is complicated and time-consuming. Also, scenario developers should be mindful of the motivation of stakeholders’ in participating in the scenario exercise; under some circumstances the scenarios could become biased towards the particular interests of the stakeholders’.

undertake some reading on the issue that will form the focus of the event (2011: 26). For a more complex scenario, where much less is known about what the key issue is or how it will be addressed in the scenario, they recommend more in-depth prior investigation including conducting a series of preliminary semi-structured interviews with key decision-making, power-holding and directly-affected stakeholders (see also James et al., 2015). Such interviews will provide an opportunity for researchers to consider the degree of convergence and divergence of scales and concerns amongst these key individuals. 'The degree of such agreement or diversity,' Wright and Cairns state, can provide initial insight into largely predetermined issues and critical uncertainties prior to the scenario commencing (2011: 27). Content analysis of the interviews can not only inform the topics and themes of the scenario exercises, it can also be collated into an anonymised report (that is, with no attributions to statements) which is then provided to participants before the scenario sessions to debrief them on what the scenario sessions will concern in detail. This more complex scenario clearly places much higher demands on participants while also offering higher prospective 'ownership' of the scenarios and their content.

2.5. Scenario facilitation

Alternately, the literature offers little guidance of its own on the actual facilitation of scenarios exercises, typically drawing heavily on works devoted to focus group facilitation. In this latter field, the dominant approaches are the essentialist and social constructionist methods led by one facilitator. Following Millward (2012: 418–9; 428), the essentialist method requires the facilitator to take 'control over what is discussed as well as how it is discussed,' in contrast to social constructionist method, which prioritises 'skilful facilitation of the group dynamic' over the relevance of the discussion. As the object of focus groups is, as Millward notes, the production of verbal data from participants reflecting attitudes and beliefs, the question becomes one of the ideal questions to elicit 'accurate' data. Addressing these two methods, Morgan (1997: 39–40) summarises each as a response to the trade-off between direct responses to researchers' interests and the ability to be sure these interests matter to participants. At a less general level, several scenario exercise authors make specific suggestions regarding the inclusion of other actors – particularly experts, scientists and stakeholders with a deep understanding of aspects of the issue (e.g. Alcamo, 2008: 27) – who might be included without being participants, providing feedback on group responses. Others' specific suggestions include having three non-participants in any scenario exercise, including a facilitator or 'chair', a 'scribe' to be responsible for documents, paperwork and writing up participants' ideas and responses, and a timekeeper to keep the process flowing in accordance with an agreed timetable (James et al., 2015: 217; Wright and Cairns, 2011: 24–25).

2.6. The 'element of surprise'

One final consideration is the under-acknowledged use of what Alcamo calls the 'element of surprise' in scenario exercises. Some modicum of surprise is necessarily part of any scenario exercise, not only because they concern potential, and inherently unknowable futures, but also because they are about exploring 'known-knowns', 'known-unknowns' and, ideally, 'unknown-knowns.' Optimally, a scenario exercise will not simply reproduce existing forms of knowledge and practice and, as such, those with a flexible or partly flexible structure will have an enhanced capacity to approximate the inherent unpredictability of the future and to provide opportunities for spontaneity and improvisation. But, while Alcamo sees these potentialities as resolutely positive, he and others (e.g. van Asselt, van't Klooster, van Notten, & Smits, 2012; van Notten et al., 2005) have found that surprises are usually omitted from scenario design and results. In a study of 25 scenario projects, van Asselt et al. (2012: 119–133) found that most specifically excluded surprises – sometimes called 'wild cards' or 'contingent events' (Mendonça, e Cunha, Kaivo-Oja, & Ruff, 2004) – while the majority of the 11 that did allow for them included no specific criteria or method for selecting or integrating them.

These authors attribute the tendency to exclude or elide surprises to several factors. First, the desires of scenario developers to maintain the credibility of their exercises may lead to the excision of claims or assumptions that might be, or might be perceived to be, contentious; it is possible that including surprises may alienate participants or users. Second, as van Asselt et al. note (2012: 126), the innate conservatism of governance organisations can often preclude any attention to events or influences outside historic trends. Third, participants and developers alike frequently request 'surprise-free' scenarios, given not only the latent difficulty of developing responses or policies for a surprise-free future but, also, that the given system may have a comparatively narrow thematic or temporal scope (Alcamo, 2008: 30). Whether they emerge from unexpected discrete events, trend discontinuities, or the sudden emergence of new information (see Ayres, 2000), surprises are a significant departure from the past and, therefore, necessarily challenge the historicist premises of scenario design (Marien, 2002).

Surveying the literature, van Asselt et al. (2012: 126–7) suggest that the three prevailing approaches to incorporating surprises are: to place them in parallel to a preferred or 'most likely' scenario; to use them as the trigger for a scenario; or, to introduce them partway through a scenario. Like others, Alexander (2000) is adamant that surprises are integral to anticipating possible futures, offering several suggestions as to how the preference for 'surprise-free' scenarios might be reconciled with the intrinsic benefit of addressing and encountering discontinuities. Exercise facilitation might therefore involve the use of updates to discussants, introducing chance factors, altering the speed or intensity of impacts, or providing critical information previously withheld in order to 'boost the discussion or alter participants' views of the developing situation. Such a reconciliation is, he notes (2000: 93), particularly necessary in scenario exercises involving emergency

management, where decisions involve great uncertainty, very limited time constraints, and the piecemeal arrival of essential information. Scenario exercises that mimic the conditions of operational or practical decision-making are, as such, a synthesis of simulation, training and testing.

The issue of surprises goes to the heart of the purpose of scenario exercises and the criteria by which they might be deemed successful in any one instance (Berkhout, Hertin, & Jordan, 2002: 8). So: are surprises 'good' for scenario exercises? The question of whose interests, preferences and ends take priority in scenario exercises is a difficult question, often unresolved or unacknowledged in the literature. This is not to suggest that interests, preferences and ends amongst participants or amongst participants and scenario developers will necessarily diverge, but that we should not assume that they necessarily converge. As the following section argues, interests, preferences and ends may be expected to diverge to the extent that these groups differ in their ideas about what constitutes a credible possible future and how they are best generated.

3. Evaluating scenarios

As Henrichs concludes (2007: 30), just as it is difficult to establish a standard recipe for success in developing and staging scenario exercises, it is equally difficult to determine and measure success in terms of results. Is it necessary or sufficient for scenarios to have triggered active discussions during the exercise, or do these discussions have to lead to lasting changes in perceptions and behaviours which are much harder to quantify? Is it necessary or sufficient for scenarios to lead participants to state that it has raised new issues to be implemented, or do practices such as decision-making and conflict resolution processes have to explicitly change? Over what time scale might these various measures attempt to quantify success?

Reviewing a wide array of scenario exercise literature, it is evident that no uniform system of measurement or recommendations exists. In their critical review of evaluating the 'success' of climate change scenarios, Hulme and Dessai (2008) assert that this notable inconsistency in measurement and absence of definitive recommendations stems from how climate scenarios have been evaluated as 'products' rather than "the procedural aspects of their creation", and, furthermore, that "much greater attention" has been placed on evaluating their procedural aspects than "the evaluation of the 'success' of the ensuing scenarios" (2008: 2). Given they define scenarios "as, primarily, processes of shared enquiry and mutual learning," (2008: 4) this differentiation between scenarios as *products* versus *processes* thus becomes critical for formulating criteria for determining success.

Within this context there are some general trends emerging in the literature, the most widely evident being the support for 'good scientific practice' as a measure of success. This is the primary aspect of the more general contention that success derives from scenarios' perceived credibility, legitimacy and saliency. Indeed, Hulme and Dessai (2008) cite these same three evaluation criteria of credibility, saliency and legitimacy in forming their three conjoined criteria for determining the success of a climate scenario: predictive success, by which they mean 'has the future turned out as envisaged?'; decision success, in terms of whether "good" decisions subsequently been made'; and learning success in terms of whether 'scenarios enabled participation and learning' (2008: 2).

With regard to the more common trend of 'good scientific practice' as being the principal measure of success, it is worth quickly reviewing its articulation across several of the key authors we have encountered in this article to illustrate the ambiguity of this formulation. Albert (2008a: 9), for example, concludes that scenarios are successful to the extent that they are influential in policy, and they are influential to the extent that they are 'perceived as simultaneously credible, salient, legitimate, and creative' by users. Only credible or plausible scenarios are useable, Albert suggests, adding that saliency and legitimacy rest on the extent to which scenarios are: internally consistent and consistent with existing information; comprehensive in their coverage; and, exhibiting a high degree of transparency and scientific rigor that is retraceable by experts, participants, users, and lay audiences alike. At one level, therefore, success depends on applied influence which, in turn, depends upon users but not necessarily scenario developers or participants. Rounsevell also uses four criteria and similar terminology to describe success, but without prescribing who the 'creativity, rigor, internal coherence, and plausibility' of scenarios is adjudged by (2010: 606). Henrichs is similarly ambivalent, noting that scenario exercises are necessarily speculative and, in a certain sense, unscientific, as they are not reproducible and therefore are not capable of being validated. Validation, for Henrichs (2007: 31), is seemingly only available through the promotion of transparency in all aspects of design and results, in that this renders comparisons across geographic and temporal scales possible. One can never reproduce a scenario exercise, but two exercises might be regarded as relatively successful if they produce the potential to be restaged and rigorously compared in other contexts.

There are four clear issues with these relatively equivocal guidelines. The first, as noted, is their uncertainty about the audience able to adjudge success. A second issue, related to the first, is that neither influence, credibility, legitimacy nor saliency offer themselves up easily to quantitative analysis. Whereas influence might be measured in terms of citations and credibility, for example, and saliency might be measured through surveying scenario developers, participants, and/or users, none of these metrics is without its own uncertainties. Is a scenario that changes participant attitudes but is unable to influence policy-makers necessarily unsuccessful? The third issue emerges directly from this second issue: since any measure of success is certain to fluctuate over time and across contexts, the status of a scenario will fluctuate over time and across contexts. Just as it is possible that a scenario exercise first deemed limited in its plausibility will become successful following a political, environmental or social change, the opposite trajectory is also possible. This consideration necessarily limits any party declaring a scenario exercise successfully rather than, more modestly, presently useful. Finally, it is clear

from the above review of literature that certain types of scenarios do not seek policy influence as their foremost aim. In Actor-focused and Reflexive Interventionist/Multi-Agent-Based (RIMA) scenario methods, the end sought is to reveal hierarchies, peer communication, group norms and, in the latter case, make these the source of sometime uncomfortable reflection for participants. It is illogical to suggest, in such cases, that success lies more in the utility of these scenarios to policymakers than their utility to developers.

The issue of success in scenario exercises bares comparison with the literature on focus group research and participatory or deliberative governance, both of which contend with parallel issues regarding the ethical, governance and research value of participation. Each of these fields, while conditioned by their own histories and concerns, must face the fact that participation is neither an 'uncomplicated good' (Cleaver, 2001) nor a 'discrete activity' with a straightforward beginning or end (Baker & Hinton, 1999). Baker and Hinton, discussing focus group research, suggest that the origin of participatory research in the democratic norms of development practice has encouraged the problematic assumption that greater participation necessarily leads to greater effectiveness (cf. Fischhoff, 1995). This is not necessarily true, particularly as researchers do not necessarily seek applied ends in any given case (Petts and Brooks, 2006: 1046–7), just as stakeholders do not all push towards resolution. Another justification for participatory research, common in the literature on participatory governance, stems from critiques of both the 'trickle down' and 'transfer and translate' models of knowledge distribution. Such models, researchers suggest, imagine non-experts as barriers to effective policy development rather than, more positively, knowledgeable stakeholders (see Healey, 2006a; Hajer and Wagenaar, 2003; Renn, 2008; van Kerkhoff and Lebel, 2006). As such, participation, integration, learning, and negotiation have been reconceptualised as possible solutions to perceived power imbalances that also afford opportunities to share responsibility and develop capacity in researcher and non-researcher communities alike (Randolph, 2004: 65). Each of these approaches attempts to provide a structure for a more sustainable interface with policymakers, though each also has their own affordances and flaws: a more democratic system, for instance, may also be of higher cost and equally hegemonic in reproducing existing hierarchies and understandings. What is relatively clear from the literature is that participant trust in researchers and government is necessary to successful participatory governance, even if, as Petts (2008) argues, this trust does not itself spring from participation or engagement.

4. Conclusion

Scenario exercises can be a method to both articulate and contemplate credible possible environmental futures, creating a dynamic context in which participants should face difficult questions and a variety of uncertainties. This literature review has demonstrated that there is a wide array of advice available from scenario exercise practitioners regarding, in particular, how to formulate framing questions, decide on the optimal size and number, select and prepare participants, facilitate and elicit participation, and assess the success of scenario exercises. In completing this review, the authors have also noted the interesting, though under-acknowledged, potential utility of surprise in scenario exercises as a proxy for 'real world' decision-making conditions.

What is apparent from this review is that scenario development and scenario analysis parallel scenario exercises themselves in two important senses. First, they parallel one another in the sense that they are determined by continual inquiry into the latent interests and implicit scales and preferences of a given context, whether derived from institutions, policies, environments, or participants. At different stages, participants and researchers may hope to adopt these contextual dimensions, or simply make them explicit, while in others they may seek to question their necessity, investigate alternatives, or explore their positive and negative potentials. The stages of scenario exercises might be summarised, in this way, as composed of exhaustive processes of multi-directional and multi-scalar questioning. Concerns, processes, ownership, participation, metrics and outputs are each, at some point, interrogated and resettled. Methodologically scenario exercises seem to be, to use Knorr-Cetina's (2001) description of scientific apparatuses, 'epistemic objects,' meaning they are both functioning 'things-to-be-used' and, at the same time, fluid 'things-in-a-process-of-transformation'. Second, the development, exercise and analysis methods addressed in this review generally treat participants as privileged sources of knowledges, ideally capable of providing input into every aspect. This broad assumption has an evident normative value, and aligns with the contention in participatory governance literature that participation is important to sustainable governance, but it implicitly places a large burden on participants' time and resources. As in the case of focus groups, researchers using scenario exercises needs to remain considerate of participants' expectations, interests and capacities.

Ultimately, the success of a given scenario exercise may be undecidable as success, to borrow a phrase, is in the eye of the beholder. Ratcliffe concludes that while there may not be an objective measure in this regard, there are a constellation of signs whose presence are highly indicative that multiple parties consider a scenario exercise to be credible, salient, and legitimate (2002:29). Those that are conceptually focused, broadly comprehended, contain a sense of fun and enjoyment, and that elicit enthusiasm, commitment and a sense of ownership from participants will be successful for researchers and participants alike. To take another example, Henrichs concludes that a scenario exercise should be evaluated simply in terms of its content- and context-specific aims and purposes. However, neither palette of measurements is as discrete as it appears, implying that aims and purposes are at some point settled consensually or reside only with participants and researchers. Rather than settle upon one set of metrics, the authors suggest that scenario practitioners and users embrace uncertainty, strategically utilising the multiple methods noted above to compare, manage and measure success.

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• Appendix A

Figure: how are scenarios used?

Element	Summary	Key sources
Framework	<ul style="list-style-type: none"> Some suggest the use of a framing question of single issue that will determine the type, narrative, form and function of a scenario Others prescribed deliberation on multiple aspects, such as the key themes, goals, indicators and policies to be explored There is considerable variation regarding the sequences and relative priority of these (and other) different elements in shaping scenario development 	Alcamo (2008); Mahmoud et al. (2009); UNEP (2007b)
Number	<ul style="list-style-type: none"> Relative consensus that more than one 'possible future' should be addressed Many sources suggest developing 2 or 4 scenarios, as this is both manageable and avoids drift towards a 'middle' compromise 	Albert (2008a); Alcamo (2008)
Scale	<ul style="list-style-type: none"> All scenarios have spatiotemporal scales. These should be set in light of: the purpose and the interests of potential users; the scales of driving forces; the scales of institutional/personal influence; and, the scales of available analytical tools The implications and restrictions of choices regarding scenario scales should be made as transparent as possible 	Alcamo (2008); UNEP (2007a)
Participation	<ul style="list-style-type: none"> Many incorporate stakeholders and/or members of the public into the scenario process as well as its outputs There is considerable variation about when, and to what extent, participation should be included Participation may: enhance the legitimacy of scenarios; allow diverse knowledges and values to be incorporated; increase public acceptance; give rise to disagreements; extend the length of exercises 	Henrichs (2007); Reed (2008); Wilkinson and Eidinow (2008); Wright and Cairns (2011)
Facilitation	<ul style="list-style-type: none"> The literature offers little guidance on facilitation Dominant approaches are based on 'essentialist' and 'social constructionist' focus group methods 	Millward (2012); James et al. (2015)
Surprise	<ul style="list-style-type: none"> Discontinuities or 'surprises' are often evaluated as theoretically crucial but they are also often excluded in practice There is widespread uncertainty about how surprises can or should be incorporated into scenarios 	Alexander (2000); Mendoça et al. (2004); van Asselt et al. 2012

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