Scenarios in society, society in scenarios: toward a social scientific analysis of storyline-driven environmental modeling

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Abstract
Scenario analysis, an approach to thinking about alternative futures based on storyline-driven modeling, has become increasingly common and important in attempts to understand and respond to the impacts of human activities on natural systems at a variety of scales. The construction of scenarios is a fundamentally social activity, yet social scientific perspectives have rarely been brought to bear on it. Indeed, there is a growing imbalance between the increasing technical sophistication of the modeling elements of scenarios and the continued simplicity of our understanding of the social origins, linkages, and implications of the narratives to which they are coupled. Drawing on conceptual and methodological tools from science and technology studies, sociology and political science, we offer an overview of what a social scientific analysis of scenarios might include. In particular, we explore both how scenarios intervene in social microscale and macroscale contexts and how aspects of such contexts are embedded in scenarios, often implicitly. Analyzing the social ‘work’ of scenarios (i) can enhance the understanding of scenario developers and modeling practitioners of the knowledge production processes in which they participate and (ii) can improve the utility of scenario products as decision-support tools to actual, rather than imagined, decision-makers.

Keywords: scenarios, global environmental assessment, climate change, modeling, science and society, policy, science and technology studies, political science, global models

Scenarios have become an increasingly common, consequential, and complex approach for describing potential environmental futures. While there is considerable variety—and some would say chaos—in the concept’s definitions and methodologies, there is a clear common thread to recent uses of scenarios as tools for environmental assessment. This common basis has been termed a ‘story and simulation’ approach, in which storylines about how relevant events might unfold in the future are used to parameterize models of biophysical and social processes, each consistent with an alternative future (Alcamo 2001). For example, in a global greenhouse gas emissions scenario, the storylines might portray various internally cohesive futures, differing in degree of globalization, kinds of economic growth, or depth of environmental protection. Modelers would then use these to choose appropriate numerical estimates related to the driving forces of future emissions (land use, population growth, technology mix, etc).

Smaller-scale environmental scenario exercises number in the hundreds, and the larger global ones have occupied the energies of international teams for years. Yet, the widespread use of scenarios in environmental change research belies the relative absence of social science scholarship on scenarios; this despite the fact that the process of constructing storyline-driven models of human–environment interactions indicates...
several critical pivot points to which social analysis might be applied. For example, there is the disciplinary linking of those that study social, technological, and biophysical systems; there are the epistemic questions regarding the coupling of more subjectively and intuitively produced storylines with the apparently objective enterprise of quantitative modeling; there are questions related to how the scientific and policy communities respond differently to the indeterminacy of the future versus the determinism of the models used; and there are questions of the intended and actual users and uses of scenario products and their linkage to policy.

Already from this capsule description, we can sense that scenarios are social objects, operating in the social sphere. We include in the social sphere interactions of members of a scenario team, the uptake of storyline-model packages by various audiences, and society at large, for whom the scenario reports are likely to be the most visible face of a massive and mostly hidden body of careful work. Yet if we look at the efforts made to improve environmental scenario exercises, they are primarily along the technical axis of the modeling process, for example in downscaling models from global to national to regional scales, or in quantifying the likelihood of alternative scenarios probabilistically. Less attention is paid to analyzing the development of storylines and their coupling to environmental models, even though the complexity of the social, economic, political and other dynamics that scenarios attempt to encapsulate is as analytically demanding as that of the biophysical systems modeled. Even fewer resources are brought to reflection on the creation and distribution of scenario products (such as reports and websites), and the utilization of those products by those not involved in their development, though these can shape the quality and policy-relevance of the overall product just as much as its content.

As an example of the absence of social analysis consider two recent reviews of scenario-based assessment. The European Environmental Agency conducted a comprehensive inventory and assessment of 40 scenario-based studies (Greeuw et al 2000). While this survey exhaustively parses various aspects of over 40 studies (their time horizons, the optimism of their stances, their quality), it offers virtually no insight into the social dynamics or functions of the scenario-making enterprise. The second study is more recent and probing. As part of the US Climate Change Science Program, a major synthesis and assessment product was commissioned entitled ‘Global Change Scenarios: Their Development and Use’ (Parson et al 2007; see also Parson 2008). As described in the project’s draft prospectus sent out for public review, the mandate of the synthesis and assessment product was to ‘review and evaluate how the science and stakeholder communities define, develop, implement, and communicate scenarios in the global climate change context, and how this process might be enhanced or improved’ (US Climate Change Science Program 2005 p 2). Social scientific analyses would seem to be centrally in line with the report’s mandate to understand and improve the development and use of scenarios. But the team, composed of eight distinguished scientists and policy analysts with considerable experience in global change modeling, included no sociologists, anthropologists, or others whose discipline places the study of society at center stage. Thus, while their survey raised topics and contained observations ripe for a social scientific analysis of scenarios, this otherwise outstanding report did not cross the threshold into conducting such an analysis.

As an effort to cross this threshold, this paper outlines an approach that considers scenarios as social objects, worthy of serious attention from the social sciences. The paper offers examples of how conceptual frameworks and methodological tools drawn from sociology, political science, and science and technology studies (STS) illuminate the social aspects of scenarios and illustrates some of the questions that can be asked by such approaches. We argue that scenarios operate on social contexts, by facilitating some linkages, dialogs, and outcomes over others (the subject of section 1). At the same time, social contexts get embedded into the scenarios, structuring processes of scenario development, distribution and utilization (the subject of section 2). Section 3 explores how greater attention to social contexts might be applied to increase the utility of scenarios in environmental assessments.

1. How scenarios work in social contexts

One fairly straightforward set of questions regarding the effects of scenarios on their contexts involves how scenario development processes and products shape what political actors know, say and do. Such research can be organized at various levels of analysis, from the individual level through local and national to international levels of political organization. Relevant here are insights from research on how scientific and technical assessments influence politics by inducing change in particular ‘issue domains’ (Farrell and Jaeger 2005, Mitchell et al 2006). Issue domains are arenas within which engaged or interested actors interact as they attempt to address an issue of common concern, about which they have differing beliefs and policy preferences (Jenkins-Smith and Sabatier 1997). For example, detailed case research demonstrates that environmental and technical assessment processes altered actors’ expectations, knowledge and behaviors around, for example, the need for international political action to regulate ozone depleting substances, around the farming practices of US and Zimbabwean farmers, and among European and US policy-makers who become increasingly concerned about the impacts of precipitation acidification (Mitchell et al 2006).

It is important to emphasize that the influence of scenarios is not simply through changes in explicit knowledge and understanding, but also through more implicit shifts in how problems are framed. For example, a scenario storyline casts some aspects of the world as fixed (and implicitly not the objects of policy intervention), and others as variable. Sometimes the language, or even the images and metaphors, in scenario descriptions and reports implicitly shape a cognitive
landscape of where risks and opportunities lie. These define the priorities of a particular community of actors and what these actors believe their audience should think about. For example, images of air pollution transport and deposition patterns across the European continent help to convey the notion that European nations share an airshed and that no national government could protect national air quality on its own (VanDeveer 2004). Such images thus served to justify national government could protect national air quality on its patterns across the European continent help to convey the example, images of air pollution transport and deposition these actors believe their audience should think about. For their priorities of a particular community of actors and what these define landscape of where risks and opportunities lie. These are known as ‘boundary work’ or ‘boundary objects’ (Star and Griesemer 1989) and the possibility of seeing scenarios as ‘boundary-spanning’ artifacts (Gieryn 1999, Guston 1999, Jasanoff 1990). Boundary objects link different social worlds, such as science and non-science, natural and social science, and even the different sub-disciplines and styles within natural science communities. Scenarios do exactly that. The development of scenario storylines generally brings together individuals with a host of differing training, interests and backgrounds. The amalgamated storylines that emerge from shared discourse and negotiation serve to bridge some of the gaps and boundaries between participants and their differing ideas, interests and expertise. Even though each participant might understand the shared storyline in a somewhat different way, these boundary objects are useful and robust enough to be used by all, and thus serve as a practical way of mediating different worlds and enabling joint work. This applies not only to the translation across boundaries within a scenario group, but, also, to the boundary between scenario-makers and those who use or refer to scenario products, policy-makers in particular.

The coupling of storylines and models in scenarios is a way of stabilizing or ‘taming’ tension across another kind of boundary: between the predictive capacities of science and the increasingly complex and unpredictable realities science is called upon to predict. Models strive for deterministic (or, at least, probabilistic) statements about driving forces, causation and outcomes. While macro futures are overwhelming complex and patently unpredictable, a huge amount of specialized knowledge enables scientists to model and project the regularities of natural systems within controlled parameters and under cetera paribus conditions. This modeling prowess can only be mobilized if the connection to the actual world’s massive dynamism and uncertainty is frozen, through treating many processes and parameters as given, i.e. making them exogenous to the model, and fixed. But here we have a problem. While a fully dynamic incorporation of salient processes and variables is intractable, the exogenization of key aspects of the world as fixed inputs makes a model dependent on a single guess at a set of inputs. The very certainty of such a model would raise doubts about its applicability into the future. Enter scenarios, which are an artful attempt to enjoy both worlds, coupling modeling precision with openness to the broadest range of change and contingency. They typically operate as a hinge point that matches coherent plausible narratives about the future, on the one hand, with a set of quantitative inputs (and sometimes system relations) on the other. The former allow a broad scanning of and intuitive integration of the social, economic, and technical landscape, and potential dynamics. The latter provides the formal and explicit structuring needed by the models.

Thus, perhaps scenarios have a kind of constructive ambiguity that can help reduce the confusion and contestation that often accompanies boundary work. This function, like Shackley and Wynne’s (1996) ‘boundary ordering devices’, produces consistency, despite the fact that boundaries between science and policy and precise models and complex and mostly unpredictable process are inconsistent and dynamic. This cluster of boundary concepts might help us understand how tensions and debates endemic within and between scientific research agendas and policy-making agendas are contested.
and, perhaps, settled (or temporarily stabilized) through the use of scenarios, in ways that allows dialogs among scientific specialties and between scenario producers and a range of scenario users.

2. How social contexts get into scenarios

Thus far we have discussed how scenarios act upon their social contexts. A social scientific analysis of scenarios would also examine the reverse arc, namely how social contexts are embedded in scenarios, often implicitly. A useful place to start would be to consider whether the scenario-formulation impulse and procedures themselves carry the imprint of their political, social, and organizational contexts of origin. Scenarios emerged in the military sphere; their use can be traced from the war games of the 19th century and their 20th century development during the Cold War period, especially by the RAND Corporation in the US (Raskin 2005). These methods were next taken up in the corporate realm, with the much described strategic scenarios of the Royal Dutch/Shell oil company, and the various offshoots conducted elsewhere by the team involved in those efforts (Wack 1985a, 1985b). Currently one of the most active spheres of scenario-making activity is in environmental planning and policy-making, and, specifically, their use to structure large-scale environmental change modeling exercises (Nakicenovic et al 2000, Parson et al 2007, Raskin 2005).

The military, corporate, and natural science spheres represent socially powerful sectors of society that have needed a principled way to grapple with and sharpen their thinking toward futures of great complexity, unpredictability, and consequence. Probing beneath the surface of this seemingly accidental lineage, we might ask about the diffusion of scenario practices across spheres. Organizational sociology offers two perspectives on this diffusion. A standard explanation would hold that scenario practices arose and spread because they efficiently fulfilled a necessary function (Hannah and Freeman 1977). From this perspective, the rise of scenario analysis across spheres would be interpreted as evidence of its utility. A more critical strand of organizational sociology argues that legitimacy is a better explanation of organizational form and survival. Legitimacy is achieved by copying the behaviors of other legitimate organizations (DiMaggio and Powell 1983, Fligstein 1990). Research tracing the processes by which scenario analysis was transported from the military to the corporate to the environmental change spheres would reveal how claims regarding their legitimacy and utility were established. One might also ask whether actors and approaches shaped in one milieu carry over into the next, and with what consequences. For example, Gerald Davis, formerly of Shell, facilitated the 2000 scenario analysis of the Intergovernmental Panel on Climate Change (Nakicenovic et al 2000). Put differently, would a systematic approach to thinking about possible futures look different had it originated among ecologists, geologists, or climatologists, for example, rather than war-gamers or corporate leaders? Those who might answer ‘of course not, scenarios are a simple tool’, might think differently after having read the rich examples from the field of science and technology studies, demonstrating the imprint of contexts of origin on the cognitive style of seemingly neutral tools (Biagioli 1999, Jasonoff et al 1995, Shapin 1995, Sismondo 2003, Swidler and Arditi 1994, Taylor 2005).

Another kind of contextualizing might relate scenarios to the broader political and organizational contexts in which they are sponsored and carried out. A rare example of this kind of contextual analysis is Ward and Ray’s (2004) examination of the political context of rural scenario building conducted by the New Labour Government in the UK. The authors describe the degree to which New Labor relied on future analyses in a broad range of domains as part of a general orientation toward modernization. The extension of these futurological methods to the rural sphere is particularly interesting, given the seeming clash between such an enterprise and prevalent conceptions of rurality as antithetical to novelty and innovation. The authors locate the rural scenario exercise within the contexts of the Labour party’s push for modernization of the countryside whenever it has been in power, as a way of countering rural traditionalism (i.e. Toryism). They argue that these ambitions suffused this particular scenario-making enterprise. Ward and Ray’s analysis also points to the essential tension between the principles of scenario building and the dynamics of government. Institutions are by definition conservative. Thus, the kind of scanning of the future and openness to change, especially disruptive change suggested by scenario practices, is unlikely to be their strong point. ‘Given that scenarios are meant both to challenge current assumptions and to speculate on mega-trajectories of change, any government or mainstream political party that sponsors them is taking a risk’ (Ward and Ray 2004 p 12). Their study provides a possible explanation for the pattern that most scenario exercises are initiated by non-governmental or supra-governmental actors, or, when emanating from a government agency, are conducted by external consultants. If, as Ward and Ray argue, uncertainty and long timescales are anathema to political players, further research could test the degree to which these aspects of scenarios are inversely correlated with the institutional liabilities of the bodies conducting them.

Finally, following Latour (1987) and Jasonoff (2004), scenarios might be understood as spheres of ‘co-production’, where knowledge and social order are produced simultaneously. The co-production approach proposes a more complex picture of the relation between science and politics/policy and between facts and value, in which these mutually constitute one another. Scenarios, in this framework, co-produce knowledge and social order by facilitating collaboration between scientific and technical experts of various types and policy-makers and other non-scientists, as together they ‘make sense’ of aspects of the natural world and aspects of social interaction (their own and that of societies at large). As a simple example, scenario parameters and assumptions might be shaped by a complex mix of the worldviews, rules and data associated with existing political institutions and organizations, defined in terms of scientific and technical disciplines. In linking this set of organizations and institutions via scenario-making, the resultant scenarios may further legitimize existing institutions even as they organize and interpret the vast complexities of
the global environment. An advantage of the co-productionist perspective is that it also calls attention to the audiences for information and knowledge—and the ways audiences may formally and informally influence knowledge production. That is, one can explore how both knowledge creators (those participating in scenario development, for example) and their audiences are (or can be) trained to understand information (images, texts, etc) in particular ways that link their social reality or world views with particular knowledge sets (VanDeveer 2004). A co-productionist approach does not simply attempt to ‘deconstruct’ scientific, technical or social expertise. Rather, it portrays a complex milieu in which aspects of the world, the scientists who interpret it, and those who draw on this science, interact with and reshape one another.

3. Beyond the ‘clumsy hand-off’

While scenarios are a fascinating field for social scientific investigation in their own right, such investigation also offers the prospect of more applied benefits. A particularly salient line of applied research is on the policy use of scenarios. For example, the Parson et al (2007) synthesis and assessment of the development and use of global change scenarios came closest to a social analysis in their evaluation of scenario use. In assessing the influence (or lack thereof) of storyline-based global change modeling in various policy-making arenas, the report emphasizes the importance of moving beyond a generalized notion of ‘decision-makers’ to think more specifically about if, where, why, and how scenarios will be used. Discussion at the ‘Global Environmental Futures: Interrogating the Practice and Politics of Scenarios’ conference at Brown University in March 2007 likewise highlighted the prevalence of a perceived social divide between scenario developers and scenario users. Scenarios are shaped, or seen to be shaped, entirely on one side of the divide, and then taken up, or not, by decision-makers on the other, in a process that one participant called ‘a clumsy hand-off’.

Evidence from the Millennium Ecosystem Assessment (MA), a recent large-scale global change scenario effort, underscores the persistent divide between scenario developers and scenario users. The MA is considered cutting edge in the degree to which non-state stakeholders were incorporated into the scenario development process (Reid 2006). However assessments of the impacts of the MA rate its ‘direct impact on policy formulation and decision-making, especially in developing countries’ as one of its weaknesses (Wells et al 2006 p ii). The evaluation goes on to describe the main impact of the MA as conceptual, in part because it is ‘not a product that can be readily used by planners or policy-makers’ (2006 p 22).

Parson et al (2007) and Reid (2006) offer an important first step toward thinking about the divide between scenario developers and users, in suggesting a more refined segmentation of the key kinds of decision-maker audiences for global change scenarios: impact and adaptation managers, energy resource and technology managers, and national officials, etc. Similar conclusions were reached in a recent assessment of the state of carbon cycle research about how best to make carbon cycle science more useful to various stakeholders and decision-makers (Dilling et al 2007). We agree that more careful attention to audiences (and engagement of them) can increase understanding of the relevance of scenarios for each and provide ways of enhancing developer–user relations accordingly. Moreover, we argue that social scientific approaches can provide conceptual frameworks and analytic tools necessary for advancing beyond the clumsy hand-off referred to above.

For example, the gap between scenario developers and users could be described as a ‘principal–agent’ problem, i.e. the problem of motivating one party (the ‘agent’) to act on behalf of another party (the ‘principal’), given their different perspectives and incentives. In the case of global environmental scenarios, the incentives of the (mostly academic) world of cutting edge modelers might be quite different than those of the policy-makers who fund or, ostensibly, use their products. The former might be motivated by the academic reward system, in which new models must be reportable as novel and challenging in peer-reviewed journals, while policy-makers might prefer simplicity, tried-and-tested approaches, or simply approximate answers to pointed, policy-relevant questions. Scenarios developers and scenarios users and funders may each struggle to control or shape various parameters of the scenario storylines and models to reflect their differing perspectives and incentives. Despite the friction it may engender at times, this struggle has a positive, generative aspect as well. If principal and agent are synonymous or too closely linked, scenario-making may lose its critical facility for providing unexpected or even uncomfortable outcomes or choices.

Various options exist for aligning the information needs of scenario users and the information capacities of scenario producers and thus addressing the principal–agent problem. One starting place is an understanding of the needs and perspectives of scenario users, and the circumstances of and motivations for their scenario use. Permutations of scenario developer–user relations abound, and these deserve greater socio-analytic observation both to understand how they work and to mine them for potential improved practices. For example, the US National Intelligence Council’s ‘global trends scenarios’ have as their direct and clearly identified clients Washington, DC foreign and security policy-makers (NIC 1997, 2000, 2004). The scenarios are developed and released in December between the presidential election and inauguration, meaning that as it develops the scenarios, the NIC does not know its specific ‘customer’. However, the general category of scenario user is clearly identified, and his/her needs are incorporated into the scenario design process and the NIC’s scenario output communication strategy (Burrows 2007). Furthermore, most of the users share a similar worldview, one that focuses on US national security threats and opportunities and is quite comfortable with the maintenance and overt and covert use of US military, economic and political power.

Royal Dutch/Shell’s scenario practice offers a different model, of scenario developers and users housed within the same organization. The Shell scenarios are the work of
small group in the Planning, Environment and External Affairs division in Shell’s London corporate center. The scenarios group reports directly to the Committee of Managing Directors (CMD), Shell’s top management. While Shell’s scenario practice is constantly evolving, historically Shell scenarios were initiated through a year spent in research mode followed by interviews with the CMD and other senior executives in order to elucidate their concerns. The five Shell global scenarios produced between 1989 and 2001 and their 2008 energy scenarios were centered on one key question and structured around two alternative and credible storylines (Shell 2008). Once the scenarios were developed, the scenarios group presented results to the CMD. Despite the organizational proximity of the developers and users of the Shell scenarios, the scenarios group still faces the challenge of bridging the gap between the scenario planners and operational executives. Scenarios group members explicitly acknowledged that they have a more academic focus and that their work can be divorced from the reality of business. The Shell experience with scenario production and dissemination thus offers a cautionary perspective to global environmental scenario efforts on the possibility of linking scenario producers and users. The Shell solution has been to focus on dissemination efforts. After producing and presenting global scenarios, the scenarios group creates country-level and issue-specific scenarios. The latter are central to disseminating scenario results to Shell’s over a hundred business units. Dissemination strategies include scenario presentations, focused scenarios, scenario modules, scenario-to-strategy workshops, and project-specific scenario workshops (Shell 1998).

The preceding discussion focused on one particular application of a social scientific analysis of scenarios, namely enhancing their uptake by policy communities and other decision-makers. A focus on micro and macro social contexts also points to other lines of applied research for improving scenario practice. Recognizing that scenarios enable cross-disciplinary, boundary-spanning dialog makes them useful tools for coalescing issue-centered networks and prompting adaptive organizational learning (van der Heijden et al 2002). Likewise, recognizing the contextual imprints in scenario techniques and storylines makes evident the need to make explicit the assumptions and parameters that guide scenario analyses, a lesson already learned in the environmental modeling community.

4. Conclusions and suggestions

Scenarios are becoming ubiquitous and consequential in global environmental change assessments. Simultaneously, the biophysical modeling underlying scenario exercises is becoming increasingly refined and sophisticated. However, there has not been a concomitant increase in the examination of two related aspects of scenarios where a social scientific analysis is required. The first is the way in which tremendously complex dynamics and possible future states of socio-environmental systems are encapsulated in storylines that are, by definition, marked by their relative (and, hopefully elegant) simplicity. The second is the social processes surrounding scenario development and use, including, for example, their formulation as a shared object within a group with diverse disciplinary and other backgrounds, their bi-directional processes of knowledge and community co-production, and their diffusion and uptake.

Within social science, one finds concepts and methods that can be used to analyze the social ‘work’ being done within scenario development and uptake. They can help understand how aspects of society get written into scenarios, and understand in more detail how scenarios work within the professional groups that shape them and beyond. We have given the briefest sketch of how some notions in STS, political science, and sociology might begin to illuminate these two understudied areas. We illustrated the reciprocal influences between scenarios and society using examples drawn from a wide range of scenario types and subject domains.

The research we highlighted is grounded in various social science research methodologies. Research methods such as survey research, structured interviews or focus groups can be used to assess how various individuals or types or individuals’ knowledge or assumptions may be shaped by participating in a scenarios analysis exercise or by receiving information generated by such a process. Likewise, intensive ethnographies of scenario-making, and in particular ones that examine the multiple sites related to the production and uptake of a single storyline-driven modeling initiative over a period of time, can reveal the imprint of social context on scenario processes and products. In such research, no attempt is made by the researcher to assess the inherent quality or accuracy of a particular scenario (that is left to others). Rather, such social science research attempts to assess these imprints and elucidate why particular participants in the scenario process or why particular users of the scenario information perceive the scenario to be credible, legitimate and/or salient (Farrell and Jaeger 2005, Mitchell et al 2006)

Our sketch of a social scientific analysis of scenarios is, by necessity, eclectic and brief. Yet, it demonstrates that such analysis can be organized to begin to answer questions of interest to many scenarios practitioners, including those related to how and why scenarios influence knowledge production over time and under what conditions scenarios may have more impact on policy-making and other behaviors of actors and organizations. Looking forward, we identify the following measures as helping to fill in the gaps uncovered here in a more systematic way.

- Include in global environmental scenario teams more representatives of social science professionals (beyond a few economics and public policy specialists, who are the main exceptions to a mostly natural science orientation in such groups).
- Create fora in which scenario practitioners, modelers, decision-makers, and social scientists of various kinds can discuss the process of scenario construction and use.
- Draw on the extensive toolkit of social science research methods to analyze the social ‘work’ of scenarios.

Earlier in this paper we suggested that some of the power and versatility of the scenarios stems from their constructive
ambiguity in bridging different perspectives, for example, determinism and indeterminacy. But the looseness inherent in the process of harnessing available knowledge to grappling with a future whose anticipation is a massively complex and nigh impossible task should not be an excuse for ceding clear analytic examination of the scenario process. In particular, the study of the ‘softer’ parts of the scenario production process, such as the social production of storylines and their interactions with models, and questions of scenario circulation and reception have not received adequate attention or resources. Our hope is that the review presented here shows both the need for such study, and some of the avenues along which it might proceed.

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