URBAN SUSTAINABILITY SCIENCE AS A NEW PARADIGM FOR PLANNING

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Abstract

Planning problems have been described as inherently wicked, i.e. difficult to define, unpredictable, and defying standard principles of science and rational decision making. Sustainability science is a new area of science that focuses specifically on understanding the dynamic interactions of social-ecological systems, of which the city is a particularly significant example. Building on the literature of planning and sustainability science, this paper presents an argument in favour of sustainability science as a theoretical basis for a planning paradigm that can effectively engage with the wicked problems presented by cities and their sustainability. The paper acknowledges that this argument is in the early stages of development and presents it as a stimulus for broader discussion and further development by a larger community.

1. Introduction

Ever since Rittel and Webber published their seminal paper on the notion of planning problems as “inherently wicked” and defying principles of rational [scientific] decision-making(1973:160), the quest has been on to find a planning paradigm that can accommodate the complex problems of cities and their sustainability. Planning theorists have proposed numerous alternatives to the rational planning paradigm that recognize the complexity and unpredictability introduced by social factors, e.g. transactive planning (Friedmann, 1973), deliberative planning (Forester, 1989 and 1999), community-based planning (Leavitt, 1994), communicative rationality (Innes, 1995), and collaborative planning (Healey, 1997). The introduction of sustainability to the goals of planning added another layer of complexity brought about by the inclusion of environmental considerations to the general social and economic concerns. This, in turn, led to calls for an ecological or sustainability planning paradigm (e.g. Blowers, 1993; Lyle, 1994; Van der Ryn and Cowan, 1996; Beatley and Manning, 1997; Berke and Conroy, 2000). However, as Cooper (2002:117) discusses, drawing on Palmer *et al.* (1997), there is “no consensus on what sustainable urban development is …nor on what a sustainable human settlement looks like or how it functions”. To achieve such a consensus, Jepson (2003:391) argues for a definition of [urban] sustainable development that is based on scientific principles derived from the theoretical frameworks presented by, for example, ecology and thermodynamics of living systems.

Discerning that sustainability is a problem described by the complex dynamics of human-nature interactions, and that it requires a decisive change in the way that science is undertaken, the National Academy of Science in the USA formally recognized sustainability science as a branch of science (US National Research Council, 1999). As such, sustainability science is a product of the convergence between an emerging ecological/ whole systems worldview and its associated scientific and social paradigms, and what is probably the most critical challenge of current times: the transition of society towards a more sustainable developmental pathway (Du Plessis, 2008:61), and it offers a definition of [urban] sustainability that is based on both a scientific and philosophical understanding of the world.

This paper presents an argument in favour of sustainability science as a theoretical basis for a planning paradigm (i.e. a shared set of concepts and practices, as defined by Kuhn, 1996) that can effectively engage with the wicked problems presented by cities (as systems of humans and nature) and their sustainability. It is grounded in the work of the Southern African Sustainability Science Network (published in Burns and Weaver, 2008), as well as the author’s ongoing PhD work, which constructed a meta-theory of urban sustainability within an ecological worldview from an extensive analysis and synthesis of literature drawing on domains ranging from science (e.g. ecology, new physics and complexity), philosophy, and comparative religion, to theories of sustainability, planning and development. The paper first provides brief backgrounds on the notion of wicked problems, the field of sustainability science, and the concept of the city as social-ecological system (SES), before exploring the concept of urban sustainability science as planning paradigm by asking how the notion of the city as a complex, adaptive, self-organizing SES would change the way planners engage with the problems and the praxis of urban planning. Unfortunately limitations of length necessitate an extremely superficial discussion. Furthermore, the objective of the paper is not to present a tested hypothesis as illustrated through case studies, but instead to provide a philosophical starting point for discussion, reflection and further research.

2. The wicked problems of planning

In her book 'The Death and Life of Great American Cities', Jane Jacobs observed that the problems presented by cities are neither simple two or three variable problems, nor the problems of disorganized complexity which form the domain of statistical analysis and probability theory, but are instead problems of organized complexity, i.e. "problems which involve dealing simultaneously with a sizeable number of factors which are interrelated into an organic whole" (Jacobs, 1992:432). The premise of her larger argument is that traditional city planning approaches either reduce the problems of a city to problems of simplicity, dealing with closely-linked cause-effect relationships (e.g. the relationship between population and housing needs), or use statistics to determine the provision and location of facilities such as schools, hospitals or shops. These approaches treat the city as a problem of physics and mathematics, and therefore as a dead object, resulting in cities that are slowly dying. It is only by seeing the city as a problem of organized complexity, and therefore a problem of the sciences of life, that cities can be kept alive.

There is a growing body of work that seeks to model cities as dynamic and complex, adaptive systems (e.g. Casti, 1997; Alberti and Waddell, 2000; Batty, 2005). This work focuses mainly on cellular automata and agent-based modeling that proceeds from the premise that most growth in cities is based on bottom-up individual decisions and not according to a centrally-devised grand plan (Batty, 2005:107). However, in hoping to identify general generative rules that guide bottom-up behaviour with the aim of eventually being able to predict the behaviour of agents and the consequences of their actions, the approach is still based on the assumption of rational decision making by agents. As such it does not allow for the 'irrationality' of influences such as human emotions, norms and value systems that fluctuate depending on the context of the agent, and singular conditions produced by the interaction of environmental, economic and social factors in a specific time and place. These are the essence of wicked problems.

Rittel and Webber (1973:160) point out that "the kinds of problems that planners deal with are inherently different from the problems that scientists and engineers deal with".They propose that whereas the problems of science are mostly "tame", i.e. they are clearly defined problems with a clear mission and clear indicators for when the problem has been solved, this is not true of most planning problems, which they classify as "wicked" problems (*ibid*.) These wicked problems have the following ten characteristics: there is no definitive problem formulation, instead "the formulation of a wicked problem *is* the problem" (*ibid.:*161); there are no criteria to indicate when a solution has been found and the eventual 'solution' is arrived at through reasons external to the problem such as funding or time constraints; solutions to wicked problems are value-based, that is "they are not true-or-false, but good-or-bad" (*ibid*. 162); there is no way of testing and fully appreciating the consequences of a solution as the full scope of its repercussions cannot be traced; there is no opportunity for trial and error, every solution has an immediate and irreversible impact on the system; there is no fixed number or set of permissible solutions to a wicked problem; "every wicked problem is essentially unique" (*ibid*.:164) and therefore there are few replicable solutions; wicked problems are nested across levels in the sense that "every problem can be considered a symptom of a problem at a different level" (*ibid*.:165); in wicked problems the usual rules of science to formulate and test a hypothesis cannot be applied, and the explanation for a discrepancy, and hence the proposed resolution of the problem, is mainly determined by the 'world view' of the analyst; and lastly, unlike the scientist whose hypotheses can be refuted without major consequence, the planner cannot afford to be wrong as the solutions to planning problems have direct and irreversible impacts. One of the key reasons why planning problems can be considered as wicked is the fact that planning "inevitably involves value-choice issues" (Lane, 2001:659) that are further complicated by the multiple perspectives on the problem brought by different socio-economic and biophysical systems and actors in the city (Courtney, 2001:31).To develop decision support tools for planning that engage with these multiple perspectives and the underlying norms, beliefs and values that guide behaviour, Peter (2008:471) suggests instead an approach based on contemporary ideas about social-ecological systems as described by sustainability science.

3. Sustainability science

Sustainability science concerns itself with studying the "fundamental character of interactions between nature and society" (Kates *et al*., 2001:641). Rapport (2007:77) describes it as "a transdisciplinary effort to come to grips with one of the most perplexing issues of our time: how to achieve a symbiotic relationship between biological and social-cultural systems so that future options are not foreclosed". Kates *et al*. (2001: 641) propose that further development of sustainability science will require substantial advances in understanding the behaviour of complex self-organizing systems, in order to address the responses of social-ecological systems to "multiple and interacting stresses". They further suggest that "combining different ways of knowing and learning will permit different social actors to act in concert under conditions of uncertainty and limited information". The key characteristics of sustainability science can be summarized by three main ideas: it deals with problems that encompass multiple and interacting scales, levels, dynamics, actors and system thresholds in social-ecological systems; it emphasizes learning, adaptation and thus reflection; and it acknowledges and makes use of multiple participants (e.g. scientists, stakeholders, practitioners) and epistemologies to co-produce knowledge (Kates *et al*., 2001; Burns *et al.*, 2006; and Martens, 2006).

As such, sustainability science is an interface (or transdisciplinary) science in that it draws on many scientific disciplines across the natural and social sciences, as well as other knowledge systems (e.g. indigenous knowledge, tacit practitioners' knowledge) in order to study the dynamic interactions within social-ecological systems. It is also science that is "use-inspired" (Burns *et al*., 2006:380), and "problem-driven, with the goal of creating and applying knowledge in support of decision-making for sustainable development" (Clark and Dickson, 2003:8059).However, as Burns *et al*. (2006:381) point out, the debate on how sustainability science should be practiced is still in its infancy. Swart *et al*. (2002:1994) propose that sustainability science would require "the evolution of methods that can adequately and rigorously capture uncertainty, the capacity for system discontinuity, and the normative content of sustainability problems". Martens (2006:38) suggests that the novel models and techniques required for sustainability science can be characterized as demand-driven, participatory, subjective, exploratory and uncertain, and as "heuristic instruments, as aids in the acquisition of better insight into complex problems of sustainability". Swart *et al*. (2002:1994) further identify the following challenges for sustainability science: "linking themes and issues (e.g. poverty, ecosystem functions, and climate); understanding and reflecting deep uncertainty; accounting for human choice and behaviour; incorporating surprise, critical thresholds, and abrupt change; effectively combining qualitative and quantitative analysis; and linking with policy development and action through stakeholder participation".

From the above descriptions it can be seen that there are strong similarities between the problems of sustainability science and the wicked problems of planning identified by Rittel and Webber (1973). A further connection between sustainability science and planning is that the main problem space of sustainability science is that of social-ecological systems (SESs), of which the city is a particularly significant example.

4. Understanding the city as a social-ecological system

The idea of the city as system has been around for at least as long as systems thinking. Apart from its obvious infrastructural and management systems, the city has been described as an ecosystem (e.g. Odum, 1969; Lyle, 1994; Girardet, 1996; Alberti, 1996; Newman and Jennings, 2008) with both biological and technological metabolisms (Rees and Wackernagel, 1996); as a complex adaptive system (e.g. Waldrop, 1992; Holland, 1993; Johnson, 2002; Batty, 2005); and as a social-economic system (e.g. Jacobs, 1970; Castells, 1983; Hallsmith, 2003). However, as Kohler (2002: 131) suggests, it is necessary to develop a common model of urban reality that would include not just the biophysical and technological systems, but also economic, social and cultural systems – that is of the full social-ecological system.

The exact nature of social-ecological systems (SESs), or what it is that differentiate SESs from other types of ecological systems, is still open to debate. The Resilience Alliance (2006) describes SESs as "complex, integrated systems in which humans are part of nature." However, while there are numerous methodologies and conceptual frameworks for studying aspects of social-ecological systems, the understanding of how the social and ecological components are to be integrated into one system is still evolving. Grimm *et al.* (2000) suggest a modelling framework that would include variables in social patterns and processes and human perceptions as drivers of change together with ecological drivers. Alberti *et al.* (2003) propose a similar conceptual model that links human and biophysical drivers, patterns, processes and effects. However, both these models are limited to a view of humans as another species of mammal within an ecological system, with no attempt to address those aspects that differentiate social-ecological systems from other types of ecological systems. Haberl *et al.* (2004) move some way towards addressing this gap by suggesting that social-ecological systems should be seen as a 'biophysical' sphere of causation governed by natural laws, and a 'cultural' or 'symbolic' sphere of causation reproduced by symbolic communication. An analysis of papers published over the past ten years in the main journal of social-ecological system research, *Ecology and Society*, suggests four propositions as the cornerstones of a conceptual framework for understanding social-ecological systems, including cities (Du Plessis, 2008).

The ***first*** of these propositions suggests that social-ecological systems can be seen as consisting of interpenetrating biophysical and mental phenomena: an 'exterior' biosphere created by biogeochemical processes (including those originating from human activities), and an 'interior' noosphere created by and experienced through the human psyche and processes of thought and social interaction. This view brings together the two aspects of a city identified by St. Isidore of Seville (AD 560-636) in his Etymologies (described in Arida, 2002:xix): the *urbs* (the physical aspects) and the *civitas* (the emotions, rituals and rules), in an understanding of the city as a phenomenon originating from and created by both mental-social and technological-natural processes. As the noosphere is a property that emerges from the biosphere, it relies on the functional integrity of the biosphere for its continued existence. At the exterior level, humans and their artifacts (i.e. technology, infrastructure, and buildings) are an indivisible part of the biosphere and they, like any other organism, participate in and co-create the metabolic and change processes that shape the biosphere. Humans are bound by the same natural laws that apply to other organisms, but their interior processes allow them to apply these laws to create and adopt technologies that introduce novel components to the system at scales both above and below that of the individual human.

The ***second*** proposition suggests that a social-ecological system consists of relationships between elements at a number of scales, across biophysical and mental levels, and in nested systems. Two key concepts that describe the specific hierarchical nature of SESs are holarchy and panarchy. Koestler (1975:103) coined the term holarchy to describe a systems hierarchy where each element is simultaneously a whole (as an individual entity) and, as an element in the system at that level, a part of a larger whole. The whole can thus be seen as an emergent property of the structural relationships and interactions of the parts. Furthermore, each holarchic level operates according to its own set of rules or patterns that determine behaviour at that level. However, lower levels can influence higher levels through upward causation and higher levels can control or influence what happens at lower levels through downward causation (Roger Sperry cited in Wilber, 2000:28). This notion of interaction and influence across different hierarchical levels is the central tenet of the second concept, namely panarchy.

Holling *et al.,* (2002) coined the term 'panarchy' to provide an organizing framework for theory dealing with cross-scale dynamics in natural and social systems. The term is a complex wordplay on the idea of hierarchy (of level and scale) combined with the prefix 'Pan' to indicate change across the whole. Within the panarchy, change (as expressed through an adaptive renewal cycle of breakdown and release, re-organisation, growth and exploitation, and conservation) is a constant phenomenon at each level or scale of the system. Within each of these stages of the cycle different survival strategies are privileged, thus driving different types of agent behaviour. However, the adaptive cycle phases at different levels also interact or connect with one another, thus driving system change across levels. The panarchy is constructed gradually as potential accumulates at one level, until a threshold is passed that allows the establishment of a slower and larger level. Conversely, the panarchy collapses or enters state breakdown when there are simultaneous crises at different levels (e.g. all levels of the system enters the breakdown phase of their individual adaptive cycles at more or less the same time) or a crisis cascades across all levels. From this point of view, the objective of [urban] sustainability initiatives is not to resist or reverse change, but to accept that change is inevitable and manage the phase changes within systems in such a way that the system does not lose its functional integrity and tip into another stability regime, or that such collapses do not cascade upwards into the larger system. This means managing the capacity of the system to experience shocks while retaining essentially the same function and structure, and therefore identity, a concept known as resilience (Holling *et al.*, 2002; Walker and Salt, 2006).

In order to understand how resilience can be managed, it is necessary to introduce the ***third*** proposition: SESs are systems that are complex and adaptive, with properties of self-organization and emergence. SESs are complex, in that they are diverse and made up of multiple interconnected elements, and adaptive, in that they have the capacity to change and learn from experience. Within complex, adaptive systems (CASs), microlevel agents interact to create the global properties of the system. These global properties then feed back into the microlevel interactions. Lucas (2004) explains that the essence of CASs is that they self-organize to optimize the function of the system, creating new niches as necessary, and changing their composition (i.e. the elements and relationships of which they are composed) to fit the changing patterns they encounter. Understanding SESs as CASs means that the important properties to consider are those related to change and the system's ability to deal with change – for example, resilience, adaptability, transformability, connectivity and diversity.A key aspect of CASs is that their constituent agents are constantly making predictions based on their various internal models of the world (i.e. implicit or explicit assumptions about the way things are out there), and adapting to each other and to the external environment. These adaptive responses and interactions allow the system as a whole to undergo spontaneous self-organization into collective structures with properties that cannot be predicted from the properties of the parts, and which the agents may not have possessed individually (Waldrop, 1992) - a concept referred to as emergence. This happens in both physical and social systems. What differentiates physical systems from social systems is that the agents in social systems often alter their behaviour in response to *anticipated* outcomes.

This brings us to the ***fourth*** proposition: what differentiates SESs from other systems is the introduction of abstract thought and symbolic construction. As Westley *et al.,* (2002:108) explain, the ability of humans to make sense of their world through abstract thought and symbolic construction allows "the formation of social systems and a 'virtual reality' through which options and scenarios can be explored and new possibilities can be imagined". They suggest four elements of symbolic construction: the creation of a hierarchy of abstraction (which allows the agent to separate him/herself mentally from the realm of time and space); the capacity for reflexivity; the ability to remember the past and learn from it (hindsight) and imagine the future and plan for it (foresight); and the ability to externalize symbolic constructions in technology. The ability to use symbols and with symbols, language, allows humans to develop sophisticated means of communication that allow abstract ideas to be communicated not just across vast distances, but also across time. The capacity for symbolic construction further introduces new types of entities that only exist in the symbolic realm of the noosphere, e.g. nations, corporations, and legal, political and economic systems, as well as values, norms and beliefs (i.e. rules of engagement) that influence agent behaviour. It is this sophisticated interior aspect and the opportunity it creates for novelty, foresight, reflection and learning, as well as the rules of engagement that are formed at this intangible (mental) level, that differentiate SESs from other ecological systems.

Within this conceptual framework, sustainability science focuses specifically on understanding the dynamic interactions of SESs at and between all levels (e.g. biosphere and noosphere) and scales (e.g. household, neighbourhood, suburban or metropolitan) of the urban system with the aim to understand the factors that determine the resilience, vulnerability and adaptability (seen as the conditions for sustainability) of the city. It therefore addresses the ever-changing, unpredictable and cross-scale nature of the wicked problems of planning, as well as the aspects of these problems that lie in the domain of the human mind at both individual and social levels such as values and multiple perspectives. Sustainability science further offers a particular interpretation of the sustainability of cities and how the planning profession should engage with urban sustainability.

5. Sustainability science and the problem of urban sustainability

From the above understanding of cities as social-ecological systems (SESs), it can be argued that the objective of urban sustainability is to uphold relationships and dynamics (within and across levels and scales) that maintain the ability of the city to provide not just life-supporting but also life-enhancing conditions for the local and global community of life by maintaining the critical structures, functional integrity, overall health and well-being, and capacity for regeneration and evolution of the city, its sub-systems and the global SES of which it is a part. This would require learning how to respond and adapt to, and evolve with change and surprise, while avoiding changes that would move SESs at levels from global to local into stability regimes that would threaten the life-supporting and life-enhancing capacity of these systems. What is important in this interplay of allowing and adapting to change, and ensuring the persistence of conditions that would keep the system within a preferred stability regime, is the need for reflection in order to learn from both failures and successes, and to achieve sufficient understanding of how global and local social-ecological systems function to be able to learn from, work with and anticipate the dynamics within and between these systems. Achieving such an understanding is the objective of sustainability science.

In their seminal paper Kates *et al.* (2001:641) propose a set of core questions for sustainability science that have become the main point of departure for studies in this field. These are concerned with how the dynamic interactions between nature and society can be incorporated in models that integrate both earth systems and human systems (i.e. social-ecological systems); how long-term trends in environment and development are reshaping nature-society interactions; what determines the vulnerability or resilience of the different nature-society systems; whether scientifically meaningful limits or boundaries can be defined that would provide effective warning of serious degradation risks; how existing monitoring and reporting systems can be extended to provide more meaningful guidance for efforts aimed at a sustainability transition; and how to integrate activities of research, planning, monitoring, assessment and decision support in systems for adaptive management and societal learning.

Building on these early questions and the understanding of the city as social-ecological system (SES) within a global SES, urban sustainability science would ask the following: what determines the functional integrity and resilience of the urban SES; how do we most effectively participate in the functioning, regeneration, evolution and overall well-being of the urban SES; and do we understand the dynamics of urban processes within the SES, that is, do we understand the system structure (the networks of relationships) as it spans across the different scales and mental and physical aspects of the city, do we know the critical variables and their parameters which describe the stability regimes within which we need to keep the urban and global SES, and can we determine and monitor the system's position relative to these parameters? Engaging with urban sustainability from a planning perspective is therefore not necessarily about how to make 'correct' choices of technology or social and economic ideologies, or to find solutions to a range of pre-determined problems (e.g. poverty, pollution, crime, or waste), but to understand the dynamics that gave rise to desirable and undesirable phenomena so as to participate most effectively in the natural evolution of the city while keeping the urban and global SESs from crossing critical thresholds.

6. Discussion: a planning paradigm based on sustainability science

The theoretical basis provided by sustainability science as discussed in section 5 offers a number of new concepts and practices to planning. Let us look at the first characteristic of sustainability science as dealing with problems that encompass multiple and interacting scales, levels, dynamics, actors and system thresholds in social-ecological systems. What is particularly new about the perspective offered by sustainability science is the emphasis on understanding networks, relationships, flows and thresholds, instead of quantitative and qualitative analysis of the parts of the urban system. This requires that planning and regulatory processes are guided by an understanding of systemic interactions; take into account issues of behaviour, relationship, resource flows and resilience across the social-ecological system; and acknowledge that uncertainty and unpredictability is a characteristic of cities that requires adaptive management and flexibility in implementation.

It further introduces a view that integrates the physical aspects of the city as biosphere (i.e. spatial patterns, infrastructure networks, flows of energy and matter, ecological relationships and biogeochemical processes) with the aspects of the city that sit in the noosphere (e.g. values, norms, beliefs, legal, economic and political systems and noospheric entities such as corporations, governance structures, and civil society organizations) into a model of the interactions and relationships between bio and noospheres. This would require that the conceptual and other models used to inform systemic planning processes account for the flows between interior aspects (e.g. value systems or structures of legitimization such as regulations) and both interior changes (e.g. a shift towards a specific value system such as environmentalism) and exterior change (e.g. changing value systems driving the development of new technologies). It must further be able to close the loop by accounting for changes in the exterior related to manifestation of interior events (e.g. the use of a new technology increasing pollution levels).

Sustainability science further shifts the objective of planning away from providing solutions to problems that appear to be “easily definable, consensual and judged undesirable by the predominant opinion” (Rittel and Webber, 1973:156), and then solving the problems created by these solutions. Instead, the objectives of the planning professional become to a) study, understand and monitor the thresholds and boundaries that define the preferred stability regime of the urban SES and the variables that influence them; b) study and understand the dynamics that gave rise to undesirable phenomena in order to find the most effective leverage points at which to intervene to keep the urban SES within a desirable stability regime; and c) develop management structures and performance measures that accept and embrace change and novelty while building the capacity for resilience in the interaction between noosphere and biosphere.

This brings us to the second characteristic of sustainability science – its emphasis on learning, adaptation and thus reflection. In an environment that has to deal with constant change and uncertainty, planning changes from a prescriptive activity to a process of reflection and adaptation that needs to happen at several levels. The first level of reflection is about our understanding of the possible consequences of an intended action, not just at the scale or level of the system where the action is intended, but also the consequences of such actions at lower and higher scales or levels and the appropriateness of the proposed action to its context. However, it is important that such precautionary reflection is an ongoing process, leading to the second level of reflection, which is to remain aware as we act of what is happening, and to respond and adapt to changing circumstances, new knowledge and surprise. This, in turn, feeds into the third level of reflection which requires reflecting about what was learnt during the entire cycle of decision, implementation and outcomes, and how this learning can be fed back into future actions.

However, in order to get a broad enough perspective on the dynamics of the system that would allow meaningful reflection on possible consequences and broad access to the lessons from previous actions, the planner has to not only consider the knowledge obtained from multiple sources (e.g. scientists, stakeholders, practitioners, indigenous knowledge) and epistemologies, but accept that adequate understanding of the complexity of the urban dynamics can only be achieved through co-production of knowledge with multiple participants. This is the third characteristic of sustainability science and it takes earlier notions of participatory planning one step further in that it not only considers the needs and wishes of communities and groups within communities, but also includes the perspectives brought to the table by the knowledge and understanding of these communities about the dynamics of the SES.

7. Conclusions

The objective of this paper was to explore whether sustainability science could offer a theoretical basis for a planning paradigm that can effectively engage with the wicked problems presented by cities and their sustainability. Sustainability science is a relatively new and unproven scientific domain, but it holds much promise as an approach to dealing with wicked problems. The paper presented an argument in favour of sustainability science as basis for a new planning paradigm that a) links the type of problems explored by sustainability science to the wicked problems that are the domain of planning, b) illustrates how the understanding of cities as social-ecological systems provides a conceptual framework for addressing some of the challenges presented by the characteristics of wicked problems, and c) suggests some of the concepts and practices sustainability science would bring to planning. As yet this argument is untested and in the early stages of development and it is hoped that this paper will stimulate further discussion and development of the ideas by a larger community.

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