Definition of Tame vs. Wicked Problems

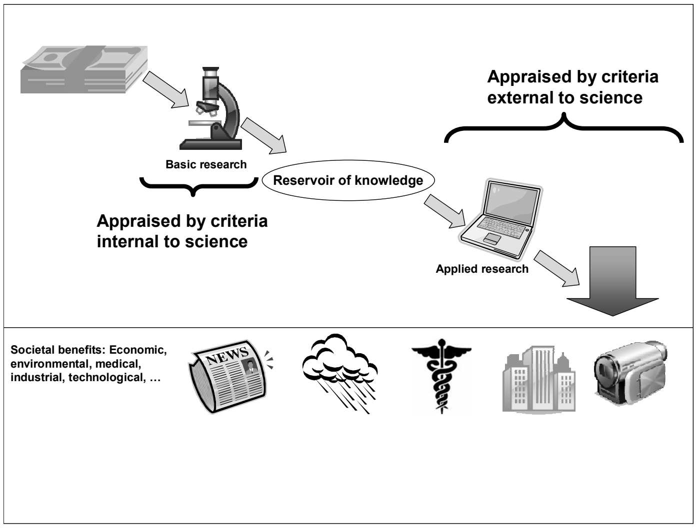
This memo is provided to acquaint you with definitions for a few terms that will be part of SMEP Academy discussion about post-normal science and approaching sustainability as a wicked problem. We suggest you read it before the Academy, but the Academy conversation will also return to more thoroughly explore the meanings and significance of these definitions and relationships.

Normal or Linear Science[1]:

There are problems with using normal science in addressing various issues and policies. That is the use of linear, normal science models for informing decision making frequently is driven by the underlying assumptions that scientific progress will lead to societal progress (Frodeman and Holbrook 2007) and that getting the science "right" is necessary to settle political disputes, to reach concensus on policy, and for effective policy making to occur (Pielke Jr. 2007; Sarewitz 2004). Figure 1 is a representation of a linear science model, where science, working independently from stakeholders, addresses a societal problem and presents answers. As a result, and as Figure 1 illustrates, normal science frequently has a division between those who do the science and those who use it: "Autonomy is implicit in the [linear] model, … science assumes no responsibility to apply the knowledge it puts into the [research findings] reservoir, and society does not set scientific priorities" (Pielke Jr. and Byerly Jr. 1998, p. 42).

[1] This section and the next is adapted from Batie (2008).

Figure 1. The linear model of science



Source: Pielke, RA, Jr. and R. Byerly, Jr. 1998

These assumptions are tantamount to conflating the "what is" and the "what if" products of science with the "what ought to be" product of politics. They are also quite problematic, but tend to be more realistic: (1) where there is widespread agreement by stakeholders as to what are desirable outcomes as well as (2) where there is low uncertainty surrounding the system components and outcomes (i.e. cause and effect) of alternative course of actions (Pielke Jr. 2007). That is, they tend to be more realistic with the "tamer" problems of society. For example, the research to develop a vaccine for a serious human disease may fall in this tame problem category. With most vaccines, there tends to be widespread agreement that protecting humans from the disease is desirable, and there is low uncertainty about the system components or outcomes. Thus, for vaccine development, the assumptions of the linear model of normal science are frequently apt, and science can work independently of stakeholders to design the vaccine, comfortable that, once completed, the science will be appropriately implemented toward solving the disease problem.

Wicked Problems:

Tame problems can be contrasted with wicked problems, of which sustainability is but one example. Wicked problems always occur in a social context, and, with wicked problems, there can be radically different views and understanding of the problem by different stakeholders, with no unique "correct" view (Horn and Weber 2007). Thus, their wicked nature stems not only from their bio-physical complexity, but also from multiple stakeholders' perceptions of them and of potential tradeoffs associated with problem-solving. With wicked problems, identification of solutions becomes as much a social and political process as it is a scientific endeavor (Kreuter et al. 2004). Also, wicked problems are characterized as having high uncertainty, not only with associated outcomes that might result from problem-solving, but also with the potential causes and effects underlying the problems. In addition, there are multiple stakeholders' viewpoints with respect to the desirability of alternative outcomes associated.

Wicked problems can be contrasted with tame problems. While frequently complex and difficult, tame problems are those that can be clearly delineated and solved by experts who produce workable solutions using the analytical approaches of their disciplines (Kreuter et al. 2004). Examples include: landing men on the moon; determining the specific source of a food contamination outbreak; identifying the cost effectiveness of different crop practices to reduce soil erosion; or determining the costs and benefits of expanding an irrigation project.

Tame problems are characterized by clear definitions of the problems which do not change overtime. Also, the problem definition of a tame problem reveals potential solutions because of clear cause and effect mechanisms. Unlike wicked problems, there is little conflict over the desirability of these potential solutions. Tame problems can be addressed primarily by experts with little or no involvement of stakeholders, and unlike wicked problems, they can be solved.

Table 1 summarizes the difference between tame and wicked problems.

Table 1. Summary of Differences between Tame and Wicked Problems

Characteristic	Tame Problem	Wicked Problem
1. The problem	The clear definition of the problem also unveils the solution. **** The outcome is true of false, successful or unsuccessful. **** The problem does not change overtime.	No agreement exists about what the problem is. Each attempt to create a solution changes the problem. *** The solution is not true or false—the end is assessed as "better" or "worse" or "good enough". *** The problem changes overtime.
2. The role of stakeholders	The causes of a problem are determined primarily by experts using scientific data.	Many stakeholders are likely to have differing ideas about what the "real" problem is and what are its causes.
3. The "stopping rule"	The task is completed when the problem is solved.	The end is accompanied by stakeholders, political forces, and resource availability. There is no definitive solution.
4. Nature of the problem	Scientifically based protocols guide the choice of solution(s). **** The problem is associated with low uncertainty as to system components and outcomes. **** There are shared values as to the desirability of the outcomes.	Solution(s) to problem is (are) based on "judgments" of multiple stakeholders. **** The problem is associated with high uncertainty as to system components and outcomes. **** There are not shared values with respect to societal goals.

Source: Adapted from Kreuter *et al.* 2004.

In addition to sustainability, examples of wicked problem issue areas include: terrorism, global climate change, nuclear energy, healthcare, poverty, crime, ecological health, pandemics, genetically-modified food, water resource management, trade liberalization, the use of stem-cells, biofuel production, nanotechnology, gun control, air quality, biodiversity, environmental restoration, forest fire management, and animal welfare. Other wicked problems include the: locating of not-in-my-backyard (NIMBY) projects (e.g. a freeway or a half-way house); reengineering a food supply chain to address food safety problems; constructing or removing a hydroelectric project; or opening of a new mineral mine. There are frequently components of wicked problems that can be made "tamer" and approached with linear science, but the fundamental issue of what "ought to be done" is not one of these components.

Types of Knowledge[2]:

Wicked problems require a different approach than normal science to address policy and decision making, some authors call this approach that of post-normal science. Post-normal science frequently involves the co-creation of new knowledge. Definitions for knowledge and types of knowledge can be taken from the classic knowledge management work by Takeuchi and Nonaka (T&N). To T&N, knowledge is about beliefs and commitments; it is about action toward some end; and, it is about meaning that is context-specific and relational.

Existing knowledge is divided into two types: (1) ***tacit knowledge*** which is context-specific and informal arising from experience and practice, and (2) ***explicit knowledge*** which is codified, rational, separable from context and thus transmittable by formal means, such as information systems or manuals.

For T&N, ***new knowledge*** is created by various forms of "conversion" between tacit and explicit knowledge. For example, tacit knowledge becomes explicit through the process of externalization, which is, taking what is known from practice and experience and making it formal and accessible to others. Scientific induction is a form of externalization. Tacit knowledge is converted into more tacit knowledge through the process of socialization, that is, by the sharing of experiences

[2] Adapted from Peterson (2008)

and practices with others. Apprenticeship is an excellent example of socialization. Explicit knowledge becomes tacit through a process of internalization that is, by taking explicit knowledge (from others) and applying it in one's own practice. Finally, explicit knowledge is converted to more explicit knowledge through combination, that is, by combining or synthesizing different bodies of explicit knowledge. Formal education is an archetype of this knowledge conversion as is scientific deduction.

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