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Link to publication in VU Research Portal

citation for published version (APA)
Pahl-Wostl, C., Nilsson, C., Gupta, J., & Tockner, K. (2011). Societal learning needed to face the water challenge. *AMBIO: A Journal of the Human Environment*, *40*(5), 549-553. https://doi.org/10.1007/s13280-011-0149-1

SYNOPSIS

Societal Learning Needed to Face the Water Challenge

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This synopsis was not peer reviewed.

News reports on catastrophic floods and devastating droughts and their implications abound in recent years. Extreme events are becoming more frequent and their impacts increase in magnitude (Solomon et al. 2007) but societies have also become more vulnerable (Fuhrer et al. 2006; Maslin 2008). A proposed major reason for this increase in vulnerability and the associated environmental degradation is that the values of natural capital and associated ecosystem services remain unrecognized. Instead of preserving natural infrastructure to build adaptive capacity and reduce vulnerability to climate change impacts, natural capital is being destroyed (Opperman et al. 2009; Smith and Barchiesi 2009). This implies that the increasing trade-offs between human and environmental needs are not entirely inevitable but depend on how and by whom the benefits derived from nature are conceptualized. Counteracting these undesirable developments is an important governance challenge. Central questions relate to which knowledge and which services are valuable, which institutions could stabilize current behavioral patterns, and which barriers and drivers impede or support multi-level processes of societal change. The required change will have to be profound and embrace structural changes. However, institutions (cultural rules, societal norms, and legal frameworks), technical infrastructure, and actor networks that shape human–environment relations have co-

developed over a long time. Such systems exhibit strong path-dependence and inertia stabilizing prevailing system configurations and impeding major processes of change (Pahl-Wostl 2007). What is required may be also described as "unlearning" of deeply engrained beliefs in established practices.

The nature of such change can be captured by the concept of triple-loop learning as depicted in Fig. 1 (Hargrove 2002; Pahl-Wostl 2009). This concept posits that societal transformations can be described as multi-level and multi-loop processes. Single-loop learning refers to an incremental improvement of action strategies and daily routines without questioning the underlying assumptions. Double-loop learning refers to a revisiting of assumptions (e.g., about cause–effect relationships) within a value-normative framework. In triple-loop learning, underlying values and beliefs and world views are reconsidered if assumptions within a world view are no longer valid. In other words, triple-loop learning allows for re-examining the underlying ideological and value system. Societal learning is an exploratory search process where actors experiment with innovation and try to overcome or even remove constraints and boundaries they encounter.

SOCIETAL LEARNING: TRAJECTORIES AND AGENTS OF CHANGE

Historically, flood management was dominated by the objective of reducing flood hazards and increasing the safety of human life and infrastructure on floodplains. Taming rivers and conquering swampy, disease-prone floodplains for human habitation were celebrated as major successes of engineering and technology. However, over time the drawbacks also became increasingly visible.

Fig. 1 Sequence of learning loops in the concept of triple-loop learning. The example of flood management, which has been subjected to a global paradigm shift over the past decades, is used to illustrate the typical kinds of questions posed in the successive stages of learning
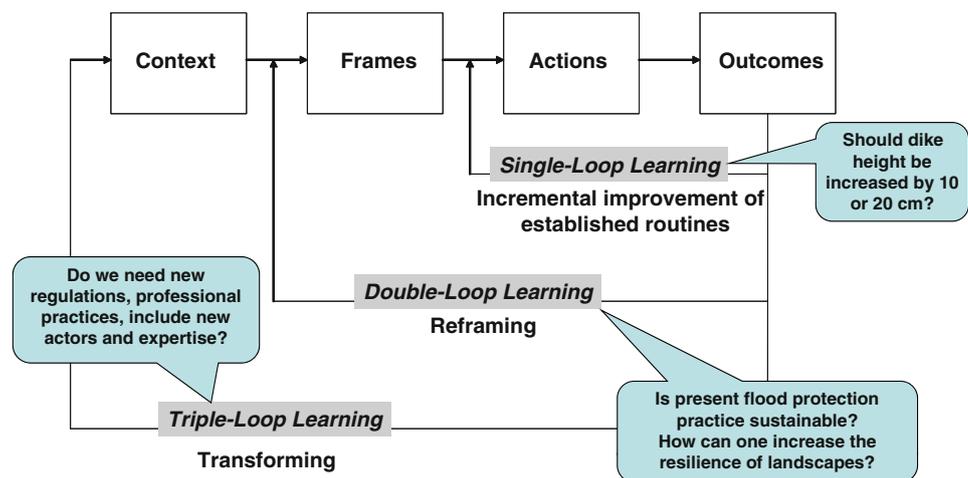
Despite reduced flood incidents, flood damage increased since more assets were located in exposed areas (Kundzewicz et al. 2010). This further increased the demand for flood protection. It is not until recently that the loss of important ecosystem services – natural buffering capacity, corridor function, and species conservation – has been realized and become the focus of restoration attempts (Arthington et al. 2010). Technical solutions for reinstalling these services by building facilities for flood retention storage and bypass have been proposed, supported by the general increase in environmental awareness in industrialized countries. This overall shift toward reducing risk and exposure rather than increasing flood protection is a major guiding principle of the European Union Flood Risk Management Directive (FRMD; e.g., van Alphen et al. 2009) on the assessment and management of flood risks that came into force in November 2007. This Directive was a response to the severe floods in many parts of Europe between 1998 and 2004. The FRMD requires EU member states to assess if watercourses and coastlines are flood prone, to map flood risk, and to take adequate and coordinated measures to reduce potential impacts. The FRMD also reinforces the rights of the public to access this information and to participate in the planning process. Such discourse and policy changes are not limited to industrialized countries but are applied also in threshold or developing countries (Dixit 2003; Rana 2003; Kahan et al. 2006).

One of the most pronounced changes can be observed in the Netherlands where the government has requested a radical rethink of water management in general and flood management in particular. The resulting policy stream, initiated through the 'Room for the River' (*Ruimte voor de Rivier*) policy (De Groot and de Groot 2009), has strongly influenced other areas of government policy. Greater emphasis is now given to the integration of water management and spatial planning with the regulating services provided by landscapes with natural flooding regimes being highly valued. This requires a revision of land-use practices and reflects a gradual movement toward integrated landscape planning in which water is recognized as a natural, structural element. Impacts related to global change are predominantly linked to the water system in particular through increased exposure to floods and droughts (Lehner et al. 2006; Smith and Barchiesi 2009). In landscaping and land-use planning, however, water is still most often considered as a secondary concern, and the delivery of water related services is taken for granted. Considering water as a key structuring element or guiding principle for landscape management and land-use planning requires technology, integrated systems thinking, and the art of thinking in terms of attractiveness and mutual influence, or even mutual consent, between the different authorities, experts, interest groups, and the public. In the Netherlands, water policy and managers have started to stress the importance of water as a structuring element in land-use planning. Moreover, the societal debate about the plans to build in deep-lying polders and other hydrologically unfavorable spots, and new ideas on floating cities indicate a considerable social engagement of both public and private parties with the issue of sustainable landscape and water management. However, such ideas although adopted in policy take time to implement as there is considerable social resistance.

The above example illustrates the multi-level nature of change and the importance of agents of change. Global knowledge communities have proven to be essential for spreading knowledge and among scientists and officials and through their different networks in leading to converging state policies (Haas 1992). Global NGOs such as the WWF or IUCN through to local networks are effective in connecting their different levels and knowledge bases,

and are present with a strong voice at the different levels of governance. Within intergovernmental relations, governments, epistemic communities and NGOs, an important factor is the role of leaders, e.g., policy entrepreneurs who build connections between levels and actor groups (Huitema and Meijerink 2009). Although potentially essential, such leadership may constitute also a weak point in the overall learning process. If political entrepreneurs miss to develop social capital in actor networks and shared practices, then a transformation process may be stalled with the departure of key individuals (Sendzimir et al. 2010). Informal settings support innovation and learning but formal agreements are required to stabilize achievements. Formal institutions that take a long time to negotiate among the social actors aim to provide a stable and predictable environment. However, at the same time, these institutions may be designed in a way that allows for limited flexibility and autonomous adaptive capacity and restrict the ability of society to adapt or innovate (Gupta et al. 2010). Particularly in flood protection, prescriptive legislation often dominates with little room for interpretation required for experimenting with innovative approaches. However, as the case of the Netherlands shows, the water legislation allows for new ideas and creativity; thus institutions can be designed to be more flexible and responsive to changing science and public perceptions. Designing institutions to be flexible, make room for redundancy, allow and stimulate learning, autonomous change and leadership, ensure equity and accountability is critical for dealing with the kinds of environmental changes that we are likely to experience in the future.

In changing institutions that have taken a long time to crystallize and stabilize, crises may play a key role. Crises have also played a key role in the overall process. Major flood events increase the awareness of the public at large and build pressure for political response. However, short-term responses after a crisis are not characterized by a reflective mode where learning and deliberation thrive. Instead, they constitute a window of opportunity which may allow new ideas to come to the fore if they had been developed beforehand.

We argue that the societal discourse on sustainable water resources management has moved to the stage of reframing (double-loop learning) in most fields especially in the developed countries but that the critical step to the next phase of structural change (triple-loop learning) is yet slow or absent. In Western flood management, there has been a shift over the past decades from the reigning paradigm "control of floods" to "living with floods" (Pahl-Wostl et al. 2011) and dynamic coasts. Such living with floods and dynamic coasts is an involuntary fact of life in many coastal and riverine states in the developing world. Although some developed states are moving in the

direction of structural reorganization and transformation of society there remain barriers and institutional inertia will still have to be overcome as well as there is need to generate broad social consensus. While the theory of living with water is appealing to scholars, for those whose property and lifestock may be affected, this may not be quite as acceptable. In contrast, approaches to dealing with water scarcity and drought seem to be largely locked in the current frame of reference with an emphasis on improving the efficiency of current water use patterns. A reframing has taken place in the shift from the sole emphasis on water supply and resource development to managing water demand (Gleick 2003). However, no evidence can yet be detected for a more profound movement toward an entirely new paradigm such as "accepting boundaries" and accepting also the rivers and floodplains as legitimate users of water. Such a paradigm would encourage land-use practices that are guided by water availability rather than trying to maintain prevailing land-use practices that can hardly be sustained in the long term.

LOOKING AHEAD: THE SCIENCE AND POLICY CHALLENGE

The major challenge for science and policy is how to understand and manage a transition toward sustainable water management in different environmental, social, economic, and political contexts. The notion of "managing" may be somewhat misleading since it could be interpreted as entailing a conscious steering of such (yet non-existing) processes. Regime transitions are societal search and learning processes, influenced by the short-term cycle of political elections and changing politics rather than a well-defined and controllable societal change. However, this does not imply that such processes cannot be supported and influenced. It is hence important to develop and convey a new understanding of what is meant by "managing transitions." More attention has to be given to network governance, emergent leadership, and negotiated order and their links to formal policy processes, to the requirements for an adaptive management of such processes of change. A better understanding is required of the role of structural and agent-based factors and their mutual interdependence in differing contexts.

Do crises and catastrophes really support learning? Are there any indications that crises and experiences at one place trigger learning in another location and can lessons be transferred? Given the complexity of the processes under consideration we cannot expect to find simple recipes. However, it would also be unsatisfactory to argue that every problem and learning situation is unique and that general conclusions are elusive. Currently, we do not have

the concepts and methods in place to build the knowledge base that would allow for testing these propositions. Interdisciplinary efforts are needed across the natural and social science interface but also within the social sciences where collaboration across disciplinary boundaries is yet quite limited. Shared conceptual and methodological frameworks and rigorous case study methodologies need to be developed to support comparative analyses across a wide range of cases (Ostrom 2009; Pahl-Wostl 2009). Viable methodologies that generate interdisciplinary knowledge are not developed on paper but in practice. Support is required for large-scale and long-term comparative studies and research efforts in different countries that transform their water governance and management systems to build adaptive capacity required for dealing with climate and global change. Such analyses will lead to a shared data and knowledge base as one product and a fruitful exchange across the science policy interface.

In this whole process, the role of power, politics, and resources cannot be ignored. Central questions relate to who frames a problem, who has the potential solutions, what and whose knowledge is considered, and what are the available resources. The epistemic community around water has for a long time been dominated by the natural sciences and engineering and by research and researchers located in the North. The major problems to be tackled lie in the human dimension and governance systems and are mainly located in the Global South. Hence, major efforts need to be undertaken to build capacity in social science research in the water field and strengthen research capacities in developing countries. It is still easier to raise money for large-scale infrastructure development than for household technologies combined with capacity building at the local level. It is futile to design laws and policies if there are no financial, human, and infrastructural resources to implement these. Designing regulatory frameworks that are applicable under specific circumstances is more useful that designing the perfect law for a context in which it is unlikely to function. Research efforts need to be combined with policy processes at global and national levels to make water governance and management the guiding principle of sustainable development policies rather than the victim of developments and priorities set in other policy fields.

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