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Opinion Paper

Emergent principles for river management

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Abstract

Paradigms for land and water management are on the move. New approaches are said to be, or meant to be, more 'participatory', 'integrated', 'adaptive', 'ecosystem-based' and so on. The present paper explores emergent principles for land and water management in ecological management theory, environmental science and the social sciences. These principles comprise adaptive management, opportunity-driven analysis, visions of managers and the public, and co-management that includes local and supra-local rationality. The paper concludes that for river management, these principles largely reinforce each other. This lays a basis for a style of river management in which the river managers may continue to be the guardians of science-based and whole-basin rationality, while at the same time interacting more successfully with society.

Introduction

In 1837, after two centuries of debate, it was decided to drain and impolder the Haarlem Lake (Haarlemmermeer), covering some 100 km^2 between the cities of Leiden and Amsterdam in the Netherlands. In order to organize this great work, a Management Commission was established, composed of high-ranking politicians, administrators and engineers. The Commission had the full responsibility of all aspects of this work – technical, financial, social and spatial. It answered directly to the Secretary of the Interior and to the King, without a need to involve any of the many other departments, local governments and agencies that would nowadays be called 'stakeholders'. On that basis of absolute power, the Commission followed a flexible approach, adapting the technical plan to changing circumstances and rational objections of regional and local organizations. Twenty years later, against all technical and financial odds, the area was dry and parcelled out for agriculture, and was given back to the local government and farmers; testimony of the success of a strictly top-down, autocratic, centralized, rational and yet responsive type of planning and implementation (Jeurgens, 1991).

In present-day views on planning, this elitist 'Haarlem Lake planning style' is regarded as a sure recipe for moral and practical failure. Planning nowadays should always be participatory, i.e. including local stakeholders from the early stages onwards, or even be fully locally based (e.g. Leuven et al., 2000; Lenders, 2003; Morrison, 2003; Wiering & Arts, 2006; Witter et al., 2006). One extreme paradigm of locally based planning is ''Endogenous Development'' that is grounded solely in indigenous visions that encompass a

community's human, natural and spiritual spheres of life, embedded in local identity and the 'bioregional narrative' (Cheney, 1989).

This paper will not review all issues of planning styles and methods that lie between these two (elitist and endogenous) extremes. Rather, we aim to draw some contours of a possible paradigm for our times, geared especially to river and river landscape planning and management. We have tried to do so, moreover, in a non-technical fashion that aims to keep aboard the natural scientist and others for whom the theory and practice of planning and management are only distant (and often rather boring) realities.

Our method will be to first take stock of a number of emergent principles in three relevant disciplinary fields. The first is on ecological management that finds new inspirations in non-equilibrium (or multi-state equilibrium) ecosystem dynamics. The second field is that of interdisciplinary environmental science, focusing especially on the shift from problem-oriented to more opportunity-oriented work. The third is social science, focusing especially on the concept of co-management. It will then be explored to what extent these principles contradict or reinforce each other. Most sections will contain a few examples of contributions of hydrobiology.

Evolution of ecological management concepts

Overall, Western societies have become more conscious of the values of nature and the functions that ecosystems and landscapes have for the quality of human life and community identity. With that, land use planning has in many places become more 'ecosystem-based'. Ecosystem-based planning is even becoming a concept of its own, with an emphasis on involving all actors that are connected to the regional ecosystem in a planning process that takes as its point of departure the functions that the system performs for these stakeholders – instead of first designing what society wants and then try to force nature into this human straightjacket (Imperial, 1999). Ecosystem-based river management means to first take heed of what the river is, how it functions and what it could be in terms of, say, hydro-morphodynamics, biodiversity, connectivity and integrity (Nienhuis & Leuven, 1998), and only then enter into a give-and-take between society and this functioning.

On a more theoretical level, studies on the dynamics of forests, drylands and other ecosystems have lead to new concepts of non-equilibrium ('states-and-transitions') ecology, such as resilience and the adaptive cycle (Holling & Gunderson, 2002) or catastrophic shifts (Scheffer et al., 2001). Although it could be argued that river system components such as wetlands and floodplains are not always the most perfect examples of dominance of adaptive cycles over 'classic' succession (Scholte, 2005), non-equilibrium ecology leads to a new appreciation of rivers as dynamic, self-rejuvenating systems.

Non-equilibrium ecology supports a vision of spatial planning as 'adaptive management', i.e. management that is constantly monitoring and responding to internal and external change of the ecosystem and its social context, rather than management based on static 'ideal' blueprints. See for instance Imperial (1993) on estuarine ecosystems. With Kessler (2003), we may add here that adaptive management requires not only flexibility on the short term, but also a guiding vision of the very long term, a vision that is realistic and yet inspirational, not blocked by all constraints that may exist on the short term (contrary to the concept of 'target image'; Lenders et al., 1998). Such a vision is not only a source of inspiration for stakeholders in the planning process (Mitchell, 2002; Morrison, 2003). It also makes adaptive management less purely reactive and more anticipatory, and it counterbalances the risk that the sum-total of short-term adaptations may later turn out to have been steps on an irreversible and undesired pathway. In the present-day context of room-for-river policies in Europe (Van Stokkom et al., 2005), it is worthy to note that in a book published more than 170 years ago, the historian Bilderdijk (1832) lamented that the Dutch should never have begun to embank their rivers in the first place. If our hydraulic forefathers would have had a truly long-term vision, Bilderdijk writes, we would have left their natural course, floodplains and floods to the rivers, and we would still live above river level.

In a long-term vision as part of an adaptive management strategy, adaptability itself should be a central tenet. Paraphrasing the well-known

definition of sustainable development, the results of our adaptive management should not compromise the ability of future generations to do their own adaptive management. The practical value of this principle of reversibility and keeping options open for future generations can easily be imagined when we realize that we ourselves are the future generations of our forefathers. Doing a bit of 'counterfactual history' as a thought experiment with regards to the impoldering of the Haarlem Lake, it could be surmised that present-day society (and hydrobiologists) would be much happier if the 19th-century planning and design of the impoldering would have been guided by a long-term vision of open options for future generations and not, as it happened, by a vision that assumed an eternal value of the two functions (land loss prevention and agriculture) that happened to be the most salient at the time of the decision-making, bypassing all principles of reversibility as well as interests of water management, waterborne (sailing) transport and fisheries. Quite possibly, the lake would have been kept more open, and buildings and infrastructure would have been planned with more reversibility, e.g. by situating them closer to the polder edges. In the course of history then, the lake-cum-polder could have been adapted to the radical change that has taken place in the value of open water versus that of sugar beets. Part of the lake would still be open, other parts could have been reflooded and nature and recreational options could have been developed. Moreover, urban development of the cities of Amsterdam, Haarlem and Leiden around such a lake would have been much more interesting than the faceless suburbs, industries and airport that have sprawled into the polder due to the currently low value of agricultural land.

Present-day Dutch river authorities do have a long-term vision, and one that looks remarkably like Bilderdijk's. The room for river ambitions of the river authorities cannot be explained by political opportunism or cost-benefit analyses using normal discount rates. They are part of a truly long-term vision. Making room for the rivers, contrary to raising ever-higher dikes, is seen as the first step in a long process of re-naturalization of the Dutch water system that is necessary if only for long-term economic reasons. Moreover, room-for-rivers is a particularly good vision for adaptive management, because it leaves room for future generations to adapt the open space to their own needs and visions. A criticism on present-day room-for-river policy could only be that its implementation is not adaptive enough yet. River authorities often seem to try forcing the room for rivers into society in stead of searching for and working with the opportunities at hand (see also Wiering and Arts, 2006).

One type of such opportunities is that, as a by-product of great value for the future, new room for rivers often implies new room for nature and landscape development, too. Due to the dynamic character of the rivers, the specific values of new riverine nature will usually lie in the rareness and naturalness of the processes that build it, rather than in species and pattern diversity *per se*. These dynamic and robust riverine ecosystems can often accommodate a relatively high level of (respectful) human presence in them. Such relatively wild nature that can accommodate human participation will be of increasing social and cultural value in North-Western Europe where other landscapes are rapidly becoming more urbanized and more regulated (De Groot, 2004). This not only enhances the democratic basis of room-for-river policies in general. The satisfaction of urban desires for wild nature also creates new opportunities for economic benefits for riverine communities. Other parts of the widened floodplains could be kept under traditional agricultural management, with the open grasslands that are of great cultural value in Dutch society. This landscape, too, can be made to accommodate much more human participation than it does at present, e.g. with less fences and more footpaths, as in the English countryside.

Evolution of environmental science

Environmental science may be defined as the discipline structured around the need to address the environmental issues of society. Seen this way, environmental science started out in the early 1900s, when biologists and chemical scientists began to study and proclaim the vulnerability of nature and the nastiness of pollution. If solutions happened to be within easy reach (e.g. flushing of city canals or purchasing of natural areas), these

efforts of natural scientists often were, as they sometimes still are, sufficient to find and implement solutions for the problems. During the 1970s, when the environmental problems rapidly acquired more urgency and depth, environmental science evolved into a truly interdisciplinary field, with the social sciences added in order to gain more insight into the social causes and solutions of environmental problems, and the humanities added later in order to reach more depth in the ethical and cultural aspects of the environmental problems.

This paradigm of 'interdisciplinarity around the problem core' proved to be productive, as shown not only by the countless applied studies focussing on specific environmental problems but also by the more fundamental development of integrated environmental models and many methodologies of environmental impact assessment, derivation of environmental standards, societal analysis and environmental policy design. Hydrobiologists contributed to this 'classic', problem-oriented environmental science with many studies on the ecology of eutrophication and toxic pollution and the development of assessment systems such as the Saprobic Index (e.g. Zelinka & Marvan, 1961) and species sensitivity distributions (Posthuma et al., 2002); see also Vugteveen et al. (2006) on ecosystem health.

In the course of time, limitations of the problem-oriented paradigm also began to show. Expansions of environmental science are sought, at present, in two directions, both of which aim to make this discipline more fundamental and with that, on the longer run, more broadly effective for society.

The first direction is caused by the limitation that traditional environmental methodologies such as problem in context (De Groot, 1998), even though enabling the researcher to connect environmental problems with their underlying causes in society, do not facilitate to study these underlying structures and processes in their own right. From the environmental problem 'downward', the researcher may tap into the cultural phenomena and the structures of actors causally connected by the mechanisms of power, which he may then use to explain and maybe even solve the environmental problem at hand. Next time he may do this again, and again – but what is the pattern, the 'systemness' of these social causes? Out of the ensuing desire to address these fundamental relationships between environment and society in a more systematic manner grew the study of the society–environment system. Ecological economics and the study of the material metabolism of societies, e.g. in material flows or ecological footprint analyses, are important expressions of this new 'sustainability science'.

Secondly and more importantly for the present exploration, it was increasingly felt that environmental science should not continue seeing the world as only the total sum of environmental problems, ignoring the fact that right next door, as it were, lie the myriad of instances where the environment is not a problem but rather a source of happiness and benefit. The environment is not only a constraint. Nature is not only something vulnerable that should be protected. The environment is also an opportunity for improved quality of life, and nature is also something dynamic that may be further developed. Integration of these insights into the discipline leads to an environmental science that retains its basic normative drive of working for relatively concrete issues of society, but is more broadly future-oriented than its problem-oriented origin. A good example is the book of Mitchell (2002) on environmental management that discusses methods of long-term visioning and participatory opportunity analysis alongside with traditional problem-oriented approaches such as environmental impact assessment (EIA). Another typical product of this happier and more opportunity-driven environmental science are the studies of Van den Born et al. (2001) that aim to elicit the philosophical visions that people in the Netherlands and elsewhere have of the relationship between humans and nature, cast in terms of mastership over nature, stewardship of nature, partnership with nature and spiritual participation in nature. One of the results of these studies is that to a remarkable extent, people in Western Europe express visions that lie far beyond the Cartesian image of mastership over nature, and seek to encounter nature also in its greatness and wildness.

Rivers and river landscapes offer obvious opportunities for this encounter. Put more generally, rivers and other water bodies, besides being objects of pollution, risks and other problems, obviously play many positive roles in the lives of people too. They naturally link up, therefore, with

the more opportunity-driven new branch of environmental science and management. Along with that, hydrobiologists find new employ for studies on the restoration and rehabilitation of water systems (e.g. Nienhuis et al., 2002) and, remarkably, also for descriptive studies elucidating the history and intricate beauty of local aquatic ecosystems such as those of Nienhuis (2003) on the Dutch estuaries – studies that used to be associated with the earliest phase of environmental science (see above).

Evolution in social-scientific management concepts

A central distinction within the social sciences is between the 'micro' and 'macro' levels of analysis, denoting, respectively, the level of individual actors and the level of the large social systems ('societies') where actors are anonymous. Within economics, for instance, micro-economics focuses on the rational behaviour of individual people, households and firms and stands besides macro-economics that studies the overall behaviour of large-scale economic systems in terms of aggregate indicators.

Implicitly in this scheme, nothing *between* these two levels is conceptualized as worthy of analysis. A well-known example of this pattern of reasoning and the recommendations it gives rise to is Hardin's (1968) 'Tragedy of the Commons', in which he explained that individual actors (micro level) are always bound to over-exploit and destroy their common good (macro level) even if this is to the detriment of each actor. Obviously then, the recommendation can only be that all common goods, including environmental goods such as forests and water bodies, should either be cut up into privately owned portions or be fully state-owned, so that private actors can be coerced to behave.

Many social scientists became increasingly uncomfortable with this situation. It was found, for instance, that many common goods such as grazing lands, forests and fisheries had been managed sustainably over the ages neither by private actors nor by the state, but by voluntary associations of actors that organised the management of the commons among each other, tuned to the local ecology and culture. If many of such common properties did disappear in the course of history, it was often by usurpation by the state or external private powers rather than by internal incapacity of the communities (Cox, 1985). Observations such as these supported a new interest in community-level institutions, as found, for instance, in the seminal work of Putnam (1993) on social capital and of Ostrom (1990) on environmental common properties. In economics, institutional economists and game theorists try to fill the void between the micro and macro levels.

The new social science supported the ongoing drive towards community-based rather than state-based management of nature and natural resources (Ghimire & Pimbert, 1997). Much of this drive is fuelled by the practical limitations and the moral *défit* of state-based nature conservation in developing countries (e.g. Colchester, 1997) but even in these countries, community-based management is often confronted with strong limitations, too. Communities may be quite capable of small-scale environmental monitoring (e.g. Hunsberger et al., 2005) but may find themselves at a loss when large-scale monitoring of resources is at stake. Fishery communities, for instance, may experience great difficulty in organizing the monitoring of large-scale fish stocks, and a supra-local actor such as the state may then step in to fulfil this function. Other limitations of communities are more fundamental, and especially concern local *motivations* rather than capacities. It is quite difficult for a local community, for instance, to see, let alone be motivated by, the national or global rareness or functions of say, the forest, the species or the floods that are so abundant locally. To a varying but significant degree, therefore, the state, speaking on behalf of supra-local scales and functions, is often quite justified to remain involved in local natural resource management. *Co-management* is the term most used for this pattern of mixed responsibilities and mutual support of communities and supra-local authorities (e.g. Borrini-Feyerabend et al., 2004). Other terms are joint management, collaborative management or cross-scale institutional linkages (Berkes, 2002).

Co-management has a long-standing tradition in fisheries, a sector where strong government motivations tend to clash with strong local communities, so that co-management arrangements arise almost naturally (Wilson et al., 2003). Co-management concepts are now expanding over

terrestrial sectors too, e.g. as 'Joint Forest Management' in India. In fact, principles of co-management are applicable in all situations where evident local interests interweave with evident supra-local rationalities, even in centralistic countries such as the Netherlands. One Dutch example, discussed by Brussaard (2004), though without mentioning the term co-management, is a case in the province of Friesland where the government exempted a local farmers group of a generic nitrate control measure, under the condition that the farmers would find their own creative solutions for the nitrate problem.

Rivers, obviously, also belong to the category of candidates for co-management inspirations. Local identities and economic interests are often river-bound but at the same time, rivers are typically large-scale systems that call for a large-scale (state or state-like) management authority. Some river problems such as large-scale pollution may lie beyond the scope of community involvement, but for many other policy issues (e.g. room-for-rivers), river management can develop into directions that seek to include the voice of local communities from the very beginning, in a style of communication and negotiation that is much more fitting, practically and ethically, than traditional 'participation' of communities in essentially state-driven planning.

Could this have implications for (applied) hydrobiology? Could there exist a distinct style and/or content of applied hydrobiological studies geared towards the co-management of rivers and other water bodies? Brussaard (2004) is optimistic in this respect based on his (terrestrial) case study, when he talks about the role of ecology in the design of locally viable management and monitoring options, and the fact that scientists can learn from this work, but he also mentions the problem that governments have funds for research, while communities do not. Institutions and funding for 'joint science', in our view, are prerequisite for developing an ecology and hydrobiology to underpin co-management of land and water in Western societies.

Confluence or contradiction?

Sciences are connected to societal sectors and interests. To all likelihood, therefore, our focus on ecology, environmental science and social science has ensured that the identified principles are conducive to express the interests of nature, sustainability and communities, respectively. Other disciplines will generate other principles, however, and the fact that we did not focus on, say, economics, logistics, risk analysis or conflict sociology implies that the principles we found may not be equally conducive to express the needs of cost-effectiveness, river-based transport, flood risk management or conflict mediation, e.g. between upstream and downstream interests. Obviously then, the principles discussed in this paper are not the only ones needed for balanced river management. We will not further explore this limitation here, however, and rather focus this concluding section on the degree to which the principles we have identified may contradict or reinforce each other. We will ignore the too obvious cases, e.g. that adaptive management goes well together with opportunity-driven environmental science.

Starting out with the idea of adaptive management that is supposed to go together with a long-term vision, we have seen in the section on ecological concepts that these two do not go together automatically. River authorities can have a strong long-term vision and at the same time be relatively un-adaptive in their mode of operation. On the other hand, nothing seems to stand in the way of change in this respect. We might even say that the better you know where you want to arrive in the long run, the easier it is to make flexible choices along the way.

The principle of ecosystem-based management may appear to contradict the principle of co-management. After all, the idea of co-management is only an idea about how human agents could deal with each other, without the ecosystem being in view. This, however, is nothing specific for co-management, since any type of management is a human affair. In fact, ecosystem-based planning and management may well reinforce the characteristic 'co-' in co-management. In ecosystem-based co-management, the state and the local communities, in stead of addressing each other head on, first listen to the ecosystem as a 'third party' and analyse what the ecosystem means to them. This gives parties a common footing before entering into their more adversary roles, and is comparable to the role of research into the groundwater system in Ostrom's (1990) case study

of building institutions for groundwater management in the USA.

The vision of managers in the principle of adaptive-management-with-long-term-vision is a quite different thing from the 'visions of nature' of the public. The content of these visions might therefore well contradict each other, as would be the case, for instance, if the river managers would entertain a long-term vision of an ever more fully regulated river while the public would cherish partnership with nature and participation in a more natural river landscape. It so happens that at least in the Netherlands, this contradiction does not present itself at all, however. Re-naturalization is a shared vision of river managers and society. This does not mean, at the same time, that concrete proposals of river re-naturalization will always be greeted with happiness by the concerned community. People's responses are always highly contextual, and people's ideas on nature vary a lot when going from the 'high visions' down to daily life necessities (De Groot & Van den Born, 2003).

A strong long-term vision of the river managers could easily run counter to the open exchange of views with local communities that is implied in co-management. True motivation for co-management may in fact arise only if the river managers' vision would include not only the re-naturalization of river itself but also the co-managing and adaptive style of getting there. Reaching such a more inclusive vision, to a depth equal to the present-day vision that focuses on the river only, requires a rethinking of present-day paradigms and restyling of the way that river managers feel and communicate. But this is certainly not a mission impossible because the rethinking and restyling does not contradict the most basic motivations of river managers. Also in settings of adaptive co-management, river managers can continue to be the guardians of technical, science-based and supra-local rationality, and they can continue the pursuit of re-naturalization of the great rivers – only, possibly, more successfully.

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