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Water, ecology and health: ecosystems as settings for promoting health and sustainability

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SUMMARY

Despite the proposed ecological and systems-based perspectives of the settings-based approach to health promotion, most initiatives have tended to overlook the fundamental nature of ecosystems. This paper responds to this oversight by proposing an explicit re-integration of ecosystems within the healthy settings approach. We make this case by focusing on water as an integrating unit of analysis. Water, on which all life depends, is not only an integral consideration for the existing healthy settings (schools, hospitals, workplaces) but also highlights the ecosystem context of health and sustainability. A focus on catchments (also know as watersheds and river basins) exemplifies the scaled and upstream/downstream nature of ecosystems and draws into sharp focus the cross-sectoral and transdisciplinary context of the social and environmental determinants of health. We position this work in relation to the converging agendas of health promotion and ecosystem management at the local, regional and global scales—and draw on evidence from international initiatives as diverse as the WHO Commission on Social Determinants of Health, and the Millennium Ecosystem Assessment. Using water as a vehicle for understanding the systemic context for human wellbeing, health promotion and disease prevention draws inevitable attention to key challenges of scale, intersectoral governance and the complementary themes of promoting resilience and preventing vulnerability. We conclude by highlighting the importance of building individual and institutional capacity for this kind of integration—equipping a new generation of researchers, practitioners and decision-makers to be conversant with the language of ecosystems, capable of systemic thought and focused on settings that can promote both health and sustainability.

Key words: healthy settings; ecosystem; water; health and sustainability

INTRODUCTION

The settings approach to health promotion is characterized by ‘ecological’ and systemic perspectives (Green et al., 1996; Poland et al., 2000; Dooris, 2006). Despite this orientation, healthy settings initiatives, such as healthy cities, schools, workplaces and hospitals, often overlook the situated and contextual specifics of the ecosystem. This results in the incongruous situation of initiatives that are place-based and conceptually ‘ecological’, but blind to the processes, functions and populations of local ecosystems. This disconnect is inconsistent with the socio-ecological approach of the Ottawa Charter (WHO, 1986), and recognition of ecosystems as a basis for framing and informing health promotion (Cole et al., 1999; Butler, 2006). It is also out of step with growing awareness of the supporting, provisioning, regulating and cultural role of ecosystems, and recognition that ecosystem disruption has both direct and indirect implications for health that tend to exacerbate existing health inequities—whether through exposure to physical

Table 1: Applications of systems theory relevant to – but not explicit in – the healthy settings agenda

Field of endeavour	Systems theory (and application)	References
Epidemiology	a social–ecological perspective;	(McMichael 1999)
	an ecosocial approach to health	(Krieger, 2001)
Environmental health	environment as ecosystem, ecoystem services support health and wellbeing, ecosystem impairment leads to 'direct'; 'ecosystem mediated' and 'indirect, deferred, displaced' health impacts.	(Corvalan et al., 2005)
Ecosystem approaches to human health, and Ecohealth	ecosystem approaches to health ecosystem sustainability and health	(Lebel. 2003) (Waltner-Toews, 2004)
Infectious disease ecology –	social ecology, coupled human–natural systems, linked social–ecological systems	(Wilcox and Colwell, 2005; social and ecological systems Parkes et al., 2005)
Natural resource management, ecosystem management	social–ecological systems, resilience, adaptive management, governance of common pool resources	(Berkes et al. 2003; Ostrom 1990)
Business and organizational behaviour	open systems theory, participative strategic planning.	(Emery, 2000)
Community development	soft systems methodology, process of inquiry; purposeful participative action	(Checkland, 1999)

hazards or loss of livelihoods (Corvalan et al., 2005; Marmot, 2007). The failure to embed healthy settings within ecosystems is also a missed opportunity to enable more integrated approaches to promoting the commonalities between health promotion and sustainable development (Dooris, 1999). Ecosystems can intuitively be recognized where boundaries are obvious, for instance, urban ecosystems, island ecosystems or water catchments.

The aims of this paper are to draw attention to the importance of ecosystems as contexts for healthy settings initiatives; to introduce water as a physical, literal and figurative vehicle for understanding the systemic context for health and wellbeing; and to examine the potential contributions of catchments as a setting for achieving health promotion. We argue that such an approach not only provides direction for the greening of health settings, but also offers a timely platform for integrated and cross-sectoral approaches to improving health by addressing both its social and environmental determinants (Parkes et al., 2003).

CONCEPTS: RE-INTEGRATING SETTINGS, ECOSYSTEMS, WATER AND HEALTH

Settings and ecosystems

While the evolution of the healthy settings approach is characterized by debate regarding the definition

and evaluation (Whitelaw et al., 2001), an overarching conceptual consistency has been proposed for a settings approach—based on an ecological model of health promotion, a systems perspective and a focus on whole system organization development and change (Dooris, 2006). Despite this conceptual coherence, we note some practical concerns and dilemmas about how the 'ecological' approach to health settings has manifested. One of these is the relative lack of cross-reference and exchange with other health, environment and development fields that have been heavily informed by ecological and systems-based thinking (Table 1). Arguably, each of these fields is equally guilty of implementing their 'systemic' approach in territorial silos of 'health protection/promotion', 'environment', 'community development' and so on. Another related concern is that core health promotion practices often fail to reflect system behaviours or to incorporate the fundamentals of ecosystems in their design and approach (see Table 2). We see this oversight as a manifestation of what James Kay describes as the unsurprising challenges of (eco)systemic thinking. 'Generally these [dynamics of complex systems] are not intuitive to people. They do not conform to the Newtonian notion of linear causality mode of reasoning that is cornerstone to ... culture' (Kay and Schneider, 1995).

Water, catchments and systems

James Kay's quote raises the question of how to integrate genuinely ecological and (eco)systemic thinking to the mainstream health sector without surrendering such an endeavour to the domain of specialists and isolationist language. We claim that a focus on water can respond to this dilemma. Water, where it is found and how it behaves, is variously expressed in such terms as catchments, river basins or watersheds. These terms refer to a practical geographical unit for where water concentrates along with solar energy, nutrients and soil, and where functions of water purification, nutrient recycling, waste decomposition and flood and drought resilience, are performed. 'Water's flow in the landscape makes the catchment i.e. the area inside a water divide, a useful spatial unit in which ...management also involves the linking of upstream and downstream activities in the catchment' [(Falkenmark and Folke, 2002), p. 4].

Barry Commoner's laws of ecology[a]	Matching systems attributes:	Water properties
Everything is connected to everything else	Interconnectedness and complexity	The hydrological cycle, constant dynamic changes in state and location
There is no such thing as a free lunch	Inter-relationships and reciprocity	Reciprocity: flow and cycling of water defines catchments; boundaries of catchment define where and how water moves
Nature knows best	Integration; a state of knowing comes from the whole as much as the parts; feedbacks and self organization.	Self organization into catchments, characterized by upstream and downstream interactions
Everything must go somewhere	Nestedness: there is nothing that exists outside of [its] 'ecology' Interdependence, cycling, non-linearity, uncertainty Emergent properties	Hierarchical nestedness (smaller catchments within larger catchments) temporal and spatial variability of water and hydrological cycle;

		movement of surface, ground and piped water: flows, springs, seepages, drainage, washes ...

[a] From Commoner (Commoner, 1971).

Several lines of reasoning support our focus on water. The foremost of these is the fundamental nature of water, one of several elemental features of ecosystems that unify life (the others being air, earth and fire). The properties of water are extraordinary, from its ubiquity, to its status as a solvent and its thermal properties. For humans, water is meaningful for everything from physiology to spirituality. Water is arguably human society's principal natural resource, and its distribution and abundance lies at the basis of human settlement, the growth of urban areas, the provision of food for those metropolizes and the expulsion of their wastes. We engineer the delivery of water and wastes, further structuring our community spaces and personal lives, as well as protecting ourselves from the immediacy of water extremes such as floods and droughts.

These fundamental features of water can be well understood by people everywhere (U. Goeft, unpublished thesis). Falkenmark and Folke highlight the concerning implications if these features are overlooked: 'the deep and multiple involvement of water, in its function as the bloodstream of both the anthropogenic world and the non-human natural world suggests that goal conflicts related to water may be numerous ...Developing understanding of the role of freshwater ...and its relation to the dynamic interactions between water security, environmental security, and food security is needed urgently if prosperous societal development is to be achieved within a sustainable biosphere.' [(Falkenmark and Folke, 2002) pp. 2–3]. Many would argue that these challenges extend beyond the domain of Health Promotion, whereas we propose an overlooked need to reengage with the imperative of water and ecosystems for promoting health.

Second, the location of water, whether surface water or groundwater aquifers, can be considered a surrogate for the distribution of all natural resources. The conditions under which the water has carved the catchment (or defined the aquifer's sediment) are strongly influenced by both climatic regime and geological foundations, which are the same regional conditions under which the soil has been formed, and vegetation evolved. If surface water distribution is a proxy for the distribution of natural resources, then organization of local and regional societies will, to certain extent, reflect that distribution. The local and regional appropriateness of development, particularly where it affects natural resources, land use and climate, is best determined by foregrounding water and its catchment supply. This argument is best exemplified by new integrated catchment management (ICM) (Bellamy et al., 1999) (although it is rarely practised as such).

Third, the cultural, social, biophysical and political nature of water is universal over time and culture. Catchments, river basins and water sources are often important sources of cultural or community identity and sense of place (Horwitz et al., 2001; Parkes and Panelli, 2001)—a contemporary reality that reflects long-standing connections between waterways and Indigenous cultures (Townsend et al., 2004; Kaneshiro et al., 2005). The forecasts of global climate change, including changing seasons and distributions of rainfall (IPCC, 2007), will only intensify the political ecology of water (Postel, 2000). In sum, 'where we are and who we are' is related to water access, flows and cycles in a manner that embraces both environmental and social determinants of health and demands socio-ecological perspective. A reciprocity then holds, that' ... sustainable and regenerated water catchments are the emergent property of social processes, and not the technical property of an ecosystem ...That is, desirable water catchment properties arise out of interaction ...among multiple, interdependent, stakeholders ...'[(Ison et al., 2007)
p. 500]. The biophysical and social processes of water are intertwined in complex ways.

Together, these understandings of water are represented by our metaphorical use of water-related terms to express more complex phenomena, like the upstream (causal) determinants of

(downstream) health consequences. Concepts of flows, cycles, springs, floods, droughts and so on all have meaning in other contexts. Such metaphors are powerful in indigenous languages too, and in proverbs, sayings and other wise utterances. For instance,

> Nothing in the world is more flexible and yielding than water. Yet when it attacks the firm and the strong, none can withstand it, because they have no way to change it. So the flexible overcome the adamant, the yielding overcome the forceful. Everyone knows this, but no one can do it. (Lao Tzu, translated by Cleary [(Cleary, 1993), p. 66].

This quote, attributed to the Chinese Taoist Lao Tzu, helps us to see the systemic properties of water and draws attention to the links between general laws of ecology, systems thinking, and the properties and behaviours of water as presented in Table 2.

The systems thinking outlined in Table 2 reminds us that nature, societies or organizations are not best understood by relatively simple, linear, equilibrium-based models. Systemic principles implore us to think about alternatives to controlling a system. Similarly, predicting a system's behaviour without attending to uncertainties (unforeseen or unforeseeable consequences) or complexities becomes part of the problem. Perhaps most importantly, attending to systems principles redresses a dysfunction in western thinking and policy-making that separates people or their institutions from their surroundings, their context.

CONTEXT: CATCHMENTS AS SETTINGS FOR HEALTH AND SUSTAINABILITY

'Locating' ourselves—and our settings for health promotion—in relation to water is both a description of and a means to understand 'context' and reciprocity. Here, we draw on the socio-ecological features of water, ecosystems and health to examine the proposal of catchments as context, and settings, for promoting health and sustainability. We propose catchments as a tangible context within which to fulfil the Ottawa Charter's (WHO, 1986) call for reciprocal maintenance 'to take care of each other, our communities and our natural environment'. Table 3 summarizes this potential in relation to a series of mutually reinforcing arguments spanning ICM, the determinants of health and health promotion.

More reciprocity: health promotion and ecosystem management

The increased recognition of the life—and health—supporting qualities of ecosystems indicated by the Millennium Ecosystem Assessment (Corvalan et al., 2005) is extended and supported by a range of international initiatives. The WHO Commission on the Social Determinants of Health is explicit about links between ecosystems and social determinants of health noting that 'addressing the intersection between social determinants of environmental change and the effect of environmental change on health inequities will benefit sustainable ecological and population health alike' [(Marmot, 2007) p. 1156]. Likewise, the Millennium Development Goal to 'Ensure environmental sustainability' (MDG7) has implications for most other MDG's—not least the provision of ecosystem services required to 'Eradicate extreme poverty and hunger (MDG1)' (United Nations Development Programme, 2008). There is also a shift from global-scale concerns such as climate change (Confalonieri et al., 2007) to the specific implications of place-based ecosystem management and conservation policies for health and wellbeing (including poverty reduction). For instance, the intergovernmental Ramsar Convention on Wetlands has resolved to undertake an extensive review of the interactions between wetlands and human health, and adopted the theme 'Healthy Wetlands, Healthy People' for its Conference of parties in 2008. Another example is the increasing attention to public health implications of water resources management (Parkes et al., 2008).

Table 3: Simple arguments for complex relationships—catchments as settings for health and sustainability[a]

Integrated catchment management (ICM)	Connection with determinants of health	Implications for healthy settings
Calls for ecosystem-based approaches to integrated water resources management have led to the field of ICM.	Our understanding of environmental hazards (microbiological and chemical) is enhanced by understanding of ecosystems attributes (see Table 2).	Catchments provide an ecosystem-based setting to understand and respond to water-based environmental hazards and water-related disease.
ICM is recognized as an important influence on socioeconomic context in rural and urban settings (including livelihoods, equity of access, poverty).	Socioeconomic context has far-reaching implications for social determinants of health and health inequalities.	Through its influence on socio-economic factors, ICM can be viewed as a strategy to improve the social determinants of health.
ICM is a multi-stakeholder process that involves social learning and collaboration within the context of a particular (catchment) ecosystem.	Multi-stakeholder processes that involve social learning and collaboration are characteristic of—and consistent with—both settings approaches to health promotion and ecosystem management.	ICM provides a setting and a process with the capacity to promote both health and sustainability.

[a]Source: Parkes et al. (Parkes et al., 2008). Catchments are also referred to as river basins (especially in Europe) or watersheds (especially in North America).

These international developments represent a converging, cross-sectoral recognition the need for integration of (eco)system approaches and ecological context into strategies to improve health and wellbeing. They add weight to the calls for 'health in all policies' (Kickbusch et al., 2008) and recognition that climate change and food-security are health promotion concerns as well as economic and environmental issues (Catford, 2008). An important consequence of this convergence is a demand for reciprocal exchange between different modes of thinking, and flow of new ideas into areas where such thinking has been non-traditional—including growing awareness of the cross-cutting relevance of (eco)systemic approaches and thinking (see Table 1). We see this as a direct reflection of complex systems, and discuss their implications briefly here in relation to the three challenges of scale, intersectoral governance, and the complementary themes of promoting resilience and preventing vulnerability.

Scale issues: from local settings to global concerns

Considering catchments as settings for health promotion, draws attention to issues of scale and hierarchical nestedness (see Table 2). In particular, the catchment scale demands recognition of a middle (meso) ground that is smaller than a focus on global context for health promotion (Lee, 2007), but larger and more complex than a single institution or jurisdiction such as healthy schools, hospitals or cities. Perhaps, the closest precedent in the healthy settings repertoire is the scale of 'Healthy

Island' (Nutbeam, 1996).

An informative contribution to understanding catchments as a mesoscale 'setting' is provided by one of the four future scenarios examined by the Millennium Ecosystem Assessment. The 'Adapting Mosaic' scenario is characterized by integrated management, local adaptation and learning, and explicitly refers to socio-ecological systems. Under this scenario, confidence in the ability of humans to better manage these systems is balanced by humility and an active preparation for ecological surprises; political and economic power devolves to regions with great regional variation; and 'learning while managing' is widely acclaimed as an approach to good governance, management and problem-solving (Corvalan et al., 2005).

Predictions for the 'Adapting Mosaic' scenario include (inter alia, and compared with other scenarios developed in the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment, 2005): greater regional pride and more cultural and social diversity, an improvement in mental health (including that of minority populations), a reduction in alcoholism, domestic violence, depression and intravenous drug use, better preservation of knowledge and practices of traditional health systems (with spin-off benefits in relation to new pharmaceuticals). These proposed improvements appear to be based on a heightened sense of place and sense of community—echoing proposed salutogenic effects of healthy settings that strengthen 'both sense of place and sense of self' (Kickbusch, 1996) and reflecting the health-promoting benefits of participatory, empowering, multi-stakeholder processes.

At the same time, the 'Adapting Mosaic' scenario draws attention to the need for explicit attention to cross-scale phenomena. The scenario predicted decline in food supplies per capita (partly compensated for by a more equal distribution), as well as system failures in dealing with:
(i) the global commons, (ii) global capacity to provide emergency relief, (iii) an inability to develop critical masses of expertise or economies of scale and (iv) a dearth of global leadership. Collectively, these mean inadequate response to large scale environmental problems like climate change (Corvalan et al., 2005).

Rather than dealing a definitive blow to the mesoscale settings approach, these predicted failures emphasize the need for proactive engagement with other fields already grappling with the methodological challenges—including attention to cross-scale and intersectoral dynamics—that is characteristic of work on social–ecological systems (Gunderson and Holling, 2002). It has, for example, been noted that community-based natural resource management programmes that succeeded in solving complex problems of collective action in an enduring way had been organized in multiple layers of nested enterprises (Ostrom, 1990). These kinds of lessons offer important and tangible insights for health promotion in the twenty-first century if the vision of a socio-ecological context for health is to be realized.

Governance

Viewing 'settings' at different scales highlights generic concerns that transcend sectoral, thematic or regional boundaries and reflects the fact that '...many people, individually and collectively, contribute, often inadvertently, to the suffering of others while improving their own well-being. This can result from environmental changes which are linked across scales and between geographical regions through both biophysical and social processes.' [(UNEP, 2007), p. 301].

Whether or not it is an easy or convenient fit with our existing templates for sectoral governance and action, the rate and scale of change in both society and ecosystems means that any settings-based approach should eventually intersect with the sectors and stakeholders representative of the ecosystem context for health. Drawing on experiences of community-based conservation in watersheds in Thailand, Lebel et al. observe that 'A multi-level perspective also helps explore more deeply the institutional possibilities inherent in a multi-layered, networked and dynamic world.' [(Lebel et al., 2008) p. 146].

The linkage between human health and water in catchment settings exposes human health as part of a 'resource dilemma' (sensu Ison et al., 2007), applicable when the externalities of rational choices of one set of actors spoil their use by another set—in other words situations of complexity, uncertainty, interdependence, multiple perspectives and controversy. We concur that such situations

tend to be inappropriately coordinated and governed by either hierarchical command and control mechanisms that fail due to loss of legitimation and information, or market-based mechanisms subject to market failure. Ison proposes a third approach to supplement these two others; drawing on 'network' mechanisms for governance—and a language notable for its 'echo' of equity-focused health promotion—with the following properties:

- using equity to resolve resource dilemmas;
- using exchange of meaning, sense making and interdependence as dynamics;
- prioritizing learning processes communication, cooperation, negotiated agreement and reciprocity;
- intervention mechanisms characterized by process facilitation;
- welfare characterized by social capital, trust, community and concerted action;
- failure characterized as inequality in power relations; and
- criteria for success centre around common meanings, concerted action and institutional change (Ison et al., 2007).

Resilience, vulnerability and health

Catchments provide tangible contexts within which to fulfil overlapping objectives across fields with a preventive and pro-active orientation. Water resources have important implications for a range of fields with converging interests in 'reducing vulnerability' and 'increasing resilience', including community development, ecosystems management, disaster preparedness, sustainability and public health (Woodward, et al., 1998; Ryff and Singer, 2003; Turner et al., 2003; ISDR, 2007; Berkes et al., 2003; Tobin, 1999). These fields echo a duality familiar to public health, where vulnerability is viewed as a 'hazard' to be avoided, whereas resilience focuses on an 'asset' to be enhanced, but which is also much harder to evaluate. The focus on 'resilience' that is emerging in contexts as varied as agro-ecosystem health (Waltner-Toews and Wall, 1997), rural communities responding to drought, hailstorms and bush-fire (Hegney et al., 2007) and disaster preparedness and recovery (Masten and Obradovic´,2008) has considerable overlap with, and implications for, settings-based health promotion.

In the catchment context, promotion of health and resilience converge towards a common goal: to cultivate enduring capacity to respond positively to change and challenges. We acknowledge that this proposal is, in many ways, a re-integration and re-contextualization of how indigenous and place-based cultures and communities have envisioned the relationship among health, ecosystems and communities over millennia [see, for example, Panelli and Tipa (Panelli and Tipa, 2007)].

LESSONS AND CONCLUSIONS

A central lesson from this analysis is the important overlaps and overlooked commonalities between the aims of health promotion and ecosystem management (also natural resource management). At the mesoscale setting of river catchments, health promotion could leverage off the community engagement inherent in participatory catchment initiatives (Hinchcliffe et al., 1999), and also mobilize the capacity for proactive engagement in community design, land-use decision-making and impact assessments (Bhatia, 2007; Wernham, 2007; Dannenberg et al., 2003). Water and catchment-based initiatives provide opportunities for both 'creating supportive environments' and 'strengthening community action' (WHO, 1986). Recognition is increasing of the potential to both promote health and reduce inequities through water resources management (Parkes et al., 2008).

The opportunities and challenges of the systemic context for health promotion are obviously not new—in terms of intersectoral, collaborative or multi-stakeholder processes (Sindall, 1997; WHO, 2007). Building on conceptual, methodological and operational strengths, we see health promotion as making an important contribution to the collective thinking and action that will characterize the converging terrain between public health, sustainability governance and ecosystem management (Brown, 2007). Yet, the 'rising tide' of interest in these issues has multiple origins and outlets. There will therefore be a need for careful navigation, especially since issues of territoriality and funding can

become exaggerated in proactive, preventive—and under-valued—fields such as public health and sustain-ability. In summary, recognizing ecosystems as settings for health promotion provides new reminders of the need for the health sector to 'share power with other sectors, other disciplines and most importantly with people themselves' (WHO, 1986).

Beyond the specific implications for the field of health promotion, a critical implication of our argument is the challenge of building individual and institutional capacity—equipping a new generation of researchers, practitioners and decision-makers to be promoters of both heath and sustainability. In this context, we see catchments as not only a context for future collaboration and actions, but as real, ecosystem-based settings for individuals and society to (re)learn and (re)integrate the fundamental relationships between water, ecology and the determinants of health.

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