

Water-focused landscape management

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Highlights

- Water and watershed management are among the oldest ‘landscape approaches’
- The way land and land cover interacts with the full hydrological cycle is still ‘science in progress’
- The blending of local and external knowledge is essential for effective management
- Beyond rules and economic incentives, the social basis for collective action is key to success
- Current integrated watershed projects may need stronger performance-based management

1. Introduction: water, landscapes and collective action

The way water flows and shapes the surface of the Earth, interacting with all forms of life, is often used as the defining element of a landscape. Landscapes are ‘lifescapes’: the space within which human lives can run their course; without access to water no humans can live. The archetypical landscape that we see as beautiful includes clean water, trees in an accessible, half-open terrain, and sources of food and physical security (Dutton, 2010). Beyond artistic beauty, sense of place and identity, water is of key importance to many aspects of human life.

Several elements have gradually been added to what became a need for ‘integrated water management’ (van Noordwijk et al., 2007), dealing with many tradeoffs among interests. In many types of terrain, water courses are preferred entry routes into landscapes as well as supporting transport for trade with the outside world. Changes to water flows and quality also became one of the first obvious environmental impacts of human land use, and as such, the basis for conflicts and social institutions to contain these. With increasing scale, the physical and social concepts dealing with water range through a

valley, the land around a single stream and the links between land tenure and water access that gave rise to a

landscape (in this case, a sub-watershed), the wider area in which all requirements for local livelihoods, except for ‘external’ trade, are found and can be controlled, and a **watershed**, all the land contributing water to a river system, from headwaters to outflow into oceans or large inland lakes (large watersheds are sometimes called ‘basins’) to a **precipitationshed**, all land plus ocean that contributes water vapour to the precipitation (rainfall) over a defined area (for example, a watershed or country) (Keys et al., 2012).

Collective action to modify water flows (Steps 1–4 in Figure 13.1) was the basis for two iconic examples of landscape management: the ‘subak’ system of regulating use of irrigation water for paddy rice in Bali, Indonesia, fully intertwined with religion and social norms (Lansing, 1987) and the ‘polders’ of northwest Europe. Effort to keep water out from polders required collective action with attention to the weakest part of the chain (dyke); this has been interpreted as the basis of a non-hierarchical society that seeks consensus in managing landscapes (van de Ven, 1996; Delsen, 2002). Interest in the subak—now recognized as a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage landscape—and its institutions arose from the obvious failure of exogenous models of water management supported by development banks (Lansing, 2009). These had focused on individual gains but ignored ecological feedback through pests and diseases that the subak controlled by imposing synchrony at the landscape scale. Interestingly, simple agent-based rules can account for the emergence of what seems to be complex patterns at the landscape scale and outperform top–down planning based on ‘expert’ knowledge (Lansing & Miller, 2005). For a similar discussion for an area in Lao, see Coward (1976).

Landscapes integrate a ‘theory of place’ (understanding of the current situation) and a ‘theory of change’ (understanding of a dynamic system of how change can be influenced).

A landscape approach emerges when a socio-ecological system is understood as a feedback loop, integrating answers to six key questions (van Noordwijk et al., 2013). Water and watershed management are good examples of how answering these questions, singly and in combination, can contribute insights. A coherent set of methods to help with the various steps of diagnosis and planning for interventions has emerged (Table 13.2) and at the process level, the replicability has been confirmed.

Building on existing syntheses (Agus et al., 2004; Bruijnzeel, 2004; van Noordwijk et al., 2007; Descheemaeker et al., 2013), we briefly introduce six synthetic topics that all inform water-focussed landscape approaches:

1. **So What?:** Basic understanding of the hydrological cycle as captured in ‘the colours of water’
2. **Who Decides?:** The basic policy tools for inducing collective action and public benefits: ‘carrots, sticks and sermons’
3. **Who Decides? ⇒ Who?:** The interactions between local communities and scientists/experts
4. **Where, What?:** Forest protection versus engineering for restoration and prevention of degradation
5. **Who Cares?:** Have participatory approaches and social objectives in watershed management gone too far?
6. **So What?:** ‘Rainbow water’ and climatic teleconnections as the new frontier for water-focused land management

Table 13.1 Six questions that in combination lead to a basic understanding of water management at the landscape scale and the interactions with other ecosystem services (modified from van Noordwijk et al., 2014b)

Theory of place			Theory of change		
<i>Who?</i>	<i>What?</i>	<i>Where?</i>	<i>So what?</i>	<i>Who cares?</i>	<i>Who decides?</i>
Demography, social stratification in historical and political perspectives	Land-use practices, profitability and water requirements	Landscape structure, water flows and gradients of land-use intensity	Consequences for ecosystem services: water quantity, water quality, flow buffering	Stakeholders of ecosystem services and the way they are organized	Leverage on drivers of change ('carrots, sticks and sermons')

Table 13.2 Methods for various stages of negotiating integrated water management at the landscape scale, referring to the six questions of Table 13.1 (methods are described in van Noordwijk et al., 2013).

Topic Questions	Exploration What?, Where?, So what?	Multiple stakeholder knowledge mapping Who?, Who cares?, Who decides?	Scenarios What?, Where?, So what?, Who cares?	Negotiations Who cares?, Who decides?	Monitoring change Where?, So what?
Basic context	Participatory Landscape Appraisal (PaLA)				
Water flows in relation to climate		Rapid Hydrological Appraisal (RHA)	Flow persistence analysis (FlowPer)		
Land use effects, interventions		Rapid Landslide Mitigation Appraisal (RaLMA)	Land-use change scenarios (GenRiver)	Conservation auction (Con\$erv)	
Incentive systems for inducing land-use change				Multi-scale payments for environmental service paradigms (MuScaPES)	
Water quality monitoring in relation to land-use change					Participatory water quality monitoring (PaWaMo)

2. Insights into water and watershed management

2.1 Colours of water and land-cover management

There is a tradition of describing different parts of the hydrological cycle as different colours. Hydrology started with concerns over, and measurements of, water in rivers and other surface waters, subsequently known as ‘blue water’ issues. Regularity of flow (avoiding floods and droughts) along with quality (microbial concentrations causing human diseases (*Escherichia coli*), sediment load, biological oxygen demand, nutrient contents, and contaminants) were the first issues to get attention. Where reservoirs were constructed for inter- and intra-annual storage, the total water yield became an additional issue. Urban and industrial water use led to a return flow of polluted (‘grey’) water to rivers and a need for waste-water treatment. On average, only 40% of rainfall reaches the blue-water stage, with the remainder returning to the atmosphere through plants at, or close by, the location of rainfall. This ‘green water’ became an issue first when fast-growing trees such as eucalyptus became known for their water consumption, proportional to their growth rate. ‘Green-water’ use by forest plantations became taxed in South Africa and rules against eucalyptus near watercourses were adopted in East African countries out of concern for dry-season flows of streams and rivers. Full understanding of the hydrological cycle, in which no losses occur, only transfers between pools, led to the re-emergence of interest in, and new methods for, quantifying the role of evapotranspiration over land in contributing to rainfall on the same continent (van der Ent et al., 2010). van Noordwijk et al. (2014a) coined the term ‘rainbow water’ for water vapour in the sky, whether from oceanic or terrestrial origin, that potentially becomes rainfall.

Blue, grey, green and rainbow water can be influenced by land cover, depending on its seasonal pattern of water use, its direct protection of soil from the effects of rainfall and sunshine, and its rooting pattern and associated depth of actively buffering soil profile (van Noordwijk et al., 2014b). The primary step in managing both blue and green water is still the choice and management of land cover because it influences canopy interception, water use and litter-layer dynamics as protectors of soil from splash erosion and as primary filters for incoming overland flow (Hairiah et al., 2006). While forests generally use more water than other vegetation, partial forest cover has a more than proportional effect in reducing annual stream flow: at 20% and 40% forest cover (van Dijk et al., 2012) reported 35% and 55% of the reduction of stream flow that full forest cover would induce. Lateral resource flows cause such non-linear response functions to changes in forest cover (van Noordwijk et al., 2004). Increased water use and increased infiltration related to forest cover lead to lower flooding risks at stream or sub-catchment levels, but the often presumed role of forests in protecting from large floods remains debated (van Dijk et al., 2009; see Box 13.1 on flow buffering).

Deep-rooted vegetation protects slopes from shallow landslides (Sidle et al., 2006), but increased infiltration in forests can increase the risk of deep landslides. The early years after deforestation have a high landslide risk, further enhanced by road construction; increased land degradation reduces infiltration and hence a greater risk of landslides. Verbist et al. (2010) compared the processes that control sediment transport (as a result of erosion and sedimentation) at various scales in a sub-watershed and found that riverbank stability and road-based erosion were prominent in processes at the medium

Box 13.1

Buffering of river flow: combining local and hydrological understanding?

The most common explanation people living downstream give of what watershed degradation means to them is that river flow becomes less predictable (more erratic), that even moderate rainfall leads to ‘flash floods’, and that streams dry up more rapidly in the dry season. This synthetic description of water flow dynamics is captured in the ‘flow persistence’ or buffering indicator (van Noordwijk et al., 2011).

An algorithm is now available for estimating this flow persistence parameter (p) from even a limited time series of daily river discharge (Q) measurements:

$$Q_{t+1} = p Q_t + (1-p) \text{ Rainfall}$$

The fraction of rainfall that reaches the river on the first day equals 1 minus the flow persistence factor.

Table 13.1 Fraction of rainfall that reaches the river on the day of rainfall and in the first week after rain.

P	0.99	0.98	0.95	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
% Day 1	1	2	5	10	20	30	40	50	60	70	80	90
% 1st week	5.9	11.4	26.5	46.9	73.8	88.2	95.3	98.4	99.6	99.9	100.0	100.0
Rating	Well-functioning upper watersheds						Degraded watersheds		Severely degraded			

Note: Expressed as a function of the flow persistence factor (p) and a tentative rating of well-functioning (p > 0.7) versus degraded (p < 0.7) watersheds (van Noordwijk et al., 2011).

If the flow persistence index changes from 0.8 to 0.6 peak flows directly after rain double (from 20 to 40% of rainfall). The index is a good candidate for performance-based contracts for watershed rehabilitation. It monitors decline and recovery but between-year variation, due to specific rainfall patterns, can be about 0.1, implying that data for several years are needed before a trend (downward or upward) can be firmly established.

scale, replacing hill-slope erosion as the primary explanation for sediment loads in rivers. Exclosure areas protected from grazing downhill of eroding areas can be substantial sediment filters. Descheemaeker et al. (2006) found that in Tigray, Ethiopia, mean sediment deposition rates ranged between 26 and 123 ton (t)/hectare (ha)/year (yr), with dark soils rich in organic matter being formed. Nyssen et al. (2014) documented changes in land cover over a 100-year period in northern Ethiopia and found that more trees and conservation structures occurred where there was high population density. Overall, the northern Ethiopian highlands are greener than at any time in the last 145 years.

Initial problems with many of the watershed functions when natural forests are converted may, over time, be largely resolved if appropriate perennial vegetation, including trees, is established. However, the experience with reforestation based on monoculture tree plantations is mixed at best (Scott et al., 2005). A recent study of reforestation in Nepal demonstrated negative effects not only on total water yield, but also on dry season flows (Ghimire, 2014; Ghimire et al., 2014). Increased ‘green-water’ use can, however, now be interpreted as increased rainbow-water contributions to rainfall elsewhere.

2.2 Sticks, carrots and sermons as governance instruments for inducing collective action and public benefits

Governance systems have three basic types of instruments: 1) regulations that establish rights and require enforcement, 2) economic incentives to partially internalize externalities when making decisions (based on payments, fines, taxes, tax rebates, market mechanisms), and 3) moral suasion aimed at internalization into the basic value systems and social norms of behaviour.

The primary level deals with rights and regulation. Most of the existing ‘water policy’ is in fact blue-water policy, even though globally only about 40% of rainfall reaches the blue-water stage. Depending on the historical roots of existing legislation in a country (Bate & Tren, 2002; van Noordwijk, 2005), the rules for access to, and sharing of, surface water are primarily based on a combination of concepts that define water as either a

private good, which is often associated with land rights where a ‘settler’ principle assigns the rights to water to the first user (or their inheritors) and which might be restricted to stagnant water and periodic streams; a

club good, which is riparian rights to share access to water along with obligations to jointly manage water quality by all countries, communities or private landowners harbouring, or bordering, a river; or a

public good, in which rights to clean water for all inhabitants of a country (or the planet) are being articulated as a part of human rights.

Within the public-goods perspective, incentives for behaviour that respects the rights and interests of others follow the general aspects of ‘altruism’: they require, and further enhance, a sense of joint identity and shared interests at the interface of public and club goods (van Noordwijk et al., 2012). There is some empirical evidence for crowding out social norms of behaviour when financial payments are introduced, with a risk of negative long-term effects if payments cannot be maintained.

Negotiations can shift aspects of water policy between these categories (Bruns & Meinzen-Dick, 2000). The gradual emergence of markets for tradable rights of use (Rosegrant & Binswanger, 1994) with associated rights to pollute has become part of a set of public-policy experiments in ‘payments for environmental services’ (PES), with rather mixed results on achieving a desirable level of collective action for protecting and managing water as a public good (Landell-Mills & Porras, 2002).

Three conceptual underpinnings of the broader PES concept are now recognized (van Noordwijk & Leimona, 2010), which are:

commoditization, which is mostly linked to tradable private rights;

compensation, which is mostly linked to club goods (but can also be private) and voluntary or mandatory restrictions of land use; and

co-investment, which is aimed at establishing trust and potentially leading to stronger articulation of rights and other instruments.

Existing payments or rewards for watershed services’ schemes in Asia and Africa are mostly of the co-investment type (Lopa et al., 2012; Minang & van Noordwijk, 2013; Namirembe et al., 2014; see Box 13.2 on River Care). Across all PES-related instruments, a balancing act is needed to secure both fairness and efficiency (Table 13.3).

Table 13.3 Four key dimensions to understand the spectrum of governance instruments for enhancing watershed functions of landscapes in ways that are both efficient and fair (modified from van Noordwijk, 2005; van Noordwijk & Leimona, 2010).

Efficiency		↔	Fairness	
Conditional	Realistic		Voluntary	Pro-poor
Performance-based at various levels: <ul style="list-style-type: none"> • watershed outcome • condition of land • activity and inputs • planning & management 	Avoided degradation and/or active restoration that improves water quality and increases flow buffering, dry-season flows and/or total water yield at specified, strategic locations within a targeted area		Free and prior informed consent at the community level and negotiated contracts with individuals directly involved and/or affected; mandatory where large public interests justify such, with adequate compensation	Recognition of perceptions, preferences and interests of all stakeholders regardless of wealth, gender, ethnicity; preferential treatment for underprivileged

Box 13.2

River Care

The Way Besai hydroelectricity power company ('PLTA') operates in Sumberjaya, Sumatra, Indonesia. The PLTA has problems with high sediment flow into its relatively small reservoir, as do many other hydroelectric dams around the world. In this case, an annual budget of USD 1 million a year was needed to clean sediment from the reservoir. Therefore the mother company was open to suggestions that there might be cheaper ways to prevent sediment from reaching the reservoir in the first place.

The Rewarding Upland Poor for Environmental Services (RUPES) project coordinated by the World Agroforestry Centre set up a pilot project with the community in one sub-catchment at Buluh Kapur village. Farmers identified current sources of sediment flow, and constructed check dams and drainage along pathways. RUPES helped with the technical sediment monitoring and calculations. The principle underlying the contract between the two parties was 'conditionality', which meant that the River Care group would receive payments if they met the condition of reducing the load of sediment in the river: the target was a reduction of 30% with a reward of USD 1000. But lesser achievements would also be recognised: USD 700 for a 20–30% reduction; USD 500 for 10–20%; and USD 250 for less than 10%.

By the time the project reached its agreed end, the community had executed the contract with an 86% activity success rate, which was high, demonstrating the villagers' commitment. Analysis of sediment concentration by the RUPES team, however, showed only a 20% decrease by comparison with the initial baseline. The PLTA nevertheless appreciated the community's efforts in reducing the sediment concentration in the Air Ringkih River and provided a micro-hydropower unit as a reward, bringing electricity to the village. This appreciation had a big impact on the community. They were inspired to continue to improve their watershed. A next round was also successful in securing co-investment and the programme is currently being scaled-up to all watersheds with hydropower generation in Sumatra.

2.3 Scientists and experts interaction with local communities

Within the ‘realistic’ dimension of governance instruments, the target is to achieve activities that lead to avoided degradation or active restoration of, preferably measurable, watershed services that matter. At the start of engagement there may be a wide divergence between the various knowledge systems. As a first step, an exploration of how different the knowledge and knowledge systems (which include pathways to learning) are between various groups of local stakeholders, the public discourse and associated policy debates, and scientists from a wide range of disciplines is needed (Jeanes et al., 2006). A recent summary of such scoping studies in Indonesia (Leimona, 2011) concluded that there were indeed considerable knowledge and perception gaps. Local community members sought location-specific solutions while public/policy stakeholders referred to generic solutions, such as ‘reforestation’. The attention policymakers gave to the role of ‘forest’ in providing beneficial watershed services and to ‘deforestation’ as the cause of problems did not match the perception of those living in the landscape (Joshi et al., 2004; Verbist et al., 2010). Cross-site analysis showed that the reality check provided by the knowledge-integration approach presented rich information on causes of location-specific watershed problems and fine-tuned solutions that allow people to continue to live in the landscape.

In the past, governments relied primarily on technical expertise to advise on the most effective and efficient course of action to achieve publicly stated goals. This approach led to conflicts in many landscapes as well as to wrong decisions especially when the vested interests of the technical advisors (for example, advising on the feasibility of dam projects) were not recognized by subsequent decision-makers. In response to conflicts, a negotiation-system approach emerged that includes a multistakeholder negotiation platform (van Noordwijk et al., 2001). To overcome a history of distrust and misunderstanding, the co-creation of ‘boundary objects’ that can function across multiple knowledge systems and stakeholder groups, are recognized scientifically and yet understandable locally, is now seen to be an essential ingredient for success (Clark et al., 2011). Such boundary objects include agreed methods for monitoring the initial condition and subsequent change (Rahayu et al., 2013).

Sabatier et al. (2005) and Bulkley (2011) analyzed how a more integrative, consensus-oriented approach to watershed management evolved in parts of Europe and North America, replacing a set of technical agencies that had been set up to handle specific aspects (such as various types of pollution and water flow regulation), often in competitive mode. Collaborative approaches, including multiple stakeholders and sources of information, are increasingly used to address challenging environmental problems; building social capital helps in reaching agreements but subsequent implementation is not guaranteed without funding and effective coordination (Koontz & Newig, 2014). A similar process may have been slower to emerge in a developing country context (Gupta, 2014), where social gaps are wide and bureaucracies well entrenched.

2.4 Forester plus engineer

Watershed management has interacted with many scientific disciplines but an important historical debate that still resonates is that between the forester and the engineer (Galudra & Sirait, 2009). Foresters emphasized the paramount role that forests play in watershed services and used concerns about watershed functions as a support for their political control over a large part of a landscape. Engineers saw many technical opportunities to

regulate and improve water flows and buffering with canals, dams, reservoirs, diversions and modifications of the riverbed. They offered two very different ‘theories of change’, aimed at the common goal of supporting intensified agriculture with full access to technical irrigation and drainage.

In the early 20th century a magic number emerged of ‘30% forest’ as a requirement for a healthy watershed (initially based on research on gradual snowmelt in the Alps, with forests delaying water flows in spring), which served as a political compromise. It is still quoted in legislation even though there was, and is, no substantiation of this (or any other) number.

It took time for both foresters and engineers to appreciate and understand the positive roles that partial tree cover in agroforestry systems managed by smallholders can play for measurable watershed functions (Agus et al., 2004). Current progress in integrated watershed management has roles for both the forester and the engineer and there is progress in methods to dissect their respective contributions to watershed restoration and improvement (Ma et al., 2014).

2.5 Have participatory approaches and social objectives gone too far?

India and China probably have between them by far the most experience with forms of ‘integrated watershed management’ but have taken different routes. The destructive Yangtze floods of 1998 (Yu et al., 2009) gave rise to the world’s largest PES scheme in the form of the sloping land conversion programme, although it has been challenged on all the axes of whether it is realistic, conditional, voluntary and pro-poor (Bennett, 2008). Initially using rice surpluses from the lowlands, farmers in the uplands were compensated with annual rice supplies if they agreed to reconvert their farms on steep sloping land to forest. Technical challenges in project implementation concerned the choice of tree species (monocultures or mixtures), rules against intercropping with annual crops (with biannual medicinal ones accepted as a borderline case) and the need to accommodate, post-hoc, local initiatives and preferences within a rigid top-down form of project implementation (however, location-specific variation proved to be possible where local officials developed relationships with local communities; Xu et al., 2010).

Meanwhile, the experience in India with watershed management projects started from a much more participatory and multi-sectoral basis. Covering a large part of the country, the programme shifted more and more towards addressing local needs. However, a recent evaluation of actual changes in land cover could not find any evidence of the effectiveness of the programme and the opinion was expressed that the programme had shifted too far towards satisfying social goals, ignoring hydrological restoration (Bhalla et al., 2013). Conversely, in China, the country with the strongest top-down governance tradition, programmes allowing conversion of sloping forest lands without trees to agroforests based on the initiative of local farmers’ groups proved to be a major success (Xu et al., 2012), satisfying local needs as well as achieving environmental improvements.

2.6 Rainbow water as the new frontier

Evapotranspiration implies a local ‘loss’ of water for areas ‘downstream’ but the water vapour might return as rainfall in neighbouring ‘upwind’ areas and ultimately as river flow, depending on topography. Recent recognition of rainbow water adds another dimension to the scale at which the hydrological cycle can, and must, be managed.

Including downwind beneficiaries of recycled rainfall in discussions on how to balance blue-and-green water needs will certainly add to the complexity (Keys et al., 2012; van Noordwijk et al., 2014a) but ignoring the complexity does not reduce the influence. The issue has long since been debated for the Amazon basin but similar relationships appear to hold between East, Central and West Africa, between Myanmar and China, and possibly on the island of Borneo, in contrast with the rest of the Indonesian archipelago.

Williamson et al. (2014) provided an example where a change in more local rainfall recycling by loss of forest cover from an East African watertower shifted water over a watershed boundary, reducing availability on one side and increasing it on the other. Once such hydrological effects become known, the political consequences and conflicts may be substantial. It is important that the scientific basis of such claims is quickly investigated.

3. Discussion

Integrated watershed management as one of the main pillars on which a new landscape approach can build, needs simultaneous answers to the six questions of Table 13.1. Over time, water-focussed landscape management has learned to deal with these six aspects of the management cycle for the increasing complexity of issues, as a quick summary in Figure 13.1 suggests.

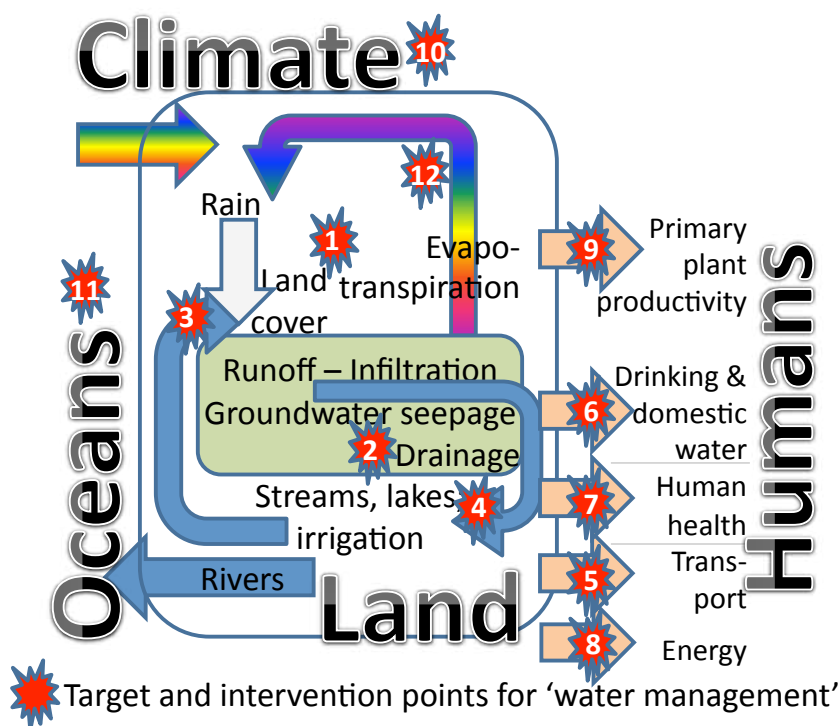


Figure 13.1 Schematic representation of the hydrological cycle between oceans and land with twelve targets and intervention points that have over time been included in ‘integrated water management’ discussions.

Points 1-4 are related to the way the watershed managers intervene to achieve desirable watershed management outcomes.

1. Modifying land cover to increase harvestable vegetation, hunting, homesteads/villages/cities/roads, with impacts on surface runoff, erosion, sedimentation, annual water balance and plant growth.
2. Drainage, making land more suitable for desirable plants, controlling disease pressures, etc.
3. Irrigation, providing water when needed for the growth of desirable plants.
4. Modifying riverbeds, associated wetlands, lakes, creating artificial reservoirs, to increase water availability for other uses (see points 3, 6, 9).

Points 5-9 are desired outcomes of integrated watershed management focusing on the goal of improving quality and increasing quantity of water for specific users.

5. Surface water as a means of transport, with all its military, political and commercial implications.
6. Water for domestic and industrial use, with associated pollution concerns ('grey water').
7. Human health, concerning safe drinking water, hygiene and control of water-borne diseases.
8. Use of flowing water as a source of mechanical and electrical power.
9. Increased plant productivity for agriculture and forestry and associated concerns over the 60% of rainfall that recycles to the atmosphere as 'green water' without reaching the 'blue water' stage.

Points 10-12 are more recent additions that relate the watershed to the global hydrological cycle.

10. Concern over global climate change, with parts of the world getting wetter, others drier, and all parts more uncertain about future rainfall, and warming implying an increase in the need for water.
11. Concern over the health of oceans in relation to land (marine productivity, pollution) and associated climate effects.
12. 'Rainbow-water' relationships between terrestrial evapotranspiration and its recycling in rainfall elsewhere ('teleconnections'), as well as meso-scale climatic effects (van Noordwijk et al., 2014a).

The processes of water flow through landscapes are relatively well understood (with the exception of the atmospheric part of the hydrological cycle contributing to rainfall). Yet standard recipes for watershed management and default values, such as "we need at least 30% forest cover" or "reforestation always helps", have not contributed to positive change. More fine-tuning in local contexts is needed, with an active learning loop that builds on local experience, beyond generic methods and concepts that can be borrowed from elsewhere.

The current challenge is to ensure that water is always included as a 'co-benefit' when other concerns (such as climate-change adaptation, biodiversity, greenhouse gas emissions) drive the process or, vice versa, include such concerns into an ever-more integrated approach to watershed management at the landscape scale.

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