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Integrating Sustainability, Justice, and Diversity?

Opportunities and Challenges for Inclusively Framing Water Research

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Abstract

The twentieth century has seen a dramatic increase in human uses of and human impacts on water resources, increasing competition over water as well as depleting or deteriorating its availability. Given its importance to human life and livelihoods, water is becoming one of the major foci of environmental research. The coincidence of water scarcity with poverty in many parts of the world makes it a focal point of international development efforts. With engineering thinking dominating over past decades, water management research has embraced more integrative approaches triggered by an increasing awareness of failures that focused on narrow single issues or technical solutions to address the complex challenges of sustainable water management. This chapter explores whether, when, and how more inclusive framings might enable more socially relevant and impactful research, and lead to more effective action. Discussion begins by establishing what a frame is and then defining what is meant by an "inclusive frame" for interdisciplinary research on environmental problems. Seven frames in water research are examined; emphasis is given to how framings are driven by differences in normative and theoretical positions, which yields very different views on progress and how best to achieve it. Next, the use of more inclusive frames in academic or research contexts

Group photos (top left to bottom right) Amber Wutich, Juan-Camilo Cardenas, Sharad Lele, Felix Rauschmayer, Christian Schleyer and Margreet Zwarteveen, Claudia Pahl-Wostl, Heather Tallis, Sharad Lele, Diana Suhardiman, Juan-Camilo Cardenas, Felix Rauschmayer, Christian Schleyer, Diana Suhardiman, Christian Schleyer, Amber Wutich, Nancy Grimm and Heather Tallis, Margreet Zwarteveen, Claudia Pahl-Wostl, Juan-Camilo Cardenas, Amber Wutich, Sharad Lele and Christian Schleyer

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is explored using two examples which incorporate multiple normative and theoretical positions. Barriers encountered by academics and researchers, as they attempt to use inclusive frames, are then examined. To explore how inclusive frames can be used to address real-world problems, three cases highlight the possibilities and challenges in applying inclusive frames to research with the goal of informing action and practice.

What Are Inclusive Frames and Why Do They Matter?

In a research context, as elaborated in the introductory chapter (Lele et al., this volume), problem frames define and bound what researchers examine and from which perspective. Water is a complex socioenvironmental phenomenon, essential for human survival and well-being and laden with multiple meanings since time immemorial. Water problems are therefore framed in myriad ways, and academic research on water emphasizes different aspects of complex water problems and points to different paths toward solutions. The fragmentation, tension, and conflict within the academic discourse on water are a matter of concern, insofar as it paralyzes action or undermines the possibility of reasonable solutions. Exploring where and how these tensions are located could open up possibilities for more meaningful dialogue on water. The concept of "framing," as discussed by Lele et al. (this volume), provides a way for us to carry out this exploration.

Frames vary widely in terms of how inclusive they are of normative and theoretical positions. At the normative level, we considered a frame to be more inclusive when it addresses more than one of the three broad values or normative concerns within the sphere of environmentalism: sustainability, justice, and diversity. Following on from Lele et al. (this volume), we consider these broad values to have many layers or components: sustainability (ecological, economic, social); justice (distributional, procedural, interactional recognition); and diversity (biological, cultural, linguistic, institutional). We also recognize that apparently "non-environmental" concerns, such as efficiency or productivity, may be used as expressions or indicators of broader values. Finally, we recognize some potential causal connectivity—conceptual or empirical—between these values. For instance, preserving biodiversity may play a role in accomplishing ecological sustainability. Intergenerational justice, which is a core component of sustainability, may be considered a form of distributional justice. Prioritizing cultural, linguistic, or institutional diversity in decision making may help accomplish procedural justice. These areas of connectivity can be important in determining the normative inclusivity of a frame.

At the theoretical level, the inclusivity of frames refers to their ability to incorporate, combine, or reconcile different representations of social and natural reality (often coming from different disciplines or subdisciplines in academia). For instance, a "bucket model" of groundwater is a less accurate and inclusive framing than a model that incorporates surface–groundwater links. Similarly, a frame that accommodates the ways that social structure constrains people's

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choices—and people's choices can change social structure—would be more inclusive than others that assume only one of these matters. We acknowledge that there may be trade-offs between theoretical inclusivity and analytical tractability: complex representations are harder to translate in unequivocal predictions or courses for action. Also, in discussing the theoretical inclusivity of frames, we recognize that it is not always possible or desirable to combine different representations: recognizing incompatibilities between representations may be a productive starting point for discussing alternative scenarios or intervention pathways.

We believe, nevertheless, that it is important for research to strive for normative and theoretical inclusivity. Normative inclusivity (i.e., being inclusive of or speaking to a broader set of values) may make research more relevant to societal debates. Theoretical inclusivity (i.e., being inclusive of, recognizing, or reconciling different representations of social and natural phenomena) should make research more accurate and, as a result, interventions based on such research may be more effective. In this chapter, we explore the extent of inclusiveness of different frames in the water sector at these two levels and then explore the possibilities of, and challenges to, more inclusive framings in academia. Finally, we examine the link between inclusiveness and effectiveness on the ground.

How Do We Describe and Compare the Inclusivity of Different Water Frames?

A wide range of frames are commonly used in research on water problems. Rather than choose the "best" frames or the "most influential" frames (however defined) for this analysis, we purposively chose a range of frames based on the configurations of normative values (in terms of sustainability, justice, and diversity) that they express or emphasize: integrated water resource management, adaptive water management, common-pool resources, water footprinting, hydrosocial cycle, human right to water, and ecosystem services.

Table 12.1 presents an overview of the seven frames in terms of the problem, causes, and solutions. By "problem," we mean the manner in which the frame identifies the core problem being considered. "Causes" indicate the frame's typical approach to diagnosing the source of the problem. These often include claims about biophysical and social processes. Following from the diagnosis (but perhaps making additional assumptions), many frames identify or suggest solutions to water problems.

Below, for each of these frames, we assess the following key aspects:

1. A brief *intellectual history* is provided to explain where each frame came from and who developed it. We note if it has changed much over time and mention, where possible, who tends to use it now and how it

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Table 12.1 Overview of seven frames for water problems: (1) integrated water resources management, (2) adaptive water management, (3) common-pool resources, (4) water footprinting, (5) hydrosocial cycle, (6) human right to water, and (7) ecosystem services.

Problem	Causes	Solutions
1. Increasing scarcity and inefficient allocation of water	Biophysical: Water flows within the river basin boundary, links different users Social: Administrative fragmentation leads to disconnected decision making and inefficient allocation	Plan at basin scale; introduce participatory approaches; recognize role of women, recognize water as an economic good
2. Existing water management systems are too inflexible to variability in the environment	Biophysical: Engineering assumption that everything is knowable and predictable Social: All decisions in the hands of technocrats or engineers	Design management systems that adapt to unpredictability, using buffers, polycentric rules, and multiple knowledge
3. Individuals under-provide and over-extract water due to misaligned individual and group incentives	Biophysical: Water is rival and limited by physical cycles Social: Groundwater and surface water are non-excludable, often open access	Assign property rights to private owners, the state or self-governed organizations, with clear rules on boundaries, rights, and responsibilities. Governments need to facilitate the formation of self-governed institutions
4. Water is being wasted in the production and consumption of goods	Biophysical: Production and consumption of goods involve water as an input Social: Invisibility or incomplete accounting of the water used in final goods	Estimate and disseminate the correct direct and indirect amounts of water involved in production and consumption of goods
5. Water is being unfairly or unequally distributed	Biophysical: Downstream flow of water is mediated by technology and human use Social: Those with more power appropriate more water, with effects (feedbacks) on nature and the powerless	No clear solutions, not prescriptive
6. Some humans are excluded from accessing a minimally sufficient quantity of water	Biophysical: Biophysical cycles limit water available Social: Lack of legal protections to all and overemphasis on commodification of water leading to its privatization	Legislative action pushing access to water as a human right; subsequent actions by governments to ensure such right with a minimum guaranteed amount of water per capita
7. Environmental degradation decreases provision of ecosystem services, including water regulation and purification, which in turn reduces human well-being	Biophysical: Many ecosystem functions and services unknown, not well understood, not assessed or accounted for Social: Neglect in recognizing these services leads to market activities and policies that degrade them	Assessment and valuation of water-related ecosystem services. Policy and/or market tools that capture (internalize) ecosystem service values, to induce transfers from beneficiaries to potential agents of water conservation, and to induce conservation practices

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is typically used. This background information helps inform our interpretation of the theoretical inclusiveness of the frame.

2. *Basic assumptions* may have been built into the frame which may not be apparent but are fundamental to the causal claims and solutions. Understanding these basic (but often unstated) assumptions is helpful for assessing normative and theoretical inclusiveness.
3. Every frame emphasizes or is focused on certain *values*, which in the environmental context may be some variants and combinations of justice, sustainability, diversity, efficiency, or productivity, as detailed by Lele et al. (this volume). Frames may also vary in terms of how much room they leave (implicitly or explicitly) to explore other values beyond the focal value(s). Understanding the values promoted in the frame is essential to assessing the normative inclusiveness of each frame.
4. *Additional values promoted through implementation* may be present though not essential to the framing. These may be the values that are typically embraced by people who promote the frame or seek to operationalize its ideas in particular contexts. Information about additional values may be useful to evaluate the capacity of the frame to accommodate alternative values in real-world implementation.
5. The frame's *representational accuracy* is assessed by discussing to what extent it produces a faithful and credible account of the described reality. Representational accuracy is relevant to understand the frame's capacity to produce effective interventions.
6. Each frame's *political effectiveness* is assessed in terms of how influential it has been in bringing about political, institutional, or practical change. This may be due to inherent features of the frame or the acceptability of a particular framing among the powerful actors in the water sector. Hence, explicit separation of representational accuracy from political effectiveness allows us to distinguish between a frame's popularity and its ability to represent reality accurately. Political effectiveness bears directly on the ability of the frame to yield workable real-world solutions.

The purpose of our analysis of these seven frames is to showcase how different framings of environmental problems are driven by differences in normative and theoretical positions. Following this evaluation, we compare the frames, discuss the potential for and challenges to the adoption of inclusive frames in academia, and assess the capacity of inclusive frames for bringing about real-world change in water problems.

Integrated Water Resource Management Frame

Integrated water resource management (IWRM) frames water problems that stem from increasing scarcity of water and (economically) inefficient allocation

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of water. The biophysical causes of these problems, as framed by IWRM, include water flowing within the river basin boundary and linking different users. The social causes of the problem include administrative fragmentation, which leads to disconnected decision making and inefficient allocation across users and sectors. An IWRM framing often leads to solutions such as planning at the basin scale, introducing participatory approaches, recognizing the role of women, and recognizing water as an economic good.

Key Aspects

1. Intellectual history
   - In 1992, the International Conference on Water and the Environment developed and published the Dublin Principles which sets out recommendations for action at local, national. and international levels to reduce water scarcity.
   - In 1996, the Global Water Partnership was established to foster IWRM. This group is an action network open to all organizations involved in water resources: country government institutions, international agencies, NGOs, research institutions, bi- and multilateral development banks as well as the private sector.
2. Basic assumptions
   - Bringing stakeholders together is the first step to resolving/sharing problems.
   - Participation is power neutral.
3. Values emphasized in the frame
   - Sustainability: mentioned but economic efficiency is strongly emphasized.
   - Justice: included to the extent that the frame recognizes and gives voice to multiple stakeholders; gender is also mentioned.
   - Diversity: not emphasized.
4. Additional values promoted through implementation
   - Inclusion of multiple stakeholders (e.g., conservationists) which may increase diversity.
5. Representational accuracy
   - Strengths: reveals linkages created by water flow or movement and the multiple stakeholders and sectors involved.
   - Weaknesses: assumes that participation automatically translates into fair allocation. Water as an economic good contradicts the idea of stakeholder-based allocation.
6. Political effectiveness
   - Aimed at policy and managerial communities (as opposed to activists, NGOs).
   - Politically conservative as it respects established principles of

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governance. Because it is not overtly subversive or antagonistic, this can serve to establish a dialogue.

- Change is generally perceived as incremental. No aim for radical systems change, thus it does not overtly address power issues.
- Adopted more in developing countries; adaptive water management is more common in developed countries.

Example: The Cases of Burkina Faso and Nepal

The starting point for IWRM was the recognition that water flows within a river basin that connects users across locations (upstream to downstream) and across sectors, leading to the inference that both research and management decisions must occur at the basin scale. However, from the idea of coordinated river basin management, the concept metamorphosed in the global water policy discourse in the 1990s into a holistic perspective on water resources management (Lenton and Muller 2009) with objectives "to improve efficiency in water use (the economic rationale), promote equity in access to water (the social or developmental rationale), and to achieve sustainability (the environmental rationale)" (Butterworth et al. 2010:69).

Donor agencies have put in enormous resources to support research as well as a large number of implementation projects using this framework, especially in developing countries.

Researchers have applied this frame by integrating basin hydrology with (typically) economics to identify opportunities for water savings, cross-sectoral transfers, and so on (Molden et al. 2001). Such research has demonstrated, for instance, the importance of looking at water savings at the system level instead of the farm level. On the implementation side, the success of IWRM approaches has been limited (Biswas 2008; Medema et al. 2008).

In Burkina Faso, in spite of adopting policies and laws to enable basin-level management, the setting up of basin-wise nested institutions, the rationalization of pricing policies, and major investments in training, a big gap remains between IWRM principles and outcomes on the ground (Suhardiman et al. 2015). Local-level committees have little autonomy, and newly designed institutions failed to take into account the informal and often undocumented nature of water withdrawals and the complexity of existing land-tenure arrangements (Petit and Baron 2009). In Nepal, legislation that would enable intersectoral coordination could never be passed as existing ministries perceived it as a loss of power and not as a benefit, other than a way of attracting donor funds for individual projects (Suhardiman et al. 2015). Individual project-level implementation seemed to make some headway at the local level but lacked authority to scale up to the basin. Indeed, whether cross-sectoral coordination is really needed to achieve what objectives, for whom, at which (operational) level, and how key government stakeholders could benefit from

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IWRM policy formulation and implementation are questions that have not yet been fully answered.

Adaptive Water Management Frame

The adaptive water management (AWM) frame identifies as its core problem the inflexibility of water management structures and procedures, making them too inflexible to address uncertainties such as climate change. The biophysical causes identified in the AWM frame include the engineering assumption that everything is knowable and predictable. Social causes identified by the frame point to decision-making control being placed almost exclusively in the hands of technocrats or engineers. The main solution suggested by the AWM frame is to design systems that can be managed adaptively, using techniques such as emphasizing unpredictability, creating buffers or safe margins, building polycentricity in governance, and drawing from multiple knowledge systems.

Key Aspects

1. Intellectual history
   - Developed in the 1980s by ecologists.
   - Moved beyond the command-and-control approach in IWRM to management as a process with built-in feedback loops.
2. Basic assumptions
   - Ecosystems are complex and must be evaluated in conjunction with participatory processes.
   - Climate change necessitates more flexible approaches to address uncertainties.
3. Values emphasized in the frame
   - Sustainability: resilience and flexibility.
   - Justice: not emphasized.
   - Diversity: Biological and knowledge diversity is not emphasized because it is not a goal; it is a means to achieve adaptability.
4. Additional values promoted through implementation
   - Can link to sustainability, intergenerational justice
   - Can be made participatory
   - Can link to diversity by recognizing aquatic life as a stakeholder
5. Representational accuracy
   - Strengths: Can address complex resource management problems and uncertain contextual conditions.
   - Weaknesses: Adaptation and learning require particular management frames and cultures. May not sufficiently address path dependency, low management or decision-making capacity, power

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imbalances or inequities, and so forth. In systems where the uncertainty is not high, this may not be an efficient frame.

6. Political effectiveness
   - More common in developed countries.
   - Addresses policy, manager, and planner communities (as opposed to activists, NGOs); generally enhances adaptive capacity and resilience.
   - Good fit for flood management, agricultural settings, contexts where some infrastructure is already established but can be used in initial design for communities receiving new infrastructure.
   - Not a good fit for contexts where infrastructure is insufficient (discussed further below) or too fixed (e.g., German wastewater systems).
   - Tends to be adopted by people who aim to preserve ecosystems; difficult for engineers to adopt because they are trained in command-and-control thinking; cultural, linguistic, and institutional diversity is an instrument, not a goal.
   - Politically conservative in the sense that it respects established principles of governance. It is not overtly subversive or antagonistic, thus it can function as a "space-opener" for conversation. Change is generally perceived as incremental; it does not prompt radical systems change nor does it overtly address power issues.
   - May be compromised by powerful groups if processes of adapting management decisions are not transparent.

Example: The Case for a Transition toward Adaptive Flood Management in the Tisza River in Hungary

In flood management, the shift to adaptive management is aptly captured by the move from "controlling water" to "living with water" (Pahl-Wostl 2015). The EU-funded project NeWater (New Approaches to Adaptive Water Management under Uncertainty) adopted a broad framing of AWM, defining it as "a systematic process for improving management policies and practices by systemic learning from the outcomes of implemented management strategies and by taking into account changes in external factors" (Sendzimir et al. 2010:573).

An example of successful adaptive and integrated management is the paradigm shift in flood management in the Tisza River Basin in Central Europe. Traditional flood management largely focused on keeping the water out of the landscape by using structural measures (e.g., dikes or reservoirs). This was a reactive approach that protected human lives and assets exposed to increasing flood risk because the settlements are on the former river floodplains. Despite a shrinking population density in a region of chronic poverty, rising trends of flood damage from major floods have increasingly challenged the conventional

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engineering paradigm (Sendzimir et al. 2007). Recent years saw the slow infiltration of more advanced practices, such as polders, used as flood volume retention areas. A more radical change in approach was promoted by an informal network of actors (a "shadow" network) from the government, academia, and NGOs. Their proposal involved a more inclusive framing and a more participatory process, including the involvement of marginalized groups. A major environmental disaster, a cyanide spill, generated increasing political pressure and increased public awareness of environmental problems, facilitating more ecological considerations in flood management policy. Pilot experiments with floodplain restoration and traditional agriculture were initiated, and a combination of change in leadership and a further severe flooding facilitated the scaling-up of innovative programs (Werners et al. 2009; Sendzimir et al. 2010).

Research identified a number of potential measures (soft and hard)—mainly at the local level—that could be used to promote adaptive flood management to build resilience against floods, increase the portfolio of ecosystem services delivered or provided by a more healthy riverine ecosystem, and develop livelihoods for the more marginalized groups.

AWM, thus, highlights the critical role played by social learning processes in transitions to more resilient management in the face of uncertainty. However, learning can be costly and risky—one of the key obstacles to the acceptance of AWM (Medema et al. 2008). Moreover, AWM does not pay sufficient attention to addressing the presence of vested interests and asymmetries of power; these same problems also plague IWRM.

Common-Pool Resource Frame

The common-pool resource frame points to the inadequate provisioning of surface water and/or the depletion of the groundwater resource as major water problems. Biophysical causes for this are that groundwater (and water provisioning) is rival (subtractable) and non-excludable at the scale of the individual user.

Social causes are that groundwater and surface water are often open access. Given the above properties, free riding then happens and the resource depletes or under-provisioning takes place.

For solutions, this frame suggests converting open-access water resources to state, private, or community control. Specifically, the frame recommends creating or enabling collective action institutions at a scale that matches the resource boundary, and creating rules for monitoring, regulation, and sanctioning. The government's role should be to facilitate the formation of such institutions.

Key Aspects

1. Intellectual history
    - Increased in popularity around the 1950s.

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- Emerged out of bioeconomics, game theory, and new institutional economics in conversation with natural scientists.

2. Basic assumptions
   - Actors are motivated by self-interest (methodological individualism) and behave rationally.
   - Actors have similar interests and abilities in the resource to exploit it; there is no variation in social, economic, or political power between users.
3. Values emphasized in the frame
   - Sustainability: Avoidance of groundwater depletion, framed as efficiency and maximizing provisioning of the resource.
   - Justice: Fair results assumed to emerge automatically, but no explicit analysis of the causes of inequalities or exclusions.
   - Diversity: Biodiversity not included in the basic framework.
4. Additional values promoted through implementation
   - Focus is on promoting community control (as against state or private control), believed to produce a better balance of power between state and community (but not within the community). In addition, within-community fairness is considered.
   - In some cases, biodiversity has been incorporated into the goals, when the user group itself values biodiversity.
5. Representational accuracy
   - Strengths: Predicts the emergence and continuation of successful collective action in certain situations and has been proven accurate.
   - Biophysical weaknesses: Surface water has upstream–downstream asymmetries that prevent cooperation. In groundwater systems, the assumption of aquifers having a closed boundary is incorrect, as it ignores natural discharge that feeds into downstream flows or reservoirs.
   - Social weaknesses: Cooperation can be fragile, but presence of altruistic individuals can keep cooperation going. Forced cooperation (by powerful individuals) exacts a high cost to weak parties.
   - When analyzing cooperation, a too narrow focus on the natural resource can overlook the deeply embedded nature of local institutions and organizations, networks, interdependencies, and relations of collaboration that encompass many more areas.
   - Lack of attention to political dynamics and power asymmetries results in overestimating the emergence of cooperation, and the acceptance of social hierarchies as long as these are functional for effective resource management.
6. Political effectiveness
   - Represents a potentially attractive alternative to fully public or private forms of natural resource management. Aligns well with the

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agenda of powerful actors pushing for state withdrawal as well as those representing communities that demand more control.

- Its popularity has led to widespread promotion of "principles of self-governance" in canal irrigation management, watershed development, and some programs for groundwater management.

Example: The Case of the Acequias de la Vega de Valencia and Its Tribunal

The Acequias de la Vega de Valencia irrigation system is comprised of seven water canals or ditches and a main canal that irrigates small farms in Valencia, Spain. Today, it covers an area of 17,000 ha, and its Tribunal has existed for centuries. There is no exact date of when the Tribunal was created, but it is believed to have started during the Moorish rule in the eighth century. Its mandate is to resolve claims of mismanagement of water by any of the water users. Disputes are discussed every Thursday by its members (*síndicos*) who are irrigators themselves, and who receive the complaints and resolve them orally in front of the rest of the community, with no room for appeal. The *síndico,* who is a member of the ditch involved, does not participate in the deliberation and assignment of the penalty. The Tribunal does not use written documents or lawyers, and over centuries has successfully processed all claims without the need for public intervention.

The success of the Tribunal can be accurately explained through a common-pool resource frame, which defines the problem of water management as a collective action problem where individual and collective incentives may not be aligned since water users may benefit from the contributions of others while not contributing themselves. To use the language of public economics, since water is a rival (or subtractable) but non-excludable good for those water users in the irrigation system, the group needs to solve this social dilemma via institutions. The self-governance solution for this common-pool resource requires that water users endogenously develop, monitor, and enforce the rules that govern the provision and distribution of the water resource. The maintenance of these rules and social norms is a second-order social dilemma in which costly actions by each water user are required for the rules to produce the collective benefits, namely, efficient provision of the water and a fair distribution of the resource.

The research within this frame assumes that each water user has a utility function that maps actions and water benefits onto individual well-being. The social dilemma emerging from the divergence between the individual interest and the group interest requires that self-governed institutions are set in motion to restrict free riding by group members. The research conducted over this landmark case concludes that the Tribunal has successfully created a system of rules and norms that is enforced by the members who have monitoring responsibilities, and that the ease by which disputes are solved weekly, in an open

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and expeditious manner, has maintained the overall efficiency and fairness of the water management system over centuries (Ostrom 1990; Ortega-Reig et al. 2014).

Many of the usual solutions suggested by this framework, the Valencia Acequias Tribunal being a clear case, imply a prescription for higher government levels not to intervene with top-down regulations as these may erode the capacity of the water user system to self-govern. The common policy prescription, therefore, is to let the group of users, according to their particular conditions, devise rules and norms that are the best fit for the management of their own common pool.

This framing, however, usually omits other ecological functions of water management systems, such as the coexistence of other components associated with water (e.g., biological diversity, soil conservation). The upstream–downstream hydrological dynamics are often ignored in this framework. The common-pool resources approach usually concentrates on one resource: water in this case. Nonetheless, in this and most cases, there are other ecological functions associated with the containing ecosystems that can be of critical importance for the sustaining of life for the water users. An implication is that biodiversity, as a value in itself in many water management systems, plays a minor or nonexistent role. Likewise, little attention is paid to the hydrogeological aspects and their relationship with water quality, focusing mostly on quantity. Fairness and sustainability concerns, in this particular case, are central to the robustness of this long-standing case of successful water management.

Water Footprinting Frame

The focal problem addressed by the water footprinting frame is to identify where productive uses of water are wasteful. It seeks to reveal where water consumption in production is not accounted for or visible to the consumer, which leads to overconsumption.

The solution promoted within this frame is to calculate and display the amount of consumptive use of water embedded in a product or service. Further developments include water accounting and vulnerability evaluation (WAVE), which incorporates basin-level evaporation recycling, and corporate supply chain accounting (value chain capture of water use).

Key Aspects

1. Intellectual history
    - Emerged out of the virtual water concept by Tony Allan and is related to the ecological footprint (Hoekstra 2003).
2. Basic assumptions
    - More consumption is negative (no sustainability thresholds).

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- More efficient production will automatically lead to systemic water savings.

3. Values emphasized in the frame
   - Sustainability: Emphasizes efficiency in the consumption of water.
   - Justice: Not developed.
   - Diversity: Not developed.
4. Additional values promoted through implementation
   - Economic efficiency: Optimizes economic output per drop of water.
5. Representational accuracy
   - Strengths: Contributes information currently hidden, as prices seldom reflect water use in production.
   - Weaknesses: A drop of water is not comparable across sites. More information may not lead to behavioral change if consumers respond only to prices. Efficiency gains may not lead to water savings because production expands.
6. Political effectiveness
   - Attractive to the corporate sector due to its simple, biophysical quantification approach.
   - Susceptible to "greenwashing."

Example: Mitigating the Water Footprint of Export Cut Flowers from the Lake Naivasha Basin, Kenya

The water footprint of a crop (m^3/ton) is calculated as the ratio of the volume of water (m^3/ha) consumed or polluted during the entire period of crop growth to the corresponding crop yield (ton/ha). Water consumption has green and blue components: green refers to the volume of rainwater consumed whereas blue refers to the volume of fresh water from rivers, lakes, or aquifers needed to produce crops. A third component, gray water, refers to the fresh water required to assimilate the load of pollutants, based on existing water quality standards.

Mekonnen et al. (2012) illustrate how the water footprint could be used to inform water policy decisions through an elaborate calculation of the water footprint of export cut flowers in Kenya. Economically, the export of Kenyan cut flowers is a success: from 1996–2005, it contributed to an annual average of $141 million foreign exchange (7% of Kenyan export value), with about $352 million in 2005 alone. The industry also provides employment, income, and infrastructure (e.g., schools, hospitals) for a large population around Lake Naivasha. Estimates of the net benefits of the cut flower industry, however, do not include the value (or "price") of water in their calculation and may thus be overly optimistic. Decreasing water levels in the lake, as well as complaints about pollution and a reduction in the lake's biodiversity, have caused concern—expressed among others by environmental NGOs—that the economic profits of this industry are realized at the expense of the longer-term health of

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the lake, and by implication at the expense of all those (plants, animals, and human beings) who depend on a healthy lake for their survival or well-being.

To quantify the amount of virtual water being exported, Mekonnen et al. (2012) present a meticulous and precise calculation of the water footprint of the cut-flower industry around Lake Naivasha. The water footprint of one rose flower is estimated to be seven to thirteen liters; this is the amount of water needed to produce one rose. To put this differently: for every rose exported, seven to thirteen liters of water are also virtually exported from Kenya to retailers and consumers overseas. From 1996–2005, the total virtual water export related to the export of cut flowers from the Lake Naivasha Basin was 16 Mm^3/yr, with further division into green (22%), blue (45%), and gray water (33%). The calculations also show that six big farms account for more than half (56%) of this water footprint.

The calculation of the water footprint at this scale is data intensive. It makes use of a combination of available statistical and remote-sensing data about areas cropped or irrigated and quantities exported, combined with (among others) soil moisture, precipitation, and evapotranspiration data (making use of the standard FAO CROPWAT approach). The results give an interesting aggregate indication and quantification of how much water is needed to produce something and what fraction of that might be ending up in exports.

To understand whether, and to what extent, this footprint is environmentally problematic requires, however, further investigation of the hydro-ecology of Lake Naivasha, the amount of blue water that may be considered "available," the gray water assimilative capacity, and ultimately "how much a drop in lake level is socially and politically acceptable" (Mekonnen and Hoekstra 2010). This cannot be easily or unambiguously estimated. The authors assumed that the current use was above the acceptable threshold, further acknowledged that pricing of irrigation water supplied to farmers would not work, and focused on identifying consumer-end solutions; namely, a labeling and certification scheme that would enable customers to pay a "sustainable water premium" for sustainably grown flowers. They speculated that the extra money earned would be used by producers for investment in more sustainable ways—consuming less water or polluting less—of producing flowers.

The water footprint is an attractive and effective tool to improve water consciousness, as it creates awareness about the water costs associated with producing goods and services. An important hope of the water footprint is that better information on how much water it costs to produce something can be used to inform consumers who would then put pressure (through consumption choices) on producers to change their water practices. This hope is founded on several assumptions which may not always hold: (a) that consumers actually care about how the flowers are produced; (b) that transaction costs in labeling and certification are low; and (c) that the premium generated will translate seamlessly into changes in production practices by the farmers. Further insight into the nature and processes which shape water behaviors of different

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actors along the water-value chain are thus needed to translate improved water consciousness effectively into more water-wise practices. Also, a better understanding of the site-specific nature of actual environmental implications of water consumption—including a detailed identification of how costs and benefits are distributed (or the equity question)—is needed to identify realistic solution pathways. More fundamentally, perhaps, the water footprint framing and the solutions proposed sidestep some of the fundamental questions about the drivers of water overconsumption. By suggesting that water costs can and should be incorporated into the price of water, the idea that water can be protected through market mechanisms—and that consumption levels can continue increasing—go unchallenged.

Hydrosocial Cycle Frame

The hydrosocial cycle frame identifies unfairness and inequality in the distribution of water among humans as a core water problem. Biophysical causes identified by this frame include the ways by which water flows are mediated, interrupted, and diverted by technology and labor. Social causes are that powerful people appropriate water using this technology and labor at the cost of nature and less powerful people. Further, the frame highlights that water problems also occur because the dominant understandings of water are themselves reflections of the needs of the powerful, leaving out other concerns or problem framings.

Coevolution of biophysical and social dynamics is revealed through the hydrosocial cycle frame: changes in water flow alter society and vice versa. This frame, however, is not prescriptive and does not provide clear solutions. It is often associated with and informed by social movements that aim to alter the status quo and challenge existing hierarchical power relations.

Key Aspects

1. Intellectual history
   - Grew out of political ecology, eco-Marxism, and feminist scholarship.
   - Emphasizes reflexivity in scholarship.
2. Basic assumptions
   - There is no such thing as "natural" water; nature and society coevolve.
   - Power differentials always exist and are always used exploitatively.
3. Values emphasized in the frame
   - Sustainability: Not emphasized because when water is distributed equitably, the frame assumes that sustainability will follow.
   - Justice: Constitutes the primary concern.

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- Diversity: This frame includes (bio)diversity in the sense that misallocation includes taking water away from nature. It also engages with social and cultural diversity by demanding attention to life styles beyond the mainstream to understand water.

4. Additional values promoted through implementation
   - Critique and resistance.
5. Representational accuracy
   - Strengths: By treating water as a flowing resource and highlighting power, it explains unequal appropriations well.
   - Weaknesses: Does not explain resource overuse per se. Accuracy of "equity implies sustainability" assumption is debatable. Causality is hard to trace, and reasoning can become circular.
   - Biophysical properties of water not fully considered. Its social constructivist stance precludes the possibility of a common scientific understanding of hydrology.
6. Political effectiveness
   - Does not speak to water experts and is not accessible (because of dense language) to practitioners or other disciplines. It is restricted to a small academic community.
   - Assumes that marginalized or "oppressed" peoples oppose inequality, ignoring the possibility of dependency relations which may be highly unequal yet lasting.

Example: The Case of Mollepata, Peru

The framing of the hydrosocial cycle (Swyngedouw 2009) aims to reveal how water governance, deeply permeated by power relations that are often hierarchical, produces highly uneven "waterscapes." The case of Mollepata in the Peruvian Andes has been analyzed using this framework to highlight the interactions between water, power, and cultural politics (Boelens 2014). By tracing how contemporary water arrangements in the Andes have evolved through a historical series of contestations over water between indigenous communities and state or private actors, Boelens (2014) demonstrates how water and nature are sociopolitical constructs. The problem of water scarcity is seen as rooted in existing power asymmetries, whereby powerful elites appropriate water, and this has a negative impact on ecosystems and less powerful people (Boelens 2014:234):

> Since ancient times, elites have striven to reinforce subjugation over Andean peoples by creating "convenient histories" and "socionatural order" [...] that support water hierarchies and legitimize particular distribution, extraction and control practices, as if these were entirely natural.

His analysis explicitly includes an examination of the politics of the very process of knowledge production to show how struggles over water partly play out

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through contestations about what is the best or most accurate way to represent water. Here, the label of science, through claims of efficiency or modernity, works to legitimize expropriations, while also performatively categorizing farmers into those (the potentially efficient ones) that deserve recognition and support, and those (the backward and inefficient ones) that should instead be left to their own devices.

Human Right to Water Frame

The core problem addressed by the human right to water frame is that some people do not have sufficient, safe, acceptable, and physically accessible and affordable water for personal and domestic use. This frame identifies the lack of legal and institutional protections as a major cause of the problem, and is also frequently used as a reaction against the trend toward water privatization and the emphasis on efficiency as a core value in water management (Murthy 2013). This frame does not take biophysical limitations into much consideration, given the relatively small amount of daily per capita water allocations typically involved. The immediate solutions suggested by this frame call for the enshrinement of a human right to water through international agreements (e.g., a dedicated UN resolution) and national legal frameworks (e.g., Bolivian constitution). In some cases, this has led to a quantitative operationalization of the minimum individual water allotment to survive (estimates range between 7–50 liters per day). Its larger purpose is to facilitate institutional reforms that would improve basic water access among underserved human populations. In 2011, the United Nations Human Rights Council Resolution A/HRC/RES/18/1 and World Health Organization Resolution 64/2 called for the development of strategies and solutions to realize the human right to water (e.g., financing for water and sanitation infrastructure).

Key Aspects

1. Intellectual history
   - In 1977, the UN Water Conference Action Plan identified the human right to water.
   - In 2010, the UN approved Resolution 64/292 to secure the human right to water. The resolution was introduced by Bolivia, where concern emerged from a local, indigenous framing of "water is life" (the Andean *vivir bien* worldview) and the Cochabamba Water War against water privatization.
2. Basic assumptions
   - Every human being has a right to sufficient, safe, physically accessible and affordable water for personal and domestic uses.
   - Exclusive focus on human well-being.

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3. Values emphasized in the frame
    - Sustainability: Not emphasized as goal.
    - Justice: Core focus is on distributional and, to a lesser extent, procedural justice. More recent approaches argue for interactional justice (recognition).
    - Diversity: Includes the capacity to accommodate cultural, linguistic, and institutional diversity. Could have a deleterious effect on existing diversity by putting all under state or international framework. Does not consider biological diversity.
    - The moral or value orientation is that clean water is essential to accomplish all other human rights and dignity.
4. Additional values promoted through implementation
    - Promotes community management, commons, indigenous values.
    - Sometimes aligns with anti-capitalist views.
5. Representational accuracy
    - Strengths: Exposes the human health costs of inadequate water management and reveals structural inequities in water access within and across societies.
    - Weaknesses: Very narrow focus. Addresses only human water needs and is arguably inaccurate in representing these needs, as it rarely reflects cross-cultural variation in biological (e.g., cultural adaptations to water availability or scarcity) and symbolic needs for water (e.g., for ritual ablution).
6. Political effectiveness
    - Very effective in the sense that it emerged from successful social movements and has become enshrined in national and local law.
    - Its success in providing the basis for the reform of water management institutions and practices has yet to be determined.
    - Often used by communities to challenge the uses and allocation of water (e.g., rural vs. urban drinking water).

Example: The Case of Cochabamba, Bolivia

After its Water War in 2000, Cochabamba, Bolivia was celebrated internationally as a site of anti-privatization resistance. Many of the protesters who opposed the privatization of the water system lived in squatter settlements on the outskirts of the city of Cochabamba. Ironically, after the Water War was won, and control of the water system reverted to the municipal authority, these squatters were denied access to municipal water, just as they had been before, and remained dependent on informal water vendors for the bulk of the households' water supply. The research we discuss here (Wutich et al. 2016) asks: Do water vendors have a role to play in achieving the human right to water in Cochabamba?

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Using a human right to water frame, this research examines three dimensions of justice (distributive, procedural, and interactional) in informal water vending from the perspective of the water vendors and of their clients. This frame explicitly emphasizes justice as a value and does not include sustainability or biodiversity as values. Wutich et al. (2016) find that informal water vendors adopt (institutional) rules and norms that are designed to improve distributional justice, but that their clients are much more concerned with procedural and interactional injustices in water delivery. They also find that unionized vendors (a small minority of vendors) are much more effective in designing and enforcing rules to protect distributive, procedural, and interactional justice than nonunionized vendors (the vast majority of vendors). These conclusions are very accurate in representing human views of justice, but they only address environmental sustainability (e.g., water quality) and economic sustainability (e.g., pricing) briefly, in terms of their relevance to distributive justice. They do not consider diversity at all. In its recommendations, the research suggests vendor unionization and community consultation with vendors as possible pathways to achieving the human right to water in communities that are dependent on informal water vendors.

Ecosystem Services Frame

The core problem identified by the ecosystem services frame is the degradation of ecosystems and decline of benefits they provided to society. Increasing degradation or the nonsustainable use of ecosystems causes significant harm to human well-being and represents a loss of natural assets or wealth of a country. According to the ecosystem services frame, the primary cause is that the contributions of ecosystems to humans (especially through indirect, regulatory, and/or cultural services) are not well captured by current markets, nor are they well understood or recognized by society (especially policy makers), which leads to their neglect and deterioration. This frame points to the physical, quantitative, or qualitative assessment of ecosystem functions and services as a solution, often accompanied by valuation exercises that inform decision makers, who then take policy actions that respond to or capture the value of ecosystem services (thus, trying to internalize current market externalities). The frame assumes that nonrecognition can be addressed by simply assessing ecosystem services (to make them visible), estimating their benefits and values (monetary or otherwise), or setting up market-based instruments and other governance structures to get beneficiaries to transfer economic value (e.g., payments for ecosystem services).

Key Aspects

1. Intellectual history
    - Documented as early as Plato.
    - Term and current analytical tools broadly established by the

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Millennium Ecosystem Assessment (2005) and TEEB (2008), based on previous and parallel discourses in landscape planning, agriculture, forestry, and ecological economics (e.g., Daily 1997).

2. Basic assumptions
   - Natural (biotic) ecosystems and humanly transformed ecosystems (e.g., cultural landscapes) contribute substantially to human well-being.
   - Time horizon of policy makers is long enough, it is only a matter of not "seeing" certain service flows.
3. Values emphasized in the frame
   - Sustainability: Includes social, economic, and ecological dimensions.
   - Justice: Recognition of all values is core to the frame.
   - Diversity: Biological diversity (fostering or enabling many other services) and some aspects of cultural diversity (when different cultural groups hold different values for functioning ecosystems).
   - Anthropocentric concept featuring a fairly broad understanding of human well-being. In practice, focus is on economic values and respective valuation methods; largely perceived to be a concept to "put a price on nature," yet, some initiatives (e.g., IPBES) are trying to go beyond this. Conceptually highly integrative in terms of including stakeholders at all levels.
4. Additional values promoted through implementation
   - Some implementations promote multi-stakeholder participation and partly address distributional justice. Economic valuation or market-based instruments promoted in many cases.
5. Representational accuracy
   - Strengths: Improves accuracy of understanding the relationship between ecosystem and human well-being by emphasizing (previously ignored) services and scale effects. Recognizes the relationship between ecosystem structures, functions, and service flows. Captures how management decisions create trade-offs between elements of human well-being to alter the benefit distribution among different groups of people.
   - Weaknesses: Ignores disservices of ecosystems. Assumes that accounting for or capturing of ecosystem services will benefit nature broadly, although a causal linkage between biodiversity and ecosystem service provision is only established for a small number of services.
   - Original formulation ignored role of human labor, technology, and capital in transforming "natural ecosystems" into benefits (MEA 2005). Recent methods (e.g., ecological production functions) recognize these elements more accurately.
   - Emphasizes the supply side, but not the demand side, of ecosystems.

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- Assumption that lack of recognition is cause of degradation is often incorrect.

6. Political effectiveness
    - Economic valuation is attractive to policy makers. Many national ecosystem assessments are currently ongoing or in planning.
    - Some mainstreaming in policies at national and other levels, including impact evaluation requirements of multilateral lenders.
    - Many commitments are being made (e.g., Natural Capital Protocol, WAVES); action to alter policies in response still not widespread.
    - Strongly applied in European context for monitoring.
    - IPBES to strengthen the science–policy interface for biodiversity and ecosystem services.

Example: The Case of the EU OpenNESS Project on the Lower Danube River Wetlands System in Romania

The research presented here was carried out within the EU research project OpenNESS, which aims to translate the concepts of natural capital and ecosystem services into operational frameworks that provide tested, practical, and tailored solutions for integrating ecosystem services into land, water, and urban management decision making. OpenNESS examines how the concepts link to, and support, wider EU economic, social, and environmental policy initiatives and scrutinizes the potential and limitations of their integration at national, regional, and local scales. It is a transdisciplinary project that works in close cooperation with decision makers and other stakeholders, as natural capital and ecosystem services concepts (or elements thereof) are applied to concrete management and decision-making situations, such as integrated river-basin management, in a set of real-world case studies (Furman et al. 2018).

One case study used the ecosystem services frame to facilitate the design and implementation of an adaptive management plan for the Lower Danube River Wetlands System in Romania, which is characterized by a complex network of wet meadows, alluvial forests, agricultural polders, and fish ponds. In particular, a long-standing intensive and monofunctional agricultural production system reduced many of the wetlands' major functions and services, including fish catches, nutrient retention, water quality regulation, and river pulse regulation as well as recreational services and biodiversity. This study used the ecosystem services concept to (a) assess the relationships between biophysical structure and functions, and the supply of ecosystem services in the region (mapping); (b) identify and assess the trade-offs between sectoral policy objectives (e.g., inland navigation, hydropower production, food production, water quality, flood protection, biodiversity conservation) and policy instruments (e.g., NATURA 2000, Water Framework Directive, Common Agricultural Policy) at multiple scales (local to EU) for effective conflict management; and (c) enhance the operational capacity of stakeholders involved in

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the development of the adaptive management plan for assessment and valuation of ecosystem services (including biophysical methods, mapping tools, monetary and nonmonetary valuation tools).

The underlying research questions were framed by the ecosystem services concept, informed by the case study characteristics and needs. Stakeholders were involved in the research process via a Case Study Advisory Board. This board decided on the respective methods and tools to use as well as on the specific objects/areas of application (particular ecosystems, ecosystem services, policies, or subregions), and did not have a political mandate. Various aspects of sustainability were considered and a wide range of stakeholder organizations, institutions, and perceptions were acknowledged. Only key stakeholders, however, were represented on the Board.

Preliminary results indicate that stakeholders involved in the planning process thought that the ecosystem services frame helped improve the effectiveness of the management and that it fostered an integrative understanding of linkages between ecosystem functions provided and the trade-offs between relevant sectoral policy objectives (Grizzetti et al. 2016). The Board embraced the inclusive approach of this frame, in principle, yet its practice focused on a subset of identification and mapping tools (e.g., QuickScan) and multi-criteria decision analysis methods provided by the researchers. Substantial efforts are, however, needed to generate and compile required data and information. Some justice issues (representational equity) were addressed through the inclusion of a broad range of stakeholders, both as Board members and as active participants, in the regional project workshops. Further, one major long-term goal was to enhance the operational capacity of all stakeholders involved in the development and implementation of the river-basin management plans (Dick et al. 2018).

Assessing and Comparing the Frames

The seven frames described above provide a reasonable cross-section of the different ways in which water problems tend to be framed in research and/or action. These frames vary widely, both in terms of their theoretical and normative inclusiveness as well as in terms of their representational accuracy; namely, how well, or in what way, they represent particular water realities.

At the outset, it is important to note that particular frames are often used in, and developed for, particular contexts. This means that the values they emphasize and the representations they produce may be adequate in these contexts. For instance, the uncertainty introduced by climate change may be the biggest source of stress on the water system in a Central or Northern European context, where basic water needs have been amply met across households and sectors, and thus adaptability or resilience gain more importance. In contrast, in the context of a low-income country, the challenge of meeting basic water

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needs for different users and uses may take priority over goals of adaptability and resilience. Similarly, where the allocation of rights between upstream and downstream users is well-defined and accepted, a focus on collective action *within* a user group becomes relevant. Related to this, we note that various actors may frame problems differently, depending on the context, their own viewpoint, or their association with others (Gyawali and Dixit 1999; Moench et al. 1999).

In the subset of frames we detailed more thoroughly, the most common normative goal in different framings of water seems to be sustainability, which four of the frames (IWRM, AWM, common-pool resource, and ecosystem services) emphasize. This is somewhat surprising given the point made by Lele et al. (2017) that since water is a flow resource, fairness and equity should be the key concerns rather than intertemporal sustainability. Closer examination, however, indicates that "sustainability" means different things in each frame. In the case of AWM and IWRM, sustainability means adaptability or resilience of water service delivery in the face of uncertainty or external shocks. In the case of common-pool resources, sustainability means avoiding a decline in groundwater levels or in the surface water delivery infrastructure. In the ecosystem services frame, sustainability means maintaining natural capital intact on the assumption that it will generate necessary water flows.

Few of the frames explored here emphasize justice, and fewer still diversity. Even where explicitly mentioned, such as in the IWRM frame, its conceptualization is merely process based, expressing justice in terms of whether or not all stakeholders are equally represented. Here, one sees the interplay between theory and values: theory explicitly recognizes power differentials, as in the frame of the hydrosocial cycle frame, and justice is also emphasized more comprehensively.

Our conclusion is that no frame explicitly front-pages all three dimensions: sustainability, justice, and diversity. Most of the frames can become more inclusive in their values, but within limits: the principle of water, for instance, as an economic good (implicit in the IWRM framing) is inherently biased in favor of those who can pay for water.

It is when we examine the theory behind each frame that we see the bigger barriers to inclusiveness. The assumption of power differentials as fundamental and ubiquitous in one case (hydrosocial cycle frame) is difficult, if not impossible, to reconcile with the methodological individualism of water-as-a-common-pool resource, or the process and planning emphasis of IWRM. The deep cleavages between political economy, coevolutionary thinking, and rational choice models become apparent here, as do the differences between framings aimed at descriptive understandings and those aimed at guiding planning or interventions. Similarly, if water is considered part of a cycle and its uses are contextual (hydrosocial cycle frame, IWRM frame), then the assumptions of linearity and universality of water footprints, or even water as a human right, become problematic.

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Finally, there are some clear correlations between theoretical positions and normative ones. Ecologists, for example, tend to be more receptive to the ecosystem services frame than to, say, the frame of hydrosocial cycles, because the former places a greater normative focus on biodiversity, whereas sociologists are more receptive to the hydrosocial cycle and water as a human right frame than say economists or hydrologists.

The Use of Inclusive Frames in Academic Contexts

While most of the frames we discussed have clear limitations in terms of our definition of inclusiveness, it is possible to expand these frames pragmatically to make them more inclusive. Here, we explore cases in which two frames, ecosystem services and IWRM, were expanded to include a broader range of normative and theoretical positions. In doing so, we seek to address the following question: How can scholars make framings more inclusive while ensuring they remain representationally accurate in research on complex water problems?

Expanding an Ecosystem Services Frame to Embrace a Wider Range of Values

In Northern Kenya, wildlife, pastoralists, and private ranches exist in one large landscape. Much of the landscape is not fenced, and thus decisions made about grazing-land management have implications for pastoralist well-being, private revenue generation, and wildlife populations. A group of transdisciplinary researchers (disease ecologists, agronomists, ecologists, economists, social scientists) analyzed how different forms of cattle and grazing-land management affect wildlife and human well-being in this landscape (Allan et al. 2017). Initially they used an ecosystem services frame to develop a conceptual hypothesis of the connections acting across social, economic, and ecological elements of the landscape. Thereafter they conducted field experiments, observational surveys, integrated model development, and scenario analyses to explore this hypothesis.

The ecosystem services frame captured some connections in the system between elements such as forage and livestock production, nutrition, income, tourism, wildlife populations, and disease risk. Each of these connections exists through some environmental change. However, the frame did not capture several other important connections that link rangeland management to human well-being directly, rather than through an environmental change. For example, one mode of cattle grazing, called "bunched herding," requires keeping cattle close together and moving them around the landscape differently: a practice that necessitates more herders per head of cattle. Implementing this grazing mode directly creates jobs because of the higher labor requirement.

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As the environmental system does not need to change for the creation of these jobs to be viable, this is not an ecosystem service, but it is still an important linkage between landscape management and human well-being. The research team also faced challenges in integrating ecological, agronomic, economic, disease ecology, and social models, as few dominant modeling frames in these disciplines incorporate elements of key interactions in this system. In addition, the ecosystem service frame emphasizes the flow of nature's benefits to people, often identifying those people as "beneficiaries." However, the frame is not very explicit about distributional effects and vague about how beneficiary groups should be specified. Ecosystem services analyses often use land-use classifications as the basis for modeling, but in this system, there can be multiple beneficiary groups (e.g., ranch owners, resident ranch staff, day workers) receiving different ecosystem services on one property (land-use type). Thus the researchers needed to expand the frame to capture this complexity and ensure more direct treatment of the distributional effects of landscape management decisions.

Expanding an Integrated Water Resources Management Frame to Address Multiple Concerns and Stressors

In analyzing water management in two regions of Southern India, and the potential impacts of climate change on it, Lele et al. (2018) devised an approach using the basic descriptive aspects of IWRM. This included: (a) clarifying linkages between upstream and downstream (using basin as the scale), (b) clarifying linkages between groundwater and surface water, (c) clarifying linkages across sectors and stakeholders, and (d) the core normative idea of representing all stakeholders. Over time, the frame was expanded to add the following elements:

1. Multiple concerns: adequacy, quality, fairness across sectors and equity within sectors, sustainability and democratic governance
2. Multiple stressors: climate change is not the only source of stress on the system, many other stressors already exist, including land-use change, cropping-pattern change, population growth, industrialization, so their relative impact has to be assessed
3. Clearer role of infrastructure and institutions: water is distributed through built infrastructure and rules associated with it (both in supply and in effluent disposal)
4. Participatory research: scientific monitoring was done in tandem with participatory monitoring and water-literacy programs at the grassroots level and continuous dialogue with water agencies to build a somewhat common understanding of the "system"

The implementation of this framework (Figure 12.1) in research has confronted multiple challenges. First, the absence of biophysical knowledge

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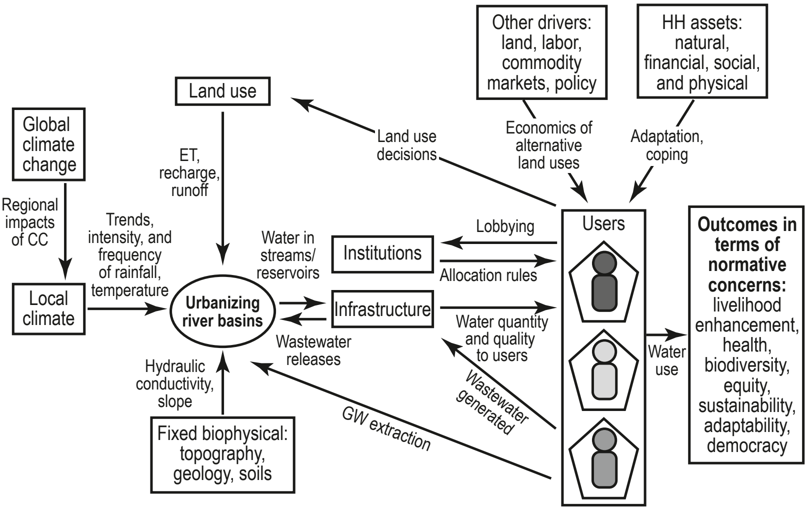

Figure 12.1 Framework for analyzing water issues in urbanizing basins in developing countries that delineates multiple concerns and stressors at multiple scales (Lele et al. 2017). CC: climate change; ET: evapotranspiration; GW: groundwater; HH: household.

and methods to understand the behavior of hard rock aquifers at 1000 feet of pumping, and the links between groundwater and surface water meant large amounts of primary research had to be conducted. Second, the limitations and contradictions in social science knowledge became quickly apparent. For instance, farmers' behavior is complex and coevolves with penetration of markets, but models of farmer decision making are usually unidirectional and incorporate limited parameters. Understanding or modeling the decision making of water agencies, (e.g., whether they will simply import more water, making the basin-level model meaningless) or the lobbying by farmers for electricity subsidies in pumping, or the level of corruption in pollution regulation and how it might change, was found to be very difficult. Third, involving farmers as partners in the research was challenging as they were at least partly complicit in groundwater depletion and feared that monitoring for research might result in them having to pay for water extraction. Overcoming these challenges was possible due to a combination of factors: a team consisting of both disciplinary and interdisciplinary scholars, a funding agency actively promoting inter- and transdisciplinarity, and sustained efforts at multilevel outreach.

As these two cases show, it is possible to build, from a base of somewhat less inclusive frames, more inclusive approaches to research on complex water problems. Implementing research based on such frames will, typically, require large interdisciplinary teams, substantial resources, and contextualized adaptation of existing theories.

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Challenges in Academic Receptivity to Inclusive Frames

Academics who wish to develop or implement more inclusive frames, like the ecosystem services and IWRM frames presented above, face both "internal" and "external" challenges. Internal challenges refer to the difficulties of actually building normatively inclusive and theoretically multicausal but rigorous frames, even when given the time, resources, and willing participants. Values are correlated with assumptions about human behavior, hidden assumptions about social limits in the thinking of the natural scientist and vice versa, and epistemological divides and notions of generality versus specificity of knowledge can make building bridges extremely challenging (Lele and Norgaard 2005).

One specific example concerns the challenges involved in advocating for a greater focus on gender and justice within sustainability approaches. Experiences in "mainstreaming" gender, or in talking about gender to water experts, illustrate how difficult it can be to merge or integrate more sustainability-oriented frames of analysis with those frames of analysis designed to see and understand questions of social justice. The traditional subject matter of water analysts is "nonsocial": the physical, biological, and chemical characteristics of water. Although efforts are increasingly made to also include social questions in the analysis of water problems, preferred or dominant scientific languages and methods continue to be derived from the physical sciences.

These, however, are not well suited for understanding the behavior of human beings and their interactions. Gender is a deeply contextual phenomenon: What gender is, and what it means to act or identify as a specific gender, is dependent on time and place. It is also variable, depending on class, caste, religion, or ethnicity. This realization makes it difficult to make general statements about gender in relation to water and to reconcile with a desire for generic truths and universally applicable solutions. Analyzing gender and analyzing water not only seem to require different ways of ordering and making abstractions about reality, the levels and units of analysis may also be difficult to reconcile. Manifestations of gendered inequities and injustices in water occur, or are most clearly visible, at the level of the end users. If the unit of analysis is a river basin or a large surface irrigation system, the group of end users is so large that it becomes conceptually difficult to do justice to all diversities and differences, including those based on gender, between stakeholders and actors. This is even more so because water interests and needs are usually not clearly gendered; although women may have specific water interests, they are usually not a homogeneous group in terms of water.

The difficulty in recognizing gender issues that affect the framing of water, and probably more broadly in combining justice frameworks with sustainability frameworks, is linked to the irreconcilability of epistemic traditions in knowing water and in knowing or thinking about (gendered) injustices. Importantly, to understand (and act on) problems of justice in water management requires active efforts to change normal ways of knowledge production related to water.

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This importantly hinges on the forging of new alliances between critical stakeholders (e.g., feminists, political ecologists) and water scholars. These alliances need to go beyond the latter studying and criticizing the former, and should instead concentrate on the active co-creation of different water knowledges.

Problems in overcoming theoretical understandings of water and society are compounded by the institutional challenges faced in academia. The full deployment of multiple value dimensions and theoretical perspectives in a research frame involves significant additional time and resources as compared to deploying the narrower, preexisting disciplinary frames. However, academia tends to value productivity over breadth. Over time, the institutionalization of interdisciplinary scholarship is also stymied, because young scholars see that engaging with such frameworks poses a handicap as they build a career in an academic world that still puts a premium on disciplinary scholarship (Bruce et al. 2004).

These difficulties increase when the frame to be developed and articulated in a specific case is not just interdisciplinary but also transdisciplinary; namely, integrating stakeholders in all steps of research (Jahn et al. 2012). Transdisciplinarity increases the appropriateness of research and its potential to contribute to resolving actually occurring water-related societal problems. However, it often does not receive full academic credit, since, by definition, it is not meant to follow disciplinary guidelines or to contribute to disciplinary development (Defila and Di Giulio 2015). As the primary instrument to guarantee scientific excellence, peer review poses a unique challenge for transdisciplinary publications, due to the lack of specific standards and journals.

Exploring How Inclusive Frameworks Work (or Not) in Practice

Using three illustrative examples, we explore how inclusive frames facilitate (or not) societal relevance, impactful research, and concerted action. We reflect on researchers' struggles to use different inclusive frames in applied contexts by describing examples that demonstrate how inclusive frameworks work in practice. While these examples also show that the inclusion of values other than those put forward by the research framing can be made through the transdisciplinary engagement of researchers, a more detailed analysis on this point would go beyond the scope of our chapter.

Success and Failure of Adopting a More Inclusive Frame: Revisiting the Tisza River Case of Adaptive Water Management

The frame adopted by the flood management research project in Hungary embraced a quite inclusive approach. Justice may not have been spelled out, but the fate of marginalized groups was explicitly addressed. In the spirit of participatory action research and transdisciplinarity, the project engaged with an

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ongoing process in the region with the goal of both analyzing and supporting it. Given the apparent success of innovative approaches, the initial research design did not explicitly address power structures and points of view of opposing groups. The choice of interview partners and people included in the action research processes had a clear bias toward representatives of the shadow network (i.e., the network of informal actors).

However, the promising initial development toward integrated flood management practices stated in new national flood policy experienced a backlash caused by a weakening influence of the shadow network and the increasing dominance of supporters of a technocratic approach and traditional flood management paradigm in the formal policy process. The influence of the shadow network was never formalized but was triggered by the presence of powerful and charismatic individuals. A subsequent analysis of the process revealed this weakness more clearly (Sendzimir et al. 2010; Pahl-Wostl et al. 2013).

This example illustrates that certain frames resonate and are supported by different groups, and paradigm shifts cause resistance. As we have long known (and still often ignore), introducing AWM does not just imply a change in some procedural aspects of water management: it requires a real transformation (Allan and Curtis 2005; Pahl-Wostl 2015).

Making an Inclusive Frame Even More Inclusive: Revisiting the Ecosystem Services Frame in the Kenya Case Example

The Northern Kenya analyses were developed in collaboration with a local NGO, and results will be shared with that NGO and local and regional decision makers. The local NGO, the Northern Rangelands Trust, has an interconnected set of goals that they state as "resilient community conservancies, transforming lives, securing peace, and conserving natural resources." Given the broad set of interests held by these groups, the inclusive framing by these transdisciplinary researchers has been relatively well received, with some challenges. This is a case where there is already discussion and recognition of the importance of multiple values on the landscape, held by a diverse set of groups. These groups have asked the transdisciplinary researchers to be even more inclusive in the analyses, to represent and consider elements of governance (particularly grazing-related cultural norms) and other interests, such as security (especially related to cattle raiding and grazing incursions) and social cohesion (including elements of trust and engagement). In that sense, even the expanded ecosystem service frame of the transdisciplinary researchers has not been inclusive enough to reflect the myriad interests from the social groups that interact within this landscape.

At the same time, the researchers have needed to develop specific metrics for each of the stakeholder groups so that these groups can readily translate research findings in terms they find useful to their thinking and decision making. Without this tailoring, a broad frame is not accessible and would likely

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have produced results that were not very relevant to stakeholders. For example, employment in cattle management is reflected in the broad frame. However, each group is interested in employment for different reasons, and thus they are interested in different measures. Managers at the Northern Rangelands Trust are interested in the cost of employing staff, donors are interested in distribution of employment by county and by gender, local and national government leaders are interested in the total number of people employed, and community and local leaders are interested in distribution of employment among tribal groups. Discussing these metrics revealed that there are further distributional justice interests held by different groups that need to be included in the frame for it to be accepted.

Adopting a Less Inclusive Frame to Understand a Water Problem in a More Inclusive Way: The Case of the Adaptive Management Frame in Arizona Water Decision Making

Here, we introduce a final case to illustrate an interesting phenomenon: sometimes the adoption of a *less* inclusive frame as a starting point can facilitate the development of a more inclusive frame later. This case involves the problem of water scarcity in Phoenix, Arizona. Phoenix is a large city located in a desert; future projections indicate that the climate will become warmer and drier over time, even as the human population continues to grow. Researchers at Arizona State University's Decision Center for a Desert City developed WaterSim, an interactive model to address water scarcity that is designed to be a "boundary object" spanning science and policy-making processes (Gober and Wheater 2014; Larson et al. 2015). Initially researchers adopted an adaptive management frame, which placed a strong emphasis on sustainability (including environmental, economic, and societal dimensions) as a core value. In emphasizing sustainability, this frame was politically appropriate and a good fit with local values. Discussions of justice and diversity, however, can be politically sensitive and, critically, impede discussion on genuine points of mutual interest and shared values in the Arizona water decision-making context (Wutich et al. 2010). As with all boundary objects, the WaterSim model was revised as the result of many conversations, critiques, and contributions from both the scientists and policy makers (Wutich et al. 2010).

Over time, this process allowed scientists and policy makers to build trust in each other and, by engaging in discussions around WaterSim, to explore issues that most academics would identify as relevant to justice (e.g., fairness in the distribution of water across sectors) and diversity (e.g., using artificially constructed wetlands to provide tertiary treatment of wastewater, and also enhance biodiversity). This case clearly highlights the importance of resisting the academic impulse to build a highly inclusive frame that emphasizes all normative values and goals at all times. Rather, it is important to consider carefully cases in which it may be better to embrace a frame that is less inclusive or emphasizes only those normative values that are most shared. Such a frame, while less overtly inclusive, can play an important role in accomplishing other normative goals by allowing these goals to be pursued in the background or for less-shared values to be built into the frame over time as a consensus slowly emerges. This case also illustrates the value of having boundary concepts and border zones where people who do not necessarily share normative concerns can meet in a way that is not politically polarizing (cf. Schleyer et al. 2017).

Some Final Reflections

If environmental problems are inherently problems of sustainability, justice, and diversity, then it may be argued that the analysis of environmental problems (including water problems) should routinely emphasize all three groups of concerns, in addition to some form of life or livelihood enhancement. It could further be argued that theoretical explanations should speak to all these concerns. This is easier said than done.

At the theoretical level, integration is often difficult because different experts use different conceptual metaphors, have different methodological preferences, and come from different epistemic traditions. Theoretical integration can perhaps best happen when scientists and researchers engage in joint research projects that run long enough to arrive at shared problem analyses and to co-develop frames of understanding and problem solving. This type of integration will perhaps necessarily happen at lower levels of abstraction than what normal disciplinary scientific rigor prescribes, but may eventually result in the types of framings that allow seeing the connections between social, environmental, and political questions.

Perhaps integration can also happen at the more practical level, by bringing together experts and practitioners (and their respective frames) to help jointly solve an environmental or justice problem. This kind of process-based integration brings its own set of challenges: Who is invited? Is "consensus" the best solution? How will issues of power and tradition affect those who participate? Overcoming such problems could entail compromises and lead to a watering down of the original objectives that may be unacceptable to some participants.

One important role for researchers involves the more instrumental and practical collection and provision of information to support decision making as well as the development and implementation of plans. Researchers can also provide critical reflection: the detailed documentation and critical assessment (against objectives of sustainability, justice, and diversity) of the messy bargains, dilemmas, choices, and compromises that any water intervention project or policy development inevitably entails. Such critical reflections could provide an interesting starting point for rethinking environmentalism.

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Many changes will only happen when actively demanded and struggled for by social movements or activists, who may be much more effective when forcefully emphasizing one value or concern instead of integrating many. In particular, concerns of social justice are often articulated most forcefully by social movements. For example, the "water warriors" network of activists (hosted by the Blue Planet Project of the Council of Canadians) has been successful in a cross-national reframing of water as a commons; this frame has been used to challenge power effectively *across scale*. It is worth noting that the difficulty of inserting justice concerns into water frameworks is itself a reflection of dominant power–knowledge networks and epistemic traditions. Accepting this may allow researchers to occupy yet another valuable role, one that comes with different requirements: researchers can support single-issue or value movements by providing them with information and analyses in support of their cause. For example, instead of attempting to arrive at integrative frameworks, the role of researchers concerned with justice can also be to uncover how the seemingly technical solutions proposed in the name of diversity or sustainability imply deeply political decisions in that they redistribute water responsibilities, rights, benefits, and risks.

Researchers who choose to adopt a less inclusive frame, with the goal of facilitating action, must have a strong identification with the movements or activists they are supporting. These researchers may also document and analyze the strategies of social movements or activists in an effort to help identify which strategies are more effective and under which conditions. In cases where the goal is not to produce impactful research or concerted action, some researchers may find that more inclusive frames are more appropriate for achieving representational accuracy in the understanding of complex water problems.

Concluding Thoughts

Water problems are clearly framed in different ways: some normatively narrow or analytically simplistic, some normatively broad or analytically deliberately fuzzy, some speaking to managers, and others highly academic. Assessing these frames on a common set of criteria, as we have done here, can help us understand points of tension, overlap or disconnect between them, as well as the contexts in which some work better than others. In the current academic culture, however, we sense that there is some interest in developing a frame that is even more inclusive than those currently used in interdisciplinary or even transdisciplinary scholarship.

When developing more inclusive frames, there is naturally a tendency for disciplinary experts to desire representation of their own familiar theoretical and normative positions. This leads to frames that "front-page" or clearly highlight multiple values. For example, an environmental justice

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expert is more likely to be supportive of a frame where justice is clearly recognized as a normative interest, rather than one where justice is implicit or could be built into the frame. However, such overtly inclusive frames may not always be acceptable to all actors because they appear to elevate values not shared by all, or preference some values that seem outside the scope or interest of the context. While it may be tempting to conclude that frames which do not explicitly emphasize all values are not inclusive, we believe that *the more important consideration in determining their inclusivity is how open a frame is to accommodating other values* (even if these values are not highlighted).

While frames that are flexible in allowing for multiple values can become more inclusive, they will not necessarily do so. It is important to acknowledge that values that are not emphasized in a frame can easily be overlooked or treated shallowly. This leads us to consider another reason why we should perhaps avoid the impulse to develop highly inclusive frames for understanding water problems. Ontological and methodological diversity is important for advancing scholarship as well as for the public debates that can result from scholarly analysis. Water systems or realities are always complex. We suggest that adopting any single language or logic in attempts to know water may be too constraining or limited. There are different versions of "water": its meanings, its uses, its management, and so on. Too much emphasis on integration, equivalence or commensuration will inevitably hide gaps, slippages, and frictions between these differences. Acknowledging these frictions instead of, or in addition to, trying to solve them or gloss over them through more inclusivity can be valuable when it helps us see the fault lines of potential conflicts that stem from human struggles over water.

These tensions—between explicit and implicit inclusivity, and between inclusiveness as viewed by researchers, practitioners, and community members—are very significant ones that need to be addressed if more inclusive frames are to be used to advance rigorous science that is socially relevant and impactful.

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