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Summary: Chile’s free-market Water Code was passed in 1981. Since then Chile has become known as the world’s leading example of the free-market approach to water law and economics – the textbook case of treating water rights not merely as private property but also as a fully marketable commodity. This approach is often referred to as the “Chilean model.” In this paper I summarize key aspects of the Chilean experience, including the weak legal reform of 2005, in order to draw broader lessons for international debates about how to reform water laws, policies, and economics. My fundamental conclusion is that the Chilean approach has had some important benefits as well as problems, but overall it is not compatible with the long-term goals of integrated water resources management or sustainable development.

Key words: water markets, property rights, governance, institutions, Chile

The Experience of Chilean Water Markets

Introduction

What can the Chilean experience teach us about water markets and sustainable development? Chile's experience is uniquely valuable to help answer the following question in international water debates: *Is a free-market approach to recognizing water as an economic good compatible with the broader and long-term goals of integrated water resources management?* I will argue that the Chilean experience shows that the answer is *no*. Other economic approaches, however, including market instruments, are nonetheless essential. In this paper I will try to explain briefly how I support this argument, drawing especially on Bauer (2004, 2005). In the process I will respond to the questions posed by the organizers of Expo Zaragoza's Water Tribune. Slightly re-phrased, the questions are:

1. What criteria should we use to evaluate the efficiency of water markets? How should these criteria be incorporated in market instruments?
2. Can the economic efficiency of water allocation be compatible with social and environmental sustainability?
3. How do water's physical characteristics affect its commoditization?
4. How useful are mathematical models for decision-making in this field?

Chile's free-market Water Code was passed in 1981. Since then Chile has become the world's leading example of the free-market approach to water law and economics – the textbook case of treating water rights not merely as private property but also as a fully marketable commodity. Other countries have recognized variations of private property rights to water, but none have done so in as unconditional and deregulated a manner as Chile. Because the 1981 Water Code is so paradigmatic an example of free-market reform, people around the world have disagreed about whether the “Chilean model” has been a glorious success or a disastrous failure or something in between.

The predominant view outside of Chile is that Chilean water markets and the Chilean model of water resources management have been a success. This has been the view of many economists in the World Bank, the Inter-American Development Bank, and related institutions, who have encouraged other countries to follow Chile's lead in water law reform. Since the early 1990s, these proponents have promoted a simplified description of the Chilean model and its results in other Latin American countries and in the wider international water policy arena. Although they sometimes recognize flaws in the model, their general tendency has been to play down the importance of those flaws and instead to emphasize the model's advantages.

For example, a senior water advisor at the World Bank has publicized Chilean water markets as a prominent international example of “good practice” in managing water “as an economic resource” (Briscoe 1996, Briscoe et al 1998). After praising “the genius of the water market approach” (1996, p.21), Briscoe concludes that in the case of Chile, the “system of tradable water rights and associated water markets is a great achievement and is universally agreed to be the bedrock on which to refine Chilean water management practices” (1998, p.9). Similarly, a paper for the Global Water Partnership describes Chile as “a world leader in water governance.” The authors recognize that “many mistakes with openness, transparency, participation, and ecosystem concerns were made in the hurry to get effective water markets established,” but they conclude that “the system is adaptive and now these concerns are being addressed 20 years after the initial laws were passed” (Rogers and Hall 2002, pp.25-26). This optimism about the prospects for correcting

the Water Code's flaws rests on ignorance of Chile's political and constitutional system, as I have argued in detail elsewhere (Bauer 2004).

The Chilean model of water markets and water rights trading is different from other countries in at least one essential way. In other countries that have allowed or encouraged water markets, in varying degrees and circumstances, these markets have been a policy instrument within the larger context of water law and regulation. In Chile this order is reversed: water resources management takes place in an institutional context that has been shaped by and for water markets. The Chilean Water Code is so *laissez faire* that *the overall legal and institutional framework has been built in the image of the free market*, with strong private property rights, broad private economic freedoms, and weak government regulation.

When we look at Chilean water markets, therefore, we are also looking at the Chilean model of water management in general, to a greater extent than in other countries. My analysis emphasizes an institutional economic perspective by showing how legal rules and political forces have affected property rights, economic incentives, and market performance.

Water Reforms and International Debate

Since the early 1990s there has been increasingly urgent international debate about a global water crisis. Growing demands and competition for water resources worldwide have caused increasing scarcity and conflict. As these problems have become worse, they have led to a broad international consensus about the need for major reforms in how water is used and managed. Such reforms point to more “integrated” water resources management (IWRM), which is supposed to be holistic, comprehensive, interdisciplinary, and sustainable over the long term (Global Water Partnership 2000). Reaching this goal will require good “water governance,” another open-ended term that refers to the social, political, and institutional aspects of water management.

One of the core principles of IWRM is that water should be recognized as an “economic good.” But people disagree about what that means and what the policy implications might be. There is a range of economic perspectives, which vary in how they address the institutional context and foundations of markets – in simple terms, the rules of the game (Bauer 2004, 2005). With respect to the idea of water as an economic good, two general economic perspectives are most important. One is that water should be treated as a scarce resource; the other is that water should be a private and marketable commodity. Both positions agree that allocating water involves difficult choices and trade-offs, for which economic incentives can be powerful tools. But they have quite different implications for the role of markets and for legal, institutional, and regulatory arrangements, as the example of Chile shows clearly.

The institutional arrangements that are critical to IWRM are those required for defining and enforcing property rights, coordinating different water uses within shared river basins, internalizing externalities (both economic and environmental), resolving conflicts, and monitoring compliance. These processes are all inter-related by their nature. Moreover, they have unavoidable social and political aspects, since they allocate costs and benefits among different people and determine who gains and who loses. Because different economic perspectives shape the design of these institutional arrangements, the stakes are high. For all these reasons, Chile's 25 years of experience with the water market model offers valuable lessons for both national and international water policy reforms.

Empirical Results in Chile

If we look back over the 25 years since the passage of the 1981 Water Code, and particularly the period since Chile's return to democratic government in 1990, two major trends stand out. First, there has been a great deal of political and policy debate about water rights and water markets in Chile, but there has been much less academic or empirical research – by which I mean research attempting to be objective rather than tied to particular political positions. Much of the academic research has been done by North Americans, and much of the policy research has been done by people in international organizations. The relative lack of empirical research by Chileans is both a cause and an effect of the highly politicized nature of the domestic debate about water policy.

Second, two related issues, or sets of issues, have dominated discussions in both policy and academic arenas:

- ⇒ What should be the basic legal rules defining property rights to water? How have the current rules, which are extremely *laissez faire*, affected the economic incentives for water use? Should the law be changed, whether for economic or social reasons?
- ⇒ How have water markets worked in practice? What have been their strengths and weaknesses, and how might they be improved by legislative or regulatory reforms?

Both sets of issues have been hotly contested in Chile. Outside the country, in contrast, nearly all attention has been directed to the second set: Chilean water markets. The distinction is important: it points to the narrow focus that has dominated international evaluation of the Chilean model.

We can assess the empirical results of the 1981 Water Code in two ways: (1) by comparing them with the law's original objectives; and (2) by comparing them with the issues now considered critical for integrated water resources management. The law's original objectives, of course, were determined by the strong political and ideological views of the Chilean military government and its civilian advisers. Many people both inside and outside Chile do not share those views. In comparing the law's results with those objectives, therefore, I do not mean to imply that the objectives themselves were necessarily correct.

Comparison with the Water Law's Original Objectives

It is important to recall a few general points about the Water Code's political background and legislative history. When the Water Code was being drafted in the late 1970s and early 1980s, the government's primary concerns were irrigation and agriculture. Relatively little attention was given to non-agricultural water issues, other than to assume that free markets would reallocate some agricultural water supplies to non-agricultural uses. As far as other issues were concerned, free-market economic theory was simply applied to water management without much effort to adapt it to the specific characteristics of water resources. The best example of this is the *laissez faire* approach to coordinating water uses within river basins. Another example is the inadequate definition of the rules governing the new category of non-consumptive water rights. Finally, issues of water quality and environmental protection were left out of the Water Code almost entirely. IWRM, in short, was not yet on policy-makers' radar screens.

It is also important to keep in mind that some of the fundamental elements of the Chilean water law model have been determined by the 1980 Constitution more than by the 1981 Water Code. One such element is the constitutional provision that declares water rights to be private property, which enjoys very strong protection from government intervention. A second such element is the basic structure of the overall institutional and regulatory framework, particularly the limited power of the government administrative agency, the *Dirección General de Aguas* (DGA),

and the strong and broad authority of the judiciary. This framework is what determines the resolution of water conflicts and related institutional functions.

The Water Code, together with the Constitution, has been fairly effective in achieving several of its original priorities, *mainly those having to do with strengthening private property rights.*

- ⇒ The legal security of private property rights has encouraged private investment in water use and infrastructure. The level of this investment has varied in different parts of the country; it has allowed new mining development, especially in northern Chile, and the planting of high-value fruits and vegetables for export.
- ⇒ The counter-reform in agrarian land tenure has been consolidated.
- ⇒ Government regulation of water use and water management has been tightly restricted.
- ⇒ The freedom to trade water rights has allowed reallocation of water resources in certain circumstances and geographic areas.
- ⇒ The autonomy of private canal users' associations from government has been affirmed, which in some cases has encouraged these organizations to improve their administrative and technical capacity; however, these organizations operate only within the agricultural sector and rarely include nonagricultural water users.
- ⇒ The creation of non-consumptive water rights has encouraged hydroelectric power development, first by government enterprises and later by private companies – though not without serious and uncompensated impacts on other water users, particularly irrigators.

The Water Code has been *much less effective in achieving other original objectives, particularly those having to do with the smooth operation of water markets and market incentives.* This observation is now widely accepted by Chilean water experts, although not by the law's strongest political supporters. Note that some of these results represent a lack of success rather than failure; others are more clearly negative.

- ⇒ Market incentives to promote more efficient water use, particularly within the agricultural sector, have not worked as expected. Irrigation efficiency remains low nationwide, and in the few areas where it has increased, the change reflects factors other than the water market – namely, investment to improve crop yields or reduce costs of labor and canal maintenance. Investment in these areas has been encouraged by the legal security of property rights, but not by market incentives to sell unused or surplus water rights. Such rights are rarely sold.
- ⇒ Continued government subsidies have been required for the construction and maintenance of irrigation works at small, medium, and large scales.
- ⇒ Examples of significant market activity, as indicated by the amount of water resources reallocated or by the frequency of water rights transactions, remain limited to a few areas of the desert north and the metropolitan area of Santiago.
- ⇒ The definitions of water rights remain vague or incomplete; the legal and technical details are inadequate and confusing in most of the country.
- ⇒ The idea that water market forces would benefit peasants and poor farmers by improving their access to or ownership of water supplies has generally failed. If anything, the water market seems to have harmed many of these farmers more than it has helped them, although there is not enough evidence to make strong generalizations.
- ⇒ Reliance on private bargaining to coordinate different water uses and resolve river basin conflicts, particularly between consumptive and non-consumptive water rights, has failed. Neither DGA nor the courts have adequately or reliably redressed the problem.
- ⇒ In the hydroelectric sector, non-consumptive water rights have been subject to problems of speculation, concentrated ownership, and private monopoly power.

The mixed performance of Chilean water markets is due to the variety of factors that shape these markets' wider social, institutional, and geographic contexts. Institutional arrangements – the

rules of the game – have been among the most important of these factors. The Water Code's laissez faire definition of property rights has obviously had a strong impact on the specific economic incentives and disincentives that are faced by water users and water rights owners. A core lesson here is that *private property rights and market forces do not always go together*. Many water rights owners (or would-be owners) consider legal *security* to be much more important than market pricing and exchange (Bauer 2004).

Comparison with IWRM Today

The most negative results of the Water Code have involved issues that were of little concern in Chile in 1981 but have emerged as ever more critical since the early 1990s. These are the economic, environmental, and social problems that are at the heart of contemporary international debates about integrated water resources management and water governance:

- ⇒ coordination of multiple water uses in managing river basins; integrated management of surface water and groundwater;
- ⇒ resolution of water conflicts through either judicial or non-judicial processes;
- ⇒ internalization of both economic and environmental externalities;
- ⇒ clarification, enforcement, and monitoring of the relationships among different property rights and duties, e.g. the relationship between consumptive and non-consumptive water rights;
- ⇒ environmental flows and ecosystem protection; and
- ⇒ public assistance to poor farmers to improve social equity in matters of water rights and water markets.

These problems are inter-related and must be addressed within a common institutional framework. Under the current framework in Chile, these issues have generally been addressed in an ad hoc or ineffective manner and in some cases they have not been addressed at all. Many of the flaws in the existing framework have been widely recognized by Chilean water experts, regardless of their political viewpoints. In some areas the empirical research is still missing or insufficient to draw definitive conclusions, although the available evidence indicates at least that there have been problems.

Research on the Chilean Water Code has had strengths and weaknesses. The relatively single-minded focus on water markets and water rights trading means that we understand how they have worked much better than before, and this is an important step forward. This focus has also had significant blind spots, however. Our improved understanding of markets has come at the cost of other issues of water management and institutional performance that are at least as important. There is much more to water resources management than simply the allocation of resources – whatever the allocation mechanism may be. In part this is because the notion of “efficiency” of allocation is often a misleading objective, to which I will return in my conclusions.

Because the Water Code did not address the broader economic, environmental, and social problems that are important today, it may be unfair to criticize the code for its failure to solve them. But that is not the point here. Rather, the current legal and institutional framework – which is determined by the Constitution as well as by the Water Code – has shown itself incapable of handling or adapting to these unforeseen problems. The current framework, as we have seen, is characterized by a combination of elements that reinforce each other to maintain the status quo: strong and broadly defined private economic rights; tightly restricted government regulatory authority; and a powerful but erratic judiciary that is untrained in public policy analysis, reluctant to intervene in issues with political implications, and committed to a narrow and formalistic conception of law. The problems of water management will only get worse as the demands and competition for water increase, putting ever more pressure on the existing institutional framework.

Water Code Reform in Chile

In view of the mixed results and the problems identified, what are the prospects for improving the current framework in Chile? In 2005 the government finally passed a new law that modified the Water Code. The political struggle over this reform lasted almost 15 years, since Chile returned to democratic government in 1990. Over that period the scope of the government's proposed reforms narrowed steadily in response to strong political opposition from conservative political parties and private sector business interests. At the same time, the government's own position on water markets gradually became more favorable.

This is not the place for a detailed analysis of the politics of Chilean reform (cf. Bauer 2004). In short, my view is that the 2005 reform contains many worthwhile and incremental improvements in water law and administration, designed in response to specific problems identified under the previous law. Important examples are the provisions to: (1) improve water rights title information and record-keeping; (2) strengthen management of groundwater; (3) strengthen the DGA's regulatory authority over future grants of water rights (but *not* over existing rights); and (4) begin to address the problems of minimum ecological flow. The most controversial change was the establishment of "fees for non-use" after more than a decade of political debate and stalemate (*ibid*). These fees aim to prevent private speculation, hoarding, and monopoly of water rights – especially the non-consumptive water rights needed for hydropower development. The fees must be paid annually to the government by any water rights owner who has not put his or her new rights to concrete use.

In the bigger picture, however, and from an international perspective, the 2005 reform of Chile's Water Code was modest. It tinkers with the existing legal rules and institutional framework but barely touches the core principles of private property rights, market forces, and a weak state. Hence the reform does very little to improve capacity for IWRM. In fact, the reform was finally approved politically because of Chile's on-going electricity crisis, not because of any consensus about integrated water management. The urgent need to stimulate hydropower development overcame the political opposition to modifying the water law. Whether the reform will have much impact on the water rights system or on water governance remains to be seen. It seems clear that no additional reforms will be politically possible for many years to come.

Lessons for International Water Reforms

Chile's experience shows the problems that can flow from implementing a free-market water law. Its narrow economic approach has led to policies and institutional arrangements that cannot meet the challenges of integrated and sustainable water resources management. To avoid such outcomes, international efforts to reform water policies must foster a broader and more interdisciplinary approach to water economics, with more legal, institutional, and political analyses of markets and economic instruments. My hope is that this analysis of the Chilean experience will help raise the level of international debate about IWRM, particularly about its economic and institutional aspects.

The Chilean model has had two main economic benefits: first, the legal security of private property rights has encouraged private investment in water use, for both agricultural and non-agricultural uses; and second, the freedom to buy and sell water rights has led to the reallocation of water resources to higher-value uses in certain areas and under certain circumstances. These are important benefits, even though market incentives themselves have been only partly functional in practice, and they are the kind of results that pro-market policies hope to deliver. Many other countries would improve their water use and management if they could achieve similar results.

However, those economic benefits are directly linked to a legal, regulatory, and constitutional framework that has proven not only rigid and resistant to change but also incapable of handling the complex governance problems of river basin management, coordination of multiple water uses, water conflicts, and environmental protection. These more complex problems, of course, are precisely the fundamental challenges of integrated water management and governance. In addition, peasants and poor farmers in Chile have for the most part not received the economic benefits, which indicates that social equity is another weak point of the current framework.

The strengths of the Chilean model, in other words, are also its weaknesses: the same legal and institutional features that have led to the model's success in some areas have effectively guaranteed its failure in others. The ability of the institutional framework to resist significant reform is the strength of rigidity. Its regulatory limitations, incomplete price signals, and lack of balance have been built to last. Even if we put the most positive spin on the model's economic benefits, for the nation as a whole these flaws are a high price to pay, particularly over the long term.

This analysis points to the inaccurate manner in which the Chilean model has often been described in international water policy circles, particularly by the economists who have been the model's strongest supporters (see **Introduction**). The Chilean experience is cited as an example of successful free-market reforms, and although supporters may recognize some problems in the model, they present them as secondary issues that do not affect the overall positive assessment. Hence the absence of effective institutions for managing river basins or resolving water conflicts is mentioned as an afterthought, or played down as a separate issue that can be addressed later, or seen as acceptable in light of the model's presumed advantages. According to this viewpoint, the problems have been identified and the Chilean government is in the process of solving them. In this way the spotlight remains on water markets and water rights trading, which are supposedly the model's strong points. The message to other countries is that they can adopt the Chilean model of water markets without also adopting its deeper institutional weaknesses in other areas of water resources management.

Such assessments are mistaken and misleading and based on insufficient knowledge about Chilean politics and institutions. The flaws in the Chilean model are structural: they are integral parts of the same legal and institutional arrangements that underlie the water market. These flaws are not separable from the rest of the model. On the contrary, they are the necessary institutional consequences of the free-market reforms of property rights and government regulation. The aspects of the model that privatize water rights so unconditionally and define them as freely tradable commodities are inextricably connected to the aspects that weaken and restrict the regulatory framework. This is not a theoretical matter: in Chile these structural connections have been demonstrated in practice over the past 25 years, both by the mixed empirical results of the Water Code and by the long and difficult process of attempted Water Code reform.

Another way of putting this argument is to return to the familiar image of IWRM and sustainable development as a tripod, whose three legs are economic efficiency and growth, social equity, and environmental sustainability. The Chilean model of water management has one strong economic leg and two weak social and environmental legs, making it unbalanced overall. The social and environmental legs cannot be strengthened without weakening the economic leg in ways that – at least in Chile – are politically and constitutionally difficult. Moreover, *even the economic leg is weaker than it appears because the ineffective mechanisms for resolving conflicts and internalizing externalities also reduce economic efficiency and growth*, especially over the long term. Because the Chilean approach to managing water as an economic good puts all the emphasis on water as a *private* good and tradable commodity, it is very difficult to recognize or enforce the other aspects of water as a *public* good.

These are sobering lessons for people in other countries and in international organizations who are interested in water law and policy reforms. The most obvious warning is that other countries should not copy or closely follow the Chilean water law model, at least not without a thorough understanding of the model's weaknesses as well as its strengths. Both the flaws and the rigidity of the Chilean institutional framework should be made clear to other countries interested in the Chilean approach. The problems for IWRM should not be presented as secondary, separate from the water market, or readily solved. The failure of the World Bank and other boosters to make this clear in their advocacy of the Chilean model has been highly irresponsible.

Many of the details of the Chilean model are unique to Chile and have been shaped by the local political and economic context, particularly by the Chilean Constitution. It is also probable that this charter has an unusual weight and importance in Chile that is matched by few constitutions in other countries, since the Chilean Constitution dictates the basic rules for economic institutions as well as for the political system. It might seem possible to create an "improved" version of the Chilean Water Code by keeping the model's better features and avoiding its more serious flaws. According to this argument, if Chile went too far in the free-market direction and is now locked in place by its history, politics, and constitution, that is Chile's problem – it does not prevent other countries from learning from Chile's mistakes.

From an institutional perspective, however, the prospects for such an improved version in other countries are slim. Regardless of the specifics of the Chilean case, any country that tries to follow the laissez faire economic approach of Chilean water law will necessarily confront similar institutional and political problems. How is it possible to create a legal and institutional framework that provides such strong guarantees for private property and economic freedom, and such wide scope for free trading of water rights and private decision-making about water use, without also severely restricting government regulation and legislative reform? If a country does not want to grant the judiciary such broad powers to review the actions of government agencies, how else can those agencies be prevented from interfering in water markets and property rights? If private economic rights are so strong and public regulation is so weak, through what institutional mechanisms other than the courts can conflicts be resolved effectively? How much room can there be for environmental protection in such a framework, and how can the level of that protection increase over time, given the strength of vested property rights?

If other countries want to follow the Chilean approach to water economics and markets, they will have to adopt a legal and institutional framework that is functionally equivalent to Chile's. If instead a country chooses a stronger regulatory framework or places more conditions on private rights, that country is, by definition, no longer following the Chilean economic approach. Hence one of the deeper lessons of the Chilean water model is to show how *different economic perspectives have different consequences for institutional design*. The Chilean experience shows the lasting problems that result when a narrow economic perspective is combined with the political power to design legal institutions in the image of the free market.

In international debates about integrated water resources management, the *principle that water should be recognized as an economic good should not be thought of as a separate or independent component of legal and policy reforms*. In particular, countries and governments should not make the mistake of thinking that they can implement reforms in two steps, by first adopting a free-market approach to water economics as a straightforward initial step, and then turning their attention to the remaining problems of IWRM and water governance. At that later point, their hands will already be tied by a definition of property rights that has major political and institutional implications. On the contrary, reformers should put greater and earlier efforts into mechanisms for resolving conflicts and reflect carefully on how to define and enforce property rights to something as complicated as water.

We do not want to throw the baby out with the bathwater (as we say in my country). I am arguing against unregulated markets and narrow economics, *not* against all use of market-based instruments in water management. The goal of a broader and more interdisciplinary approach to water law and economics is to build on conventional neoclassical principles, not to reject them. We can get the most benefits from markets by recognizing their limits and not asking them to handle problems beyond their proper scope. That is why I think we need to revive older approaches to institutional economics, approaches that are rooted in qualitative and historical analyses and that draw on politics, law, and other social sciences in order to understand so-called “economic” issues. Such an approach is especially important in developing countries, where social and institutional contexts are significantly different from the developed countries, where most economic theory has originated and continues to be shaped.

The current global water crisis is driven by growing scarcity and growing conflict, two water problems that are ever more tightly bound together. Although economic principles can be powerful tools for dealing with water scarcity, legal and political institutions are the key to resolving water conflicts. Moreover, scarcity is not simply a physical problem – rather, it depends on social context and is often driven by social factors more than physical factors (Aguilera et al 2000). This further underlines the importance of legal and political institutions in shaping the use of economic principles. In short, the Chilean experience confirms the need for a more critical and interdisciplinary approach to water law, economics, and policy.

Final Comments

I want to close by returning to the four questions posed by the conference organizers, which I listed at the beginning of the paper. Although the Water Tribune’s mission is to promote innovative solutions and “new models” for dealing with water problems, part of this mission is to “recover forgotten valuable knowledge” (Water Tribune, “An Expo without sell-by date,” p.5). In that spirit I recommend that people take another look at the older schools of historical and institutional law and economics, especially as they grappled with notions of nature and property.

Most of my paper addressed questions 1 and 2, about the *efficiency* of water markets and water allocation. My analysis drew heavily on John Commons (1924), Daniel Bromley (1989), and Karl Polanyi (1944), to name a few, who showed that law, politics, and society determine economic value, as they decide the “rules of the game” that shape how markets work and what incentives people face. Bromley’s argument about economic efficiency still seems devastating to me, 20 years after I first read it in graduate school: economic efficiency cannot serve as an objective guideline for public policy because it assumes an initial set of institutional arrangements and distribution of wealth, yet dealing with those institutions and that distribution are the essence of public policy.

My response to question 3 builds on that insight. Water’s mobility, changeability of form, and environmental functions certainly make it a hard resource to commoditize, at least not without significant social and environmental costs. My question is whether the recent global interest in valuing and protecting “ecosystem services” is a trend that runs counter to the commoditization of water, or whether the two trends are instead two sides of the same coin. Here too I think Polanyi, with his mention of Aristotle, and the environmental historian William Cronon are good points of reference for the gap between physical reality and abstract forms of value.

Finally, I am no expert on mathematical models or their efforts to quantify aspects of the world and the human condition. But it is clear that in such models it is the basic assumptions, definitions, and categories which influence the results. I myself prefer telling stories, and I think story-telling is more important for how people make decisions, about water management or most other things.

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