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WATER AS AN ECONOMIC GOOD

In the past several decades, there has been greater recognition that how we manage water scarcity and its competing uses must change.

In January 1992, a group of experts met in Dublin, Ireland, to discuss water and its relationship to sustainable development. Called the International Conference on Water and the Environment (ICWE), the meeting was concerned with the growing problems of water scarcity, overexploitation and conflict. As it sought to grapple with the economic and social implications of these problems, the ICWE turned out to be a significant landmark in transforming humankind's approach to managing water.

This new perspective is reflected in the ICWE's 1992 Dublin Statement on Water and Sustainable Development, which declared as one of its core principles: "Water has an economic value in all its competing uses and should be recognized as an economic good."[1]

What does it mean to view water as an "economic good," and how does this characterization help us understand and overcome the challenges facing global water management? The Dublin Statement offers the following explanation: "Past failure to recognize the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources."

This explanation may seem a little puzzling, especially given the mounting concerns over growing global water use that were outlined in the Introduction. If water is becoming increasingly scarce and a global water crisis is imminent, why has there been "past failure to recognize the economic value of water"? After all, water is the most essential of all natural resources for human life. We also have many valuable uses for water, as explained by the water economist Robert Griffin:

> Water is employed for such a great variety of things. We use it in our homes, businesses, and industries. We transport goods on it. We apply it to our crops and serve it to our livestock. We swim in it, fish in it, and recreate on it. We take pleasure in seeing and listening to it flow by. We directly generate power with it and cool our fossil fuel plants with it. We dump our wastes into it, relying on natural forces to transport and assimilate what we discard. Commercial fisheries, even offshore ones, depend on fresh water availability. Water is a vital substance for the maintenance of the environment, and the environment is similarly vital for supporting humankind.[2]

As we saw in the Introduction, these competing uses for water are growing worldwide, as populations increase and economies develop. In addition, water is not the free and abundant resource that it once was. Soon there may not be enough freshwater resources to meet all its uses. As a result, comparisons are being made between the "limits" to continuing water use and those of another economically vital natural resource—oil. And, increasingly, such comparisons suggest that we should be much more worried about the problem of water scarcity, as noted by water experts Meena Palaniappan and Peter Gleick:

> Real limits on water are far more worrisome, because water is fundamental for life, and for many uses, it has no substitutes. Absolute limits on affordable, accessible water will constrain the ability of regions to do certain things: in particular, limits to the availability of freshwater typically lead to the inability of a region to produce all the food required to meet domestic needs, and hence lead to a reliance on international markets for food.[3]

In sum, water has many valuable uses, yet there may not be enough available for all these uses, or at least not without incurring more and more costs. Such a situation is a familiar one in economics—the allocation of a scarce resource to meet competing uses. It requires considering the tradeoffs involved in choosing how best to allocate water among its different uses. For example, if we want to increase the amount of water for agricultural irrigation, there will be less available for urban domestic, business and industrial use. And, if we want to expand freshwater supplies to meet both growing agricultural and urban demand, we should take into account all the economic and environmental costs of increasing and delivering these supplies to meet this demand. That is, if freshwater is less affordable and accessible, then we would expect this rising scarcity to be reflected in higher costs for all uses of water.

If water is an "economic good," then our institutions for managing water—markets, policies and governance—should ensure that scarce water is allocated to its most valuable competing use. Rising freshwater scarcity would mean that all users of water would pay higher costs. In such a situation, freshwater scarcity would not get worse or impose limits on water use. Instead, any increasing scarcity would be temporary, and, as the Dublin Statement points out, the resulting higher costs would be "an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources."

Unfortunately, as discussed in the Introduction, humankind is facing a water paradox. While water has so many valuable uses, our basic market, policy and governance institutions are failing to manage it adequately to meet these uses. That is why the global water crisis is really a crisis in global water management. At the heart of this crisis is persistent underpricing—the failure to treat water as an economic good. The increasing environmental and social costs associated with freshwater scarcity are not routinely reflected in markets. Nor have we developed adequate policies and institutions to handle these costs. This means that economies do not have the correct price signals or incentives to adjust production and consumption activities so as to balance water use with supply, protect freshwater ecosystems and support necessary technological innovations. All too often, policy distortions and institutional and governance failures compound water scarcity by encouraging wasteful use of water and ecosystem degradation.

Physical and Economic Attributes of Water

One reason why it has been difficult to develop adequate policy, market and governance institutions to manage water resources is the nature of the resource itself. Water has an unusual set of physical and economic attributes that makes it different from most commodities, including other natural resources. This is easily seen by comparing water to another strategically important natural resource in modern economies—oil.

Oil is, for example, a fully marketable commodity. The rights to extract and produce oil are purchased by private companies, it is an international commodity traded in markets, and there is generally a well-defined price for the resource all over the world. Which means, when there is conflict in the Middle East, a rise in gasoline demand, an extremely cold winter, an expansion in electricity generation or any other factor that causes physical supplies of oil to fall short of rising demand, that all users of oil will face higher prices. In other words, the price that most users pay for oil will reflect its scarcity value.

In contrast, as explained by the economist Michael Hanemann, water is marketed and priced very differently, and, as a consequence, the "price" paid for using water has little to do with its scarcity:

> It is important to emphasize that the prices which most users pay for water reflect, at best, its physical supply

> cost and not its scarcity value. Users pay for the capital and operating costs of the water supply infrastructure but, in the USA and many other countries, there is no charge for the water per se. Water is owned by the state, and the right to use it is given away for free. Water is thus treated differently than oil, coal, or other minerals for which the USA government requires payment of a royalty to extract the resource. While some European countries, including England, France, Germany and Holland, do levy an abstraction charge for water, these charges tend to be in the nature of administrative fees and are not generally based on an assessment of the economic value of the water being withdrawn. Thus, in places where water is cheap, this is almost always because the infrastructure is inexpensive, or the water is being subsidized, rather than because the water per se is especially abundant.[4]

To understand why water is so different from oil and other natural resource commodities, it is worth exploring further the contrasting physical and economic characteristics of water compared to oil.

The Physical Resource

Oil is a finite, fixed resource that is a classic example of a non-renewable (stock) resource. Once underground reserves of oil are discovered, and drilling begins, the oil is extracted as a flow from this fixed stock. As a non-renewable underground stock, oil is not very mobile, and oil reserves do not naturally fluctuate in supply.

In contrast, with water, only groundwater supplies—those found in underground deposits or aquifers, in sands, gravels and rocks —are considered non-renewable stocks because of their slow recharge rate. Much of our available freshwater resource lies above ground, in lakes, rivers, streams and other water bodies. And this surface water is generally viewed as a renewable resource, because it is frequently renewed through local water cycling and flows.

Water is also highly mobile and available supplies fluctuate considerably. Water does not stay in one place: it flows, evaporates, seeps and transpires. This makes it difficult to measure and even capture the resource, and means that its available supplies fluctuate wildly, especially for surface water. The seasonal cycles of precipitation and stream flows that replenish water bodies are difficult to predict and control. This variability in turn means that there can be times when there is too much water, which can lead to disasters such as flooding, or there may be too little water, in which case there is a risk of prolonged drought. In the case of groundwater, the resource may not fluctuate seasonally, but it is often difficult to know how much water is contained in underground aquifers or how fast they are naturally recharging.

Another unusual feature of water is that it is highly solvent. That means a lot of substances—from human and animal sewage to toxic chemicals—are easily dissolved in it. This makes water an ideal medium for assimilating pollution and waste. Unfortunately, water quality can vary substantially in different locations. Thus, water that is plentiful in supply may not be of sufficient quality for some important uses, such as for human or animal consumption or for use in irrigation.

The Economic Resource

These physical features of water have important economic implications. Because water is so highly variable and mobile, it is difficult to locate, measure and capture. As a result, claiming or enforcing exclusive property rights over water can be problematic, which makes it hard to "market." Even when rights can be established, if there is uncertainty over the availability of water, it is challenging to know how much to extract and sell. Equally, some uses for water, notably irrigation in agriculture, are often intermittent. Crops need to be watered only in certain periods or seasons, and the amount used may fluctuate significantly. This encourages farmers to share their access to water, and discourages one individual from claiming exclusive ownership to supply it to other farmers.

In addition, like many liquids, water is extremely bulky and thus difficult to transport long distances. Some of these commodities, such as oil, are worth a lot of money—today (July 11, 2018), oil is $65 a barrel—and thus are worth the expense of transporting all over the world. Unlike oil, however, the value of water relative to its weight tends to be extremely low. Thus its transportation costs are very high compared to the value of most of its end uses. Compared to transporting a more valuable liquid such as oil, developing expensive transportation networks to transport water a long way across regions and even countries is too costly.

The high cost of storing, conveying, transporting and distributing water means that it is susceptible to *scale economies*. The problems of mobility and variability of water can be overcome by investing in facilities to store, convey and distribute it in large quantities, but such infrastructure is too expensive for many individual users. The only way to manage such costs is to build the necessary infrastructure on a sufficient scale so that the fixed costs of these investments are spread over larger amounts of stored and distributed water. This will ensure that the average costs of delivering water to users will fall. But achieving such scale economies requires large upfront investments that only a public authority or a single private entity can afford. Consequently, water is generally supplied publicly or through regulation of a single private investor (i.e., a monopoly).

How water is used is also unique to the resource. Oil is completely consumed when it is used, especially if it is burned to provide energy. This also means that the amount of oil consumed by one user is not available for someone else. In contrast, much water use is sequential, and it is not often fully consumed by the first user. For example, the water contained in a river may be extracted by many users as it flows from the upper watershed to its eventual end in a floodplain or ocean. Water may be withdrawn from the river by upstream users, through pumping, diversion and other methods of extraction, but there can also be a lot of return flow of water back to the river during upstream use. This return flow to the river is then available for other users further downstream. In fact, some uses of water, such as hydroelectric power generation, transportation and recreation, do not require any withdrawals of surface water. Water for these purposes is neither withdrawn from the source nor consumed.

However, the sequential use of water may have another impact, which is to affect the quality of the water. The return flow of water from upstream users on a river may be significantly degraded in quality, if it is polluted or its temperature is changed. This may create significant problems for downstream users, especially if they require water to be sufficiently clean for health and sanitation reasons. Thus, the quality of water available after sequential use may be even more important than the quantity.

Water Can Be Both a Private and a Public Good

Many of these characteristics of water mean that it is sometimes a *private good* but it can also be a *public good.* Economists usually distinguish such goods based on two properties: *rivalry* and *excludability* in use or consumption. When a good is *rival*, then one person's use of the good reduces the amount available for everybody else. When a good is *exclusive*, then one user can exclude others from consuming the good at the same time. Private goods have both these properties. But if a user can neither exclude another from using a good nor reduce the amount of that good that is available to everybody, then that commodity is a public good.

Again, oil is a good example of a private good. The gasoline I purchase for my car is exclusive for me to use, and the amount I consume means less gas is available for other car owners.[5] In comparison, whether water is a private or a public good will depend on how it is used and the specific context for that use.

For example, once water is delivered and used in homes, factories and farms, it has the characteristic of a private good. Each user has exclusive rights to the water, and how much is used reduces the amount available to others. Any water in the reservoir or delivery network is also a private good. Use of this water is exclusive, and there is less available in the reservoir or network for others. However, the storage capacity of the reservoir is likely to be a public good. It is maintained by natural water flow, possibly from a river discharging into the reservoir. Although this flow may vary with season and precipitation, continual use of the storage capacity over a period of time should not diminish the amount of total capacity available. And, assuming there is sufficient capacity, there is no exclusion of users of this capacity. In fact, a large reservoir could be employed for a variety of uses simultaneously, such as for drinking water, sanitation, industrial use, recreation and navigation.

Many nonconsumptive uses of water are also public goods. Water-based recreation and navigation on rivers and lakes do not rely on water withdrawals, and even hydroelectricity generation may not necessarily involve permanent extraction of water. These uses do not preclude the same water being employed for other purposes, and have negligible impact on the total water available. Water is also an important aquatic habitat for plants and wildlife, which an individual may enjoy without excluding others or diminishing their enjoyment.

One of the most important public goods is improvement in water quality, such as through abating pollution, removing sediment or controlling temperature extremes. Some aquatic habitats might provide these services naturally, through purifying water, regulating temperature and trapping eroded soils. Often, human treatment and sanitation infrastructure is required to improve water quality. Regardless of how it occurs, however, any resulting improvement in water is generally a public good. If I live by a lake that has had a reduction in pollution, any benefits I receive from the cleaner lake water do not reduce the benefits of the clean water to others, and all of us are free to enjoy these benefits simultaneously.

In some cases, water may be neither completely a private nor a public good, but something in between.[6] For instance, under certain circumstances, water may still be rival but not exclusive, in which case it is a *common pool resource*. Two important cases of this situation that we will explore throughout this book are groundwater depletion and river management.

Recall that groundwater stocks often recharge slowly, and thus they are effectively a nonrenewable resource. On the one hand, this means that extracting water from aquifers for irrigation or household use will reduce the amount available for others to use. But the size and extent of groundwater stocks beneath the surface are often unknown. It is difficult for one farmer who is extracting groundwater for irrigation to exclude other famers from using the same resource. Equally, many homes could be simultaneously drilling wells to use groundwater from a single aquifer. Thus, many groundwater sources are common pool resources.

Rivers also have a long history of being treated as common pool resources, mainly to keep them free for navigation or to prevent individual users from controlling the supply. In addition, rivers are the most variable and mobile of surface water resources, and, as a result, it is often difficult to identify, measure or even capture the resource. Establishing exclusive ownership by an individual or even a group of individuals is nearly impossible. In fact, since Roman times, claiming exclusive ownership of rivers has been legally prohibited. For rivers and other flowing waters, and even sometimes lakes, these resources may not be owned but can only be used. In some cases, these "rights of use" are strictly allocated and regulated, but in other circumstances and locations they are not, which in turn can complicate the management of these common pool resources.

Treating water resources and uses as public goods or common pool resources has two important consequences: they will be *undersupplied* by individuals and *undervalued* in markets. Take the example of cleaning up lake pollution. If I pay for the removal of pollution from a lake, then I will benefit from the resulting improvement in water quality. But so will other users of the lake. The difference is that they will have little incentive to pay for the pollution removal, because I will have already done so. I may decide that it might be worthwhile making such an investment anyway. But, more often than not, because removing pollution from water is likely to be an expensive process, and I know that I am not able to charge others for this benefit, I will probably not be willing or able to invest in reducing lake pollution. As other individuals using the lake will probably reach the same conclusion as I have, the pollution cleanup will not occur. Or, to use the language of economics, water quality improvement will be undersupplied, if left to individuals to make such an improvement.

Public goods are also undervalued in markets, which exist for private goods but rarely for public goods. For example, aquatic habitats such as wetlands provide diverse benefits that are often public goods, including breeding or refuge for unique species, recreation, hunting and tourism, or purification of water supplies. These benefits are enjoyed simultaneously by many people and are provided to them for "free" by the natural functioning of the wetlands. As a result, there is no "market" and thus no "price" for these public good uses of wetlands. But the actual value of these services is not zero. Because many people benefit from these services, their value is the total additional benefits of all individuals who enjoy provision of these services by wetlands. This value could be huge, even though there is no apparent "market price" for these wetland services. This gap between the (zero) price for wetland services and their actual value to all beneficiaries indicates how much these public goods are undervalued in markets.

Finally, individuals who do not use a water resource for irrigation, recreation or drinking supplies may still additionally benefit if the resource is not degraded or depleted. These individuals may still value the resource, even though they may never use, visit or even see it, simply because they value its existence or they believe the resource should be available for use by future generations. Such *non-use values* also have no "market" or "price," yet they can be significant especially for some unique water resources and habitats—such as the Great Lakes in the US and Canada, the Okavango Delta in Africa and the Danube River in Europe. For these habitats and other important water resources, the non-use values could be substantially large components of the benefits provided by such public goods.

Use It or Lose It

One implication of the unique physical and economic characteristics of water is that it has encouraged a "use it or lose it" approach worldwide. Because it is so difficult to establish exclusive property rights over water, and there are so many competing uses, the "first user" of water has a strong incentive to hoard and use as much as possible. By obtaining initial access to the water, the first user may also have priority in use over others. However, unless this water allocation is fully utilized, the right to use the water might be revoked. Another user will then claim first rights over it. Hence, the "use it or lose it" incentive is ingrained in all potential users of water.

In some parts of the world, including throughout the western United States and in many developing countries, this "use it or lose it" approach to water rights is enshrined in law. For example, the United States has the doctrine of *prior appropriation*, which was adopted for surface water by every western state beginning in the nineteenth century. Called the "first in time, first in right" rule, prior appropriation allows individuals to claim, divert and use water based on priority of claim. The priority, or most senior, water right goes to whoever first diverts water from a lake, river or stream and puts the water to beneficial use. Subsequent claimants on the water have lower priority, or junior rights. The result is a "ladder of water rights." In times of drought, for example, users of a body of water that are more junior may be left without any water if the first claimants exercise their prior right over any available water. But claims on water are also established on the basis of "beneficial use," whereby all priority users must demonstrate that the amount claimed is necessary for some "approved" application, such as irrigation for crops, watering livestock, mining, domestic, industrial and municipal supplies, and so forth. As noted by the economist Gary Libecap, "beneficial use, however, contributes to waste as rights holders devote intensively to low-marginal value 'approved' applications in order to maintain ownership and neglect higher-marginal value uses that may not be considered consistent with the doctrine, which is a political decision."[7]

The "use it or lose it" incentive also pervades management of *transboundary water resources*. A major complication in global water management is that many countries share their sources of water, as river basins, large lakes, aquifers and other freshwater bodies often cross national boundaries, and such transboundary water bodies are an important, and growing, source of water for many people, countries and regions.[8] With transboundary waters, and especially international and regional rivers, "first use" is invariably determined by geography. A country, state or province that is located in the upper watershed, or upstream, will have first claim on the water by default. This priority can be easily established through building the necessary infrastructure to capture, store and thus retain water that flows through its territory. In contrast, the political entities located in the lower watershed, or downstream, can claim only the remaining water that is released by the upstream claimant. The upstream country, state or province therefore has an incentive to use as much of the water as possible, which also yields an advantage in any subsequent negotiations with downstream neighbors over managing the transboundary water source.

Prior appropriation law and transboundary water resources are just two examples where the "use it or lose it" incentive deters effective and efficient water management. This incentive is symptomatic of the general failure to allocate available freshwater resources to meet growing and competing beneficial uses, and poses a major challenge to more efficient and equitable water management. Before we address this challenge, it is helpful to explore how humankind's complex relationship with water evolved historically to create today's water paradox. As we shall see in the next chapter, the historical roots of this relationship are a significant reason why our current institutions for managing water—markets, policies and governance—fail to ensure that scarce water today is treated as an "economic good."