Healthy Water Markets: A Conceptual Framework

November 2016

Part I

Final Report on Political Economy of Water Markets

AMP Insights

ecosystem economics

The ROCKEFELLER FOUNDATION

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Preface

This paper is one output of a project entitled "The Political Economy of Water Markets." The project was carried out by Ecosystem Economics LLC and AMP Insights. The outputs of the project include a final report and a set of case studies.

The final report consists of three papers and an annex:

1. Healthy Water Markets: A Conceptual Framework by Bruce Aylward, Davíd Pilz, Megan Dyson and Carl J. Bauer
2. Political Economy of Water Markets in the Western United States by Bruce Aylward, Davíd Pilz and Leslie Sanchez
3. Comparative Analysis of Legal Regimes with Respect to Fostering Healthy Water Markets by Davíd Pilz, Megan Dyson, Bruce Aylward, Carl J. Bauer and Amy Hardberger

Annex: Water, Public Goods and Market Failure by Bruce Aylward

The eight case studies consist of the following.

1. The Evolving Water Market in Chile's Maipo River Basin by Carl J. Bauer
2. Addressing Overallocation and Water Trade in New South Wales, Australia: Namoi Basin Groundwater by Megan Dyson
3. Evolution of Australian Water Law and the National Water Initiative Framework by Megan Dyson
4. Opportunities for Surface Water Right Marketing in Idaho's Rapidly Urbanizing Treasure Valley by Jeff Fereday
5. Texas Groundwater Markets and the Edwards Aquifer by Amy Hardberger
6. Oregon's Umatilla Basin Aquifer Recharge and Basalt Bank by Martha Pagel
7. Truckee-Carson Surface Water Markets in Northern Nevada by Leslie Sanchez, Bruce Aylward and Don Springmeyer
8. Smart Markets for Groundwater Trading in Western Nebraska: The Twin Platte by Richael Young

The report and case studies can be downloaded from the AMP Insights website at http://www.ampinsights.com/rock-report.

For further information on this work please contact Bruce Aylward at bruce@ampinsights.com.

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Contents

List of Figures

1. Introduction

This is the first of three papers that make up a final report on the political economy of water markets. The report is part of a larger effort that includes a set of case studies of water markets in the western United States (US), Australia and Chile. A group of authors with expertise and a mix of academic and professional experience in their particular markets and jurisdictions, either as attorneys, economists or geographers carried out these case studies. The final report therefore aims to build on the experiences of those directly involved in the *practice* of water markets. This practice includes the sometimes-messy job of just *making things work* in the best way possible given a difficult set of circumstances. The opportunity to step above this grind and write about the bigger picture and the rules of the game is gratifying but also intimidating.

The primary aim of the overall report is to identify and understand the economic incentives and the enabling political and legal conditions that lead water markets to function as a useful counterpart to other tools for sustainable water management. To that end, a central objective is to identify market, policy, institutional, and legal failures that impede water market function. The premise is that poor (and unhealthy) markets lock up water in traditional uses despite opportunities for beneficial trades that promote the productivity of water in its many economic, environmental or social guises.

Water markets are embedded within a particular basin geography and *an evolved jurisdiction-specific governance framework.*

This paper forms Part I of the report and consists of an attempt to first describe water markets and locate them within the frame of water management generally. The paper then goes on to propose a conceptual framework for understanding and evaluating water and water markets. The framework is intended to address not just questions about whether markets for water work or not, and how well or efficiently they work, but whether markets are healthy. In other words do water markets not just contribute to private gains between buyers and sellers, but support and reinforce desired environmental and social outcomes of water governance. Drawing on neoclassical economics, political economy and institutional economics, the framework puts forward a set of conditions and criteria against which water markets may be examined. In this the paper builds on a long history of academic inquiry and thought, adding insights drawn from professional experience with water markets.

One of the main messages emerging from this paper is that water markets are embedded within a particular basin geography *and* an evolved jurisdiction-specific governance framework. Assessment of market activity, efficiency and outcomes for the purpose of recommending reforms or other solutions need to emerge out of the application of a multidisciplinary conceptual framework to the particular setting and history of the locale. While one-size-fits-all solutions are generally not effective in particular contexts, with water it is particularly hard to bring a solution to a problem. Far better to work from within the context, understand the issues and problems and the political economy of that situation, and then propose solutions. Part II takes a first step in this direction by applying the framework to variety of circumstances and situations found in the western US where appropriative rights are found. Part III, focuses on the legal conditions and characteristics necessary and important to water markets and water management in an international context, comparing and contrasting the advantages and disadvantages of a number of regimes – including Prior Appropriation.

This paper begins with a description and definition of water markets and associated terms. A broad net is cast reflecting both transactions in water rights per se, as well as payments to alter water management practices, conserved water and the reallocation of water rights that occurs through the purchase and sale of irrigated farms and ranches. Water markets are then located in the context of water management. The strategies available for managing water resources and how they evolve as scarcity increases are summarized. For decades, all water managers had in their toolbox was supply development strategies and the result was the age of dams and large infrastructure projects (still ongoing in much of the developing world). More recently, water managers added demand management strategies to the toolbox but even these more modern advances will not necessarily close the gap between demand and scarce supply. Which leaves reallocation and one method of voluntary reallocation, water markets, as the newest and shiniest tool in the toolbox. The saying that *if all you have is a hammer, everything looks like a nail* is an apt one for this discussion. The paper therefore emphasizes, that water markets are but one tool in the water management toolbox, and it is wise to avoid the trap of the hammer and nail.

Still, markets remain a useful tool and one that brings a suite of advantages. The paper thus goes on to examine the benefits that market-based reallocation provide to water management generally. These include a vehicle to move water to more productive uses and the benefits of transparent price discovery. The latter can provide a sound footing for fiscal discipline in the comparison of alternatives in water management. The potential role of water markets as the tool for mediating between different water uses or as a much sharper and refined tool for allocating water between commercial uses is then discussed. The preamble to the conceptual framework wraps up by addressing the normative question of "to what end water management and water markets?" The idea of healthy water markets as proposed by The Water Funder Initiative is adopted and examined. The framework as proposed is intended to understand not just the enabling conditions for trade and the market imperfections that affect market activity and efficiency, but also the conditions that determine whether markets protect or deliver social and environmental outcomes.

The framework begins with a review of the economic and political nature of water to explain people and ecosystems' relationships to water. The discussion proceeds through the economic concepts of *rivalry* and *exclusion* to illuminate characteristics of water that are critical for an understanding of how water fits within traditional concepts of private goods and, by extension, the impact this understanding has on water markets. This discussion illustrates that the various resources involved – natural flow, surface storage and groundwater, ecosystem services and withdrawn water – all have various public good characteristics and therefore lend themselves to other-than-private-market institutional arrangements and property regimes for their production and management. This argument is more fully elaborated in the Annex to this report.

This leads to a discussion of collective action and the approach – based on regulated water use rights – many countries have taken to the problem of market failure. The standard conditions for a market in water rights within a property rights framework are explained and then amended to address the needs of healthy water markets. The section concludes by describing the types of potential market imperfections that may affect water market activity and efficiency. Consideration of market failure and imperfections aids in understanding market function, or why trade is present in one locale but not in another. The framework also provides a systematic basis for the identification of necessary reforms in the direction of healthy markets. Achieving reform is a matter for collective action and so the paper closes by discussing the political economy and intuitional economics of water markets and their reform.

2. Water Markets

In common usage a market is a place where buyers and sellers meet to buy and sell goods. In most parts of the world when you go to a market it is a physical space where a large number of sellers display and hawk their wares to a large number of buyers. In developed economies, when shoppers go to the supermarket for their groceries it is just one store, albeit one displaying similar products from many producers (at a fixed price). Another important market is the real estate market. In this market there are many property owners with properties for sale and many interested buyers, but no real physical marketplace. In the real estate market, brokers representing a seller and a buyer facilitate the real estate transaction. The physical marketplace, if there is one, is the trek from house to house with your broker or a virtual trek on an online marketplace like Zillow™. The trade in the real estate market is simply the aggregate sum of these many real estate transactions. Underlying a market in real property is a body of real property law that sets out the nature of the property and the rules that govern the exchange of this property. Similarly, any marketplace will have its own set of rules, for example, the terms and conditions on eBay™.

A *market* then, is a set of rules that govern the voluntary exchange of property, or *transactions,* between buyers and sellers. A *marketplace* is a physical or other (e.g., online) place that is organized by a buyer, a seller or some intermediary for the purpose of facilitating transactions. *Trade* is simply the aggregate number and amount of transactions in the market. These concepts can be usefully applied to clearly define water markets.

2.1 Water Market Definitions

A *water rights market* is a set of rules, set by the appropriate authority, to govern the exchange of water rights between willing buyers and sellers. The rules define the property involved – the water rights – as well as the process by which the temporary or permanent transfer of water rights from one use/user to another is accomplished. Creating a water market refers to the establishment of rules and agreements that govern transactions in water rights within a given jurisdiction and hydrographic setting.

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A *water marketplace* is a specific mechanism developed as a place where market participants can obtain market information and/or conduct transactions. Examples of water marketplaces include water brokers, water banks/exchanges, water auctions and smart markets. A water marketplace may promulgate its own rules for eligibility, participation and market clearing, but the laws and regulations governing the water rights market give the marketplace transactions legitimacy. Marketplaces may involve manual or online bidding and manual or automated clearing

Trade in a water rights market represents the set of water right transactions in unregulated (natural) flow, regulated or stored water, or groundwater. Trades in a water rights market are executed between willing sellers and willing buyers for the purpose of meeting unmet, new or different demands from existing permitted water supplies. Purchase of water rights with the sole intent of renting them out for income and or holding them for capital appreciation is also a potential source of market activity, at least in well-developed and liquid markets.

A water market may be defined more broadly than just a water rights market. Trade in a water market may extend beyond merely transactions in water rights per se, to include water management agreements, as well as real estate markets for land and water rights.

The distinction between water rights transactions and water management agreements is worth explanation. *Water rights transactions* consist of the sale of the water right itself or some form of temporary trade of the water available under a water right. Temporary trade may involve either the lease or rental of a right and the water that will be available under it over a specified future time frame, or the outright sale of an allocation of water already assigned to the water right holder (e.g., water already stored in a reservoir).

2.2 Water Transactions and Water Transactions Programs

This paper therefore uses an inclusive definition of the term *water market*, including the market-based allocation/reallocation of water rights, no matter if they occur as ad hoc transactions, as highly structured transactions in a robust and organized marketplace, or through proxy transactions in land and related assets. Under this definition, water market transactions include (at least) the following six compensated agreements between buyers and sellers for:

1. *Water Allocations*: an already existing and known amount of water allocated to a water right by the relevant authority to the seller (e.g. an amount of water already stored in a reservoir and allocated to the seller).
2. *Water Leases*: the right to call on and use water that will be allocated to the seller's water right in one or more future years (e.g. leasing another user's allocation before allocations are made).
3. *Water Rights Transfer*: all or a portion of the seller's full water right (for the duration of its term) including all water that may be allocated to the seller's right or portion thereof.
4. *Water Management*: a change in an existing water user's behavior that benefits another water right holder or water use/user, to include potentially the non-use of a water right or an allocation made to a water right.
5. *Conserved Water*: a payment for efficiency improvements that results in a transferable right to a portion of the saved water as conserved water.
6. *Land and Water Rights*: purchase of land and water rights, with the purpose of making the water user more efficient and remarketing the savings, or where all or a portion of the water right itself is to be moved to a new type of use or place of use.

Simplifying these somewhat they can be categorized as the actual purchase of the water right, either on its own or along with the land, the purchase of some amount of water available under a water right, or a payment to incentivize a change in water use. The latter three of these are alternatives to the more traditional time-limited and permanent water right transactions and therefore are explained in more detail in Box 1. *Environmental water transactions* (EWTs) are a particular form of water market trade in which transactions are undertaken to protect additional water in waterways or water bodies for environmental purpose.

A *water transactions program* is an explicit act of collective action by stakeholders to set up the policies, rules, plans, funding and/or capacity to achieve an agreed upon set of objectives in terms of water allocation and use. Other terms for such programs include water trading or water marketing programs. Such programs may be driven primarily by environmental objectives. So an environmental water transaction program is a program set up to carry out environmental water transactions, e.g., the Columbia Basin Water Transactions Program funded by Bonneville Power Administration to carry out EWTs across the Columbia Basin. But transaction programs may be set up by any group of stakeholders to meet their needs. The Palo Verde Land Management, Crop Rotation and Water Supply Program is set up to

facilitate rotational fallowing and trading of water between irrigators in the Palo Verde Irrigation District and the Metropolitan Water District. Multi-sector transactions (or trading) programs are relatively novel but should serve to meet changing needs across sectors in an orderly fashion as part of larger political agreements on watershed, water resource or basin management.

Box 1: Alternatives to Time-Limited & Permanent Water Right Transactions

There are a large number of transactions that could be pointed to as examples of a water market or trade in water rights, besides simple time-limited and permanent water rights transactions. Three of the more frequent examples are explained below.

Water Management Agreements. Water management agreements refer to contracts between a water right holder and another entity under which the water right holder agrees to change their water use or water management consistent with the legal purposes and use of the underlying water rights in return for compensation. These agreements are also called water use or water user agreements, or water sharing agreements. These agreements are not for the acquisition of water rights or water. Instead they are akin to payments or incentives for a water user to change their behavior in a way that benefits the buyer, often by conserving water. For example, conservation groups may pay an irrigator not to divert surface water when streamflow is insufficient for fish passage. The buyer does not acquire a water right or legal right to call on a certain amount of water, but may accomplish similar ends without having to go through an administrative change of the water right. Another example would be government programs that pay for or subsidize the installment of water use efficiency measures by irrigators. Implicit to such programs is a reduction in water use with changes in availability to other users in the system. While water user agreements might more properly be called economic incentives for water conservation, they often involve the signing of formal agreements and are considered here as a form of water market transaction in order to cast a broad net around potential water market tools.

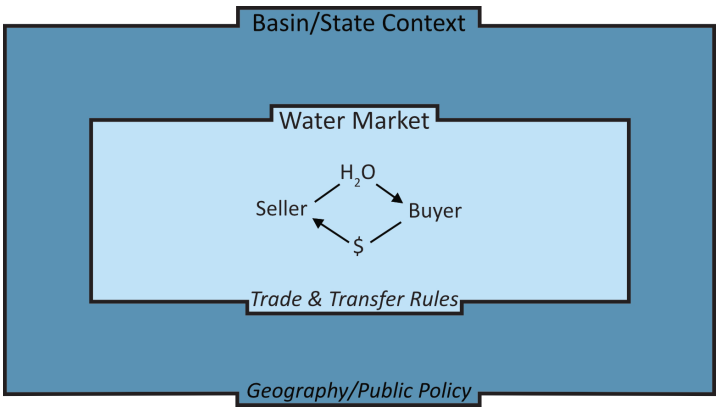
Conserved Water. Water use efficiency measures implemented by water users produce water savings. If the user is provided an incentive to undertake such measures but the resulting savings are simply left to accrue to another water user in the system or are left un-withdrawn by the prior user then these can be considered as water management agreements. Conserved water is the portion of such water savings that can be quantified and separated from the existing water right and used to establish a new consumptive or non-consumptive water use or water right. For example, in Oregon and Washington, such efficiency savings can be used to create new water rights (Oregon's Allocation of Conserved Water Program) or temporary instream rights (Washington's Trust Water Rights Program).

Land and Water Transactions. In jurisdictions where the sale of land carries with it associated water rights, i.e., in prior appropriation systems where water *runs with the land* or in riparian systems where the water right is attached to the land, the market for rural properties effectively represents the sale of land and water rights. For example, in the western US municipalities and conservation groups have purchased ranches or farms in order to acquire water rights. In arid areas these transactions may reflect the seller's lack of interest in severing their water right from land, selling it and then being left with bare land. They may also signal issues of inequitable access by these groups to the market for water rights. In such cases the real estate market is an outlet for their demand. In other words, just because there is no visible trade in water rights (on their own) does not mean that water rights are not being purchased and moved to new uses.

2.3 Evolution of Markets, Transaction Programs and Marketplaces

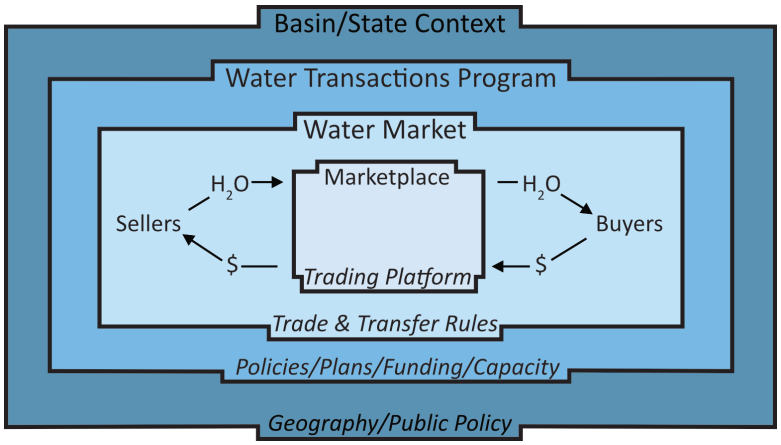
Figure 1 shows how the key elements are layered in a simple water market. The market sits within a particular basin and state context. The context defines the geographic setting (natural, human and economic) and provides the evolved historical context of public policy (in this case the water code and property rights). The water market is simply a set of established rules for the trade and transfer of water rights. Within any given water market water transactions occur on an ad hoc and occasional basis between individual sellers or buyers. This is a passive situation in which purely private economic interests drive trade in the market.

FIGURE 1: A SIMPLE WATER MARKET WITH WATER TRANSACTIONS



A healthy water market typically includes a water transactions program (Figure 2). Such programs are established through collective action by stakeholders and serve to motivate a water market in an agreed upon direction. Such transactions programs may include specific policies and plans, as well as funding and institutional capacity. Thus, an environmental water transactions program may provide plans, funding and capacity to restore streamflow through market transactions. A multi-sector program, such as a water bank, may represent a policy that drives market actors to specific transactions with a set of outcomes that benefit different sectors. In this case political agreement shapes and drives the market, even as it also responds to private interests in the basin. A further element of a proactive water market is the developing of marketplaces, or formal trading programs where buyers and sellers can congregate to transact and meet their needs (as shown in Figure 2).

FIGURE 2: WATER MARKET WITH WATER TRANSACTIONS PROGRAM AND MARKETPLACE



2.4 Evaluating Water Market Performance

An important caveat to make up front is that judging performance of a water market is difficult. Just because the market is *thin,* i.e., that there are few transactions, does not mean that the market is not working. Instead, this could mean that the market is dysfunctional or simply that there are no underlying economic drivers for trade. Similarly, the price in a market may be reported to be high. This could mean that the market is very inefficient and only the high value buyers are able to close deals, or it could mean that supply is scarce, demand is high and so price is high. On the surface then observations of whether markets are thick or thin, and whether prices are low and high, tell little.

This is similar to unemployment. Unemployment can be measured and assigned a percentage. The proportion of the workforce that is out of work may be 3% or 6% or 10%. But the number tells you little unless you know what economists call the natural rate of unemployment for the economy. This is the rate of unemployment that economists would expect given the makeup of the economy and the workforce. If that rate is 5% and the actual rate is 10% then you know the economy is underperforming with respect to employment.

So the issue with water markets is that there is no method or figure that purports to say how any given market should ideally be performing. Market volume and price will vary with the drivers of demand and supply, as well as the utility of the market rules and the efficiency of the market. So its hard to know just from basic data if a market is working or not. Nevertheless economists have a firm view of under what conditions markets work (or fail) and what constitutes a perfectly competitive market. Reviewing these theories and deploying them to assess market function can assist in assessing perceived issues encountered with water markets, as well as suggesting opportunities for improvement.

First, however, it is important to set water markets in the context of water resource management so as to better understand their potential scope and role, that is to say their purpose as one of many water management tools.

3. Water Resources Management: The Role & Scope of Water Markets

It is useful to recognize that there are both positive and normative perspectives on water resource management. Integrated water resource management, IWRM, may have attained a normative sheen, but to the extent that it is intended as a set of instructions about how water management is best organized, arranged and undertaken – based on empirical evidence – IWRM can be said to be a positive approach. Statements about water resources development or sustainable water management on the other hand enter the realm of normative decision-making. After all what does the objective term, be it development or sustainable, mean? To the farmer it may mean a reliable and inexpensive water supply for growing crops. To the urban water provider it may represent secure, clean and affordable water for customers; and for conservation groups it may mean environmental flows that replicate the natural hydrograph and are sufficient to sustain freshwater ecosystems and their species. Keeping positive and normative aspects separate ensures that the objective and the means of water management do not get mixed up; in this case ensuring that water markets are seen as a means not an end.

Water management contexts vary from one country to the next and from one basin to the next. Water is governed and managed both from above (by government and other regulatory actors) and below (by users and groups of users). Water governance refers to the policies, laws, rules and institutions that regulate the manner in which water is used and managed, and, therefore, how the allocation and reallocation of water occurs. National or state policies and laws create a set of rules and institutions that attempt to steer water management from the top down. Local conditions – hydrological, socioeconomic, environmental, political, and cultural – as well as local governance, i.e., customary rules and practice, drive water management from the bottom up.

Governance, whether from above or below, combines with the fact situation on the ground to drive the selection of water management strategies in a given locale and represents the decision-making that shapes the rules of the game for water management. Governance therefore presumes some normative goal for water management, whether it is called water resources development or sustainable water management. This normative objective may or may not, therefore, include that functioning water markets be one of the available water management strategies. In keeping with the positive/normative distinction this section first addresses water management in a positive, analytical fashion, in order to understand the various management strategies and their role in water management generally. The potential role and scope of water markets as one of many water management strategies is then reviewed. At the end of the section, the purpose of water markets is discussed, including the adoption of a normative stance – i.e., that water markets should play a positive role in sustainable water management.

Water is governed and managed both from above (by government and other regulatory actors) and below (by users and groups of users).

3.1 Water Resources

The focus of this report and paper is water markets and the trade in water quantity. Water quality is important and there are numerous linkages between water quality and quantity, but the topic here is water quantity. The report uses the term *water* as an abbreviation for water resources, referring to

freshwater generally, whether flowing or still, above or below ground. The water cycle provides water to the earth's surface as precipitation, a portion of which is evaporated or transpired back to the atmosphere before reaching an aquifer, a watercourse or a water body. The portion of precipitation that goes directly to evapotranspiration contributes to the growth of forests, grasslands, crops, etc. In international spheres this is often called green water (Falkenmark and Rockström 2004). The remaining portion of precipitation either percolates through the water table and into groundwater or runs overland or through shallow groundwater channels to a watercourse or water body of some kind. As opposed to green water, this water is often called *blue water* (Falkenmark and Rockström 2004). This report is primarily about the governance and management of the blue portion of the freshwater resource, which can be generalized as consisting of *surface water* (overland flow, streams, rivers, lakes, etc.) and *groundwater* (the water held underground in aquifers).

From the standpoint of society's use of water it comes in renewable and non-renewable forms. Renewable water is the water that is provided annually and seasonally through the water cycle as a regular, though variable input to the hydrologic system. Renewable water is the flow through the system. Non-renewable water is simply the stock of water that has been stored over such a long period of geologic time such that the withdrawal of this water at rates that well outstrip its natural replenishment mean that the stock of water cannot reasonably be renewed within a typical human resource planning horizon (i.e. from a year up to fifty or hundred years). From an economic perspective these flows and stocks lead to classifications as either *renewable* or *exhaustible resources*.

Lakes and groundwater may be exhaustible, while streams and rivers are thought of as renewable. Some groundwater, such as fossil groundwater, may be fully exhaustible. Groundwater in a shallow alluvial aquifer may on the other hand essentially be treated as renewable, with precipitation percolating through the aquifer to the stream on a relatively continuous basis and on a time frame of months. A complicating factor to this characterization is that many aquifers store significant water but also discharge a small portion to surface water. These aquifers have both renewable and exhaustible character in that a change in storage through changes in infiltration on the surface or an increase in the pumping of groundwater will affect the discharge of water.

A further distinction between groundwater and surface water has to do with location, accessibility, variability and visibility of the resource. Rivers bisect land whereas groundwater pools beneath the land. Water resting in an aquifer is potentially available to all prospective users that have access to the land that overlies the aquifer. With horizontal drilling techniques the water is now even more widely available. In this sense, groundwater can be thought of as a pool of water that certain users have access to should they make the investment, whether for their own use or for conveyance to other users. The extreme example of how immobile groundwater can be is fossil groundwater aquifers that simply shrink in amount/size when tapped for extraction. As mentioned above, other aquifers may involve a drainage gradient and flow through the aquifer. Still the pumper is tapping into a relatively discrete pool of water. Of course, to the extent that groundwater is moving within the aquifer or a cone of depression is created as groundwater is withdrawn, the exact location and depth of the aquifer may not be clear.

Rivers and other watercourses on the other hand are different from a pooled resource like groundwater. Surface water from rivers is available in varying quantities over the course of a year, and across years, but its location is predictable. Surface water flows from point A to point B. Potential water users are either adjacent to the resource or far away. The further away a user is situated and the larger any increase in elevation, the higher the up-front cost of capturing water and delivering it to the user. Arguably, storing water requires much higher up-front investment (in dams as opposed to diversion structures) than simply withdrawing water from the river. Capturing surface water thus requires investment and effort but once the expenditure is made the cost of storing or diverting water each year is relatively low and consists largely of operations and maintenance expenditure. This is different than for groundwater pumping,

where the recurring energy costs are significant. This of course is not the case for the inter-basin transfer of surface water and other uses that require significant up elevation pumping.

When society intervenes in the water cycle to dam or divert surface water or pump groundwater this alters the hydrologic cycle. This paper (and the report) refers to such alterations as *withdrawals* of water from the system. Withdrawal of blue water typically leads to one or both *evaporation* (from reservoirs, soil or human uses) and *transpiration* (from crops). Taken together these form *evapotranspiration* (ET). The history of water resources development can be seen as a historical process of supplementing ET from green water with additional ET from blue water sources – to meet human demands for drinking water, food, power and industry. Irrigation accounts for more than three-fourths of human water use globally (World Water Assessment Programme 2014). As a result, discussions about water and water use often focus on the use of water to grow crops (and this paper is no exception).

Of primary importance to the discussion below is that the withdrawal and use of water by humans is often only partially consumptive. In other words, the act of using water in the home, for irrigation, or industry leaves some portion of the water for return to the hydrologic system. This *return flow* may run immediately to water bodies or percolate to groundwater where it changes the pressure of the groundwater system affecting groundwater discharge in days or over decades or centuries, depending on the hydrogeology. Apart from issues of water quality and treatment that this may pose, what is significant for this paper is simply that some portion of the water continues on down gradient and is therefore available for use by other water users.

In sum, the technical difficulties inherent in managing water quantity arise in the first instance from the physical complexity and interconnectedness of the water cycle and the resulting lack of (or high cost of attaining) adequate scientific information. But the key challenge in water management is increasingly recognized as more of a social than a physical problem. The water crisis is increasingly understood as a crisis of governance rather than one of physical supply and demand because new water cannot be created. In dry regions of the world water is available in limited supply. The problem society faces is how to decide what use to make of water and how to organize itself to make water available when and where it is needed.

3.2 Freshwater Ecosystem Services and Human Uses

The Millennium Ecosystem Assessment (MA) formalized an approach to characterizing ecosystem services that has been widely adopted over the last decade (Millennium Ecosystem Assessment 2002; Millennium Ecosystem Assessment 2005). According to the MA, ecosystem services are the benefits provided to people, both directly and indirectly, by ecosystems and biodiversity. These services are parsed into four categories: provisioning, supporting, regulating and cultural services. In the MA, freshwater is regarded as a *provisioning* service, referring to the human use of fresh water for domestic use, irrigation, power generation, and transportation. However, the hydrologic cycle and surface and ground water also sustain inland water ecosystems, including springs, rivers, lakes, and wetlands. These ecosystems provide *cultural*, *regulating*, and *supporting* services that contribute directly and indirectly to human well-being through recreation, scenic values, and maintenance of fisheries (Figure 3). Fresh water also plays a role in sustaining freshwater-dependent coastal ecosystems such as mangroves, inter-tidal zones, and estuaries, which provide another set of services to local communities and tourists alike. The MA highlights the trade-offs between these differing uses of fresh water and inland water systems and the need to balance these uses in the midst of increasing demand for all types of human benefit derived from fresh water (Aylward, Bandyopadhyay, and Belausteguigotia 2005).

The MA framework was developed largely out of concerns about the global loss of biodiversity and functioning ecosystems. The MA classification system is therefore somewhat awkward in its application to

the hydrologic cycle and freshwater, which is as much about a physical and chemical system as a biological or ecological system. When it comes to water there are provisioning services provided by naturally occurring ecosystems. Clean water from headwater catchments is available for drinking by those living along streams. These rivers supply fish and wildlife. Large rivers provide available transport corridors. But it is hard to see how the use of a river to generate mechanical or electrical energy has much to do with ecosystems. Water falls from the sky and gravity pulls it down gradient. These are physical not ecological processes. Intact ecosystems may help to keep rivers and streams clean, but they do not *provide* water. It is not accurate to credit ecosystems with the major provisioning services of water quantity when it comes to providing drinking water, irrigation, and hydropower to masses of people. This provisioning requires capital investment in the form of technology and infrastructure. That said the extent of ecosystem management will greatly affect the cleanliness of the surface water supply.

Figure 3: Water and Ecosystem Services: the Millennium Ecosystem Assessment

Ecosystem Services Provided by Fresh Water and the Hydrologic Cycle.
Many of the provisioning, regulatory, and cultural services can be enhanced through development of water resources (large-scale navigation can be increased by creating slackwater systems using dams); however, there are often offsetting losses or trade-offs between these service categories, such as loss of rapid transport downstream to locals or those seeking recreation.

Provisioning Services	Regulatory Services	Cultural Services	Supporting Services
Water quantity & quality for consumptive use: domestic, agriculture, industrial, etc.	Maintenance of water quality: natural filtration, water treatment, etc.	Recreation: river rafting, kayaking, hiking, fishing as sport, etc.	Role in nutrient cycling: role in maintenance of floodplain fertility, primary production, etc.
Water for non-consumptive use: hydropower, transport, navigation, etc.	Buffering of flood flows, erosion control through water/land interactions, flood control infrastructure, etc.	Tourism: river viewing	Predatory/prey relationships in ecosystem resilience
Aquatic organisms for food & medicines		Existence values: personal satisfaction from free-flowing rivers	

Source: Aylward et al. (2005)

For the purpose of the report and this paper then, the following terminology is used with respect to the services derived from surface and groundwater resources:

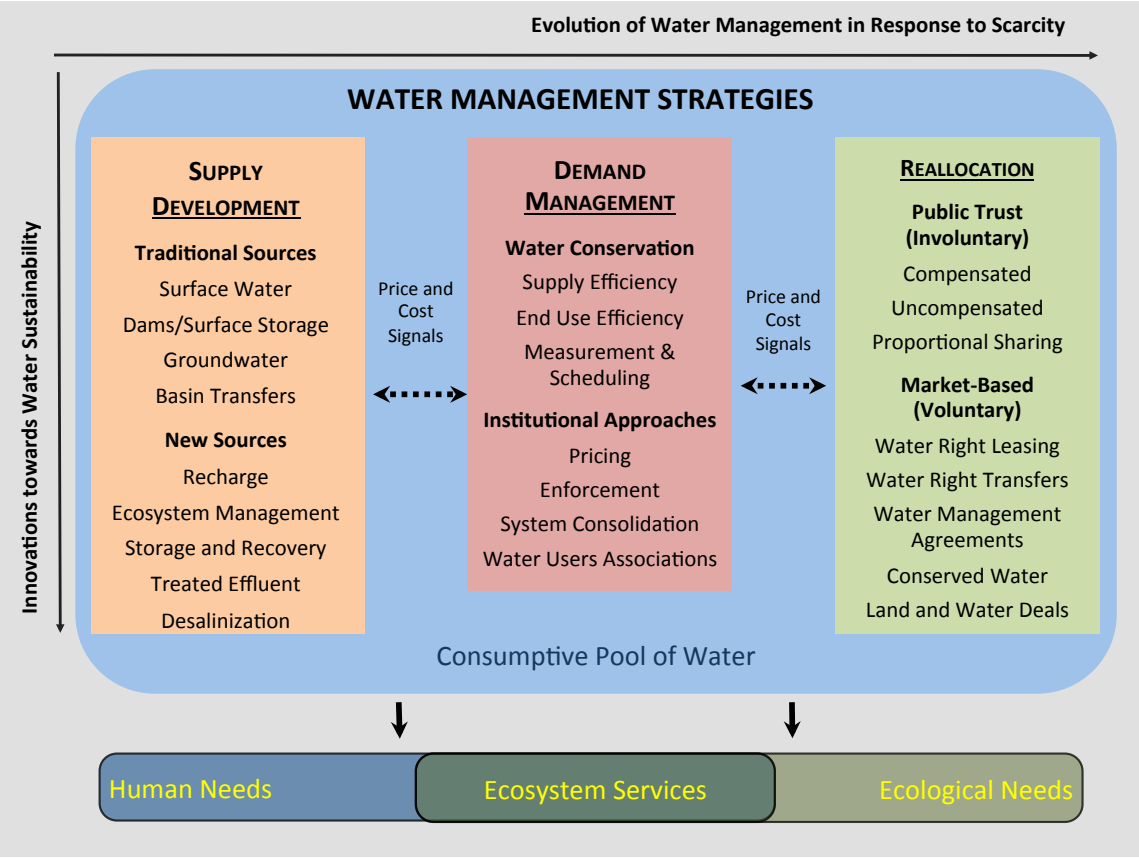
- Human provisioning services or human uses of water refers to:
  - withdrawal of water from freshwater ecosystems and aquifers to meet human uses for domestic, industrial, commercial, irrigation, thermoelectric and hydropower uses.
- Freshwater ecosystem services or ecosystem uses of water refers to:
  - provisioning services such as habitat for fish and wildlife;
  - regulatory functions of ecosystems such as maintenance of the hydrologic regime and water quality;
  - supporting functions such as habitat for species; and
  - cultural functions such as sacred sites, tourism and recreation.

3.3 Water Management Strategies

This section briefly surveys the range of water management strategies, in part to provide context and in part to clarify that water markets are just one of many tools available to policy-makers. Depending on circumstance markets may be an important tool in the tool-chest, but likewise they may not.

There are a wide variety of strategies available to manage water and achieve the development or sustainable management of water resources. These can be categorized as: supply, demand, or reallocation strategies (see Figure 4). Human civilization has expended and will continue to expend vast amounts of effort and resources to supply water in the quantity needed and at the time and place required. These efforts are devoted to the aforementioned human uses needed for domestic purposes, agriculture, industrial uses, power generation, etc. Where surface water is available, traditional strategies typically first involve the development of surface water diversions and delivery to water users. As demand outstrips the ability of natural flows and lakes to fulfill human needs, societies have made further investment in more costly supply approaches, including surface water storage, groundwater withdrawal, and interbasin transfers. In arid areas today, new and more innovative supply options include shallow aquifer recharge (SAR), aquifer storage and recovery (ASR), desalination and water reuse. Supply strategies typically rely heavily on engineered solutions that involve the development of water infrastructure. In the case of SAR, ASR, and reuse, continuing to meet new consumptive demands from these sources means less water for residual users, particularly ecosystems, and decreases the available consumptive pool of water. Desalination has the unique advantage of adding to the available supply of water by bringing in brackish water or seawater as a source of freshwater supply.

FIGURE 4: WATER MANAGEMENT STRATEGIES



As new opportunities to increase supply dwindle and increase in cost, society has looked to demand management in order to do more with less. Demand management, also called water conservation, can include direct, often technological or infrastructure solutions that drive greater water use efficiency. This may include improving efficiency on the way to the end use, for example, eliminating leakage during water transportation by repairing municipal pipes or lining irrigation canals increases supply efficiency. In addition, water demand may be reduced at the point of end use by switching to lower water-use crops or installing water-efficient toilets. Better measurement, monitoring, and enforcement – including using supervisory control and data acquisition systems (SCADA) in water delivery systems, can also increase the efficiency with which water is delivered. Another set of demand management options are related to governance and institutional approaches. These softer approaches can also result in large savings or reduced end use. For example, better planning and adoption of new governance structures such as water-user associations may resolve inefficiencies in water management or unlock new ideas for more profitable, less water-intensive use.

As discussed above, many uses of water are only partly consumptive in nature. The traditional supply approach thus takes a portion of the water (the water consumed) away from other customary water uses (whether human or environmental). This may also occur with investment in demand management. Improving water use efficiency means increasing the portion of water withdrawn that is consumed by the end use. By improving efficiency, many of these demand side water conservation approaches can reduce water withdrawn (i.e. diversions or pumping) to meet the existing end use. If this water is not withdrawn for the prior use, this can benefit aquifers, ecosystems and downstream users, thereby improving sustainability. However, where such improvements are used to underpin new consumptive uses, not only might benefits not materialize but flows and water availability might be diminished downstream or down-gradient, with net negative impacts to human users and ecosystems. In arid areas where water demand is increasing and per capita natural supply is decreasing due to population growth, rising incomes and climate change, improving water use efficiency is not always an unalloyed positive strategy. This is particularly the case if it simply allows one user to consume more water, leaving other users bereft of their former supply.

Once all downstream users are taken into account, both supply and demand management options reallocate water from an existing to a new use.

In a sense then, once all downstream users are taken into account, both supply and demand management options reallocate water from an existing to a new use. Building dams and storage has often led to low flows and water quality problems downstream with knock-on effects for fish, wildlife and people; in other words, effectively reallocating water from those affected by the dams (fish, wildlife, and people) to those who benefit. Piping an irrigation ditch to make irrigation water supply more reliable during low flow periods can have similar impacts downstream and result in a similar de facto reallocation. It is clear then, that addressing supply and demand in a vacuum can be harmful for overall system equity and health. Examples of this play out across the globe, especially in places that lack meaningful oversight.

This gives rise to the need to explore the role of water governance in driving water management, particularly through the allocation and reallocation of rights to use water. Historically, especially during early phases of development when supply can seem unlimited, systems to evaluate and permit new water sources may not have been in place, or downstream ecosystem and marginal users (like subsistence populations living on floodplains) may not have had legally recognized rights to use water and, therefore, were not part of initial allocation decisions. Regardless, the point is that the rules of the game may have been, and may still be in some areas, structured to allow new users, and now conservation projects, to adversely affect downstream ecosystems and users. Or they may not. If water management is to be more

than a zero sum game, with new efforts in demand management simply altering the game of who has the right to capture water, then water governance needs to be carefully crafted.

The presence of increasing scarcity, despite new and innovative supply and demand management strategies can lead to the evolution of a third set of strategies grouped here as *reallocation*. As depicted in Figure 4, these involve the reallocation of water rights from one user to another. This may be accomplished involuntarily by legal or administrative decree, or voluntarily, as through compensated exchanges in a water market. Alternatively, society may choose not to reallocate water but simply spend larger and large amounts of money developing new supplies, or reuse of existing supplies, or engaging in demand management.

If water users have no established and recognized *rights* to use water then technically there is no reallocation of *rights*, only of *uses*. If users have rights then such reallocation can occur when the right expires. Or the state (and by state in this paper we mean the nation or a state within the nation that has requisite authority over water) may choose to force the reallocation when the right is still active. Such involuntary reallocation may result simply from a calculated choice by the state. The calculation may be that economic needs of the nation are best served by another use of the water. A central question is whether involuntary reallocation must occur with compensation, or whether the state can effectively expropriate or cancel the right without compensation. If government cannot take or cancel a water right without paying compensation, the property rights can be characterized as very strong (and secure).

The presence of increasing scarcity, despite new and innovative supply and demand management strategies can lead to the evolution of a third set of strategies grouped here as reallocation.

Another rationale for involuntary reallocation – which may include compensated reallocation – may be the result of efforts to address social or environmental claims. For example, in the US compensated reallocation is often the result of regulatory action to implement water settlements with tribal (indigenous) governments, or to remedy water management practices within the context of major environmental legislation such as the Clean Water Act or the Endangered Species Act. In Australia at various times, including following reforms sparked by the country's economic reforms of the mid 1990s, some states carried out uncompensated reductions in water entitlement amounts (Dyson 2016b).

The alternative approach to involuntary reallocation is for the state to provide those with rights to use water the opportunity to voluntarily transfer these rights – either temporarily or for the duration of the underlying permit. In such a system, existing and prospective water users can engage in willing buyer/willing seller transactions for mutual benefit. These transactions can involve rights created through the development of supply or from water saved through demand management. In some cases these transactions will evolve into formal marketplaces – places where buyers and sellers meet to trade. This alternative is therefore called market-based reallocation in order to differentiate it from government-mandated reallocation.

Figure 4 illustrates the full set of strategies, laying them out on a continuum from an emphasis on supply, to management of demand, and finally to reallocation as scarcity of the resource grows. Within each set of strategies, it is also possible to identify, somewhat generically, how innovation further develops and evolves these strategies. As suggested above, in a given location at a given time, each strategy and each potential set of strategies will have their own relative advantages, disadvantages, and cost-effectiveness. From an economic perspective, and as shown in Figure 4, these strategies can be assessed based on the relative cost per unit of water via supply development, demand management, or reallocation.

3.4 Markets, Economic Efficiency and Water Management

When comparing supply, demand management and reallocation strategies it can be difficult to discern the true economic cost of the alternatives. This is due to many factors, including a lack of transparency and full cost accounting on public projects, and the existence of subsidies and taxes that can hide the economic opportunity cost of resources dedicated to these projects. A unique feature of market-based reallocation is that it can provide observable data on the price of water. Market prices turn out to be useful in two separate ways.

First, markets in water rights are regarded as encouraging economically efficient water use. From a perspective purely of economic efficiency in order to attain the efficient use of the water the user needs to face the opportunity cost of their use of water. This can be accomplished either through setting up a market in water rights or by levying fees or charges on the use of water. A water user who has available the option of marketing their water right implicitly is deciding whether their use of the water under the right is worthwhile. In other words, water is no longer free to the water user, even if the user acquired the permit from the state for free in the first place. The decision to use the water imposes an opportunity cost on the water user – that of not marketing the water and taking the returns to the bank. The market discipline this instills is critical as it incentivizes the user towards the highest and best financial use of the water. A second approach to encouraging efficiency is to simply charge the user for the use of the water. Such fees are the resource use equivalent of a Pigouvian tax on pollution. Under a system of water charges water users may choose (or not) to pay for the use of water. Other things equal, they will do so if their use of water generates revenue in excess of the cost of the water.

From a policy perspective then there is a choice to be made between allocating rights and enabling trade, or simply allocating uses (but not rights) and charging for the use of water. Or the two can be combined in some fashion. For example, in South Australia, where water rights are fully tradable, rights holders also incur charges for those rights. Charges may be based on the amount of water to which they are entitled, as well as on the quantity actually used. The intent of the policy is in part at least, to enhance the understanding of value of water as described above. Administration of the use charge proved not worth the benefit, so only the entitlement levy is generally charged today. It is important then to be clear in water policy how policy proposals for markets and water use charges may complement each other or be substitutes (or alternatives aimed at the same objective).

Water as a resource has public goods characteristics, which cause markets to fail as efficient allocation mechanisms.

A final caveat on the use of markets presages the discussion below (Section 4.1). Water as a resource has public goods characteristics, which cause markets to fail as efficient allocation mechanisms. In a given market, the user only responds to the price in that market. If the market is not inclusive and if the market price does not reflect the full social and environmental costs of water usage then it will not necessarily incentivize the highest and best use from an economic perspective but rather just from the financial perspective of the supplies and demands that are monetized in the market. Another way of saying this is that markets only work for those allowed to participate in the market and for the uses that can be monetized. A water market will not be healthy if social or environmental demands are left to the market but these demands are not able to participate in the market, or if the value of their use of water cannot be monetized in some fashion.

The second benefit of market-based reallocation is that prices emerging from the market can be compared to the cost of other alternatives for accomplishing water supply needs of buyers. In other words the prices emerging from transactions and markets can be compared to the costs of water secured through demand

management or new supply development. As market prices provide an indication of value they can be used to validate whether supply or demand management options are worthwhile investments.

For example, if government is deciding on financing a project that will supply additional irrigation water at a cost of $3,000/acre-foot, or a city council is considering investing in conservation efforts that are projected to save water at a cost of $4,000/acre-foot saved, or a large business is scrutinizing a proposal for treating wastewater that would produce clean water at $3,500/acre-foot, these decisions would benefit from reference to the market price of water in the area or to the cost of reallocating an acre-foot of water in the absence of an active market. Such comparisons may require further analysis to ensure that the effects of other policy and economic factors at play (e.g., subsidies) are accounted for in cost figures or prices. Developing market-based reallocation strategies can therefore assist overall water sustainability by providing price signals that can inform the choice of strategies going forward. Making such information available may also increase the economic incentive for providers to improve the cost effectiveness of supply- and demand-management alternatives. Further, if reallocation is involuntary and achieved through unilateral government action, then information about the comparative economics of different sources and uses of water is not produced and not made transparent.

Ideally, choices of appropriate water management strategies are made using a full set of criteria including issues of equity and accountability, not just economic criteria (World Commission on Dams 2000). However, in decision making it is often helpful to compare the varying costs of different alternatives to the varying benefits in terms of cultural, ecological, and other criteria. Making both economic and non-economic tradeoffs transparent can help to make better decisions. For example, in the case above there may be important social reasons why new irrigation water is needed. Making the tradeoff clear—in this case social objectives could be met either by buying water on the open market or by building the project and incurring an extra $1,000/acre-foot in cost—is an important step in the direction of sustainability.

Managing water sustainably should include making the best use of a portfolio of supply development, demand management, and reallocation options.

In sum, managing water sustainably should include making the best use of a portfolio of supply development, demand management, and reallocation options. The risks, costs, and benefits of all approaches—as well as their political feasibility and accommodation of diverse stakeholder views and decision-making processes—will dictate the mix of management responses. The efficiency with which water sustainability is achieved depends in part on the transparency of price and costs signals, which in turn is greatly aided by enabling market-based reallocation. The next section dives deeper into market based allocation as a tool help manage increased water scarcity once supply and demand strategies have begun to reach the end of their usefulness.

3.5 The Role of Water Markets in Water Management

The case for water markets as an integral part of water management is easy to describe. The need for improved water management is gaining increased attention as the factors driving the need for adaptation are rapidly building. Global growth in population and income has long been recognized as a key driver of water scarcity. Now climate change and its impacts on water supply and demand are further exaggerating the issue. In the presence of growing water scarcity, the eventual need for reallocation is self-evident. The advantages of market-based reallocation over involuntary reallocation stem from the expected economic efficiency and socio-political benefits (such as lower conflict) of allowing water users to effect reallocation rather than leaving this to administrative fiat. Yet, systems of water governance that enable water markets

are in their infancy and are themselves scarce across the globe. The Nature Conservancy estimates that over twenty countries have provisions in place to allow market transactions (Richter 2014). Even in these countries, with the possible exception of Australia, it is hard to say that markets consistently receive rave reviews or that they have delivered on expectations. It is therefore useful to explore why such an apparently desirable strategy might not have met with widespread adoption, implementation and success. The simple answer is that while market-based reallocation holds promise as a potential solution to pressing water issues, markets have limitations, detractors and alternatives.

Merely declaring that markets are desirable achieves little in the face of the need to build markets on a solid foundation of good governance and water management. In many countries the enabling conditions that must be present to underpin market reallocation – such as the permitting of surface water and groundwater uses, and effective monitoring and enforcement of water uses – are themselves not yet present, much less the policy reforms necessary to institute water trading. For example, if water managers cannot account for how, when and where water is moving within a basin then a market is probably not the immediate solution. Markets created under such conditions often end up as paper markets. These are markets where entities trade paper (often to obtain necessary development approvals) but not "wet" water. Just as with a poor accounting system in a business, the problem with these systems is that they can obfuscate the fact that when the water is physically needed it won't actually be present. So the most basic enabling condition for a market is sound water measurement and accounting, enforcement of existing allocations and regulation of changes to these allocations. And of course, if a country's legal system does not recognize private property, or the water code does not allocate water in the form of a property right, then trade in water will be limited and informal. Building a solid governance and management foundation is also not something that happens overnight or something that is easy or inexpensive to accomplish. In many places markets might be appropriate as a longer-term strategy. The difficulty is that it often seems that climate change and increasing water scarcity do not provide the luxury of time.

Political and legal changes to the rules of the game for managing and regulating water are a matter of setting and history. The path of history in this regard is somewhat determined by the setting and prior history, so that changes build on each other over time. This *path dependency* of legal and political evolution represent a further difficulty when it comes to establishing effective water markets. As described earlier, increasing water scarcity and resulting water stresses tend to move the focus of water management from supply, to demand, to reallocation. This process happens over time and is accompanied by associated changes in policy and law. With some notable exceptions, legal frameworks for water governance did not evolve in the age of scarcity. Two examples where this did happen are Australia and the Republic of South Africa. In Australia, the early departure from common law between the late 1880s and early 1900s, and vesting of water and control of water in the Crown (i.e., the state) with statutory authorization of use through license schemes enabled the reforms that occurred from the 1990s to present. These latter, recent reforms reduced the level of over allocation through reductions in rights and the buy-back of rights by the state (Dyson 2016b). In South Africa, the end of apartheid created the opportunity for a rewrite of the water code that led to a transition from a private rights system to one in which the social and ecological "reserve" sets aside water for people and the environment before water for commercial uses (Woodhouse 2012).

Many of the traditional legal frameworks were not designed with reallocation (or water markets) in mind, even if they were designed with scarcity in mind, such as with the case of Prior Appropriation in the western US. Nor would such traditional frameworks be designed to enable markets to meet new, emerging uses such as environmental uses. This may affect whether these frameworks are, or are not, equipped to facilitate water markets and environmental uses. Existing legal frameworks for water governance therefore are a key driving force in the success or failure of water markets as a tool and, in particular, for addressing changing supply and demand for water and freshwater ecosystem services.

Another hurdle markets face is that many stakeholders – and the list of stakeholders in the water management arena is long – are not convinced that markets for water are a good idea. It is vital to recall that the history of water resource development in many places is one of large powerful water bureaucracies planning a centralized water future and driving the politics associated with water resources management, i.e. the hydraulic mission (Molle, Mollinga, and Wester 2009). This is true even in capitalist countries. For example, even the Economist magazine has stated that "when it comes to water politics, no Soviet central planner could have done worse than America" (Peet 2003). The traditional water bureaucracies, staffed with engineers, are not going to be early adopters of the idea of leaving the future of our water supply to a multitude of actors in an unpredictable and unregulated market.

Many of the traditional legal frameworks were not designed with reallocation (or water markets) in mind … This may affect whether these frameworks are, or are not, equipped to facilitate water markets and environmental uses.

Other stakeholders also will doubt that water should be left as the saying goes "to flow uphill to money." The qualities of a market so liked by economists – that the preferences of a large number of producers and consumers are left to drive resource allocation – are typically not favored by special interest groups, whether community, environment or agricultural in flavor. Many community-centered and environmental groups view markets with a healthy degree of distrust. Indeed, many questions remain about how water trading fares on grounds of social equity and environmental protection. Much work therefore remains with respect to water governance in terms of how to develop, adapt and implement reallocation systems that are efficient, equitable and protect or restore the environment. This distrust may also be shared by rank and file irrigators who are concerned about markets as mere tools to move water from agriculture to cities and the environment. Pictures from Australia of rural communities and farmers burning the Murray-Darling Basin Plan suggest that this kind of fear and opposition is even present in places where markets are touted as highly effective.

Even if the necessary tools for good water management are in place and stakeholders are not virulently opposed, it is important to point out that markets do have alternatives and markets are just one of a number of strategies that are at water managers' and water users' disposal. In some cases, a large public project that solves a community water scarcity problem may be lower cost than creating a formal marketplace. Creative ways of reducing end use demand – for example reusing water in data centers – may be costly, but the security that is offered in terms of reduced risk of supply disruption may argue for building a project instead of going to the market to buy water. There are few instances where there is no alternative but reallocation to a given water scarcity problem. Rather it is more a question of what is the best solution. Coloring this choice of the best solution in a given situation will be intertwined with the local setting, the history of water policy, the mind-set of stakeholders, the requirements of finance, and the political economy of water management. Participation in water planning and decision-making is increasingly regarded as essential. The inevitable outcome is that sometimes the least cost or most economic approach to a problem is not selected.

Finally, it is important to consider whether a market is given a political mission or whether it is just left to be a market with no direction. In the western US, basins include a range of water use sectors including agriculture, mining, recreation, hydropower, municipalities and the environment. In some locations only two of these are present, in others three or more are present. Asking a market to effectively mediate between so many different uses and users is challenging, unless there is general political agreement that this is the role of the market. So it is also useful to consider whether the body politic is asking the market to figure out the answer to how to balance supply and demand broadly, or whether markets are assigned a

more circumscribed task by their political masters. For example, in some western US basins and in Australia the market has been effectively assigned the task of reducing the over allocation of water and redistributing water from agriculture to the environment or from agriculture to cities. In other words the political decision is made that a redistribution of water rights is needed. The market is chosen as the manner in which this reallocation is to be implemented and the government provides funds to the market to implement this political decision. The role of politics in driving markets cannot be underestimated.

In sum, markets face a large number of hurdles. So rather than assume that markets are an obvious and necessary solution to any and all water scarcity problems (the proverbial hammer just looking for a nail), it may be wise to carefully assess where and in what circumstances markets are an appropriate, desirable and, most importantly of all, feasible alternative. Before turning to the conceptual framework that the paper proposes as a means to this end it is useful to briefly consider the purpose of markets. If markets are one of many tools for water management to what end should they be directed?

3.6 The Purpose of Water Markets

A variety of views on the purpose of water markets exist. These are characterized briefly in the following four general views:

- Neoclassical Economist or Neoliberal view: water is a natural resource and markets are the most efficient way to allocate water in the face of scarcity, i.e., to move water to its highest and best use.
- Water for Life not for Profit view: water markets and the resulting commodification of water perverts the nature of water as a public good; water markets will result in water going to the highest bidder and make water even more unaffordable for poor communities.
- Public Trust view: the state's first responsibility is to meet its public trust, which means meeting environmental needs for water (at least to maintain ecosystems and species); after that markets or other mechanism may be used to allocate water.
- Food Security view: agriculture is vital to the economy and rural communities; water markets just siphon water away from agriculture when more water is what is needed to feed the world's growing population.

Each of these perspectives has an element of truth to them. The problem is that they conflict. A normative expression of whether and how to engage with water markets and set the rules of the game will depend on which perspective you subscribe to or how you balance these perspectives.

The remainder of the paper introduces a conceptual, interdisciplinary framework for understanding the conditions and approaches that enable markets to function effectively. What *effective* means to people is the normative component. Water policy (and as subsequently reflected in water laws) often provides a normative objective, typically expressed as principles or criteria towards which governance should be oriented. For example, if the normative objective is *sustainable* water management, then water policy and law can be crafted to reflect the objective to manage water for the long-term benefit of society and the environment, not just short-term economic gains. At the other end of the spectrum, the normative objective might well be framed as maximizing economic gains from water use as quickly as possible. However, with some notable exceptions, such as Chile and Australia, very few existing legal frameworks for water governance have facilitating water markets as even one of, let alone their primary, objective.

A recent expression of such a normative view frames the question in terms of how to "shape healthy water markets;" suggesting healthy markets should be "efficient and effective" and should serve to "meet changing needs, reduce over-allocation, and embed social equity and environmental considerations into equitable and transparent markets" (Water Funder Initiative 2016).

Stated differently, in the face of increasing water scarcity and conflict over human and ecosystem uses of water there is a need for effective or "healthy" water markets to achieve a balancing of the following outcomes:

- *efficacy*: effectively managing supply and demand for water, and – where possible – conflict over water, in response to driving forces and changing circumstances;
- *economic efficiency*: achieving efficacy in a cost-effective and timely manner; and
- *environmental and social sustainability*: avoiding adverse impacts and providing pathways to social inclusion and equity, as well as environmental conservation and restoration and ecosystem resiliency.

How this balance plays out in a given location will depend on the setting and history amongst other factors and what a market is asked to do.

The question addressed in this paper is how does one understand water markets in a way that enables the shaping of such healthy markets. The extent to which markets are healthy and produce the desired outcomes depends, at least in part, on the extent to which the market, including overt attempts at market design or development of specific marketplaces, is designed to meet these objectives; and how good that design proves to be in implementation.

4. Conceptual Framework for Healthy Water Markets

In order for a water market to function and trade to be present, the rules in place must satisfy certain minimum enabling conditions. How well a market functions depends on not just how well these enabling conditions are met but also the extent to which the conditions of a competitive market exist. Whether or not a market produces desired social or environmental outcomes depends on whether the necessary protections are in place to maintain or promote social and environmental uses, and whether and on what terms the market enables access and participation by these sectors.

Whether or not a market produces desired social or environmental outcomes depends on whether the necessary protections are in place to maintain or promote social and environmental uses, and whether and on what terms the market enables access and participation by these sectors.

These issues are explored below. The framework consists of three main ideas, working from broad, overarching issues to the specific:

1. *Market Failure and Collective Action*. With strong public goods characteristics, water is subject to market failure as an economic good and therefore is generally not regulated as private property; rather water is owned by the state which extends use rights to users and regulates this use and changes in this use.

2. *Enabling Conditions for a Water Market*. If these use rights are well defined, secure and flexible, the state enables the trade and transfer of these rights, and these rights are scarce (either as a matter of demand and supply, or of state imposed use restrictions) a market can be created and trade in water and water rights can occur.

3. *Drivers of a Competitive Market*. The extent and efficiency of trade is determined by the completeness of these enabling conditions, as well as the extent to which the basic requirements of a competitive market are met.

4.1 Market Failure and Collective Action

Economists are well known for asserting that competitive markets will arrive at efficient production and allocation of private goods. A more nuanced, political economy view is that all markets – even those for private goods – require careful regulation by the state in order to avoid the tendency for moneyed political interests to engage in rent seeking behavior that restrains trade and is ultimately anti-competitive and leads to inequitable outcomes (Stiglitz 2012). Despite this disagreement, economists of all persuasions maintain that the market is *not* a good allocation mechanism for public goods (Varian 1992). In the case of public goods markets are said to fail.

Water in its various guises is often regarded as a public good. It may then seem a conundrum that if water is a public good that water markets exist, or that a conversation about what constitutes a healthy water market is a practical exercise. The origin of the market failure problem is briefly reviewed in this section and more fully explained in the Annex to the report. The section then proceeds to describe manner in which collective action to counter market failure has found its way back to markets as a viable tool for managing water.

4.1.1 Water and Ecosystems: Common Pool Resources and Public Goods

The phenomenon of public goods, is often attributed to an early paper by Samuelson (1954, 387) who called these goods "collective consumption goods" and characterized them as goods that "all enjoy in common in the sense that each individual's consumption of such a good leads to no subtraction from any other individual's consumption of that good." As recounted by Ostrom (2011) the dichotomy between private and public goods grew over time to include club goods and common pool resources based on the elaboration of the concepts of exclusion and rivalry. In a valuable paper, Randall (1983) lays out how these two concepts taken together portray the entirety of what is needed to be known about the nature of economic goods, and therefore the conditions under which standard neoclassical theory fails to hold and markets are not the answer to economic production and consumption.

*Exclusio*n refers to whether it is easy or difficult (i.e., costly) to exclude or limit consumption by other potential users or beneficiaries. In the case of water flowing through watercourse and pooled underground it is difficult (i.e., costly) to create exclusion through physical barriers and control (e.g., the application of technology), or through institutional arrangements (e.g., a legal system of property rights). Once water is initially withdrawn, either by diversion from a stream or pumped from an aquifer, however, exclusion is much easier to accomplish. *Rivalry* reflects the degree to which the use of a unit of a good by one individual reduces, or does not reduce, the potential for others to use that same unit. Water, like many natural resources, is largely regarded as a congestible good, meaning that the more users flock to withdraw water the more likely it is that the use of water by one will affect in a deleterious manner the use of another. A further characteristic of water use is that even when demand is high it is difficult and costly to consume all the water that is withdrawn. This leads to a rather unique aspect of water use. Unlike other resources like wildlife or oil, once the water is withdrawn and used a portion of it may return to the hydrologic system. When water is scarce this returned water likely forms the water supply of another user. This character of water use as partly non-rival creates unique challenges to managing water, including in regulating use rights and water markets.

The long and short of the discussion in the Appendix (as summarized in Figure 5) is that water, once withdrawn, varies in rivalry, but is generally excludable. This water may be classified as club goods or as private goods. By implication the latter are amenable to management through markets or by a club (with fees, or tolls, paid by members) that creates a natural monopoly in the service of water delivery. Surface water, groundwater and ecosystem services also vary in the extent of their rivalry but are non-excludable, meaning that they may largely be classified as either public goods or common pool resources. They cannot be considered as private goods. Therefore, if left to markets, they are unlikely to be produced and allocated in amounts consistent with their marginal value to society. Without understanding rivalry and exclusion and the nature of water as a sometimes private, sometimes public, common-pool, or club good, a framework for understanding water markets risks missing fundamental determinants of success or failure of water markets.

4.1.2 Collective Action: Property and Ownership of Water

The analysis of rivalry and exclusion thus leads to the identification of goods that are subject to market failure. Market failure challenges society to find and rely on alternative means for the production and allocation of these goods. This is framed as moving from market allocation to *collective action* (Olson 1965). This was originally interpreted as meaning that the state should provide public goods, while the market provides private goods. However, over time the expansion of the set of goods with public goods characteristics and the study of institutions led to the broadening of the potential scope for collective action beyond the state (Ostrom 2010).

FIGURE 5: EXCLUSION AND RIVALRY OF WATER

Rivalry of Consumption (subtractability of use)	Exclusion (difficulty of excluding others): Non-Excludable (high difficulty)	Exclusion (difficulty of excluding others): Excludable (low difficulty)
Non-Rival (low)	Public Goods Freshwater Ecosytem Services -Supporting -Regulatory -Cultural Groundwater (short run)	
Congestible	Common Pool Resources Surface Water (rivers, lakes) Groundwater (long run) Freshwater ecosystem services -Provisioning (e.g. fish, wildlife, plants)	Club Goods Surface Water Withdrawn for Irrigation
Rival (high)		Private Goods Groundwater Pumped for Irrigation

Collective action to address market failure associated with water's public good characteristics generally consists of addressing who owns water, how rights to use water are allocated, and how the use of water is regulated.

The phrase "possession is 9/10ths of the law" is well known, but few have explored the legal principles that underlie the phrase. Most introductory property law classes in US law schools begin with a historic case from 1805, *Pierson v. Post*. In *Pierson*, Post was pursuing a fox when Pierson, knowing that Post was pursuing the same fox, shot and killed the fox himself. Post sued Pierson, claiming that his *pursuit* of the fox created a right of ownership against which Pierson trespassed. The court ruled in Pierson's favor, espousing the principle that *capture* and *possession*, not *pursuit*, are the only way to establish ownership of a wild animal. Aside from confusing many generations of fresh-faced law students, *Pierson* serves to illustrate a particularly vexing issue about ownership of natural resources: how to define property rights in things that refuse to stay in one place.

This issue has confounded people for as long as people have cared about the concept of property. The rule of capture illustrated by *Pierson v. Post* existed long before the case was decided. The judges in *Pierson* cited precedent as old as Roman times in supporting the notion of capture. And the rule of capture still exists in many contexts today. In fact, the problem of defining ownership over feral animals, also called *migratory* or *fugitive* natural resources, is no easier to solve today than it was in Roman times or in 1805. Perhaps no specific resource exemplifies this difficulty as much as water. Whether flowing above ground in a stream, or below ground in subterranean channels or aquifers, water can be just as hard to exert control over as a wild animal. While, unlike wild animals, it is always possible to know the location of surface water flowing in a channel, water's constant motion and considerable physical heft require ingenuity and engineering to control. For groundwater, even knowing the exact location and how pumping in one place may or may not affect the broader resource is a relatively modern innovation. As a result, the legal regimes that have grown to govern and define property rights, use, and ownership of water are complex and varied.

Property is a right that reflects an enforceable claim to a particular thing or a share in some common resource (MacPherson 1978). A property interest in, or ownership of, a resource conveys certain rights and obligations to the owner (Schlager and Ostrom 1992). Generally speaking, and with regard to water resources, there are four possibilities (MacPherson 1978):

- *Res nullis* or nobody's property, or what economists often call *open access*;
- *Common property* in which a group or community asserts ownership over the resource;
- *Public property* in which the state declares itself the owner of the resource, usually on behalf of its citizens; and
- *Private property* in which individuals claim ownership of the resource.

Even this categorization comes with an immediate series of caveats. First and foremost is the concept, of *de jure* and *de facto* rights. In a world with no rules, *res nullis* is the norm and *ownership* of a resource by any collective as common property or by any individual is a form of *de facto* ownership reflected in physical possession. In a world where states declare themselves the owner of the resource, there may be conflicts between *de jure* and *de facto* rights. For example the claims of communities that have customarily relied on streamflow and freshwater ecosystem services may be at odds with assertions of ownership and subsequent disposition of rights to the water resource by the state.

The public good characteristics of water and its relationship to freshwater ecosystem services imply that water does not lend itself to rival and exclusive consumption and is not, at least in these terms, an inherently private good. However, the economic idea of *private goods* is distinct from the concept of *private property*. Private property in a *de jure* sense does not exist apart from the state. Private property and markets as such do not exist in a policy or legislative vacuum. Property rights are an institutional mechanism that government uses to create formal, regulated markets (Demsetz 1967). Law and order (e.g. police power) underpins the effective exchange of property. Without clear definition of property interests and the ability to enforce those interests there is little incentive for buyers to pay sellers in the exchange of private property.

In most jurisdictions, however, the state (the term *state* here is used broadly and does not refer to a state in the sense of one of the United States) has chosen to assert ownership over water within their jurisdiction. Whether such an interest is made as an outright claim or a claim on behalf of the public varies, but the end result is the same: the state is the authority that sets the rules for the use of water but it does not relinquish its ownership of the resource. Again, given the public good nature of the different forms of water and freshwater ecosystem services, there is logic to this assertion. But likewise water itself may be more precisely defined as a congestible good and thus a common pool resource. By implication, common property management is a viable alternative to public ownership. The difficulty of course comes from the fact that many of the freshwater ecosystem services associated with surface water and groundwater are themselves public goods. Ownership exercised by a community nested at one scale in a basin may not adequately account for the costs and benefits of water usage at another scale, with respect to both water and freshwater ecosystem services. This would argue for ownership by the community at the larger scale, i.e. basin level. However, this quickly becomes impractical in a world where administrative boundaries are not based on hydrographic delineations.

In summary, while there are a number of options for defining ownership of water generally, water is most often treated as public property in a *de jure* sense. However, this assertion of property rights may overlap or conflict with local customary uses which themselves may constitute *de facto* property rights held in common. In both cases, ownership is underpinned by collective action reflected in public policy, as it should be given the public good characteristics of water and freshwater ecosystem services.

4.1.3 Collective Action: Regulated Usufructory Rights to Water

One way to interpret the public/private goods distinction is that the non-rival or non-exclusive nature of a good is not just what makes markets fail but what makes management of the good difficult, short of the state simply providing the good (as with a lighthouse or national defense). Another way to look at this is that to the extent that the difficulty of making a good rival and exclusive (i.e., to move into the private good box in Figure 5) can be overcome with technology and institutions it reduces the degree of market failure and renders the good more amenable to management that captures some of the efficiencies of markets, while retaining the sideboards provided by collective action. So a common property regime seeks to address the exclusion problem inherent to common pool resources. In such a regime user groups set their own rules for exclusion, management, alienation and how individual users exercise their operational access and withdrawal rights (Schlager and Ostrom 1992).

However, it is not inconceivable that a common pool resource could be managed through other means. Randall (1983) examines the example of creating non-attenuated property rights and using market forces to achieve efficient production in a common pool resource. For Randall, who uses the case of the ocean fishery, this option suffers from the costs of enforcing exclusion in the open sea. He concludes that the problem is that these transactions costs are not only so high as to eliminate any gains from trade in the market, but reflect the cost (read impossibility) of creating effective property rights. For these he blames "peculiarities in the nature of the physical resource itself" (Randall 1983, 133). By implication, if exclusion can be accomplished at some reasonable cost then property rights may be a viable institutional solution to the problem of market failure. Indeed if the problem of partial consumption and non-rivalry of water uses were eliminated, it could be argued that such an effort in collective action would propel water into a sphere were market allocation of water would be advisable. It may be important to emphasize that the costs and benefits of establishing exclusion are not stationary. As scarcity increases over time and the value of the water resource increases what may have been an exorbitant cost to properly manage the resource becomes affordable and even a necessity.

...in the case of water resources collective action to resolve market failure has generally led to ownership over the resource by the state.

To sum up, in the case of water resources collective action to resolve market failure has generally led to ownership over the resource by the state. In many countries the state has issued rights to members of the public for the use of the resource. These rights may be no more than limited term licenses for the use of water, subject to revocation by the state, or they may be property rights entrenched in statutory or constitutional law that cannot be abrogated by the state without payment of compensation. And finally, the state may choose to regulate the use of water and the exchange of these property rights. Again, the partially consumptive nature of water uses and the reliance of other existing right holders on this non-consumptive portion of one user's right provides an imperative for the state to regulate both the use and the exchange of these rights.

States have taken a number of different paths with regard to rights and regulations. These are examined in light of water markets in Part III of this report. Here it is useful just to note the variety of approaches. One approach is for the state to assert ownership but to issue no rights or regulations to govern the management and use of water. For example, in the state of Arizona groundwater is regulated within specific designated management areas. These management areas are effectively the urban areas in the state, leaving groundwater unpermitted and unregulated in large rural swaths of Arizona. Another approach is for the state to issue rights and enable their trade and transfer, but not to regulate this market. Such a pure market is rarely seen, with Chile perhaps coming closest to arriving at such a *laissez faire*

approach. A third variation is Mexico, which issues rights and allows their transfer, but does not sanction the purchase and sale of rights, as public property may not be alienated. In the reasonable middle between these examples are states, such as many of the Australian states and most of those in the western US, which issue rights and regulate their use and exchange with some degree of attention to ensuring that the exchange of rights does not affect existing water users or other public values.

4.1.4 Alternative Roles for Markets

Returning to the theme of the role of markets in water management it is important to distinguish between two approaches to water right allocation and markets. In asserting ownership on behalf of the public and allocating use rights to water the state faces a critical question about how to address social and environmental needs. As previously elaborated, once water is withdrawn the difficulty of exclusion is low. Further, the use of withdrawn water is often for production of either water for sale, such as with municipal water providers, or the production of goods and services for sale, such as with agriculture and hydropower. This can be distinguished from meeting basic human needs for water for communities of little means or of meeting ecosystem and species' needs for water.

Over the last few decades a number of countries, principally among them Australia and the Republic of South Africa have revised their water policy to provide for these public goods, before allocating water to commercial water uses. South Africa has created the Reserve, which is intended to provide water to previously disadvantaged communities and ecosystems, before providing water to other uses including commercial agriculture (Woodhouse 2012).With their National Water Initiative, Australian states agreed to adopt a planning and allocation system in which water for environmental needs and other public benefit outcomes are first provided for and then the remaining "consumptive" pool is allocated to users (Dyson 2016b). There are differences between these two systems, with South Africa offering ten-year renewable licenses to commercial users and Australian states mostly issuing rights to the consumptive pool that are perpetual, though subject to planning cycles (generally ten years) to determine amongst other things the split between environmental, public benefits and consumptive use. Australia is also well known for providing clear rules to underpin a vibrant water market in these consumptive rights. Between these two systems there are differences in terms of how pro-market they are and the extent to which they treat water rights, in effect, as private goods. However, the main similarity is that these two countries have chosen to meet the public needs for water first, then create use rights for the remainder and, at least in Australia, rely on the market to reallocate those rights to their highest and best use. To some extent then this type of approach lessens the need to overly worry about whether water markets are healthy. The task of making sure that basic human needs for water are met and that freshwater ecosystems are maintained or restored is not left to the market.

The approach taken in South Africa and Australia is radically different to systems, such as those in the western US and Chile, where use rights for traditional out-of-stream uses have, over the period of a century and a half or more, been issued largely without consideration of social and environmental public needs. In both of these countries these use rights are tradable; indeed neoliberal reforms to the Chilean water code in 1981 encouraged the treatment of water as a private good subject to market exchange (Bauer 2016). Market transactions in water rights in the US date back over 100 years, as explored further in Part II of this report and the associated case studies. So markets exist in both places, but the task of the market is different. For example, there is a great variation in the extent of interest and progress amongst Chilean and western US states and basins in conserving or restoring environmental flows. Absent the ability to rescind already allocated rights (referred to as *claw-back)*, the remaining option

> *… the role of markets is one determined by policy and politics, even if shaped by economics.*

for government and conservation groups attempting to restore environmental flows is to engage in the purchase and transfer of existing rights (referred to as *buy-back)*. Similarly, other commercial and non-commercial uses of water that arise and grow in demand over time must turn to the market for their water supply. In these jurisdictions then the reallocation of water is effectively left to the market. If the water code or market excludes particular uses or users, or functions very inefficiently the result is that water stays locked in its traditional uses and is not available to meet new economic and public uses.

The point of this discussion is to illustrate that what is being asked of markets will vary from jurisdiction to jurisdiction. Some will feel it is better not to ask too much of markets or to ask them to mediate between private and public uses. Others will feel that the market is well suited to the latter task. Ultimately, what matters are outcomes, not the path that is taken. The examples above reveal that the role of markets is one determined by policy and politics, even if shaped by economics. And as emphasized by Ostrom (2010) the setting in a given locale will have a large role to play in determining the appropriate path. With regards to water and markets, the history and evolution of the existing legal and policy system will be a critical factor that provides opportunities or presents limitations. For this reason one-size-fits-all policies are not effective (Ostrom 2010).

4.2 Enabling Conditions for Water Markets

In order to understand markets and assess whether they are "healthy" or not, it is necessary to understand the conditions under which trade will occur. This helps to understand why there is trade in water rights in one place but not in another.

Strictly speaking the primary requirement for a market is scarcity. If a good or service is not scarce then no one will take the effort to find someone who has the good and offer to purchase it. In the presence of scarcity, there is demand. As long as there is supply trade may emerge. But trade in what? In order for the buyer to expend resources in the market the buyer must obtain something of value. The buyer must also have assurances that what they buy is for their own consumption. Again this leads back to the concepts of rivalry and exclusion and the idea of private goods. A well-defined and secure property right provides these assurances to the buyer and provides the seller with a product that conveys value. Property rights as a form of collective action are an institutional construct. As part of this construct in order for trade to occur a key question is whether the entity granting the property rights will recognize the trade and confirm that the buyer may use the good in question. The final condition then for a market is that there are rules that govern the trade of the good.

That water markets require scarcity, well-defined and secure property rights and the ability to trade is generally well accepted (Anderson and Snyder 1997; National Water Commission 2011). These requirements reflect the necessary and sufficient conditions for any market, not just water markets. Healthy water markets, however, require two additional components: flexible rights and the ability to transfer the right. The latter is distinct from the ability to trade, which is the ability to alienate or sell the rate. The ability to transfer implies the ability to then modify the water right so that it may be used by the buyer, for example so that water may be taken from a new location.

At first blush flexibility might seem an odd choice for a desirable characteristic of a market. A flexible right could mean an insecure right for example. This is indeed true. Rigid, fixed rights seem to offer a high degree of security. After all the buyer of a water right needs to know how much to buy the right for and therefore needs to know how much water, when and under what circumstance the right will yield. The addition of flexibility is not really about maximizing market return and a narrow focus on property and marketing. Flexibility is used here to suggest that in order to be *healthy* water markets need to be *adaptable* to changing circumstances. If there is no flexibility to water rights then changes in policy may have little impact on water use. Flexibility is about ensuring there is a balance between the private benefits

of market reallocation and the goal of ensuring that a public resource contributes to the public good. An example of flexibility in water rights is the ability to vary the allocation made to a water right depending on hydrological conditions.

Flexibility is used here to suggest that in order to be healthy water markets need to be adaptable to changing circumstances.

In the Umatilla Basin in Oregon, annual allocations of groundwater are made based on projections of the sustainable annual yield (Pagel 2016). In the Namoi Basin in New South Wales, the environmental needs and the consumptive pool for groundwater were determined in 2006, resulting in substantial reduction (claw-back) of water rights; they will be revised in 2016 (Dyson 2016a). As climate change progresses, the determinations of sustainable yield or the consumptive pool may vary in each of these basins. Flexibility then allows a basin to live within its means, rather than on borrowed time. Flexibility is then not so much about promoting trade or market efficiency, but about ensuring that water rights and the water market operate within the scope of public policy.

The need to include the ability to transfer alongside the ability to trade stems from the public good characteristics of water, and in particular its non-rival, partly consumptive uses. The right to use water is often granted subject to a set of terms and conditions for that use. These may also be thought of as the elements that describe the water rights. These may include the source from which the water is withdrawn, the location where the water is withdrawn from the source, the period of time the water may be withdrawn, the quantity that is withdrawn (in flow rate and or volume), the type of use to which the withdrawn water is put, and the location of that use. In addition, a water right may be assigned some priority or rank with respect to all the other rights to withdraw water from the source. When trade in water takes place the new user may wish to change one or more of these elements of a water right. Given the potential impact this might have on other existing users of water or other communities and or the environment the state will typically wish to review and approve such a change, or transfer of the water right. Many a proposed water trade in the western US has failed or had to be revised when such a transfer does not go as planned by the proponent. But fundamentally trade is enhanced when the regulating agency permits transfers and has clear rules as to what is allowed and what is not.

So to summarize, the three necessary and sufficient conditions for trade in a water market are (in the order in which they are likely to occur over time):

1. Well-defined, secure and flexible entitlements.
2. Scarcity.
3. Tradable and transferable entitlements.

These conditions closely mirror those proposed by (Daly 1992) based on analysis of tradable permits for resource depletion or environmental pollution. However, Daly (1992) disaggregates the policy decisions into three components, scale, distribution and allocation:

1. Scale: create a limited set of permits in the maximum allowable amount of resource use or pollution load.
2. Distribution: distribute these permits to resources users or polluters.
3. Allocation: institute a system for trading of permits within the capped amount (between users/polluters and/or between users/polluters and third parties).

These three steps are framed in this order in accordance with Daly's view that environmental sustainability comes first, followed by distributional equity and finally allocative efficiency. Although Daly

does not use the term "cap" this approach can be likened to the "cap and trade" approach to creating regulated markets in resources and environmental quality.

This approach is more or less the approach taken under the National Water Initiative, except that the cap is set at the water supply less the environmental and other public benefit needs (Dyson 2016b; National Water Commission 2011). Trading is then for consumptive purposes and not environmental purposes although as with Daly's system, the environmental buyer can also purchase rights and reduce the withdrawal of water from the system.

In countries with existing water permitting systems the difficulty is that permits have already been created – sometimes in excess of available supply or sustainable yield – and distributed. Markets may or may not be available as a means of reallocation. In countries where water remains unpermitted working through the steps Daly lays out would seem advisable. The difficulty of course is that even if the state has yet to implement a permit system, there will be existing and customary uses of water. So there will always be a struggle between the desire to follow a logical and science based permitting approach and the system that is in place. The political economy of this situation is that existing users will want to maintain their advantage, and may be legally guaranteed the right to do so, and so efforts to claw-back already existing entitlements will be difficult. While perhaps a second-best solution, the option of buying-back such entitlements remains an important option provided by the establishment of water markets.

There are a variety of settings that can be found around the world in this regard. Even within the western US, no two states have the same set of policy and legal antecedents. Recalling the objective of finding a way to understand, and at times, assess how to improve water market function, efficiency and outcomes, the discussion above is framed here in terms of three sets of criteria for the existence of trade in a water market:

1. The water resource must be scarce in physical, economic or legal terms (i.e., the resource must display rivalry or be congestible).
2. Property rights to water must be well defined, secure and flexible (i.e., the resource must be excludable).
3. The property rights to water must be tradable and transferable to new uses.

These conditions do not ensure that the market will be perfectly competitive or even *work* in a general sense; rather they form the necessary and sufficient high-level conditions for market transactions to occur. For example, property rights may be well defined and secure, and also tradable, but if the resource supply is not scarce with respect to demand there may be no trading. Similarly, the resource may be scarce and tradable, but if rights are not secure then the prospective new user will find a way to access the resource without engaging in the market. And finally, if the resource is scarce and rights are well defined and secure, but the prospective buyer cannot transfer the water to their intended use, no market will develop. The application of these conditions (and their component parts) to markets in the western US is explored in detail in Part II of this report.

4.3 Drivers of a Competitive Market

Market activity occurs when the willingness to pay of the buyer exceeds the sum of the willingness to accept of a seller (net of their transaction costs) and the transaction costs incurred by the buyer. In practical terms there are five immediate drivers of market inactivity:

1. Uniform utility derived from water; no gains from trade.
2. Little willingness to pay on the part of buyers.
3. Little ability to pay on the part of buyers.
4. Exaggerated threshold of sellers' willingness to accept.
5. Market inefficiency; high transaction costs (for either seller or buyer).

Some of these drivers are just a product of the situation on the ground. The first requirement for trade is that there be at least the potential for gains from trade. Each seller has a willingness to accept, reflecting what he or she gives up if they sell the water. Typically this is their foregone net earnings from the use of the water or water right. Each buyer has a willingness to pay, ideally reflecting what his or her net earnings from the use of the water or water right will be. That there must be buyers with a willingness to pay that exceeds some sellers' willingness to accept is fundamental to the value proposition of markets and the potential for trade. In some places there will be a diversity of uses and values and in others not so much. Other things equal, trade would be expected to be higher in the former case. That said, it is important to acknowledge that in some cases the number and volume of trades will be low. This may be the case for a lot of different reasons, some of which we investigate below. But it is useful to consider that in some markets trade will be thin at best. Just because there is a market for water and/or a marketplace where buyers and sellers can meet to trade does not mean there will be any trades. Nor does the lack of trade necessarily mean that the market is not working. There just may not be potential for appreciable gains from trade.

Also some of these immediate drivers may originate from market failure or reflect the presence/absence of the enabling conditions for markets, as outlined earlier. For example, willingness to pay will be limited if the rights to be acquired are poorly defined or insecure. And, the public goods nature of freshwater ecosystem services implies that environmental buyers may have limited ability to pay. Similar issues may also apply to low-income, marginal, or indigenous groups that may likewise be unable to pay for the human or ecosystem uses of water that would sustain their communities.

4.3.1 Market Imperfections

A number of these immediate drivers arise from the failure of a market to be competitive. An imperfect market is one where the economic conditions for a perfectly competitive market as represented by the following eight conditions (Pearce 1986) are not present:

1. Large number of buyers and sellers each with a small share of the market.
2. There is no collusion between buyers and sellers.
3. Buyers are maximizing utility.
4. Sellers are maximizing profit.
5. The good is homogenous.
6. Buyers and sellers possess perfect information.
7. Buyers and sellers are free to enter and exit the market.
8. The good is transferable.

The transferability of the good is already covered above in the enabling conditions for a market. The remainder of these imperfections represent items that may or may not be imperfections in a given water market. Understanding each of these and how they can affect the market is a useful part of a framework

for understanding water markets and assessing markets. The first three on the list go to the potential gains from trade and the next four on the list concern market efficiency.

Imperfections in water markets that affect willingness to pay and willingness to accept include:

- Market concentration, e.g., one or few producers (monopoly or oligopoly) dominate the market and concentrate power so that they may control the water market and sell at higher than efficient prices extracting excess profit from buyer, thereby reallocating less water then would be good for the economy.
- Asymmetric information, e.g., insiders or those with market power may be much better informed than the casual market participant skewing pricing in favor of the former and leading to buyer/seller remorse and distrust of the market.
- Collusion based on market concentration or other affiliations may also be deployed to limit access to water markets or exclude unwanted buyers.

The problem of sellers wanting *too much* for their water and thereby lowering trade can be linked to the issue of whether sellers are maximizing profit. If sellers fail to put forward an accurate estimate of their willingness to accept, and instead place a premium on the price they are willing to accept from the buyer, this simply squeezes the potential gains from trade and increases the probability that either there are no gains from trade or that transaction costs will stand in the way of a consummated transaction. In this regard, research has shown that people holding an asset that is not frequently traded and, therefore, for which there is no market and/or the market value is uncertain will focus on the risk of loss and not the potential gains from the sale when asked to sell the asset (Thaler 1980). This *endowment effect* implies that it will be difficult to persuade such asset holders to part with property of this nature. In some markets, with a limited history of trading, water rights may fit this definition of a long held asset that is rarely traded. A practical implication of the endowment effect is that potential sellers will demand a premium to sell or trade. This problem is observed in water markets in some areas of the western US. Implicitly then there is a need by the buyer (or the market) to find a way of overcoming this fear of loss – and persuading the water right holder to focus on the potential gains of the transaction.

There are also a number of market conditions that will affect the efficiency of the market:

- Heterogeneous products, e.g., water rights of many different types and classes make due diligence on the expected reliability of a water right and appraisal of value more difficult for the prospective buyer.
- Incomplete information, e.g., a lack of, or poor, data on water rights, their extent, validity and transferability creates uncertainty for buyers and sellers reducing market participation.
- Barriers/high costs to entry (and exit), e.g., fees, qualifications and the need for specialized advice in order to participate in the market impede the efficient entry/exit of buyers/sellers to the market.

This list of market imperfections is useful in assessing potential market activity and how likely it is that a market will serve to match supply with demand in an efficient manner. In some cases these imperfections reflect the transaction costs of operating in the water market. For example, heterogeneous water rights make markets difficult and costly to organize and effectuate. Similarly, imperfect information and barriers to entry may reduce the efficiency of the market. Market concentration on the other hand has the potential to affect market price and drastically affect interest in the market. Market concentration can also be understood as a form of market failure, as a case of hyper-exclusion (Randall 1983). The creation of large irrigation districts with a property interest in water rights is one way in which such market power and hyper-exclusion is created through policy and institutions.

These factors driving competitive markets and their presence or absence is explored for the western US in Paper 2, drawing on broader experience from the case studies and literature.

4.3.2 Market Efficiency and Transaction Costs

In their broadest interpretation, transaction costs are the costs of resolving market failure. High-level transaction costs are the *policy enactment* costs of collective action and the development of property rights to solve market failure (McCann et al. 2005). In other words this is the cost of institutionalizing exclusion. Operational level, or *implementation*, transaction costs incurred by participants in market transactions include transaction-level costs of transaction prioritization and planning, water rights due diligence, negotiation and price discovery, administrative fees and processing, conflict resolution, monitoring and enforcement, and financing (Garrick and Aylward 2012).

In theory, policy enactment costs for setting up new markets in environmental goods and services can be compared to those of alternatives forms of collective action to address public goods issues. For example the costs of a cap and trade system in greenhouse gases may be compared to the costs of developing a greenhouse gas tax. However, for water entitlements these policy enactment costs are difficult to assess and are anyway moot as the entitlements and market systems are long established in many jurisdictions. What is of more consequence in terms of market activity today and to the purpose of this paper are the transaction costs associated with implementing water markets.

These implementation transaction costs are often misunderstood. At times they are painted as a bad thing that must be eliminated so that markets may flourish and at times they are lumped in as a source of market failure or as a market imperfection. But this gets things exactly backwards. Transaction costs are not a cause of market failure or a market imperfection; rather they are the necessary result of failure and imperfections. For example, heterogeneous (as opposed to homogenous) water rights simply increase the transaction costs of developing and consummating trades.

In a competitive market transaction costs are low, in a market with many imperfections transaction costs are high. So transaction costs are neither inherently good nor bad, they simply are.

In other words, broadly speaking, policy enactment and implementation transaction costs emerge out of collective action to resolve market failure and the operations of a market, respectively. In a competitive market transaction costs are low, in a market with many imperfections transaction costs are high.

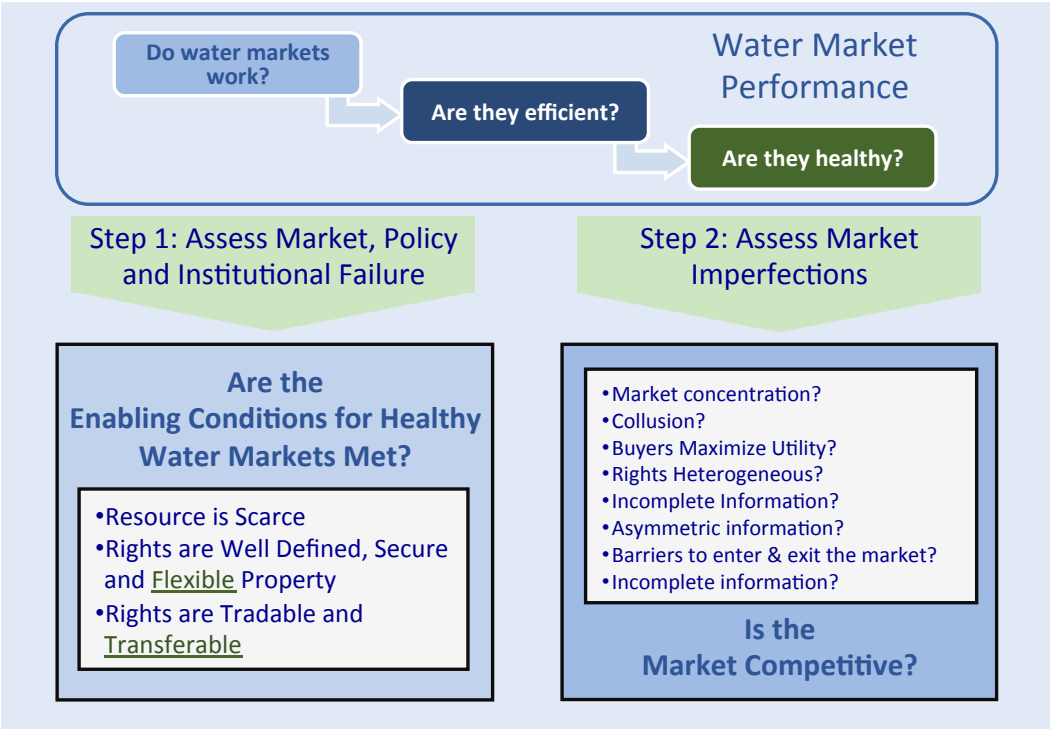
So transaction costs are neither inherently good nor bad, they simply are. Transaction costs matter because market transactions occur when the willingness to pay of a buyer exceeds the willingness to accept of a seller plus the costs of consummating the transaction. What matters then is whether transaction costs are low or high, and if high, whether they can be lowered by addressing market imperfections. The efficiency of the water market reflects the level of transaction costs which in turn emerge out of how adequate the property rights and market are to the task of resolving market failure and creating a competitive market. Logically, then to understand how to create an efficient and efficacious water market it is vital to assess how well market failure is addressed and what market imperfections exist, and what are the measures that can be taken to improve on both of these fronts.

4.4 Framework Summary

The framework proposed above provides a response to key questions about water market performance by suggesting that an analysis of market failure and market imperfections will identify the key conditions and

criteria that are, or are not, met with regard to healthy water markets. Figure 6 summarizes the key points about the framework, along with the driving questions.

FIGURE 6: THE CONCEPTUAL FRAMEWORK



5. Political Economy and Institutional Economics of Water Markets

People in different schools of thought define political economy in different ways. The term itself represents the early version of the discipline of economics before it was narrowed to just economic (and not political) science (Cohen 2008). The simplest meaning of political economy is that it refers to the combined study of political and economic factors, in this case factors that affect how people use water resources. *Politics* is the province of collective action and making of public policy. *Economics* refers to systems for producing and distributing material wealth (and conversely poverty). Both fields are deeply interconnected in the real world, although some academic theories and political ideologies may try to keep them separate. The discussion in this paper of private and public goods and the optimal mix of collective action and markets in managing water resources is reflective of the integration of these disciplines.

The field of institutional economics is perhaps even more valuable to the investigation of water management, water governance and water markets. The key idea is that institutions – broadly defined as rules and norms that structure human behavior – are the foundations and framework for economic activities: the *rules of the game*. Rules come before markets: that is, markets depend on a set of legal and institutional conditions that define property rights as rival, exclusive, and tradable. Those rules determine the nuts and bolts of how a specific market works, and therefore how the market determines economic values. This is true of all markets, but it is especially crucial for water markets because the unique nature of the resource requires special rules.

Rules come before markets: that is, markets depend on a set of legal and institutional conditions that define property rights as rival, exclusive, and tradable.

The rules of the game provide the incentives that drive human behavior and lead to the management or mismanagement of water resources. In institutional economics (and in political science) incentives are construed more broadly than in economics. Incentives refer to more than just financial rewards and penalties. Incentives are "the positive and negative changes in outcomes that individuals perceive as likely to result from particular actions taken within a set of rules in a particular physical and social context" (Ostrom, Schroeder, and Wynne 1993, 8). With regard to water, these incentives may be of an economic, social or moral nature, mirroring the myriad different values society places on water. These incentives affect individual and group evaluation of the costs and benefits of alternative courses of action. In turn, institutional arrangements set the rules and norms by which behavior in society is governed and, thus, structure these incentives.

From the perspective of neoclassical economics the challenge is to align incentives so as to maximize economic welfare, to achieve what is called *incentive compatibility*. In the presence of public goods, markets cannot be relied on to serve as the *invisible hand*. Instead political decision-making will make the incentive-altering choices. To the extent that these decisions are driven by self-interest of some kind or another (whether of fame, fortune or loyalty) incentive compatibility in water resources management is a difficult proposition. There is then a political economic perspective which asks the crucial question of who wins and who loses. This is an important question when it comes to projects, policies and programs – whether initiated by government, the private sector, civil society or some polycentric effort. Central to this aspect

of political economy is that actors will pursue political goals to reach their economic ends. The long history of controversy and conflict over water resources development simply documents this behavior.

Another key lesson from institutional economics is to be careful when making arguments about economic efficiency, a concept close to the heart of market theories. The term is often used as if it were a neutral, objective criterion: that is, efficiency is good because it maximizes overall social welfare for a given set of inputs, i.e. it makes the pie bigger. But to compare the efficiencies of different allocations of resources, we must assume an initial institutional framework and an initial distribution of resources: that is, a system of property rights. In the world of politics and public policymaking, however, that framework and distribution are often exactly what must be decided instead of assumed. Economic efficiency is an important public interest, but it is not a clever way to avoid hard political choices about trade-offs (Bromley 1982; Wandschneider 1986; Brown 1997; Bruns and Meinzen-Dick 2003).

The point here is that water markets can be powerful mechanisms for changing water uses, depending on the rules of the game (which in essence means the property rights system). Those rules are both political and economic. Property rights provide the over-arching framework; markets are a tool for managing such rights. Or, put another way, defining and enforcing property rights is or primary importance and, in practice, is harder than it looks.

Borrowing from international political economy it is possible to characterize the interplay of economic and political factors. There are three schools of thought in international political economy that can be adapted to formulate three perspectives on the age old question of whether politics drives economics or economics drives politics (Gilpin 1976) :

1. *Liberalism*: emphasis on economic actors (individuals, households and firms); actors can reconcile interests and create positive outcomes (a non-zero sum game); *economics should determine politics*.
2. *Realism (Mercantilist)*: emphasis on the state and political power; economic relations are conflictual and outcomes are zero sum; *politics determines economics*.
3. *Structuralism (Marxist)*: emphasis on class and social forces; relations are conflictual and zero sum; *economics does determine politics*.

Another way to interpret these schools of thought is that economics and politics are constantly influencing each other and that power (and class) relations in society will play a role in this balance. This is a useful lens for understanding the governance and management of water resources. Perhaps nothing illustrates this interplay of economics, politics and power in water management better than the prevalence of truisms on the point: *water flows uphill to money*; *whiskey is for drinking, water is for fighting*; and *we will only know the value of water when the well runs dry*, to name a few.

6. Conclusions

This paper presents a framework for understanding and evaluating water markets and their role in water management. It is argued that a clear normative perspective is required for a water market to be considered healthy, i.e., one that is active, efficient and that delivers not just private benefits but social and environmental outcomes. For a market to effectively address changing supply and demand conditions and play a role in avoiding or reducing conflict over water the rules of the market must be framed within the context of policy and politics. This is all the more important when asking markets to ensure the protection of basic human needs for water, as well as providing for the conservation and restoration of freshwater ecosystem services. In good measure this framework emerges from the characterization of water as an economic good with public good characteristics. Water is therefore not a private good and should not be left to the free market. Instead, extending property rights for the use of water and allowing these to be exchanged in the market represents the most that can be asked from a neoliberal approach. Using markets to reallocate water rights must therefore logically be set firmly within the bounds of collective action. The rules for market interactions should be designed to meet the public good not just private and commercial needs. Alternatively, in societies where the costs of setting up and administering a rights and market system are high, it may be preferable simply to allow the use of water and charge for this use as a means of motivating economically efficient water use.

Water is not a private good and should not be left to the free market.

The framework suggested here sets forth the enabling conditions for trade to occur in a healthy water market including scarcity, well-defined, secure and flexible rights, and the ability to trade and transfer these rights. Drilling deeper the framework examines the preconditions for a competitive market in water rights. A series of *market imperfections* are identified that when evaluated provide insight regarding how active and efficient the market will be. Simply understanding this framework in and of itself does not lead to policy proposals for improving water markets or making them healthy. Instead, the framework must be applied to a given context, which consists of the local basin setting which itself sits in a particular jurisdiction with its own history of policy and legal evolution. Then and only then can actionable reforms and actions emerge. For these reasons one-size-fits-all policies are unworkable (and unlikely to be found acceptable by stakeholders). Rather an understanding of the political economy in a given context will dictate likely possibilities and areas for reform.

The framework in this paper is an attempt to synthesize and deploy a number of ideas from neoclassical economics, institutional economics and political economy to construct a framework for understanding and evaluating water markets. The utility of the framework may in part be its heuristic value, at least if it aids the donor community and others to understand the role and potential of healthy water markets. However, the intent is also that the framework be useful in practice. To this end in Part II of this report the framework is applied to water markets in the western US and in Part III the legal elements from the framework are further developed as a means of comparing and contrasting a number of legal regimes that have emerged around the world with a view towards understanding how these regimes provide for healthy water markets.

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