GLOBAL FRESHWATER CHALLENGES AND OPPORTUNITIES

A review of global freshwater management challenges, potential solutions, and opportunities for philanthropy

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CEA California Environmental Associates

ABOUT THIS REPORT

This document provides an overview of the freshwater space. It is intended to provide a comprehensive, readable summary of the issues to a broad audience, with an emphasis on philanthropic organizations. The conclusions drawn in this report are California Environmental Associates alone, as are any mistakes. California Environmental Associates is an environmental consulting firm that works with foundations, nonprofits, and businesses on a range of environmental and strategic planning issues. This report was produced with support from the Rockefeller Foundation.

EXECUTIVE SUMMARY

Freshwater scarcity is one of the most significant natural resource challenges of our generation, posing an enormous threat to global health and security.[1] The World Economic Forum's 2014 top ten list of global risks ranks water crises as the number three global threat, behind a fiscal crisis in a major economy and structurally high unemployment. Indeed, the world is already facing serious consequences from overuse and mismanagement of water. Demand for water is rising steadily, driven by growing populations and rising incomes, even as usable supply shrinks. The gap between global demand and current supply of freshwater is projected to reach 40 percent by 2030.[2] By 2025, two-thirds of the world's population could be living in severe water stress conditions.[3] Left unabated, the increasing competition for water could cause social unrest in cities and geo-political conflict between nations. Aquifer depletion could trigger regional agricultural collapses, global food price spikes, and mass migrations. Water-related disasters (e.g., floods and droughts) account for 90 percent of all natural disasters, taking hundreds of thousands of lives and costing billions of dollars per year; [4] climate change could make such disasters more frequent by shifting weather patterns such that many dry regions experience more droughts while wet regions suffer more floods.

Despite the dire situation, we have the technical capacity to greatly reduce our water usage and thus our vulnerability to water scarcity. There are massive inefficiencies in current water usage, particularly in the agricultural sector, which accounts for 70 percent of water withdrawals globally and as much as 90 percent in some developing countries. If we addressed those inefficiencies, there would be far more water to go around. Unfortunately, we lack the strong management systems and effective economic incentives necessary for the adoption of improved technologies and practices.

Ultimately, sustainable, long-term water management depends on strong governance and needs to be addressed at the basin level. However, a wide range of approaches can help propel governments, water managers, and water users around the world towards more effective management systems. There are three main ways to address the problem, all of which work in concert with one another. The first is to develop and promote solutions that can have a direct impact on water security regardless of the quality of governance (e.g., voluntary market structures, corporate engagement). The second is to promote solutions that can help improve governance or that are only viable in places that already have good governance (e.g., platforms for multi-stakeholder engagement, formal water markets, discrete policies). Finally, there are a number of tools that can support and enable a wide range of water management solutions, but that alone will not change how water is used (e.g., improved ecosystem valuation, water savings technologies, improved use of data, financial tools).

The task at hand is to continue to innovate, harvest, and codify lessons and best practices from successful initiatives, and build the capacity of governments and local resource managers. As daunting as the task may seem, future generations depend on the strength of our response today. We cannot afford to wait.

"Water is the ultimate commons. Watercourses once seemed as boundless as those pigeons that darkened the sky overhead, and the notion of protecting water was as silly as bottling it. But rules change."

—Barbara Kingsolver [5]

1 Throughout the rest of the document, the term 'water' is used to mean 'freshwater'.

2 Addams, L., Boccaletti, G., Kerlin, M., & Stuchtey, M. (2009). Charting Our Water Future. Economic Frameworks to Inform Decision-Making. The 2030 Water Resources Group, McKinsey.

3 United States Agency for International Development. (2011). Water and Development Strategy: 2013-2018.

4 United Nations World Water Development Report 4. (2012). Managing Water under Uncertainty and Risk.

5 Kingsolver, B., (2010). Water is Life. National Geographic.

WATER PRIMER

There is huge variability in supply of water, regionally and seasonally. The amount of water in the world is largely fixed, flowing through a cycle of evaporation and precipitation. The vast majority of the world's water is in our oceans. Less than three percent of water on our planet is freshwater, and most of that is locked away in glaciers and ice sheets.[6] Roughly 70 percent of the water used by humans comes from surface water (i.e., lakes, rivers, and wetlands), and 30 percent comes from groundwater (i.e., underground reservoirs).[7] Although, globally, there is plenty of freshwater to meet demands, it is unevenly distributed across regions and seasons. Because water is difficult to transport and costly to store, smoothing out these spikes in supply is difficult.

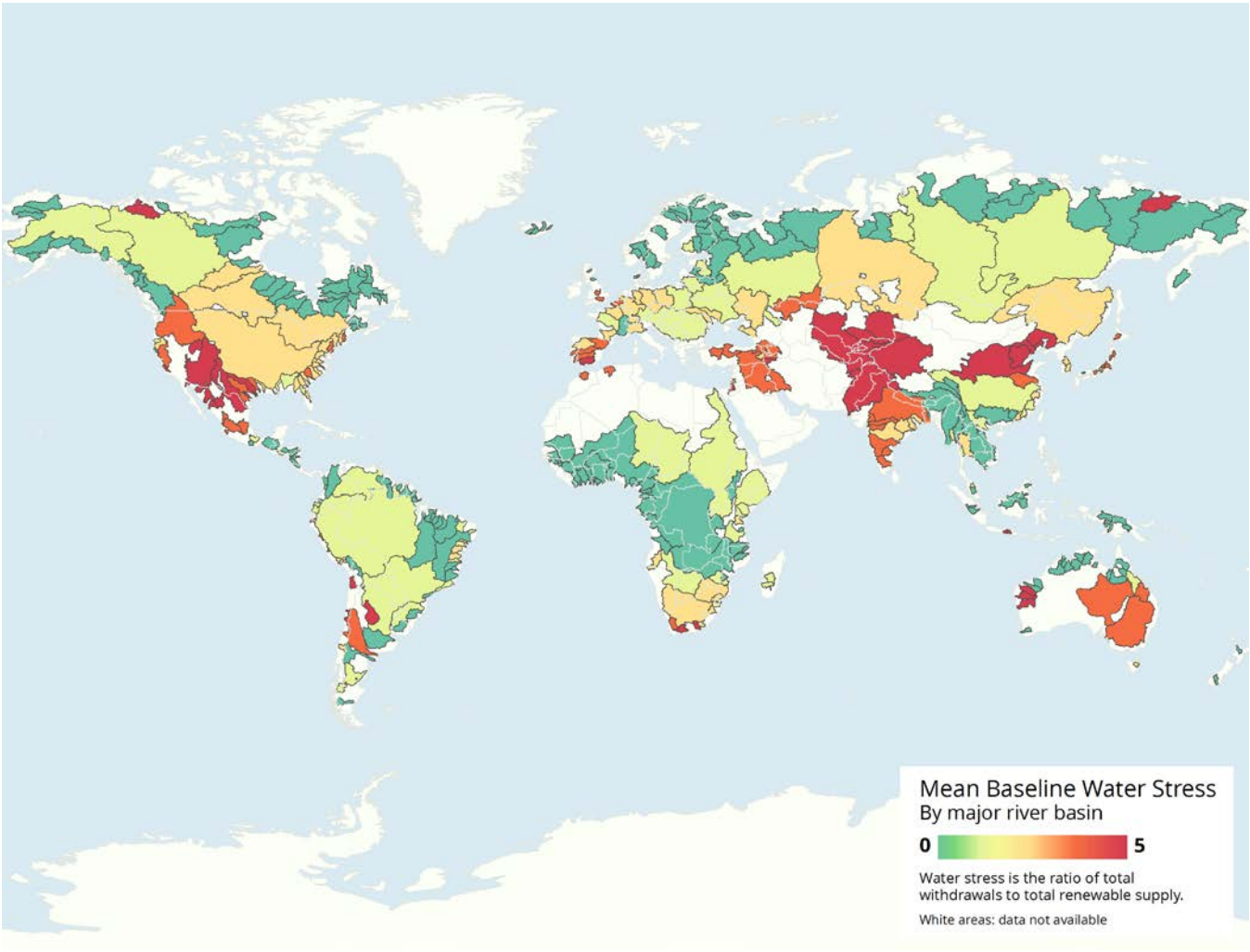
Freshwater is vital to human life on earth, providing water for drinking and sanitation, agriculture, and industry. Water is rarely substitutable in any of its diverse uses, so it is unsurprising that it is in such high demand, and given its limited quantity, unsurprising that there is not enough to satisfy that demand.

- Drinking water and sanitation are essential to human existence and health, although municipal and domestic water demands only account for about 10 percent of global water use.
- Crops and livestock are the largest users of freshwater, responsible for about 70 percent of water withdrawals; in some areas, agriculture can account for as much as 90 percent of freshwater use.
- Nearly all sectors of the global economy depend on water as a key input or processing tool. Together, energy and industry account for about 20 percent of global water withdrawals.
- Water is also important to humans for cultural, recreational, and spiritual reasons.
- Having sufficient water is critical to the ecosystems that humans and other species rely upon, allowing forests to grow, freshwater fisheries to flourish, and river valleys to flood and deposit nutrients on crop fields.

6 Heymann, E., Lizio, D. & Siehlow. M. (2013). "World Water Markets: High Investment Requirements Mixed with Institutional Risks." Deutsche Bank Research.

7 Ibid.

Figure 1: Baseline Water Stress, by river basin [8]



8 Data from WRI Aqueduct: Gassert, F., Reig, P., Luo, T., & Maddocks, A. (2013). A Weighted Aggregation of Spatially Distinct Hydrological Indicators. Working paper. Washington, DC: World Resources Institute. Retrieved from http://wri.org/publication/aqueduct-country-river-basin-rankings.

Globally, we are facing increasing risks of water shortages and water scarcity.

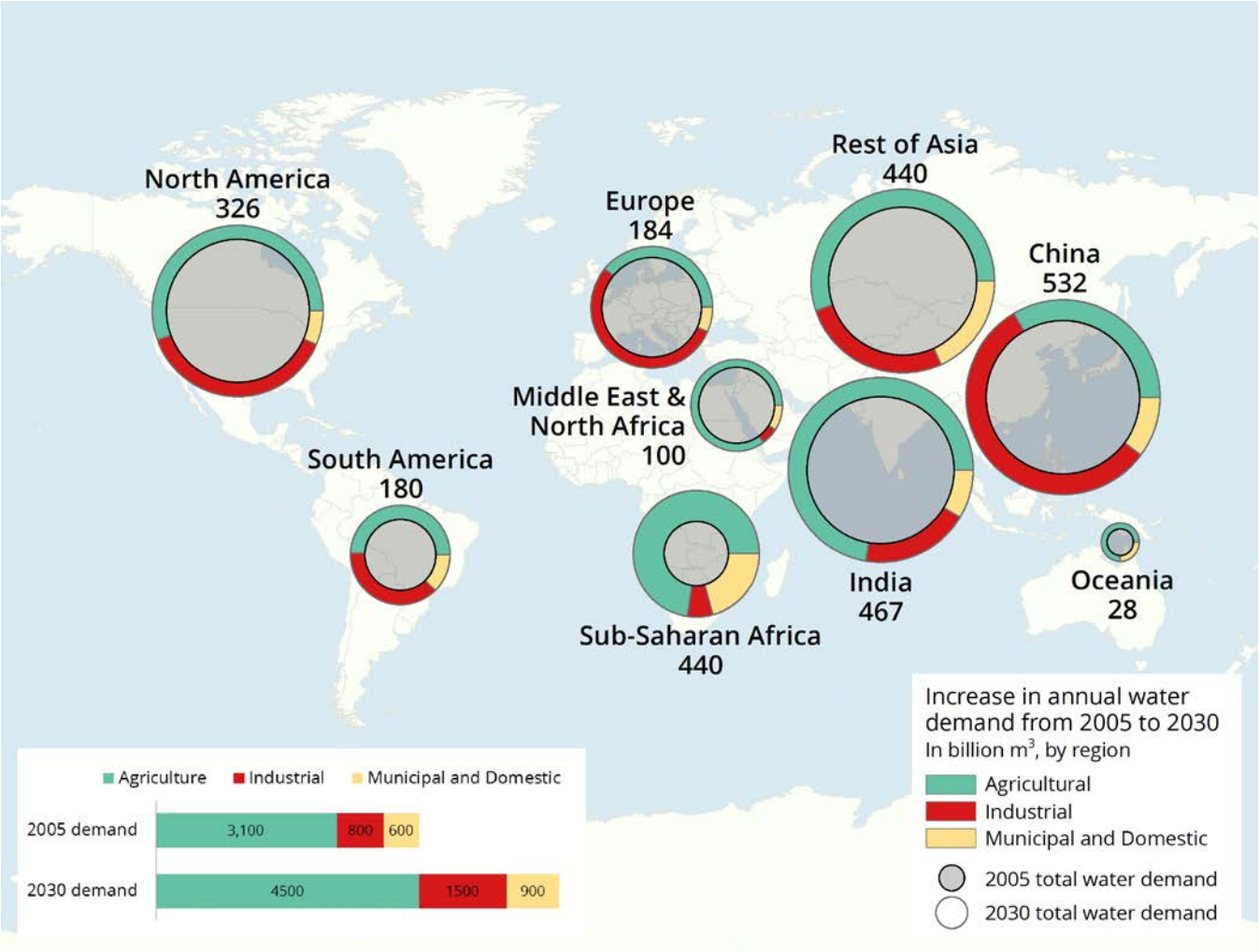
- Human demands on water are expected to increase as populations grow and living standards rise.
- At the same time, water supply is vulnerable to our changing climate which is already making many wet areas wetter and many dry areas drier.
- Pollution is also expected to further exacerbate scarcity, as is depletion of groundwater stores.
- The gap between demand for freshwater water and adequate supply is projected to reach 40 percent by 2030, globally.[9]
- Currently, 1.6 billion people live in countries and regions with physical water scarcity, and the number is expected to rise to 2.8 billion people by 2025.[10]
- Physical water stress is already a problem across many regions including Central Asia, South Asia, Northern China and Mongolia, the Andes and Andean Coast, the Middle East and North Africa, Mexico, the American West, and South Africa.
- Future increases in water demand are expected to be most acute in the so-called BRIICS countries, particularly Brazil, India, Indonesia, and China, and other large countries whose economies and/or populations are growing rapidly.

As economies grow and diversify, they face increasing sectoral competition for water. In most developing economies, agriculture represents as much as 90 percent of freshwater withdrawals. As countries develop, industrial uses, energy generation, and cities demand more and more water, and governments are challenged to allocate water resources rationally and equitably, particularly in water scarce environments. Globally, there is an increasing understanding of this nexus between water, energy, and food, and an acknowledgement that resource management systems need to address these sectors in an integrated manner.

9 Addams, L., Boccaletti, G., Kerlin, M., & Stuchtey, M. (2009). Charting Our Water Future. Economic Frameworks to Inform Decision-Making. The 2030 Water Resources Group, McKinsey.

10 World Bank. (2014). Water and Climate Change. Retrieved from: http://water.worldbank.org/topics/water-resources-management/water-and-climate-change. Water scarcity is generally defined as less than 1000 m^3-yr^{-1} per capita water resources, while water stress is generally defined as less than 1700 m^3-yr^{-1} per capita water resources.

Figure 2: Projected increase in annual water demand from 2005 to 2030, by sector [11]



11 Data from Addams, L., Boccaletti, G., Kerlin, M., & Stuchtey, M. (2009). Charting Our Water Future. Economic Frameworks to Inform Decision-Making. The 2030 Water Resources Group, McKinsey.

RISKS OF INACTION

Water scarcity threatens human health, economic growth, ecosystem function, and even political stability. Water scarcity, particularly when coupled with lack of access, can pose a fundamental threat to human populations. Lack of water can shackle economic growth, impeding development and forcing businesses to locate in more water-abundant regions. It can impose high human costs, lead to conflicts and unrest, and devastate ecosystems.

Scarcity disproportionately effects poor and vulnerable populations. Farmers, freshwater fishers, and marginal rural communities that depend directly on healthy freshwater systems for their sustenance and livelihoods are particularly exposed to the threat of water scarcity. Poor farmers who rely on irrigation—many of whom are concentrated in South and East Asia—are vulnerable to having their water coopted for industrial and domestic use, while farmers who rely on rain are extremely vulnerable to shifting weather patterns and droughts.

The potential human health risks associated with water access are extreme, though they are generally not a problem of scarcity. 780 million people worldwide lack access to an improved water source and 2.5 billion lack basic sanitation.[12] Municipal use, which includes drinking, sanitation, cooking, washing, landscaping, fire protection, and street cleaning, accounts for 10 percent of total human water use.[13] Cities typically have priority in allocation decisions in times of water scarcity. Thus, lack of access to water is usually due to lack of infrastructure (or political will) to deliver water to certain populations, not absolute scarcity within a region. Lack of access imposes a staggering disease burden. Each year, roughly 3.5 million people die due to inadequate water supply, sanitation, and hygiene, predominantly in developing countries.[14] Furthermore, when water infrastructure is not available, the burden of collecting water disproportionately falls to women and girls who often lose out on other opportunities, namely education, as a result.[15] [16]

Ecosystems have already been seriously damaged and are vulnerable as demand for water increases. As demand for water outstrips supply in many regions, ecosystems are often exploited. Aquifers are depleted, wetlands are drained, and rivers are diverted, dammed, or simply used up by the time they reach the sea. Today, over 25 percent of freshwater amphibians and 38 percent of freshwater mammals are threatened with extinction; threats to freshwater species are generally more acute than those to terrestrial or marine species.[17] Major rivers such as the Colorado and Ganges often fail to reach the sea because of human withdrawals. Half of the world's wetlands have been lost since 1900, due in part to drainage and water withdrawals.[18] When natural ecosystems are left with insufficient water, human populations that depend on intact ecosystems (e.g., fishers and other river-dependent populations) suffer as well.

Dams and large infrastructure projects can help mitigate water stress, but typically have very serious consequences. Large infrastructure projects, such as China's estimated $79 billion South-to-North Water Transfer Project and California's massive water system, help move water from where it is more abundant to where it is scarce. Large-scale hydropower dams, such as those proposed in the Amazon Basin and along the Mekong River, generate clean energy for growing economies. However, these projects come with a large

12 World Health Organization (2012). "Progress on Drinking Water and Sanitation – 2012 Update" launched on 6 March 2012; Heymann, E., Lizio, D. & Siehlow. M. (2013). "World Water Markets: High Investment Requirements Mixed with Institutional Risks." Deutsche Bank Research.

13 Humans need 0.05 m^3 of water free from contaminants each day for basic drinking and sanitation needs, according to the United Nations. For a global population, this amounts to 164 billion m^3 each year. Total human demand is about 4500 billion m^3 each year, according to the 2030 Water Resources Group, so minimum basic demands would account for 3.6 percent of total use. Although some populations use more water than required by basic demands, total water demand for drinking and sanitation is still likely less than 5 percent of total human use.

14 United Nations World Water Development Report 4. (2012). Managing Water under Uncertainty and Risk.

15 International Decade for Action: Water for Life Decade 2005-2015. (2015). UNESDA. Retrieved from http://www.un.org/waterforlifedecade/gender.shtml

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18 Russi, D., ten Brink, P., Farmer, A., Badura, T., Coates, D., Forster, J., Kumar, R., & Davison, N. (2013). The economics of ecosystems and biodiversity for water and wetlands. *IEEP, London and Brussels.*

price tag and also have high environmental and human costs. Although primarily built to generate hydropower, dams create large reservoirs that provide storage and make all downstream users less susceptible to seasonal or year-to-year fluctuations in natural supply. Yet, large dams also disrupt river flows, affecting downstream fishers, farmers, and ecosystems. Dams are estimated to have directly displaced 40-80 million people, and downstream disturbances have affected nearly 500 million people, 7 percent of the world population.[19] [20] Dam building is expected to continue at a rapid pace, especially in the Amazon Basin, Southeast Asia, and parts of Sub-Saharan Africa.

Pollution, which makes water unavailable for certain uses, exacerbates scarcity problems. Pollution is the most frequently cited water-related concern of many communities. This is particularly true in developing areas with weaker environmental controls, rapidly growing populations, and booming industry. For example, in China, 60 percent of groundwater is non-potable and nearly one-fifth of arable land is polluted with inorganic material such as cadmium, nickel, and arsenic, in part because of irrigation with polluted water.[21] [22] Globally, run-off from agriculture, industry, municipal sewage, and other sources all contribute significantly to water pollution. Left unabated, growth in all of these sectors will only cause increasingly severe water quality problems that will be costly to address.

The stakes are high. Water is one of the few natural resources for which issues of scarcity have the potential to cause major political conflict and social and economic upheaval. The transnational nature of some of the world's major river basins is driving up geopolitical tensions, such as in the case of tempered relations between Egypt and Ethiopia over construction of the Grand Renaissance Dam.[23] Over the next few decades, some of the world's major aquifers are likely to be completely depleted, and in places where large, vulnerable populations live above these aquifers, this depletion may cause regional agricultural collapse, food price spikes, and mass migration. The Yemeni capital of Sana'a with a population of 2 million may become the world's first capital city to go dry, which could fuel further unrest in a country already facing widespread poverty and political instability.[24] Finally, large-scale floods —the converse of water scarcity—which can cause high death tolls, dislocation, disease, and property destruction, are increasing in frequency and severity in large part because of ecosystem destruction.

THE ARAL SEA

One of the world's more dramatic environmental disasters, the collapse of the Aral Sea, offers a potent example of the effects of water scarcity on inland bodies of water. There, Soviet policies promoting agricultural water use drove the Aral Sea to a fraction of its original size, which caused a collapse of the surrounding fishing communities and displaced more than 100,000 people. The receding sea left large plains covered with pesticides and fertilizer runoff, industrial pollutants, and a toxic dust which causes high rates of respiratory illness, infant mortality, and cancer in the surrounding population.

Sources:

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Fiddian-Qasmiyeh, E., Loescher, G., Long, K., Sigona, N. (Eds.). (2014). *The Oxford Handbook of Refugee and Forced Migration Studies*. Oxford University Press.

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24 Mahr, K. (2010). What if Yemen is the First Country to Run Out of Water? *Time.* Retrieved from http://science.time.com/2010/12/14/what-if-yemen-is-first-country-to-run-out-of-water/

BARRIERS TO CHANGE

Water management systems are chronically weak. As demand for water increases, freshwater water allocation and management systems are strained. Allocation decisions are politically difficult and often lack transparency and equity. In many places, water allocation systems also lack sufficient (or sufficiently trusted) information and data, flexibility, adequate infrastructure, institutional capacity, and enforcement capacity. Because of the weak nature of these water allocation and management systems, individual actors have no incentives, or even have disincentives, to behave in accordance with the needs of all users or even in their own long-term interest. Often, those actors with the strongest political power, financial resources, and/or proximity to the water resource take more than their fair share.

Water is rarely managed in an integrated, holistic fashion. Although water demand crosses nearly all sectors of the economy, water management systems are not designed to operate in an integrated manner. Instead, ministries are typically siloed and make decisions without considering how they may affect water resources as a whole within a water basin or a country.

Water is consistently underpriced, which leads to underinvestment and overuse. In part because water is typically viewed as a fundamental right more than as a commodity, governments tend to keep water rates low, if it is priced at all. Often water consumption is not even measured; this is especially true with groundwater. Thus, there is little incentive for individual water users to increase their efficiency and the cost savings are insufficient to support investments in water savings technologies. Furthermore, ecosystems that provide essential freshwater services are usually not valued, given water rights, or included in the economic equation at all.

EMERGING TRENDS

Water management has been resistant to reform for a long time, but a number of solutions are starting to get traction. It remains to be seen whether the increasing presence of water issues on the international agenda will catalyze reform at scale, or whether successful projects will be limited to the scope of isolated pilots. Nonetheless, as the risks of inaction rise, a wide range of stakeholders are mobilizing resources to address the water management issue and are embracing innovative approaches to the problem.

Corporations are becoming more engaged. Increasingly, companies view water as an area where they are exposed to both material and reputational risk. Particularly those companies with water-intensive supply chains see the necessity of reducing their demand for freshwater. Corporate engagement is evolving from investments along individual supply chains, to engagement within river basins and communities in which they operate. The next frontier for corporate engagement is policy work, an area that the 2030 Water Resources Group, a prominent public-private platform for collaborative water management, is beginning to address.

Some governments are making large-scale investments in water management reform. Most governments are attacking the water scarcity problem with large-scale investments in infrastructure. A few are making policy and management reforms, which are more promising for the long term. A primary example is Australia's multibillion dollar investment in a high-functioning water rights trading system, including government purchase of environmental rights.

Nexus thinking is gaining traction. Governments, businesses, academics, think tanks, journalists, entrepreneurs, and civil society across both the developed and developing world are embracing the water-energy-food nexus concept to frame thinking on the interconnectedness of resources and growing demands. The nexus concept is headlining key conferences across sectors and gathering policy attention, elevating the issue on the global agenda.

2030 WATER RESOURCES GROUP

One of the most interesting models for accelerating water sector transformation is the 2030 Water Resources Group (WRG), a branch of the International Finance Corporation. National or state governments aiming at water sector reform request collaboration with the 2030 WRG, which builds dialogues among government, private sector, and civil society stakeholders, based on sound data. The 2030 WRG platform is designed to enable rational decisions about current and future water management, by ensuring that all parties are well informed. The group is currently or has recently been engaged in India, Jordan, South Africa, Mexico, Mongolia, and Peru. Though critics worry such an approach may favor corporations, who may be better organized, informed, or represented than environmental or civil groups in these sorts of discussions, there is no denying the pressing need for reliable information to catalyze improved water governance and the potential value of an information clearinghouse that can share lessons and best practices across multiple geographies.

Source:
http://www.2030wrg.org/

SOLUTIONS: IMPROVING WATER MANAGEMENT

The world needs water resource management systems that fulfill several functions, including the following:

- Operate at the basin level (regardless of political boundaries)
- Set enforceable caps on water withdrawals
- Provide equitable allocations for poor or otherwise vulnerable populations
- Ensure reliable environmental flows
- Are informed by data and sound economic analysis
- Have effective systems for allocations
- Are transparent and participatory
- Limit pollution
- Ensure access to clean water and sanitation

Unfortunately, most water basins have nowhere near this kind of management. Ultimately, such durable and holistic water resource management requires effective governance. Yet, building governing capacity at the water-basin, sub-basin, and national level around the world is a task too large for any institution. Instead, the issue must be addressed from multiple fronts, and at multiple scales, with focused attention on a wide range of solutions that in the aggregate will make a meaningful difference.

There are three main ways to address the problem, all of which work in concert with one another. The first is to develop and promote solutions that can have a direct impact on water security regardless of the quality of governance. The second is to promote solutions that can help improve governance or that are only viable in places that already have good governance. Finally, there are a number of tools that can support a wide range of water management solutions, but that alone will not change how water is used.

SOLUTIONS THAT CAN BE ADVANCED IN THE ABSENCE OF GOOD GOVERNANCE

While strong governance and water management systems are critical for long term, global mitigation of water scarcity crises, a number of important solutions are independent of government capacity. The solutions described below can support better watershed health, protect livelihoods, ease sectoral competition, and lay the groundwork for better holistic water management systems, even in the absence of strong governance.

Public-private partnerships: In many places, cash-strapped municipalities are shifting some of the management of water supply to private providers, effectively outsourcing some of the responsibilities of governance. Proponents say that private companies provide the same services more efficiently because they are held to higher standards than public agencies. Manila Water is a frequently cited example where the efficiency of a private company has allowed for improved and expanded service in the production, treatment, and distribution of water. Public-private partnerships for water supply are growing increasingly common, though they remain controversial. In many cases, private providers have raised water rates to cover the costs of improved service; this has sometimes led to public backlash (e.g., the 2002 riots in Bolivia).[25] However, the high cost of lack of access needs to be taken into account as well. Lack of access to municipal utilities in urban and surrounding areas often means that poor people must secure water on informal markets at 5-10 times the metered price. Higher prices within a progressive, tiered price structure might better position utilities to expand to serve these areas. As long as public-private partnerships are designed to prevent profiteering and to serve the neediest, they can be a very effective way to improve water resource management and their use should be expanded.

Corporate stewardship: Corporate interest in the water sector has risen considerably in recent years as corporations are increasingly looking to improve water efficiency within their operations and supply chains. For

25 Finnegan, W. (2002). Leasing the rain. *The New Yorker, 8,* 43-53.

example, Nestlé has instituted a shadow price on water as a way to incentivize internal water savings investments.[26] Some corporations are also looking beyond their own supply chains and aiming to engage in the communities where they operate, and to play a role in shaping policy. In many cases, the surrounding community can make water efficiency improvements at a much lower cost than a corporation, and corporations might explore ways to compensate others in the community for adopting water savings technologies or practices. A number of groups are currently working to accelerate corporate engagement, both by providing companies with platforms to learn from one another and by directly and indirectly pressuring private sector actors to manage water as a risk.

Voluntary markets: Although government regulations are required to implement formal water markets, there are many kinds of voluntary markets that can be employed with a limited number of willing parties. For example, payment for watershed services (PWS) are systems in which downstream water users pay upstream landowners to conserve lands or change land use practice (e.g., reforestation, changes in grazing practices) in ways that protect water supplies downstream. Buyers are often a single party, such as a municipal water facility, a dam operator, or a manufacturer, that requires that the downstream water be of a quality that they can use for their purposes. However, multiple users can also pay into a single fund.

Another voluntary market, as yet nascent, would allow water efficiency savings or avoided pollution to be traded in much the same way as voluntary carbon credits. These Water Benefit Certificates (WBCs) are credits that users who make water improvements (typically efficiency or purification improvements) beyond business-as-usual can sell to buyers who wish to finance such improvements. Like water funds, WBCs finance good behavior. The difference is that WBCs require quantified units of benefit, while water funds typically pay directly for changes in behavior or practice.[27] Water funds are also usually driven by single large buyers who are in the same water basin as the sellers. Conversely, WBCs are credits that can be sold to multiple buyers, regardless of geography. Demand for WBCs is more likely to be driven by corporate social responsibility strategies than by physical needs within a watershed.

LATIN AMERICA WATER FUNDS

Latin America has some of the world's most well-known water funds. Water funds are typically designed to allow downstream water users to pay upstream land owners for a range of conservation practices which improve downstream water quality. The Latin American Water Funds Partnership—a $27 million collaboration between The Nature Conservancy (TNC), FEMSA Foundation, Inter-American Development Bank, and Global Environment Facility—seeks to capitalize 32 funds by 2015. Since TNC's first water fund was established in Quito, Ecuador, in 2000, the concept has spread rapidly across the region. As momentum grows to replicate the water fund model in places such as Africa, Asia, and Australia, actors are increasingly turning to Latin America for lessons learned. According to Ecosystem Marketplace, the region is generating valuable experience on communication outreach strategies that can inform the wider field of ecosystem services. Since the language of "market mechanisms" and the notion of putting a price tag on nature are not well received in many Latin American communities, water fund developers have substituted payment for ecosystem services (PES) terminology for language such as "reciprocal agreements for water" or "benefits-sharing mechanisms." Nearly half of the water funds examined in Latin America also report paying land managers with in-kind compensation, such as agricultural inputs and technical training, instead of cash. Researchers are currently examining Latin American sites to determine whether cash versus in-kind compensation may be more effective for PES schemes, as the concept is widely debated in the literature.

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Voluntary markets of all kinds will be limited by the pool of buyers willing to make such investments. For example, PWS schemes will not be viable for communities and ecosystems that are not upstream of major municipalities or water users that require a certain water quality.

SOLUTIONS THAT CAN HELP DEVELOP GOOD GOVERNANCE

Building good water management systems is a multi-decadal effort, and the pathway to improving governance will vary according to specific local conditions. Though the challenge may seem daunting, the problem can be broken down into component parts and the work cannot begin soon enough. The following strategies are applicable across many geographies.

Strengthening community management and other participatory systems: In many cases, community empowerment can bolster good governance without any changes to policies, regulations, or government capacity. There are many ways to empower communities to take a greater role in water basin management: linking national-level management with existing community structures, allowing community participation in basin- and national-level dialogues, and developing strong water user associations at the local level.

There are also strong examples of community management in traditional forms of water governance. For example, the traditional aflaj water allocation system used by Omani farmers and the subak system in Balinese rice paddies have allowed for complex water management for millennia. Though traditional systems have been stressed by modern pressures, they can often be adapted, reformed, and built upon rather than being discarded wholesale, particularly in places where centralizing decision-making means making allocations more opaque and prone to undue political influence or even outright corruption.[28]

Water markets: Formal water markets, which allow water to be physically traded within a certain geography, are lauded by many as an effective method of water management, and have been successfully piloted in Australia and elsewhere in the past ten years. Although there are some risks inherent in formal water markets, notably insufficient protections to poor populations and ecosystems, they can offer an economically rational way to distribute water resources, keep water basins from being over-exploited, and help individual users benefit financially from increasing their water use efficiency (thus remedying the problem of underpricing). Water markets are only possible where governance is strong as they require established rights, clear trading rules and mechanisms, monitoring, and enforcement. However, many foundational elements of markets can be established slowly, in tandem with improvements in governance systems. For example, establishing water rights registries is a necessary precursor to transferable

PARTICIPATORY IRRIGATION MANAGEMENT IN INDIA AND ELSEWHERE

Participatory irrigation management, which increases farmer involvement in local water management by delegating responsibility for operation and maintenance to local Water User Associations (WUAs), has been widely applied across Asia. WUAs have been quite successful in Waghad, India, where participatory management has increased irrigation efficiency, irrigated area, maintenance of the system, collection of water charges, and other metrics in the 15 years since the farmers took over the system from the government irrigation department. Participatory management of water resources tends to be successful under the same conditions as other well-managed pooled resources, such as effective boundaries, monitoring, rules, enforcement, and conflict resolution, as described by the Nobel Prize-winning economist Elinor Ostrom and others.

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water rights. And there are a number of ways to establish flexible allocation mechanisms that can be responsive to variable supply and demand, without allowing for an open exchange of rights.

Among the potential risks of water markets, is the possibility of negatively affecting food security and livelihoods when raising water prices or establishing water markets. These considerations are particularly important given that markets, by default, tend to transfer water from low value but potentially critical uses like agriculture or pastoral activities to more profitable uses such as industry. Flows to the environment must likewise be protected. These key elements have often been left out of existing water markets. For example, Chile has been plagued by problems of inequity and speculation, with companies sometimes buying up water rights to the detriment of local residents.[29]

Indirect pricing signals: Raising water prices is a good way to help water users adjust their levels of consumption. Prices can be raised directly, through water rate increases, or dynamically, through markets. However, the idea of pricing water is often politically fraught. Instead, prices can be raised indirectly in places where directly raising prices is not politically feasible. For example, in India, electricity is heavily subsidized, making it cheap to operate groundwater pumps, causing greater demand for energy than systems can handle, and leading to shortages. Directly raising water and electricity prices is not tenable in India, so instead, one region opted to create two separate electricity systems, one for domestic use and one for agricultural use. Domestic electricity is priced at metered rates, whereas electricity for agricultural use remains free, but only operates for 8 hours per day rather than 24. By restricting the availability of groundwater, the program has also indirectly raised prices on the informal market by 30-50 percent.[30] This system, which has been selected as a priority pilot in the new government's five year plan, has also increased the regularity of power supply for critical municipal uses such as hospitals.

Subsidies reform and agricultural policies: Holistic water management, or integrated water resource management (IWRM), in which multiple stakeholders have a voice in water resource planning and allocations, may be the holy grail. However, reforms to individual policies can go a long way towards improved water management without reform of the governing systems. For example, reductions in water or energy subsidies will have an immediate effect on water prices, although such changes may be politically untenable. Another example is crop zoning, whereby national or provincial governments proscribe which crops can be grown in which agricultural areas. This kind of zoning helps avoid irrational cropping decisions, such as growing thirsty crops like rice, cotton, or alfalfa in dry regions, decisions that are possible because of artificially low water prices.

Pollution controls: While this paper focuses primarily on water scarcity, water pollution is almost as big of a challenge, and may be even harder to address. Ultimately, water pollution is a water scarcity problem insofar as it limits the availability of usable water. There are few viable solutions to water quality management short of government pollution controls. Payment for watershed services schemes can address water quality, as can water

WATER TRADING IN THE MURRAY-DARLING BASIN

The Murray-Darling Basin in Australia is a successful example of water rights trading. The water market there has helped various users deal with a record drought from 2003-2012. A number of critical components have helped to ensure the success of the system in Australia, including initial allocations, unbundling water rights from land rights so they can be freely traded, a distinction between permanent entitlements and temporary allocations, a centralized register of rights, and a basin-level cap. Water for environmental purposes was ensured through a multibillion dollar government purchase of rights. While questions remain about whether protections for the environment and vulnerable users are adequate, this market is generally considered the best model available for efficient water management in water scarce areas.

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benefit certificates; however, these markets tend not to include municipal and industrial polluters, major culprits in water pollution. Governments around the world must simply invest in tighter water quality regulation and enforcement or risk massive disease burden, ecosystem collapse, and loss of economic growth.

ENABLING TOOLS AND TECHNOLOGIES

Although insufficient to lead to better water management on their own, valuation, data, technological, and financial tools can enable improved management. For example, water planning is impossible if the quantity of water available is not known, payments for ecosystem services markets cannot survive without the means to quantify benefits, and water users cannot make efficiency improvements if the necessary technology does not exist. At the same time, users will not apply efficiency improvements if there are not sufficient incentives to do so. In short, these tools work best when coupled with or complemented by broader efforts to improve governance. That said, the stronger the stable of tools and technologies available for deployment, the more ground can be covered when small changes to incentives and water management are won.

Improved application of data and technology: Increasingly, satellites are making data available about the state of surface and groundwater resources that had previously been difficult or impossible to obtain. Online platforms and GIS are making surface and groundwater flows, and related data, increasingly accessible to users, allowing for preemptive management of water crises, better corporate water management, and more effective community participation in water decision-making processes.

New water-saving and delivery technologies: While continued innovation in scalable technology remains important, in many cases transformative technology exists but has yet to be widely applied because there is not sufficient economic incentive. For example, desalination, wastewater reuse, water-efficient irrigation and appliances, dry lubrication, and a variety of other technologies all have the potential to improve water efficiency but are rarely used because water is cheap. With regard to water purification, SODIS (leaving water out in plastic bottles to be disinfected by UV rays), ceramic filters, sand filtration systems, and other methods are helping to serve areas where municipal service falls short, but expanding municipal supply continues to represent the most viable long-term solution.

PANGANI BASIN

The Pangani River Basin Management Project is heralded as a model that united good governance, stakeholder participation, and implementation of IWRM. The Pangani River Basin provides livelihoods to over 3 million people in Tanzania, primarily through agriculture and fisheries. In response to reduced flow rates as a result of climate change and intense competing demands from the agricultural, energy, and industrial sectors, the Pangani Basin Water Board implemented a holistic basin management plan that is updated every five years by working extensively with stakeholders and incorporating climate change modeling. The inclusive stakeholder process has increased institutional capacity at the basin level, empowered water users, and provided better information on the economic and environmental trade-offs for different water allocations. Additionally, researchers have performed technical studies on environmental flows and the impacts of climate change on the basin, the first assessment of its kind in the area.

Source:

Welling, R., et al. (2011). Water and Nature Initiative Case Study: Pangani River Basin, Tanzania. IUCN Water Programme – Demonstration Case Study No. 2. Retrieved from https://portals.iucn.org/library/efiles/documents/Rep-2011-010.pdf

Improved environmental assessments: Academic institutions, NGOs, and even private companies and governments have made long-standing investments in improving our collective ability to value ecosystem services. While much of this capacity is housed in institutions in developed countries, the knowledge base is getting large enough and valuation practices are getting standardized enough that ecosystem valuation services are becoming more readily available globally, although data is often a limiting factor. The ability to conduct such valuations efficiently and effectively is fundamental to any management effort that requires payment transfers or investments in ecosystem services. This capacity also enables better integration of ecosystems into water management systems. To date, efforts have been primarily focused on advancing the science of ecosystem valuation. The trajectory of this field will thus depend on translating this information to decision-makers and promoting uptake in integrated water resources planning.

Financial tools: Innovative financial tools have the promise of unlocking greater funding for water savings technologies or natural infrastructure projects, which use forests, wetlands, and other ecosystems to provide the same services that are traditionally provided by "grey infrastructure," like water treatment plants and levees. Historically, underpricing of water has meant that investments in water savings technologies need to be subsidized. And the unproven nature of natural infrastructure projects means that the levels of risk that these projects face are too high for the return they can provide, given a typical investors risk/return appetite, so they also need some kind of philanthropic subsidy. "Development impact bonds" or "social impact bonds" have been developed in recent years to allow for small philanthropic investments to leverage larger investments from public funds or traditional investors. Donors or other impact investors can cover upfront costs or assume performance risks for expanding programs where the government promises to pay based on the outcome of service delivery, such as the number of households provided with water. These kinds of tools can also be used to prove out new concepts, such as natural infrastructure projects, using philanthropic money to absorb some of the risk, until financial returns can be proven to be reliable. Although there has been some innovation and momentum in recent years, these financial tools are still in limited use. The water sector may continue to be an unattractive field for investment given the persistently high rates of volatility and limited capacity for financial returns.

RECOMMENDATIONS: THE ROLE OF PHILANTHROPY

The task at hand, for the international community, is to actively harvest the hard-won lessons from the last decade of pilots and to accelerate replication of a range of water management models. Because of the local and political nature of water resources, solutions can be difficult to scale. We must look to successful models, such as those described above, and use them to accelerate the pace of water management reform elsewhere.

Improving water management systems globally is an enormous, slow, and costly proposition. Yet, there are catalytic investments that can be made by philanthropic or publically-minded institutions that aim to bring larger sources of private and public capital to bear on the issue and change the incentives of large numbers of water users.

This paper stresses the importance of good governance in water management reform. One role for philanthropy in accelerating good governance is to support experts and organizations that can serve in technical advisory roles. These experts can provide critical support functions to further local goals while also, in some cases, helping positively shape decision-making dialogues. As a complement to this sort of partnership, local communities and environmental groups might be supported and empowered to give voice to their needs in national and basin-level dialogues. Because governance is a fundamentally local problem, engagement should be targeted to develop models of good governance in particularly high-stress water basins. Replication can then focus on other basins with similar cultural and political conditions, even within the same country. Supporting local advocacy and technical guidance for policy reform in some of the most threatened water basins would also be highly impactful if successful.

Recognizing the challenges of weak water governance and the difficulty of policy reform, the range of strategies that do not depend on strong governance systems are also important areas for philanthropic investment. These include voluntary markets, corporate engagement, and the development of new tools. Philanthropy has an important role to play in propelling each of these areas of activity to the next level.

- **Voluntary markets are still in the pilot stage and need help to scale significantly.** Specifically, investing in better tools for project aggregation, streamlined and improved tools for ecosystem valuation, and cost-sharing mechanisms, deployed in high profile water basins, can help expand the reach and impact of voluntary markets.—There is also a continued need to support the development of new concepts (e.g., water benefit credits) and to help pilot existing models in new geographies (e.g., supporting the launch of PWS schemes in Africa).
- **Philanthropy can accelerate corporate stewardship** by providing both the tools and the pressure to encourage and enable corporations to make water savings investments directly, develop incentives for water savings through their supply chains, and get involved in multi-stakeholder groups pushing for high level water management reforms. Philanthropy can support reporting systems, coordinate pressure from investors and communities that are affected by corporate actions, support multi-stakeholder initiatives designed to engage businesses in water sustainability, demonstrate the business case for water savings, and codify best practices.
- **Finally, philanthropy can help to propel the development and use of tools that can be essential to improved water management.** Philanthropic institutions can take direct financial stakes in social impact bonds to fund projects like wetlands restoration. They can invest directly in the development of better open-access data platforms or improved ecosystem valuation systems, and they can help attract innovators to the water technology field through prizes or competitions.

CONCLUSION

The problem of water scarcity is increasingly pressing for both humans and the environment, especially in places that are experiencing strong economic and population growth. Freshwater management is a challenging natural resource management problem that depends, to a considerable degree, on governance. Because of the local nature and political nature of water resources, solutions are difficult to scale.

Despite these challenges, individual water basins around the world are innovating in their application of new and old water management tools. Examples range from governance reforms and markets to payment for watershed services and successful, participatory, basin-level plans. In parallel, there are promising signs that major segments of the private sector are increasingly taking a proactive role in water basin management and are interested in participating in strong collective action in partnership with communities and governments. There may be significant opportunities for philanthropy to accelerate good governance, propel markets, empower communities, and provide direct assistance. If successful, these interventions could improve the lives of millions.

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