The CEO Water Mandate

UNDERSTANDING "SUFFICIENCY" IN WATER-RELATED COLLECTIVE ACTION

Discussion Paper
October 2014

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The CEO Water Mandate seeks to mobilize a critical mass of business leaders to advance corporate water stewardship - in partnerships with the United Nations, civil society organizations, governments, and other stakeholders. Launched in 2007 by the UN Secretary-General, the CEO Water Mandate is overseen by the UN Global Compact, and implemented in partnership with the Pacific Institute.

The Nature Conservancy is the leading conservation organization working around the world to protect ecologically important lands and waters for nature and people.

CDP is an international, not-for-profit organization providing the only global system for companies and cities to measure, disclose, manage and share vital environmental information. We work with market forces to motivate companies to disclose their impacts on the environment and natural resources and take action to reduce them.

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UNDERSTANDING "SUFFICIENCY" IN WATER-RELATED COLLECTIVE ACTION

Executive Summary

As the private sector has become increasingly attuned to water stress and the risks it poses to business interests, many companies have begun exploring ways to reduce or mitigate water risks across their business operations and supply chains. Water stress comprises three core elements: water availability, quality, and accessibility[1] (Figure 1). As such, meaningful action to mitigate water stress inherently considers and responds to one or more of these three components. However, 'first-mover' companies have quickly learned that a comprehensive approach to resolving water stress can be a very complex undertaking. Resolving water stress in any particular geography may require attention to biophysical, engineering, cultural, economic, or political considerations that can span a broad range of geographic scales, from a local watershed or aquifer to governments at multiple geopolitical levels to regional and global economies.

This paper selectively focuses on water stewardship action at the scale of local watersheds and aquifers, as pursued through collective action with the community of water users[2] sharing those local water resources. Specifically, we introduce a concept of "sufficiency" in managing water stress. As defined here, sufficiency relates to the state at which existing water conditions and uses are consistent with a water community's needs, values, and desires, including protection of natural ecosystems. When a difference exists between a water community's needs and desires and the existing water resource conditions, water stewardship activities can be designed to close this gap (Figure 2). By measuring progress toward closing this gap, the water community can continually evaluate whether their collective stewardship actions are moving toward sufficiency.

[1] As part of its Corporate Water Disclosure Guidelines, released in September 2014, the CEO Water Mandate in collaboration with The Nature Conservancy, CDP, and others put forth conceptual definitions for water-related terms that are often used in different ways or interchangeably, namely "water scarcity", "water stress", and "water risk". This work can be explored in more detail at ceowatermandate.org/disclosure.

[2] Throughout this paper we will use the term "water community" to connote all water users and other parties interested in the utilization and sustainability of a particular water resource such as a particular river, lake, or aquifer. Members of this water community may include individuals, water utilities, water user associations or irrigation districts, local governments, etc.

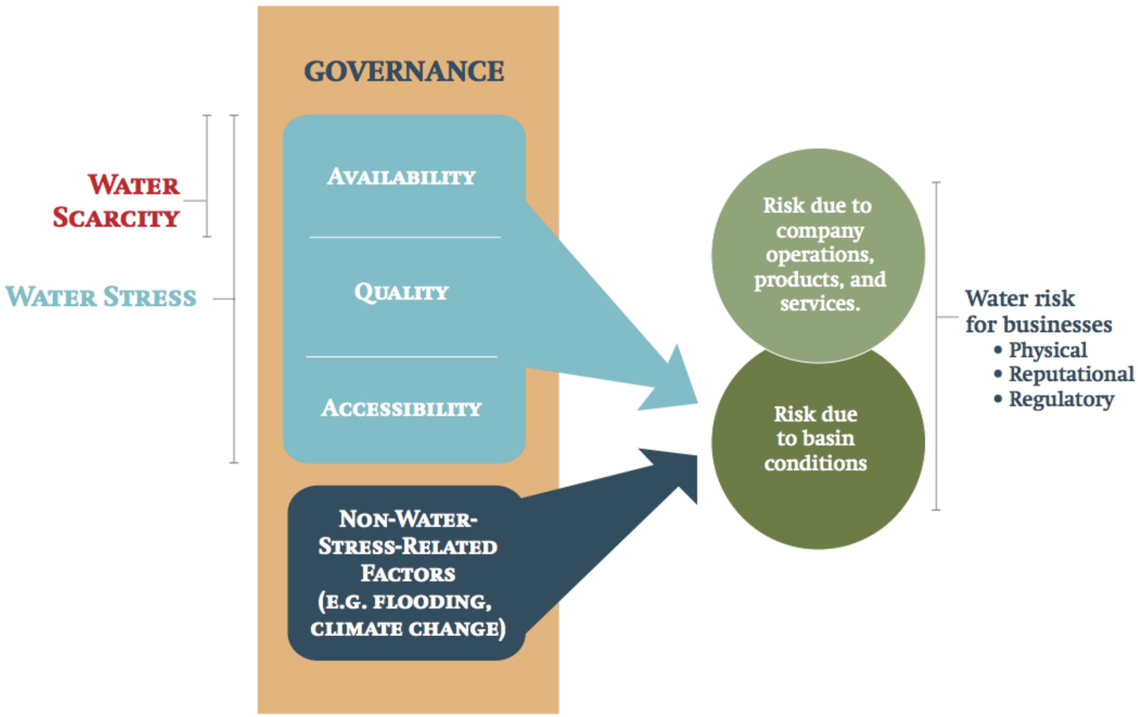


Figure 1. Water stress includes elements of water availability, quality, and accessibility.

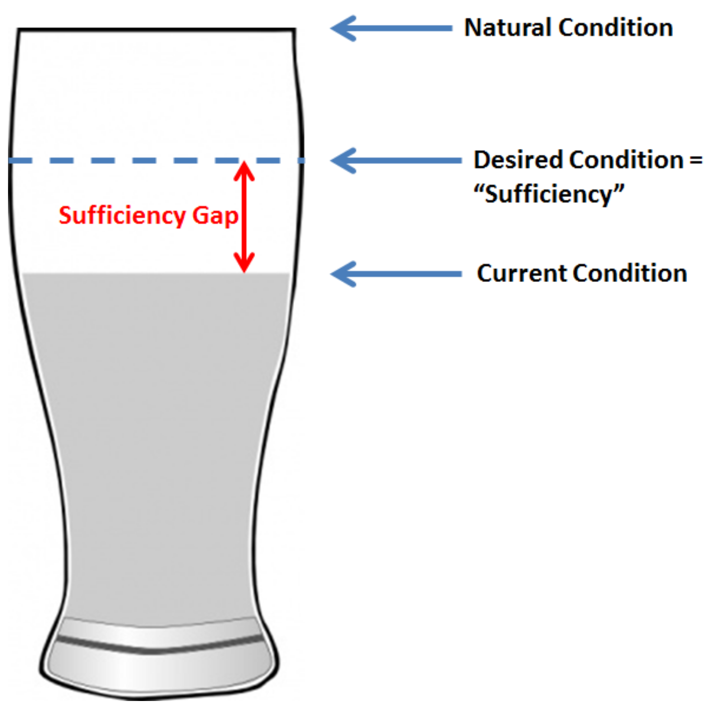


Figure 2. The concept of sufficiency in water stewardship is illustrated here. Note that this illustration presumes that current conditions are 'insufficient.' Pro-active water stewardship should take place before desired conditions are violated, but unfortunately, this is seldom the case.

While recognizing that this simple conceptual formulation of sufficiency can be applied at many scales – and in fact its application will need to transcend multiple scales to address water governance issues that influence water access, water allocation, and other concerns – we introduce its application to local watersheds and aquifers for three important reasons: (1) Few water stress issues can be resolved *without* addressing their manifestation in local water communities and with the water resources those communities depend upon; (2) Corporate exposure to water risks often emanates from localized impacts, e.g., lack of water for a particular business unit, inability to access agricultural supply-chain products from a particular growing region, or community protests over water pollution in their local river; and (3) It is usually at the local level that companies can best contribute to the resolution of water stress in a meaningful way. We fully recognize that resolution of local water issues almost always also involves interactions or negotiation with governing entities that oversee geographies much broader than a local water resource, but for the purpose of conveying the concept of sufficiency we will focus exclusively on individual water resources here. Companies can contribute to the activities discussed herein in various ways, such as by providing needed funding, lending technical capacity, or helping to facilitate a dialogue within the local water community regarding the activities and concepts outlined here.

Recent Evolution of Corporate Water Stewardship

Before diving into a review of how a company can orient its stewardship activities in specific watersheds and aquifers, we briefly review the recent history and evolution of thinking in corporate water stewardship that has led us to produce this discussion paper.

Many companies begin engaging on water issues by first developing an understanding of their own corporate water footprint, i.e., by determining how much water the company requires, or how much wastewater or runoff it produces, across its operations and supply chains (Figure 3). This water footprinting exercise helps companies to pinpoint the geographic locations where the company depends on water resources, and also helps companies to better understand the nature and magnitude of their influence on water.

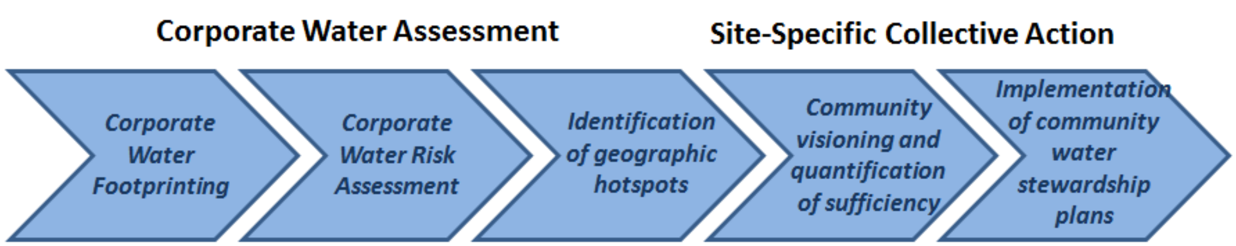


Figure 3. A typical progression of stewardship activity resulting in local collective action

A water footprint assessment provides a foundation for subsequent examination of water-related risks associated with the company's operations and supply chains. During the past decade, a number of reports or papers were prepared in an effort to articulate the nature of water-related risk for companies, and to offer initial guidelines for risk management, including:

- Understanding Water Risks and Investigating Shared Risk in Water by WWF
- Watching Water: A Guide to Evaluating Corporate Risks in a Thirsty World by JP Morgan and WRI
- Water Scarcity & Climate Change: Growing Risks for Businesses & Investors by Ceres and Pacific Institute
- At the Crest of a Wave: A Proactive Approach to Corporate Water Strategy by Pacific Institute and BSR.

There are also a variety of online tools that help companies assess water risks based on watershed or aquifer conditions, such as WWF's Water Risk Filter, WRI's Aqueduct, WFN's Water Footprint Assessment Tool, and WBCSD's Global Water Tool.

From Assessment to Action

In recent years, much of the corporate dialogue around water-related risk has decidedly shifted into discussions about managing the shared water challenges faced by companies themselves, as well as the communities and ecosystems in which they operate. Early efforts focused almost exclusively on improving operational efficiencies within factories or on farms, but as understanding of the fuller nature of water-related risk has matured, stewardship activities have moved far beyond a company's factory walls or farm fences to address issues such as water scarcity, pollution, water access, inadequate governance, and other concerns in the basins in which companies operate. A growing number of companies are recognising that the drivers for action include ensuring business continuity, securing a license to operate, and protecting or enhancing brand value. With research from CDP indicating that water is already posing serious risk for more than half of the world's largest companies, coupled with the World Economic Forum announcement that water supply crises present one of the world's greatest risks, the business case for action is clear and compelling.

Corporate management of water risk is also being spurred into action by growing expectations of corporate sustainability among consumers, civil society, and communities. Investors and purchasers are also seeking to understand how water challenges will affect a company's ability to generate returns or provide goods and services. For example, 573 investors with $63 trillion in assets as well as 14 purchasing organisations with a combined annual procurement spend of $216 billion now use CDP's water program to improve their understanding, drive action and reduce water risk.

Encouragingly, these key stakeholders understand that the root causes of corporate water risk usually reside in the way that water resources are managed or governed, both at the local watershed or aquifer level and at a broader governance level such as a federal or state agency. Smart investors know, for example, that while focusing on water use in a company's own operations may be a sensible first step for many, it will likely do little to materially reduce the risks the company is facing in the watersheds or aquifers they affect through their water use or wastewater discharge. As a result these stakeholders now realize that a company's ability to operate over the long term rests increasingly on good water stewardship being pursued at both the watershed or aquifer scale and the appropriate level of formal governance.

This increased interest in water from business is welcomed by organizations and individuals focused on improving the conditions of watersheds and aquifers. Yet there remains significant confusion about the issues, particularly how to respond in a meaningful manner, which is leading to a mixed response from many companies. As increasing numbers of investors ask companies "what are you doing about your water risk?, companies are now facing decisions regarding how to mitigate material water risk.

In 2010, the CEO Water Mandate responded to growing corporate and stakeholder anxieties over water risk by preparing a "Guide to Responsible Business Engagement with Water Policy." The guide offers strategies for how companies can effectively and responsibly leverage change beyond company fence lines. Case studies of corporate responses are now becoming available, such as the Striving for Positive Water Impact report prepared in 2011 by PepsiCo and The Nature Conservancy, which explores how water impacts can be mitigated at the basin level. Two CDP reports – The Case For Corporate Water Disclosure and Collective Responses to Rising Water Challenges provide additional guidance and examples. Collective action efforts that leverage the skills and resources of a wide range of partners have played a pivotal role in corporate water strategies, as evidenced by the Mandate's Water Action Hub.

In the discussion below we offer further thoughts that can help shape water stewardship collective action at the local level. Again, the particular role that any one company will play in a local water community's water stewardship efforts will need to be decided within the company's internal decision-making processes. We hope that the discussion that follows will help companies to better understand the work that will need to be undertaken in collective action with local water communities to realize sufficiency of water stewardship.

Grounding Water Stewardship Efforts in Watersheds and Aquifers

In conducting their evaluations of water risk, companies have come to appreciate that water risk 'hot spots' can be quite localized in nature, meaning that a facility located in one watershed may be facing serious water security or pollution issues (and therefore water risk) but another facility in an adjacent watershed may not encounter much water risk at all.

This localized nature of water risk is explained by the simple fact that each of the water resources depended upon – rivers, lakes, or aquifers – largely function as separate "water accounts." These water accounts are replenished by rain or snow draining within their associated basins, and they are polluted or depleted by human or natural uses (see Figures 4a and 4b). When the total volume of uses or losses from a water account approaches the volume being replenished, the likelihood of water shortages escalates. When the amount of pollution being introduced into a water source exceeds a freshwater ecosystem's ability to absorb or process the waste, impacts to human or ecosystem health become more likely.

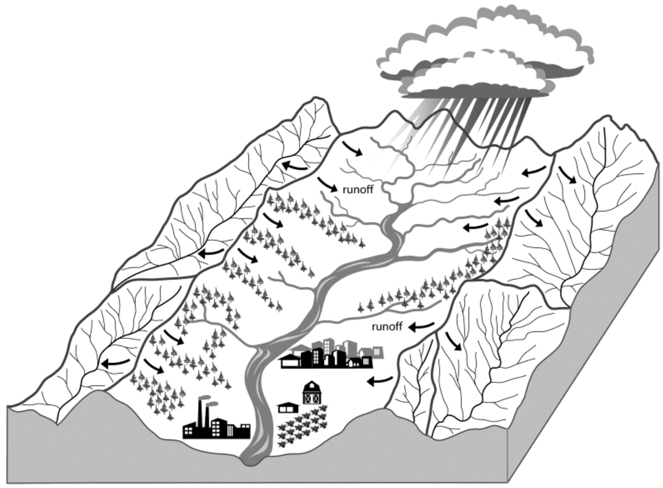


Figure 4a. Rivers and lakes are replenished by water draining from a watershed, as pictured here. Water is depleted from a river or lake by both human uses and natural processes. The ultimate limit of water extraction from a river or lake is a dry bed (i.e., the water's all gone), but ecological, social, and other impacts will usually arise long before that physical limit is reached. Similarly, pollution doesn't need to completely fill a river or lake before serious problems emerge (Illustration adapted from Chasing Water by Brian Richter, Island Press 2014)

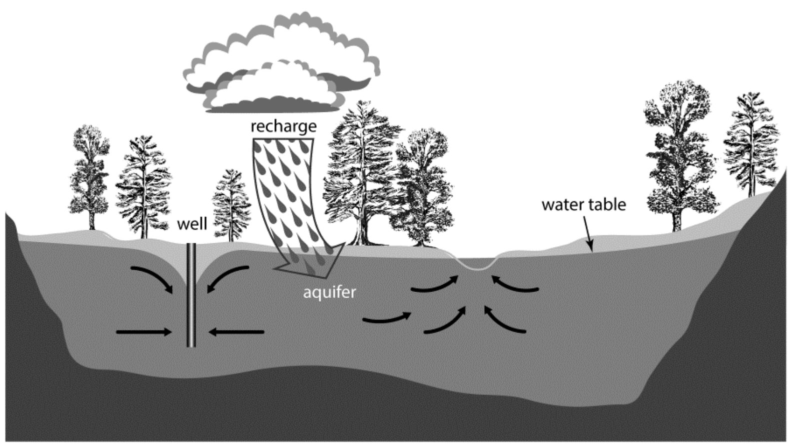


Figure 4b. An aquifer is an underground basin containing water. The water in an aquifer can be extracted using groundwater wells and pumps. The water in aquifers originates from rain or melting snow that percolates into the ground to recharge the aquifers. When water is consumed from the aquifer faster than it is being recharged, the water level (i.e., water table) in the aquifer will be lowered, sometimes to the point that wells can no longer reach the water or it becomes too costly to pump the water from great depths. The water in an aquifer can also become contaminated by pollution percolating into the aquifer, perhaps to the point of making the water unusable or costly to clean. (Illustration adapted from Chasing Water by Brian Richter, Island Press 2014)

A company's overall exposure to water risk is therefore largely driven by the sum of what is happening in each individual water source being used or affected by the company – either through its own operations or those of its suppliers. For example, water scarcity in a particular area can impact the ability of a company's facility located in this region to meet demands for products that are manufactured at that site or to do so in a profitable manner. In a similar way, a drought in an in area where an agricultural ingredient is sourced may impact a company's ability to purchase adequate volumes of the ingredient, or result in price increases due to shortages. These impacts are likely to increase the cost of production and potentially decrease net profit. These risks are discussed in considerable detail in the WWF report on "Understanding Water Risks" (Orr et al., 2009).

Because water risks tend to emerge from individual watersheds or aquifers, it is often critical to ground water stewardship strategies in those particular places. To be effective, these strategies should be based on an assessment of water stress in each location of concern. We note here that the watershed or aquifer where a company extracts water may not be the same basin where the company discharges its wastewater; both locations may be of concern. We also note that identifying the specific water resources being affected by use or discharge may be difficult to discern initially, particularly if the facility or farm is connected to a public water supply or wastewater collection system run by another agency. However, this information should be readily accessible by contacting the appropriate water utilities.

Getting to Know Your Local Water Community

The "Guide to Water-Related Collective Action" published by the CEO Water Mandate (2013) offers a number of reasons and motivations for becoming involved in collection action. One of the most obvious reasons – but not explicitly acknowledged in the Guide – is the simple fact that the task of restoring water quantity or quality conditions to a more desirable level is usually a bigger job than any one company can tackle acting unilaterally. This raises an important question: just how much effort will be enough to reduce the company's and nearby communities' and ecosystems' risk to an acceptable level?

The answers will likely be somewhat different for each individual water user or stakeholder within the water community. But assuming that collective action will be necessary, it is going to be important to gain an understanding of the community of individuals, companies, or governments that are sharing the same water resource(s). This includes water users living or working both within and outside of the watershed boundary, because exports or discharges of water outside of a watershed are not uncommon.

The Water Action Hub developed by the CEO Water Mandate can be helpful in identifying other companies and actors that share or have interest in the same water resources. However, to build a successful water stewardship plan, you will likely need a much more complete picture of who is sharing the water resource, how much they are using or discharging, and how they are putting the water to use. If water use is regulated through the issuance of water rights, entitlements, or permits, a listing of water users (by water resource) should be available publicly from the government entity responsible for issuing such rights.

Once the key interests within the water community have been identified, the "Guide to Water-Related Collective Action" should be helpful in determining how that group of interests within a community might be convened and mobilized for collective water stewardship action.

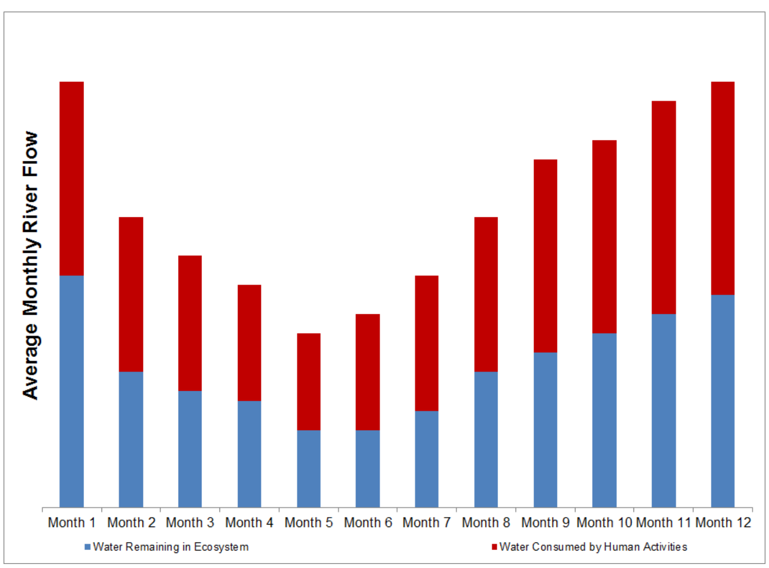
The Concept of Sufficiency as a Goal for Collective Action at the Watershed or Aquifer Level

Before committing substantial resources toward addressing water challenges, it is important for a company or community to understand how much water stewardship activity and investment is likely to be required to measurably reduce water stress. In short, how much improvement is enough?

Given that many parties will be contributing to a water stewardship collective action, this question will usually need to be answered through a dialogue among the local water community. The community should strive for general agreement about "optimal" water conditions and use, which will likely invoke conversations about the needs and desires of different users or user groups, as well as what "sustainability," "water security," or sufficiency might mean for water management as a whole. This dialogue should address the issue of how much and what quality of water must remain in the water source to protect freshwater ecosystems, cultural values, or provide a hedge against dry periods. It should also build on previous hydrologic assessments, environmental flow determinations, or basin plans that have been developed previously. The *Guide to Water-Related Collective Action* provides very useful guidance about the processes that can be employed to build consensus among actors within a water community.

The *sufficiency gap* can be determined as the difference between what exists and what the water community collectively needs or wants (see Figures 2 and 5). This difference or gap represents the extent of insufficient conditions. Understanding the extent and nature of the gap can help orient water stewardship collective actions. Sufficiency is achieved when this gap is closed. This concept can be applied to various parameters and conditions that cause water stress, including water balance or water scarcity, but also water quality and access to water and sanitation services.

To the extent possible, the agreed-upon desired conditions, or the determination of what would constitute sufficiency of stewardship action, should be quantified so that progress toward those desired conditions can be most easily measured and communicated.



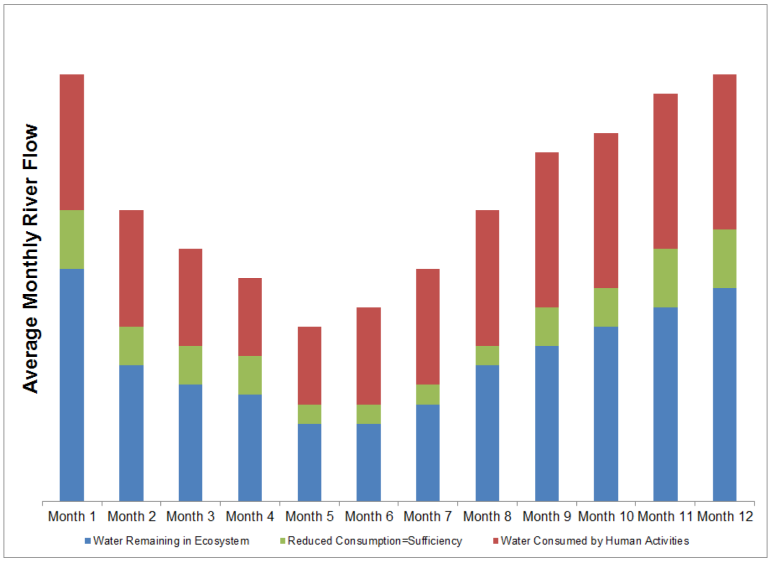


Figure 5. A central challenge of managing water sustainably is gaining community consensus around the water-related values and benefits to be gained by using water, or by leaving some portion of available water supplies for ecosystem support. This graph illustrates a fictitious scenario in which the community has decided to reduce its overall consumption of water, perhaps to sustain a fishery. The upper graph represents ***current conditions****. In the bottom graph, the volume of water savings (reduced consumption) targeted for each month to attain the* ***desired condition*** *is represented by the green portion of the bars. Once this volume of savings is achieved, the community's water stewardship activities will be "sufficient" to meet its collective ecosystem-restoration-related goals for water management.*

Gaining an Initial Sense of What's Needed

But how can a local water community actually begin quantifying the notion of "sufficiency"? In the examples below we offer insights into how one might calculate sufficiency with respect to ***water quantity*** (i.e. water availability) concerns associated with rivers and aquifers. However, the notion of sufficiency can also be applied to the other two components of water stress depicted in Figure 1 (i.e., water quality and accessibility), as well as a range of possible other non-water-stress-related factors, such as flooding and climate resilience. Indeed, the concept of sufficiency as it relates to water quality is akin to the definition of Total Maximum Daily Loads or TMDLs, as is done in the United States under the Clean Water Act. In the future, the authors aim to develop similar examples for water quality and water access issues, but for now we focus on water quantity.

Developing a quantitative estimate of the volume of water use that must be reduced, or the volume of water that would need to be added/imported in any particular watershed or aquifer will require preparation of a "water budget." A water budget generally accounts for the volume of renewable water available for human uses and to support the environment; the volume of water being withdrawn and consumptively used; and the water remaining in the watershed or aquifer.

A variety of global water models exist that can be used to obtain an initial accounting for the water budget of a watershed or aquifer.[3] For example, the global WaterGAP model developed at the University of Kassel in Germany can be used to develop an initial estimate of water availability and use (by sector) for more than 140,000 watersheds globally (see Table 1).

Table 1: Water Budget for the Jiaojiang Watershed in China
(based on output from the global WaterGAP3 model, summarized here as annual average values. Monthly values are also available. MCM=million cubic meters)

Total Renewable Water Available in Watershed = 630 MCM

Agricultural consumption	= 160 MCM
Domestic consumption	= 11 MCM
Manufacturing consumption	= 77 MCM
Electricity consumption	= 0.58 MCM
Livestock consumption	= 3.3 MCM
Total consumption in watershed	= 252 MCM
Total flow remaining in watershed	= 378 MCM

These WaterGAP3 outputs can provide insight into the proportion of water that is being consumed by agriculture, manufacturing, domestic use, power production, and other uses. These model outputs also include an estimate of how much water remains in a river or aquifer for environmental support. This information can be used by water users and other stakeholders as a starting point for discussions about potential water savings that might be attained in each water-use sector, and for estimating how much rebalancing of water use among each sector and the environment may be necessary or sufficient to meet the community's needs and goals.

In recent research conducted by Brauman and others[4] using the WaterGAP3 model, the investigators found that water flow or aquifer depletion is quite minimal (<5% of available, renewable water supply) in 2/3 of all global watersheds. This suggests that water **scarcity** is not an immediate risk in most of the watersheds of the world, and there appears to be adequate water available to meet both environmental and human needs (assuming adequate access is provided and quality assured) in these lightly-used watersheds. However, serious challenges exist in the remaining 1/3 of watersheds. Unfortunately, nearly 3/4 of all irrigated cropland and half of the global population are situated in these scarce watersheds.

[3] In addition to the WaterGAP model discussed here, WRI has developed Aqueduct, WFN has developed a Water Footprint Assessment Tool, and a number of academic institutions have developed similar global water models.
[4] "Water Depletion: Global trends in water use and availability**,** by Kate A Brauman, Brian Richter, Sandra Postel, Marcus Malsy, and Martina Floerke. In review, *Science*.

Though methods, datasets, and others resources for doing such an assessment for water quality or community access to water and sanitation services are not available to the same extent as those for water quantity, the same overarching concepts can be applied. For example, if a shared water resource is experiencing particularly high levels of a specific pollutant (or pollutants), the local water community might seek to take account of current levels of each of those contaminants relative to levels considered sufficient for human and ecological health (or otherwise defined as acceptable by the local community). This would provide a sound basis for understanding what type and how much action is needed, and as a tangible objective for collective action in the region.

Illustrative Examples of Defining Sufficiency and Designing Stewardship Actions

Here we illustrate an approach for evaluating how much water stewardship activity is likely needed to close the "sufficiency gap," using local data compiled for both a river in the western USA and an aquifer in Mexico. These examples are based on the logic that when there's an inadequate amount of water to meet a community's needs or desired conditions, some existing uses of water will need to be reduced or the proportion of water available to each user, sector, or the environment will need to be rebalanced to attain the desired conditions. Again, we acknowledge that resolution of these issues will oftentimes exceed a local water community's means or capacities, and governing agencies responsible for water allocation or infrastructure development will need to be involved in many instances. But considerable momentum and problem definition can be achieved at the local community level.

The Colorado River Delta: Overdrawn and Dried Up

Figure 6 below graphically summarizes the overall water budget of the Colorado River basin in the western US. This water budget was prepared using a variety of published data sources and a river system model developed by the US Bureau of Reclamation. [5] As illustrated here, it is clear that irrigated agriculture accounts for the largest portion of water withdrawals and consumptive uses in this large river basin (637,000 km^2). Another important point about this water budget is that all of the available water is fully consumed before the river reaches its delta in Mexico, in virtually every year. The lack of any 'reserve' of water left to flow through the delta has severely damaged freshwater and estuary ecosystems, disrupted indigenous cultures dependent on wild plants and animals for sustenance, and created substantial risks for businesses, farmers, and all other water users during years with less-than-average water availability. There is a strong desire to restore some of the water flow through the delta to support ecosystem, economic, and cultural needs locally.

[5] Published in *Chasing Water: A Guide for Moving from Scarcity to Sustainability* by Brian Richter. Island Press, 2014.

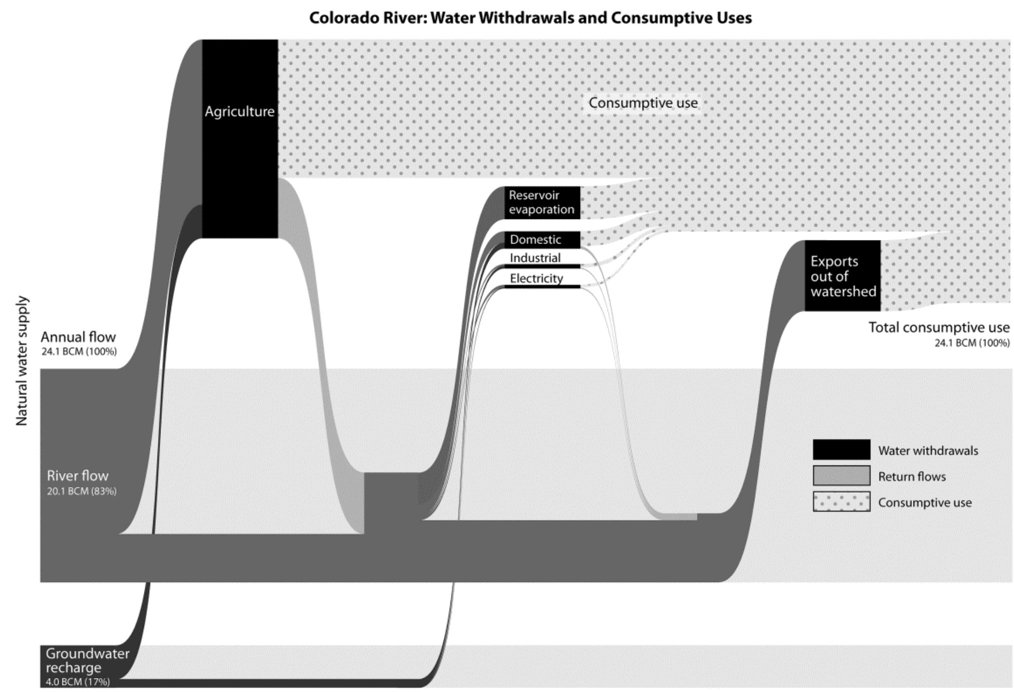


Figure 6. This diagram depicts the natural water supply, use, return flow, and consumptive loss of water in the Colorado River watershed. The far left side of the diagram indicates the average volume of water in the river and in underground aquifers that is renewed by rain and snow annually. This renewable water is withdrawn and used for various purposes, with some portion of the withdrawn water being consumptively used (depleted) and some returning to the river after use. Before reaching the river's delta in Mexico, all of the water has been consumed.

The water budget portrayed in Figure 6 provides important context for understanding the types of water uses that have led to the ecological, social, and economic impacts experienced today in the Colorado River delta. Prepared at the scale of an entire river basin, such a water budget can also provide insight into regional- or national-scale water policies that may need to be reformed, such as changes in water allocation policies (e.g., "use it or lose it" provisions) at state or federal levels that discourage water conservation in agriculture. Water governance adjustments at state or national scales can be powerful drivers for changes in water use throughout a large river basin such as the Colorado, and can thus be quite influential in mobilizing changes in water use that can help realize the attainment of desired conditions within an entire region. For example, the Commonwealth government in Australia in 2012 adopted a basin-wide plan for the Murray-Darling Basin that mandates a 30% reduction in consumptive use of water across that river basin. Private interests, including associations representing an entire water-sector (e.g., the Farm Bureau often represents the water interests of farmers in the US), can contribute to discussions about needed policy changes.

However, many companies will understandably shy away from playing a highly-visible role in large-scale water policy changes, and may prefer to focus on more localized engagement where they can participate in a more tangible way. For example, a number of companies recently contributed financially to an effort to help local communities and NGOs to determine how much water flow would need to be restored to the Colorado River delta to regain some semblance of ecological health. Scientists estimated that unmet water needs for environmental support total approximately 124 million cubic meters per year, on average.[6]

Following a review of the local water budget of the delta region, it was determined that the needed return of water to the delta ecosystem could be achieved through on-farm water conservation practices or the purchasing of water rights from farmers, thereby moving water out of the agricultural component of the water budget and into an ecosystem component that does not presently exist in the water budget as illustrated in Figure 6.

A number of companies also contributed to a monetary fund managed by multiple conservation NGOs (the "Colorado River Delta Water Trust") for the purpose of purchasing water rights to benefit the delta's ecosystem. In March 2014, the water rights purchased by the Trust were used to create the first "pulse release" of water from upstream reservoirs into the delta. This pulse release provided water to the delta for the first time in decades.[7] This restoration project has been very well-received by local communities, NGOs, and the farming community, and has garnered considerable publicity and recognition for the companies that helped support the project.

El Bajío Growing Region, Mexico: Overdrafts in the Aquifer Account

El Bajío is a key agricultural and industrial hub in Mexico and one of the fastest growing areas in the country. Its central location, healthy soils, year-round growing climate, and easy transportation access to both coasts as well as north to the U.S. and south to Central America, make it a very attractive location for national and international investment. El Bajío boasts more than 400,000 hectares of prime quality, irrigated agricultural land that produces a wide variety of agricultural products, including grains, vegetables and fruit.[8] The region is Mexico's top producer for canned and frozen produce and is responsible for 90% of Mexico's exports in frozen produce. However, this region is experiencing considerable water strain, as irrigation is essential to grow crops in this semi-arid region, and a rapidly growing manufacturing industry and urban population need ever-increasing volumes of water.

The El Bajío region overlays multiple adjacent aquifers that provide water for growing high value crops such as fruit and vegetables, and for supplying manufacturers and cities, but the water budgets for these aquifers (prepared by the national water agency CONAGUA) reveal that they are being pumped at a rate that is far outpacing annual replenishment. Aquifer levels across the state of Guanajuato are declining at an average annual rate of 2 meters per year, with some locations declining by as much as 5 meters per year.[9] If water use continues as it has, scientists estimate that

[6] This includes the provision of a continuous base flow, as well as occasional pulse flows.
[7] "A sacred reunion: the Colorado River returns to the sea," by Sandra Postel, National Geographic Water Currents, May 19, 2014: http://newswatch.nationalgeographic.com/2014/05/19/a-sacred-reunion-the-colorado-river-returns-to-the-sea/
[8] Marañón, Boris, 2006. Tension Between Agricultural Growth and Sustainability: The El Bajio Case, Mexico.
[9] Scott, Christopher A. and Tushaar Shah, 2004. Groundwater Overdraft Reduction through Agricultural Energy Policy: Insights from India and Mexico. *Water Resources Development*, Vol. 20, No. 2, 149-164.

for many of the aquifers underneath El Bajío it will become too expensive, or the water of too poor quality, for pumping to be feasible beyond 20 more years.

To arrest groundwater declines in the El Bajío region, three types of challenges will need to be addressed: inadequate water management, inappropriate economic subsidies, and lack of uptake of more efficient irrigation technology.

Mexico has a ground water rights permitting system, but neither the location nor the volume of pumping are strictly enforced, mainly due to inadequate public sector capacity. As shown in Figure 7, even as the state set a moratorium on well drilling, the number of new wells continued to grow illegally. There are limited economic incentives for growers to increase the efficiency of their water use. Under Mexican law, water is free for agricultural purposes and, until recently, the Mexican government has subsidized electricity for irrigation groundwater pumping. Finally, even though technology to enable more efficient irrigation is readily available, it has been implemented on a very limited basis in the region.

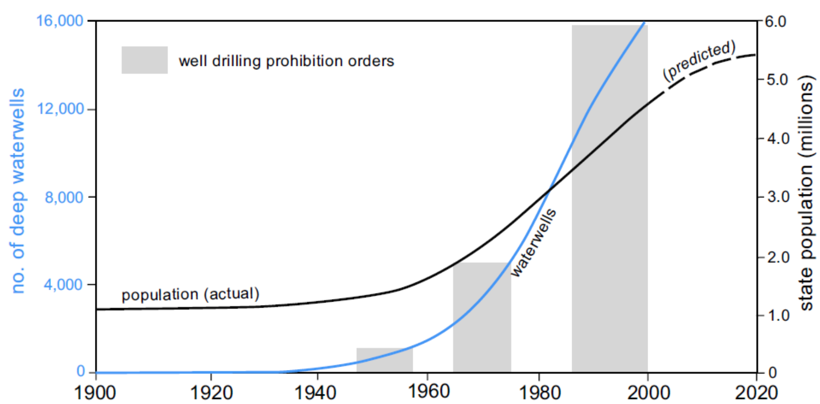


Figure 7. Number of wells in Guanajuato over time as compared to well drilling prohibition orders[10]

In order to reverse this trend, collective action efforts must address the management, economic, and technology challenges the region faces. Fortunately, the "sufficiency gap" that needs to be addressed to arrest groundwater declines has been determined by a state-supported groundwater user group, based on a water budget of the aquifers. For example, in the Irapuato-Valle de Santiago Aquifer, there is an average annual deficit (replenishment minus water use) of 255 million cubic meters per year.[11] To be "sufficient", the combined impact of a suite of water stewardship activities would need to account for this gap, and aim to replenish water at an even greater rate for several years until the volume of water in the aquifer is returned to historic levels (Figure 8).

[10] Foster, Stephen, Héctor Garduño and Karin Kemper, 2004. 'COTAS': Progress with Stakeholder Participation in Groundwater Management in Guanajuato, Mexico. *Sustainable Groundwater Management, Lessons from Practice*. The World Bank.
[11] Consejo Tecnico de Aguas de Irapuato-Valle de Santiago, A.C., 2012. Estado Actual y Caracteristicas de la Region Acuifera Irapuato-Valle. Powerpoint presentation.

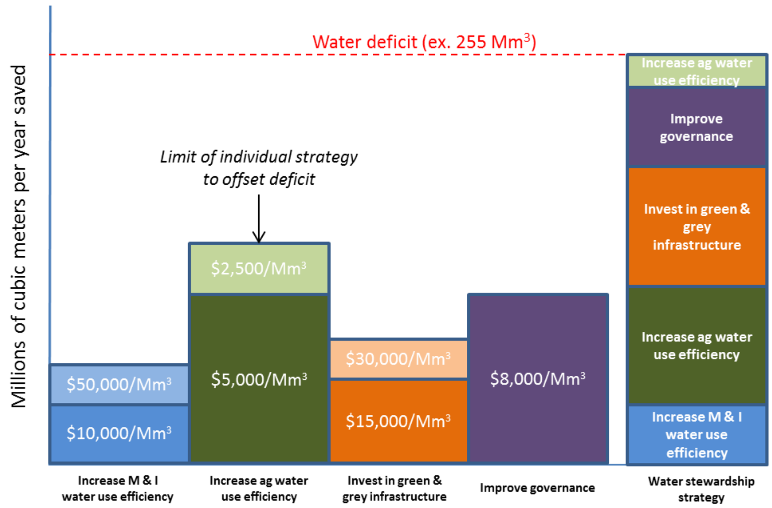


Figure 8. An example of water stewardship strategy development based on a suite of solutions aiming to meet a specific sufficiency goal. Each color represents a different strategy, and the cost in each box simply illustrates how one may employ a combination of different solutions, at different costs per cubic meter of water saved or replenished, to meet the goal.

Conclusions and Areas of Future Inquiry

This paper posits the merits of quantifying the gap between a community's water needs and desires and existing conditions, as a basis for designing water stewardship plans and activities and as a basis for interactions and negotiations among interests in a local water community. It also illustrates how such quantification can be achieved practically, both for situations in which very little local information or data exist, as well as for settings where considerable data and water models may be available. Although this quantification adds another layer of complexity to corporate water stewardship efforts, it is essential to affect meaningful change and to narrow the sufficiency gap in the places companies operate.

Unfortunately, the data and model outputs illustrated in this paper are not yet easily accessible to companies or other water users and stakeholders. For instance, accessing the water budget information generated by the global WaterGAP3 model can presently be accessed only by special request of the model developers in Germany, and their response to such requests can take considerable time. As a critical next step to improving the ability to assess sufficiency of water stewardship strategies, the authors of this paper propose that interested companies support efforts to make this type of information available in an easy-to-understand and readily-accessible web platform.

There also exists a need to demonstrate the application of the sufficiency concept for water quality and water access examples. If interest exists, the authors of this paper will be happy to discuss the possible timing and feasibility of generating these additional examples.

We also believe that this concept of sufficiency can best be advanced and refined through multiple real-world applications. We are particularly interested in the role that companies have been playing in related activities and how effective these efforts have been. The authors of this paper welcome the opportunity to discuss possible case study applications with interested companies. We are also interested in making these approaches as easy to apply as possible; we would welcome any suggestions in this regard.

Lastly and most importantly, we are most interested in understanding better how companies may be able to quantify the contributions that they are making toward reducing their water-related risks. We have offered the proposition that quantifying a “sufficiency gap” can provide some perspective on such progress. We invite further discussion about the ways that companies can meaningfully communicate their progress to stakeholders, including investors.