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TECHNICAL NOTE

MAPPING PUBLIC WATER MANAGEMENT: PROOF OF CONCEPT

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SUMMARY

Many water crises are, at their root, crises of water governance and management. To effectively respond to water crises driven by governance and management failures, there is a need for empirical, comparable, global information on the state of public water management.

In an effort to fill this data gap, this technical note tests a novel data collection approach that relies on crowdsourcing data from multinational enterprises with operations across many geographies. The approach was piloted with six contributing multinational companies, and the results were validated in eight locations in the region of Southern California (United States) and the state of Maharashtra (India).

The pilot study suggests that the new data collection approach is scalable and has the potential to generate a global dataset of public water management capacity. The field validation exercise suggests that the collected data are mostly viewed as valid by local experts and stakeholders, but the exercise also identifies a number of weaknesses. Based on these findings, this paper presents an updated survey that improves upon the original survey used in the pilot study.

CONTENTS

Technical notes document the research or analytical methodology underpinning a publication, interactive application, or tool.

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ABBREVIATIONS

DHI	Institute for Water and Environment (formerly Danish Hydraulic Institute)
IBNET	International Benchmarking Network for Water and Sanitation Utilities
IWRM	integrated water resources management
MIDC	Maharashtra Industrial Development Corporation
OECD	Organisation for Economic Co-operation and Development
PWM	public water management
PWMI	Public Water Management Index
SDG	Sustainable Development Goals
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
WHO	World Health Organization

1. INTRODUCTION

1.1. Background

Water crises and their ripple effects on society and the environment pose a great risk to people, the environment, and the world's economy (WEF 2019). Decision-makers increasingly understand that water crises are rooted in failures of governance (GWP 2000), making it necessary to tackle water management and governance as a root cause of water crises. Given this challenge, a promising approach to prevent water crises is to focus on improving the public management and regulation of water.

Improving water management or water governance first requires definition and measurement of the current state of affairs, and several organizations are working to gather information on issues related to water management (Table 1). This technical note proposes to fill knowledge gaps in existing initiatives. The Joint Monitoring Program and UN monitoring of Sustainable Development Goal 6.5 (on integrated water resources management) produce data at the country level, ideal for country-level benchmarking. The International Benchmarking Network for Water and Sanitation Utilities (IBNET) and the Organisation for Economic Co-operation and Development (OECD) take a more local approach but rely on self-reported information from entities managing water (utilities and regulators), which is ideal for in-depth development of local capacity. So far, however, there is little information about water management at the local scale that is comparable across locations. Such information is needed to complement water risk assessment tools, which are currently limited to biophysical aspects of water risk.

1.2. Public Water Management Method and Other Existing Datasets

In response to this need, Kölbel et al. (2018) developed a method to collect data on public water management (PWM). This PWM method relies on crowdsourcing data from local third-party water users—namely, industrial facilities that are already collecting information on PWM regularly. For example, the staff of a water-intensive industrial facility is often knowledgeable about local water management conditions, independent of the local utility or regulator, and sometimes collects PWM information for existing corporate water risk assessment processes. Harmonizing the information these third-party users collect with a standardized questionnaire allows for a scalable approach to generate new data that

- are collected by a third party;
- report on local conditions;
- are comparable across locations; and
- can provide global coverage.

Table 1 | **Existing Global Databases Providing Water Governance or Management Information**

ORGANIZATION	DESCRIPTION	SPATIAL RESOLUTION	DATA SOURCE
WHO/UNICEF Joint Monitoring Program	Country-by-country monitoring of water access, sanitation, and hygiene	National scale	National government
IBNET Database	Local and national tracking of water and wastewater treatment tariff rates, and utility nonrevenue water rates	Local scale	Utilities
UNEP-DHI SDG 6.5 Monitoring	National government monitoring and reporting on the implementation of integrated water resources management (IWRM), with a self-assessment questionnaire (UNEP-DHI 2018)	National scale	National government
OECD Water Governance Indicator Framework	"A self-assessment tool to assess the state of play of water governance policy frameworks (what), institutions (who) and instruments (how), and their needed improvements over time."	Local scale	Government, regulator, or utility

Source: Authors.

Data collected in such a way can offer an important complement to existing data and in turn improve the current public water management response to water risks.

1.3. Definition of Public Water Management

There are many definitions of *water management* and *water governance* (Araral and Wang 2013). For our purposes here, *public water management* is the ability of local institutions to manage water resources so that the needs of water users are met with a reliable supply. This includes the ability to (1) monitor the supply, demand, and quality of water resources; (2) build and maintain infrastructure to deliver and treat water; (3) regulate the supply, demand, and quality of water resources; and (4) respond effectively to water crisis situations.[1]

The definition of PWM looks at core attributes of water management that can be assessed and compared at scale and are foundational to achieving broader water policy goals. In other words, the input or foundational blocks of PWM are assessed—the output of the PWM process, such as whether policy goals are met, is more complex and beyond the scope of this project.

It is therefore important that assessments of PWM be interpreted correctly. For example, PWM does not assess whether water access, environmental flows, or sustainable withdrawal rates are met. Such factors are too complex and context-dependent for the proposed method to capture. Rather, strong PWM means that local institutions deliver on core attributes of water management, and likely have the abilities to achieve water policy goals. Weak PWM indicates that local institutions fail to deliver on core attributes of water management, and likely lack the abilities to achieve sound water policy goals. In the case of weak PWM, failure to deliver core attributes of water management (e.g., uninterrupted water services) almost certainly means that goals such as universal water access, protecting environmental flows, and ensuring sustainable water balance are unmet.

Objectives

This technical note has three objectives:

1. Pilot survey: Evaluate whether the PWM method provides a feasible approach to data collection.
2. Field validation: Evaluate whether the data collected using the PWM method are a valid reflection of conditions on the ground.
3. Questionnaire update: Deliver a questionnaire for industrial water users to understand the public water management context in different locations. This questionnaire is an improved version of the questionnaire published in Kölbel et al. (2018).

2. PILOT SURVEY

2.1. Objectives

- Test the feasibility, efficiency, and effectiveness of the data collection mechanism.

2.2. Method

1. Questionnaire design. The standardized PWM questionnaire was designed after a stakeholder consultation and review of relevant tools, literature, and initiatives (Kölbel et al. 2018).
2. Partner with contributing companies. A sample was assembled from water-dependent multinational companies willing to participate. Company representatives were asked to forward the questionnaire to local staff members at 5 to 10 industrial facilities. Company representatives understood the objectives and content of the questionnaire and were asked to prioritize facilities in areas facing water-related risks.
3. Collection of responses. Responses were gathered in October and November 2017.
4. Analysis of responses. To facilitate visualization and comparison of responses, a PWM Index (PWMI) was developed to aggregate facility responses into one score. The PWMI was developed for visualization purposes but has not undergone validation or peer review (Appendix A).

2.3. Results

Participation and timing

The pilot received 41 responses from six companies distributed across 14 countries, yielding a total of 1,230 data points (Table 2). All questionnaires were completed, and with only four missing entries, the response rate at data point level was 99.7 percent. On average, participants at facilities took roughly 17.5 minutes to fill out the questionnaire, excluding outliers below 3 minutes and above 180 minutes. Values below 3 minutes indicate pdf questionnaires entered manually online; values above 180 minutes suggest that respondents left the online link open and active but were not responding.

Detailed location profiles

The PWM method allows for not only comparison of different locations but also detailed analysis of specific locations (Table 3). The example provided herein is characterized by a lack of publicly available information on both water quantity and quality, volumetric limits on groundwater abstraction, mandatory metering, and effective crisis response. These results suggest that public water managers do not know or do not publish information on water availability and quality, lack regulatory oversight to limit withdrawals of groundwater, and remain vulnerable in a time of crisis.

Geographic reach

The locations of pilot study facilities were spread across the globe (Figure 1), covering a variety of countries and hydrological conditions, including the United Kingdom, Spain, Algeria, Turkey, Lebanon, Kenya, South Africa, Bangladesh, India, China, Mexico, the United States, and Brazil. In Figure 1, a PWMI of 0.125 (red) represents weak PWM capacity, and a PWMI of 1 (green) represents strong PWM capacity, with respect to the assessed indicators.

Table 2 | **Pilot Study Summary Statistics**

Number of questionnaire responses	41
Number of companies participating	6
Number of countries	14
Number of data points	1,230
Number of missing entries	4 (0.3%)
Questionnaire completion time	Average: 17 minutes 24 seconds (n = 31) *

Note: * Does not include 10 outliers; that is, completion times of under 3 minutes or more than 180 minutes.

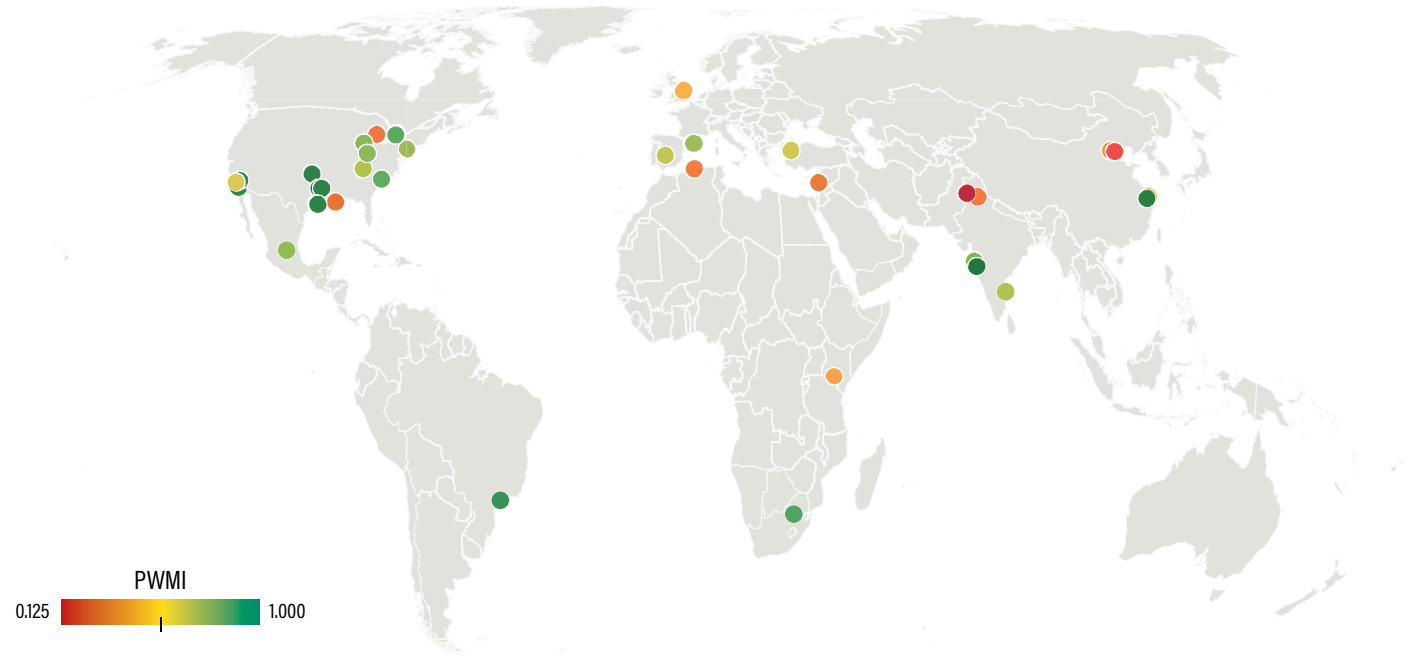
Source: Authors.

Table 3 | **Example of Location-Specific Results**

INDICATORS	RESPONSES FOR LOCATION
Information on quantity	Not publicly available
Information on quality	Not publicly available
Supply interruptions per year	None
Wastewater infrastructure	Collection and treatment
Water access regulations for groundwater	+ Permit required + Costs increase with volume - No volumetric limits - No mandatory metering
There are regular inspections.	Usually true
There is systematic enforcement.	Usually true
Industrial water users comply with regulations.	Usually true
Is there a crisis response mechanism?	Yes
Type of mechanism	If a severe drought occurs, the authorities will limit access to potable water.
Did the mechanism work during the last water crisis?	No

Source: Authors.

Figure 1 | **Spatial Distribution and PWMI of 41 Responding Locations**

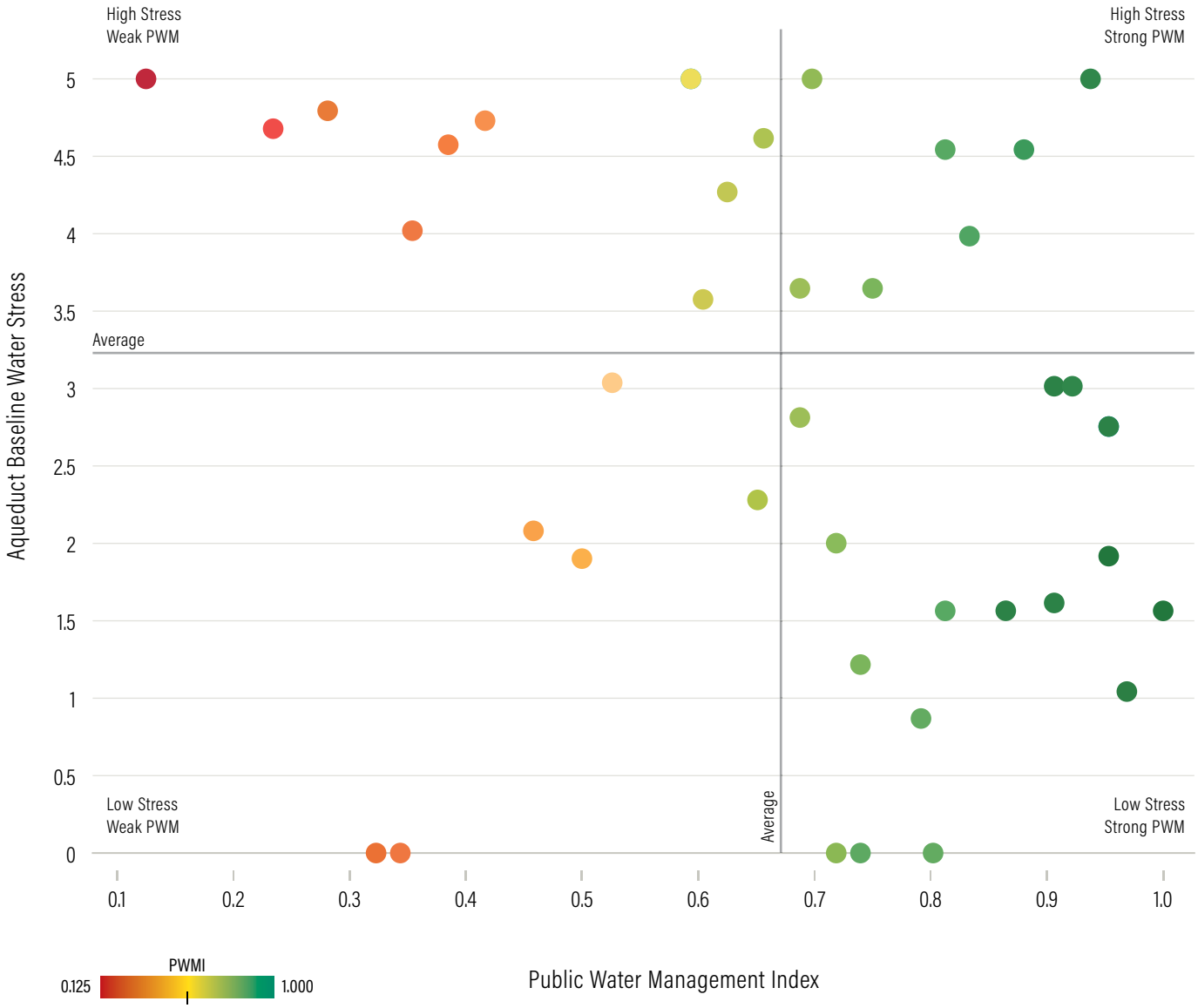


Source: Authors.

Complementarity with existing information

The pilot results were combined with Aqueduct baseline water stress values (Hofste et al. 2019) for each location (Figure 2), showing how the PWM Index can complement existing information and provide value beyond what currently exists. For example, the upper right-hand quadrant of Figure 2 identifies locations with high water stress and strong PWM, suggesting areas where water stress might be less of a concern because institutions are able to manage the available resources. The upper left-hand quadrant highlights locations with high water stress and weak PWM, where local institutions lack capacity to respond to growing water challenges.

Figure 2 | **PWMI and Baseline Water Stress Results for 41 Locations**



Note: High baseline water stress indicates high biophysical water risk.
Source: Authors.

Subnational variation

For countries with more than three observed locations, the variation of PWM was analyzed (Figure 3). The results show that the PWMI varies substantially within countries at the local scale. This indicates that there is important variation of PWM at the local scale, and that the PWM method is able to uncover this variation, which would be masked in national-level assessments.

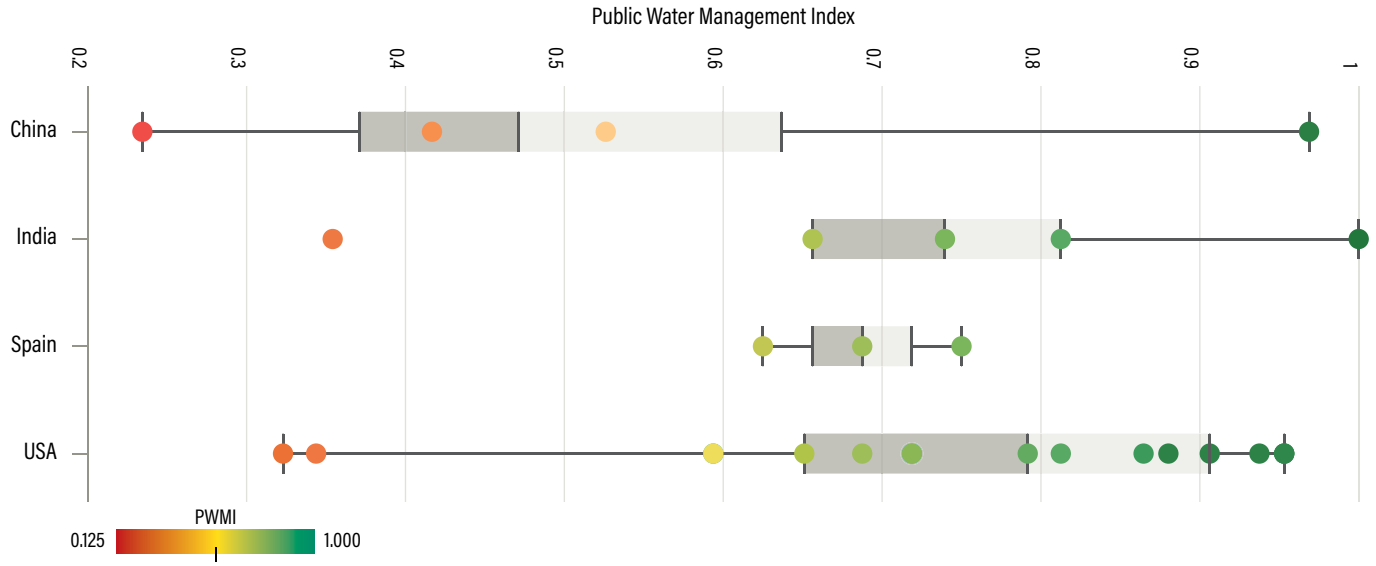
2.4. Discussion

The results suggest that the PWM method can yield scalable, globally comparable data because it possesses these attributes:

- **Contributor capacity.** An average response time of less than 20 minutes indicates that the questionnaire is not a substantial burden for corporate industrial water users. This response time suggests that other water users—with expertise on par with corporate contributors—could provide crowdsourced responses as easily.
- **Scalability.** The PWM method was deployed across corporate facilities to collect comparable data points worldwide within a few months. The pilot study shows the PWM method is effective at collecting local empirical observations from knowledgeable water users.
- **Willingness to participate.** While the pilot study only asked a small number of companies and facilities to participate, the contributors indicated strong willingness to roll out the PWM method to more facilities, and other companies have asked to participate in the mapping water management process. Enthusiasm from the private sector indicates a demand for better PWM data, and a willingness to participate in future iterations of the project.

The pilot results should not be used to assess the effectiveness of public water management in the pilot locations; the sample size is too small. Instead the purpose of these results is to assess the potential of the PWM method. Higher concentrations of data would be required to make statements about water management locations. Also, the pilot study was voluntarily performed by companies with expertise in water management, which were perhaps in the best position to provide responses. Growing the circle of contributors could yield longer response times and less complete responses.

Figure 3 | **Subnational Variation in PWMI Values in Selected Countries**



Source: Authors.

3. FIELD VALIDATION

3.1. Objectives

- Determine whether pilot study responses are valid and reflect the local water management context.
- Evaluate the perception of local stakeholders of pilot study data.

3.2. Methods

The field validation was conducted in January 2018 by Cristina Logg, a graduate student in the Massachusetts Institute of Technology Masters in City Planning Program, after the pilot study was concluded. The method for field validation is based on the research performed for a master's thesis (Logg 2018) and includes the following three steps:

1. *Choice of locations*
   The U.S. region of Southern California (home to the Los Angeles and San Diego metro areas) and the Indian state of Maharashtra (whose capital is Mumbai) were selected from the survey response locations, based on three guiding criteria:
   - Exposure to water stress
   - At least three survey responses clustered nearby
   - Distinct political, economic, and social settings
2. *Identification of interviewees*
   For each location, relevant interviewees were selected and contacted from the private sector, nonprofit organizations, academic institutions, and local, regional, and national water management authorities and service providers—prioritizing service providers in locations with data from contributing industrial facilities.
3. *Site visits and interviews*
   A field visit was conducted at both locations to obtain a firsthand account of the local context. The field visits encompassed a total of 27 interviews with 32 stakeholders, and one visit (per location) to a facility that had contributed information. Interviews with stakeholders (Appendix B) covered three topics:
   - Holistic overview of PWM at the study locations and the surrounding regions
   - Review of the anonymized responses from participating facilities for data validity
   - Review of the questionnaire to submit any reflections on the questionnaire's language, structure, and content, including missing topics

3.3. Results

Overview of locations and interview partners

The field validation included eight survey responses, five in California and three in Maharashtra (Figure 4). Field validation included 27 interviews with a total of 32 local stakeholders with intimate knowledge of the local water management context (Table 4).

General observations

- *California*. The data generated in California highlighted how the PWM method captured one important aspect of regional water management—local-level fragmentation of who is responsible for delivering water and wastewater services. The questionnaire data from the four sites in the Los Angeles area indicated that water was managed by different water management authorities, corresponding with statements by interviewees in the region, who noted the extremely fragmented nature of the public water management system. In contrast, data from San Diego showed the existence of one water provider for nearly the entire county, as well as an industrial water program supporting the long-term viability and security of water resources for industrial customers.
- *Maharashtra*. All three sites around Mumbai were in different industrial regions and serviced by the Maharashtra Industrial Development Corporation (MIDC). Though the service provider was common across all sites, pilot data suggested different user experiences between the sites. The field visit validated these findings—the MIDC uses different water sources, transfer systems, and wastewater infrastructure in different parts of Maharashtra.

Validity

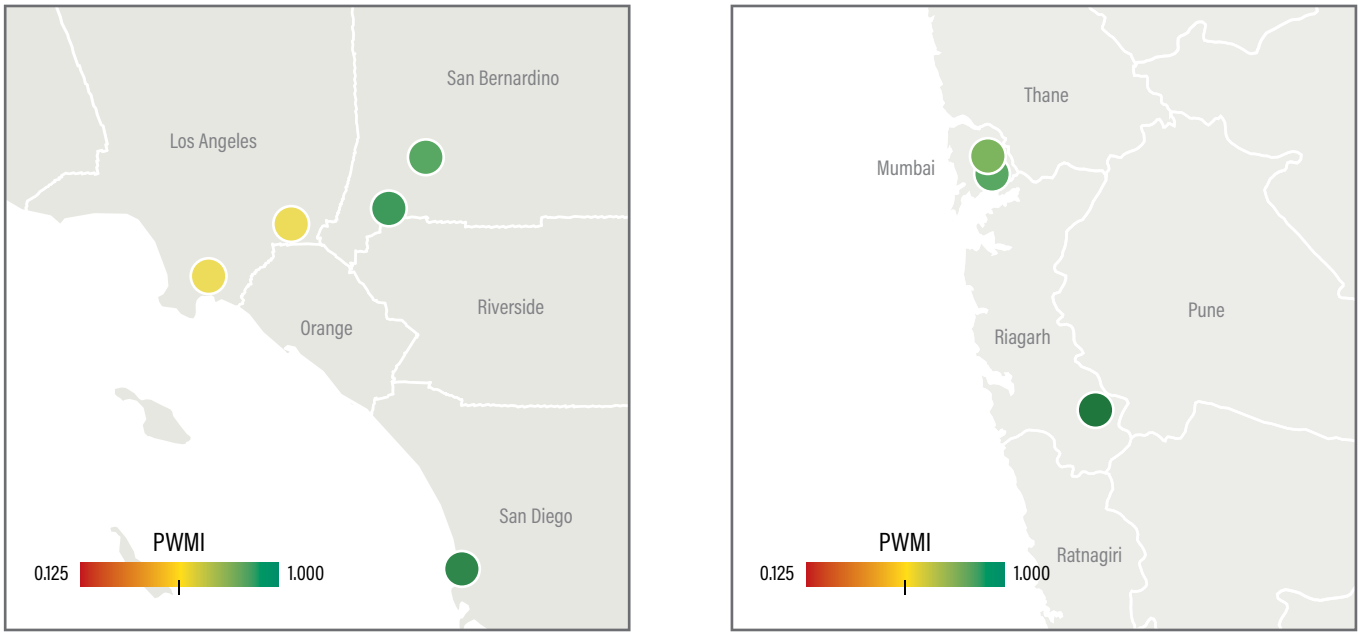
When possible, stakeholders who had not participated in the pilot reviewed local pilot results to assess whether the collected data aligned with their understanding of the local context (Table 5). Through a total of 20 external reviews, all eight pilot locations in Table 5 were reviewed

Table 4 | **Breakdown of Stakeholder Interviews during Field Validation**

STAKEHOLDER TYPE	TOTAL	MAHARASHTRA	CALIFORNIA
Public water managers	10	0*	10
NGOs	7	4	3
Corporate actor	2	1	1
Facility staff	6	2	4
Academic	2	2	0
Total	33	9	18

Note: * Efforts were made to contact 13 different relevant authorities through multiple channels with follow-up, but no government officials were available for comment in Maharashtra.
Source: Logg 2018.

Figure 4 | **Map of Field Validation Locations in California and Maharashtra**



Note: PWMI is an index representing the presence of different aspects of public water management. This index is primarily for visualization. See Appendix A for the weighting in the index.
Source: Authors.

Table 5 | **Validity Review by External Stakeholders**

PILOT LOCATION	# OF EXTERNAL REVIEWS	# OF DATA POINTS	# OF DATA POINTS CHALLENGED	WHAT WAS CHALLENGED?
Kalwe	5	16	0	
Navi	2	16	1	Intermittency rate
Mahad	2	16	1	Municipality source
San Bernardino	2	17	0	
San Diego	5	18	0	
City of Industry	1	15	1	Crisis
Ontario	1	19	1	Costs
Long Beach	2	15	1	Crisis
TOTAL	20	132	5	

Source: Logg 2018.

by at least one external stakeholder, with the majority reviewed by two or more external stakeholders. The eight validated survey responses contained 132 data points (i.e., distinct question items that stakeholders could either agree or disagree with). Of those 132 data points, 5 data points (just under 4 percent), were deemed inaccurate during the stakeholder interviews (Table 5).

Further investigation of the challenged data points in follow-up interviews revealed several reasons for divergence of responses:

- The questionnaire was being answered by a company representative who did not work on-site and did not have precise knowledge of local PWM.
- The questionnaire contained unclear language or terminology, making response difficult.
- Errors in data entry; for example, using the wrong coordinates or confusing latitude with longitude.

In addition to reviewing pilot results, the interviews also explored stakeholders' general perception of the PWM method's validity.

Regarding validity, 26 out of 31 stakeholders (83 percent) interviewed in both countries indicated they would generally trust the data produced by the PWM method. A key reason for this assessment was the perception that staff at industrial facilities have the knowledge to answer the questionnaire correctly. This view was expressed by both the interviewed facility staff themselves as well as external stakeholders. Stakeholders felt the data would be even more trustworthy if collected and shared by a third party.

Stakeholders qualified their assessment of trustworthiness in the following ways:

- Interviewees indicated that their level of trust would be greater if the questionnaire were answered by experienced, on-site staff working at facilities operated by large, multinational companies. For example, in India, multinational companies were regarded as more trustworthy and law-abiding than local or national companies.
- Interviewees (particularly in India) highlighted that facility staff may have incentives to bias their answers to avoid retaliation by poorly characterized water providers, or to falsely portray the facility's exposure to weak PWM. Stakeholders agreed that anonymity is crucial for validity, and that data from multinational companies would be more accurate than data from local businesses.
- Overall, stakeholders indicated that, in order to be effective, the data would need to be provided with sufficient density to cover entire geographies.

3.4. Discussion

The objective of the field validation as to determine the validity of pilot data through interviews with local experts. The 96 percent perceived accuracy of pilot data suggests that, at this stage, the data crowdsourcing method proposed in Kölbel et al. (2018) can produce valid data by partnering with corporate industrial water users. From the perspective of interviewed stakeholders, the pilot data were considered valid, with certain qualifications. Generally, the validation exercises suggest that the data collected reflect the experiences of industrial water users on the ground and can sometimes be a proxy for the experiences of similar water users in the area.

The field validation only covered 8 of 41 pilot study locations; therefore the conclusions are primarily valid for Southern California and Maharashtra—other locations may face different difficulties and have less accurate results. Also, the field validation represents the views of 31 stakeholders from different sectors. While most stakeholder groups were willing to share their views, the views of some stakeholders (e.g., government officials in India) are not represented in the findings.

4. QUESTIONNAIRE UPDATE

The pilot study and the field validation process revealed opportunities to improve the questionnaire design to yield responses that can provide a more accurate and valid picture of local PWM situations. As such, some of the limitations identified for the method as currently proposed have been addressed effectively through improvements to the questionnaire (Appendix C). Table 6 provides a detailed list of updates to the questionnaire. Many of these recommendations came from Logg (2018), where additional information regarding each action taken can be found.

Table 6 | **Questionnaire Feedback and Update Summary**

CATEGORY	FEEDBACK RECEIVED	ACTION TAKEN
Questionnaire structure and participation	**Support ease of answering.** Interviews and the validation analysis (Logg 2018) revealed that certain questions lacked specificity and didn't capture the full range of possible responses.	Included additional response options and updated the overall flow and structure of the questionnaire to facilitate answering and reduce errors.
	Water resources dependency. Participants and stakeholders highlighted additional types of water supplies beyond what the questionnaire accounted for.	Restructured the questionnaire to collect data and guide participants to share observations according to specific sources of water.
	Respondents. Participants, stakeholders, and the validation analysis (Logg 2018) identified the importance of having local facility staff respond to the questionnaire. Two sites in California contained inaccurate responses because the respondents didn't work on-site.	Updated the questionnaire to verify the ability of respondents to answer accurately.
Questionnaire content	**Terminology.** Facility staff (Logg 2018) expressed confusion with certain terminology and phrasing, resulting in uncertainty about how to answer and leaving room for misinterpretation.	Streamlined questionnaire with consistent, commonly accepted terminology and clear directions. Added a glossary of terms.
	Wastewater management and reclaimed water. Participants and stakeholders (Logg 2018) highlighted the lack of information on wastewater management and reclaimed water.	Included questions on wastewater management and the provision and use of reclaimed water.
	Access to information. The validation analysis (Logg 2018) revealed that the access to information section combined availability and supply, which are often published separately or not both made public by water authorities. A review of sources provided also noted the outdated nature of published reports on water quality, availability, and supply.	Separated information availability into water supply, water demand, and water quality, while also asking about the frequency of information updates.

Source: Authors.

5. CONCLUSION

The pilot study and field validation have tested two aspects of the method proposed in Kölbel et al. (2018): (a) the method's ability to collect data at speed and scale and (b) its ability to collect valid information that reflects conditions on the ground and is deemed trustworthy by local stakeholders. With some caveats, the results show that the PWM method can be characterized as possessing both qualities:

- **Scalability.** The collection of 41 data points and average response time of 17 minutes suggests that the PWM method can be crowdsourced effectively with partnered industrial water users.
- **Validity.** During the field validation, only 4 percent of data points were challenged by local stakeholders, and interviewees expressed no major concerns with the validity of present pilot data. The on-the-ground validation exercises suggest not only that the PWM information provided accurately reflects industrial water user experiences but also that it is a reasonable proxy for the local water management conditions of industrial water users.

Initial analysis of the data suggests that the collected information has the potential to significantly refine the understanding of local water management. A critical mass of corporate respondents would yield data density and dynamic information—filling a need not met by existing databases.

Despite the opportunity represented in this technical note, several shortcomings in the questionnaire or method have been identified. Where possible, questionnaire limitations have been addressed in the updated questionnaire, but these limitations remain:

- **Narrow definition of PWM.** The proposed PWM definition is limited to a small number of indicators, due to the need to not impose an excessive burden on participating respondents. The data must be interpreted appropriately and combined with other data sets where necessary. For example, the proposed data collection mechanism does not include assessment of water governance processes and stakeholder inclusiveness (OECD 2015).
- **Anonymity requirements.** To facilitate crowdsourcing by contributing companies, it is important to maintain the anonymity of respondents. Maintaining anonymity will require expanding the spatial resolution of the responses beyond specific locations, thereby sacrificing granularity and spatial resolution for anonymity.
- **Industrial focus.** The pilot study only addressed corporate industrial water users, with a limited geographic sample size. The extrapolation of information from these users to the general public water management context will vary and is not always a valid extrapolation. For example, in India, the water provider was exclusively a state-level service for industrial users—the service quality is thus likely not a full proxy for the experience of nonindustrial users with a different service in the same area.
- **Reduced precision.** The proposed database is designed to be comparable across regions. To achieve comparability, the questionnaire simplifies certain aspects of local, contextual features with less precise but still useful data points. For example, although the questionnaire measures the existence of permitting structures for water use, the complexity, sophistication, and effectiveness of those permits are not assessed—and these factors vary by managing authorities and can lead to different outcomes.

Outlook

In the long term, the possibility of crowdsourcing data from interested third-party users need not be limited to water management; the proposed method could be applied to a variety of other water-related issues. This technical note focuses on industrial water users, but another exciting possibility is applying the PWM method for other water users. As agriculture is the sector with the greatest water use, applying the PWM there would deliver valuable findings about how to improve water management to maximum effect. The proposed approach could also be applied to other issues involving common pool resources. We hope that this pilot study offers a path to improve environmental data collection to allow for better management of natural resources for the long-term sustainability of our societies.

APPENDIX A: PRELIMINARY INDEXING AND VISUALIZATIONS

The PWMI is a preliminary index, designed to provide a simple illustration of the insights that the data can provide. A different indexing method—for example, one informed by specific decision-making needs—would provide different results.

Table A1 | **Preliminary Index Weightings**

INDICATOR CATEGORY	INDICATOR NAME	INDICATOR PREDEFINED VALUE	NUMERIC VALUE	CATEGORY SUBINDEX	WEIGHT
1. Availability of information	1.1. Quantitative information on water availability and demand	Yes, publicly available	1	Average of 1.1 and 1.2	25%
		Yes, privately available	ignored		
		No	0		
	1.2. Quantitative information on water quality	Yes, publicly available	1		
		Yes, privately available	ignored		
		No	0		
2. State of infrastructure	2.1. Reliability of water supply—Number of service interruptions per year	Never	1	Average of 2.1 and 2.2	25%
		Up to 7 days	0.75		
		Up to 30 days	0.5		
		Up to 90 days	0.25		
		More than 180 days	0		
	2.2. Availability of wastewater treatment services for businesses	Collection and treatment	1		
		Collection and partial treatment	0.66		
		Collection and no treatment	0.33		
		No services available	0		
3. Water access regulations and compliance	3.1. Existence of water access regulations repeated by delivered water, self-abstracted groundwater, and self-abstracted surface water	Permit required (Y/N)	0.25	Average of 3.1 and 3.2 (3.1 is the sum of all four Y/N indicators)	25%
		Volumetric limits (Y/N)	0.25		
		Mandatory metering (Y/N)	0.25		
		Costs increase with volume (Y/N)	0.25		
		Other (Y/N)	ignored		
	3.2. Consistency of enforcement repeated by inspections, sanctions, and compliance	Usually true	1		
		Occasionally true	0.5		
		Usually not true	0		
4. Crisis response	4.2. Existence of a mechanism to limit or prioritize allocations	Yes	1	Average of 4.2 and 4.3	25%
		No	0		
	4.3. Effectiveness of mechanism during actual crisis	Yes	2		
		Partly	1		
		No	0		

APPENDIX B: STRUCTURED INTERVIEW QUESTIONS

1. How long have you worked at [Organization Name]
    a. What role do you currently fulfill?
    b. Were you employed elsewhere in this region or field before you started at [Organization Name]?
    c. Were you employed by [Organization Name] elsewhere before you were in [City/Region/Country]?
2. How is [State] and [City] water and wastewater policy and management influenced by [Country]'s national policy?
    a. What are the core responsibilities of the major institutional players at the national level?
    b. Are specific agents and/or actors (such as industrial customers or wealthy regions) prioritized during the development of national water/wastewater policy?
    c. Do industrial/commercial users of water get priority in the distribution and development (i.e., infrastructure) of water resources at the national level?
3. How is water and wastewater policy created at the local and regional level in [City] and [State]?
    a. Can you describe to me the nature of public water management in [State] state and the [City] area, particularly for industrial and commercial actors?
    b. Are specific agents and/or actors (such as industrial customers or wealthy regions) prioritized during the development of local/regional water and wastewater policy?
    c. Do industrial users of water get priority in the distribution and development (i.e., infrastructure) of water resources at the local level? How do inspection and compliance activities work within [State]/[City]?
    d. Are [City]/[State] water managers taking account of climate change into policy creation and advising?
4. [If speaking with a public water manager or advocacy organization] What is the role of [Organization] and other regional/city government organizations in assisting industrial and commercial users access water and wastewater services?
5. What do you see as the future of water resource management policy in [City]/[State] at the state and local level in the coming decades?
6. What other organizations are active in water resource management policy and advocacy at the state and regional level in [State]?
7. [Go through questionnaire] Thank you for looking at the questionnaire. Do you have any comments or concerns about the questionnaire?
    a. Do you think this questionnaire would adequately record how public water management occurs in [State/City] and its associated public water management risk to industrial/commercial customers?
    b. Are there any topics or questions missing from the survey instrument?
    c. Did any part of the assessment confuse you?
    d. How often do you think you would have to redo the assessment to ensure the data kept within it is up to date?
    e. Do you think industrial facilities will answer these questions truthfully?
    f. Do you think facility managers have the knowledge to answer the questions?
    g. Would the respondent's answers be skewed? If so, why?
    h. Why do you think multiple sites in the same basin/water authority may have answers that deviate?
    i. If I gave you these data in sufficient quantity, would you use it and trust it?
    j. How often do you think the assessment needs to be redone to ensure the data kept within the geodatabase is kept up to date?
8. Have you ever been approached or coordinated with local environmental organizations or groups of citizens concerned about water use at industrial/manufacturing facilities or pollution or wastewater from said facilities in the [City] area or [State]?
    a. If so, is this coordination a regular arrangement or a one-off occurrence?
    b. Did you have a good experience in working with or meeting with the local environmental organization or group of citizens concerned about water use at the facility level?
9. What concerns do you have about the long-term viability of industrial water use and discharge in the [City] area?
10. Do you expect the regulations and/or managing agency of public water resources to change in [City], [State], and [Country] in the future?

11. [*For facility managers*]
    a. Do you have any procedures in place for dealing with intermittent or low quality water?
    b. Has your facility experienced any issues with water quality in the last five years?
    c. Do you think the tool you filled out would have given any insight into the water risk you previously experienced had you gone through the indicators list before the incident?
    d. Do you expect the assessment conducted through this tool to be useful when determining whether to expand or contract operations at this facility?
        i. Why? Why not?
    e. How long did it take you to fill out the assessment?
    f. Would you like to walk through the questionnaire with me to point out your concerns and/or comments question by question?
    g. Did any part of the assessment confuse you? Was there any language that you found inappropriate or imprecise?
    h. How often do you think you would have to update your facility's assessment to ensure the data kept within it is up to date?
    i. Do you think other industrial users in your area will answer these questions truthfully?
    j. What are the policies you must follow for sewage and wastewater?
        i. Does your local wastewater service provider treat and sell recycled water?
            1. Do you have the opportunity to purchase recycled water to use at your facility?
            2. Has your facility ever experienced a sewage or effluent spill on site?
        ii. Do any of your facilities operate a zero or low-liquid-discharge facility? If so, is it required by the government?
            1. How do you use your treated water internally?
    k. Does [Company] have a stormwater management plan for its sites in [Country]?
        i. If so, is this required by state/local/regional authorities?
        ii. Does stormwater from the site go into the sewage stream that is treated in the local wastewater treatment center or is it diverted into surface water streams?
    l. Are you in regular contact with the local authority responsible for public water management?
        i. If so, what form does this contact take? (i.e., regularly scheduled meetings in person, phone calls, check up via email, meeting during local events)
            1. If so, how often are you in contact?
            2. If so, is this contact largely only focused on inspection and compliance activities?
        ii. How often does your facility get inspected?
            1. Is the facility inspected by the same inspector every time or does it change?
        iii. Do you find that it is important to keep a relationship with the individual(s) who work for the local water authority?
    m. What information do you wish you had about public water management in the region you are in?
        i. Do you wish you had more or less coordination with the local water authorities?
        ii. Do you wish you had more or less coordination with local organizations concerned about the water use at the facility or the effluent from the facility?
12. Do you expect the regulations and/or managing agency of public water resources to dramatically change in the future?
    a. If so, in what direction and why?

APPENDIX C: UPDATED SURVEY INSTRUMENT

As of April 2020 the following survey instrument represented the authors' latest thinking. The online version of this survey may be subject to changes based on new information.

This questionnaire is intended for **on-site facility staff or individuals who have sufficient experience on-site** to confidently assess the state of public water management in the area that concerns their facility. It contains questions about the availability of information, the state of infrastructure, water access regulations, and crisis response.

The questionnaire is part of a project that is run jointly by World Resources Institute and Pacific Institute. The objective is for this questionnaire to become part of facility water risk assessments, and that by sharing the responses we create a global dataset of public water management practices.

All data will be kept confidential and are not linked to your personal identity. Research based on the data will not disclose the exact location of your facility. Also, responses will not be linked to your organization unless we obtain explicit permission to do so.

The questionnaire will take 15 to 30 minutes to complete. We appreciate your support.

General Guidance

- ○ (*Circle*) indicates a question with one answer (select only one)
- ☐ (*Square*) indicates a question with multiple possible answers (select as many as apply)
- ___ *(Line)* indicates a question with free text answer

1. Location and Water Source

1.1. Please provide your facility address OR coordinates.

Street address: _____

City: _____

Postal code: _____

Country: _____

Latitude* (e.g., 44.968046): _____

Longitude* (e.g., –94.420307): _____

*Latitude and longitude: We recommend using a website such as http://www.latlong.net/ or https://gps-coordinates.org/ to identify these coordinates.

1.2. Please select all of the water sources used at your facility.

- ☐ Delivered water (including potable/raw, recycled/reclaimed, trucked/piped)
- ☐ Self-extracted groundwater
- ☐ Self-extracted surface water

1.3. Please select your respondent status.

- ☐ I work at the facility I am responding for.
- ☐ I do not work at the facility I am responding for.
- ☐ Other type (please specify): _____

2. Water Discharge and Treatment

2.1. Are wastewater* services provided to your facility?

- ○ Yes, our local provider collects our wastewater for treatment and/or disposal.
- ○ No, we do not receive wastewater services (i.e., water is directly treated and/or disposed of on-site).
- ○ I don't know.

* Wastewater includes effluent, sewage, and other forms of water contaminated and/or produced following commercial, industrial, and human activities. This refers only to services offered by a local provider. The question does not refer to wastewater collection or treatment performed by the facility itself, because the focus of the survey is public water management. For the purposes of this survey, wastewater does not include stormwater.

2.2. [*If "Are wastewater services provided to your facility?" is answered with "Yes..."*] Who provides wastewater services to your facility? _____

2.3. Is your facility legally required to conduct on-site treatment of wastewater?

- ○ Yes, we are legally required to treat wastewater by law, regulation, license, and/or permit and legally required to use this on-site treated wastewater within the facility grounds (i.e., for landscaping, cooling, fire suppression).
- ○ Yes, we are legally required to treat wastewater by law, regulation, license, and/or permit but are not legally required to use this on-site treated wastewater within the facility grounds.
- ○ No.
- ○ I don't know.

2.4. Do water users surrounding your facility comply with existing regulations on water discharge and treatment?

- ○ Yes.
- ○ Some.
- ○ No.
- ○ I don't know.

3. Information Availability

Do you have access to publicly available quantitative information* on the following variables for your region from public sources? Please select all that apply.

	YES, QUANTITATIVE INFORMATION IS PUBLICLY AVAILABLE.	NO, THERE IS NO QUANTITATIVE INFORMATION PUBLICLY AVAILABLE.	I DON'T KNOW WHETHER THERE IS QUANTITATIVE INFORMATION PUBLICLY AVAILABLE.
3.1. Water supply	○	○	○
3.2. Water demand	○	○	○
3.3. Water quality	○	○	○

* Quantitative information: Refers to numerical data as contained in reports and/or estimates, studies, catchment management plans, or service provider websites. Information must be from a public entity. Private information collected internally by a facility or water user does not apply.

If information is publicly available, please specify when it was most recently updated, where it can be accessed, and provide a link if available:

3.1a. Water supply information: _____

3.2a. Water demand information: _____

3.3a. Water quality information: _____

4. Delivered Water *[Only appears if this type of water source is selected above]*

The following questions are about the public water management of delivered water resources in your area.

4.1. Who are your delivered water service provider(s)?

4.1a. Primary provider: _____

4.1b. Secondary provider: _____

4.1c. Tertiary provider: _____

Please answer the following questions about your primary delivered water service provider, not your secondary and/or additional delivered water service providers.

Water Infrastructure and Access Regulations

4.2. Over the last year, on how many days did the local water service provider provide intermittent supply* of water to your location? Please select one answer.

- ○ Never
- ○ Between 1 and 7 days
- ○ Between 8 and 30 days
- ○ Between 31 and 90 days
- ○ More than 90 days

* Intermittent supply: Refers to low pressure, low (unusable quality), or no water supply.

4.3. How is the facility charged for delivered water? (Please select all that apply.)

- ☐ The facility is not charged for the use of delivered water.
- ☐ A volumetric tariff that is proportional (linear) to withdrawal*
- ☐ A volumetric tariff that increases with withdrawal (increasing-block-tariff)**
- ☐ A volumetric tariff that decreases with withdrawal (decreasing-block-tariff)***
- ☐ A flat rate charged no matter the volume of water withdrawn****
- ☐ Other type (please specify): _____
- ☐ I don't know.

* A volumetric tariff that is proportional (linear) to withdrawal: Check box if the price you pay per volumetric amount stays the same no matter how much water your facility consumes (i.e., water is charged at a constant rate of $0.15 per cubic meter).

** A volumetric tariff that increases with withdrawal (increasing-block-tariff): Check box if the price you pay for water increases per volumetric measurement the more water you purchase (i.e., for the first hundred cubic meters water is $0.10 per cubic foot; for the next thousand cubic meters, water is $0.25 per cubic foot).

*** A volumetric tariff that decreases with withdrawal (decreasing-block-tariff): Check box if the price you pay for water decreases per volumetric measurement the more water you purchase (i.e., for the first hundred cubic meters water is $0.50 per cubic foot; for the next thousand cubic meters, water is $0.25 per cubic foot).

****A flat rate charged no matter the volume of water withdrawn: Check box if your facility pays a single charged fee irrespective of the amount of water consumed. An example of this can be when a facility is charged only for a permit or license to access water or for the use of a meter but not for how much water it uses.

4.4. Which water access regulations apply to the use of delivered water? (Please select all that apply.)

- ☐ Permit/license required*
- ☐ Volumetric limits (regulatory)**
- ☐ Mandatory metering (self-conducted)***
- ☐ Mandatory metering (conducted by utility or third party)****
- ☐ There are no water access regulations in place.
- ☐ Other type (please specify):***** _____
- ☐ I don't know.

* Permit/license required: Check box if you need any form of authorization to use this source. Such authorizations may be called, for example, permits, licenses, water rights, allocations, or licenses.

** Volumetric limits (regulatory): Check box if there are any regulatory limits on daily, monthly, or yearly volumes that may be withdrawn. Leave unchecked if there are no regulatory limits. Please note that this does not include technical limits due to meter size, pipe diameter, or other technical specification of infrastructure.

*** Mandatory metering (self-conducted): Check box if you are legally required to measure and report to your service provider the amount of water that is taken from the source.

**** Mandatory metering (conducted by utility or third party): Check box if your utility measures the amount of water that you receive or take from the source.

***** Other: Select this option if you would like to supply information that is not offered in the question.

Inspection and Compliance

	YES, REGULARLY (MORE THAN TWICE A YEAR).	YES, SOME OF THE TIME OR IRREGULARLY (LESS THAN TWICE A YEAR).	NO, NEVER.	I DON'T KNOW.
4.5. Are inspections of the meters, pipes, and permits performed by your delivered water service provider in your service provider area?	○	○	○	○

5. Self-Extracted Groundwater [*Only appears if this type of water source is selected above*]

The following questions are about the public water management of self-extracted groundwater resources in your area.

5.1. Who regulates your groundwater extraction and what is the basin or aquifer you extract groundwater from?

Regulator: _____

Water body 1: _____

Water body 2 (if applicable): _____

Water body 3 (if applicable): _____

Water body 4 (if applicable): _____

Water Infrastructure and Access Regulations

5.2. How is the facility charged for self-extracted groundwater? (Please select all that apply.)

- ☐ The facility is not charged for the use of self-extracted groundwater water.
- ☐ A volumetric tariff that is proportional (linear) to withdrawal*
- ☐ A volumetric tariff that increases with withdrawal (increasing-block-tariff)**
- ☐ A volumetric tariff that decreases with withdrawal (decreasing-block-tariff)***
- ☐ A flat rate charged no matter the volume of water withdrawn****
- ☐ Other type (please specify): _____
- ☐ I don't know.

* A volumetric tariff that is proportional (linear) to withdrawal: Check box if the price you pay per volumetric amount stays the same no matter how much water your facility consumes (i.e., water is charged at a constant rate of $0.15 per cubic meter).

** A volumetric tariff that increases with withdrawal (increasing-block-tariff): Check box if the price you pay for water increases per volumetric measurement the more water you purchase (i.e., for the first hundred cubic meters water is $0.10 per cubic foot; for the next thousand cubic meters, water is $0.25 per cubic foot).

*** A volumetric tariff that decreases with withdrawal (decreasing-block-tariff): Check box if the price you pay for water decreases per volumetric measurement the more water you purchase (i.e., for the first hundred cubic meters water is $0.50 per cubic foot; for the next thousand cubic meters, water is $0.25 per cubic foot).

**** A flat rate charged no matter the volume of water withdrawn: Check box if your facility pays a single charged fee irrespective of the amount of water consumed. An example of this can be when a facility is charged only for a permit or license to access water or for the use of a meter but not for how much water it uses.

5.3. Which water access regulations apply to the use of self-extracted groundwater? (Please select all that apply.)

- ☐ Permit/license required*
- ☐ Volumetric limits (regulatory)**
- ☐ Mandatory metering (self-conducted)***
- ☐ Mandatory metering (conducted by utility or third party)****
- ☐ There are no water access regulations in place.
- ☐ Other type (please specify):***** _____
- ☐ I don't know.

* Permit/license required: Check box if you need any form of authorization to use this source. Such authorizations may be called, for example, permits, licenses, water rights, allocations, or licenses.

** Volumetric limits (regulatory): Check box if there are any regulatory limits on daily, monthly, or yearly volumes that may be withdrawn. Leave unchecked if there are no regulatory limits. Please note this does not include technical limits due to meter size, pipe diameter, or other technical specification of infrastructure.

*** Mandatory metering (self-conducted): Check box if you are legally required to measure and report to your service provider the amount of water that is taken from the source.

**** Mandatory metering (conducted by utility or third party): Check box if your utility measures the amount of water that you receive or take from the source.

***** Other: Select this option if you would like to supply information that is not offered in the question.

Inspection and Compliance

	YES, REGULARLY (MORE THAN TWICE A YEAR).	YES, SOME OF THE TIME OR IRREGULARLY (LESS THAN TWICE A YEAR).	NO, NEVER.	I DON'T KNOW.
5.4. Are inspections of the meters, pipes, and permits performed by your self-extracted groundwater service regulator in your area?	○	○	○	○

5.5. Do groundwater users surrounding your facility comply with existing regulations on self-extracted groundwater use?

- ○ Yes.
- ○ Some.
- ○ No.
- ○ I don't know.

6. Self-Extracted Surface Water *[Only appears if this type of water source is selected above]*

The following questions are about the public water management of surface water resources in your area.

6.1. Who regulates your extraction of surface water and what surface water body do you extract from?

Regulator: _____

Water body 1: _____

Water body 2 (if applicable): _____

Water body 3 (if applicable): _____

Water body 4 (if applicable): _____

Water Infrastructure and Access Regulations

6.2. How is the facility charged for self-extracted surface water? (Please select all that apply.)

- ☐ The facility is not charged for the use of self-extracted surface water.
- ☐ A volumetric tariff that is proportional (linear) to withdrawal*
- ☐ A volumetric tariff that increases with withdrawal (increasing-block-tariff)**
- ☐ A volumetric tariff that decreases with withdrawal (decreasing-block-tariff)***
- ☐ A flat rate charged no matter the volume of water withdrawn****
- ☐ Other type (please specify): _____
- ☐ I don't know.

* A volumetric tariff that is proportional (linear) to withdrawal: Check box if the price you pay per volumetric amount stays the same no matter how much water your facility consumes (i.e., water is charged at a constant rate of $0.15 per cubic meter).

** A volumetric tariff that increases with withdrawal (increasing-block-tariff): Check box if the price you pay for water increases per volumetric measurement the more water you purchase (i.e., for the first hundred cubic meters water is $0.10 per cubic foot; for the next thousand cubic meters, water is $0.25 per cubic foot).

*** A volumetric tariff that decreases with withdrawal (decreasing-block-tariff): Check box if the price you pay for water decreases per volumetric measurement the more water you purchase (i.e., for the first hundred cubic meters water is $0.50 per cubic foot; for the next thousand cubic meters, water is $0.25 per cubic foot).

**** A flat rate charged no matter the volume of water withdrawn: Check box if your facility pays a single charged fee irrespective of the amount of water consumed. An example of this can be when a facility is charged only for a permit or license to access water or for the use of a meter but not for how much water it uses.

6.3. Which water access regulations apply to the use of self-extracted surface water? (Please select all that apply.)

- ☐ Permit/license required*
- ☐ Volumetric limits (regulatory)**
- ☐ Mandatory metering (self-conducted)***
- ☐ Mandatory metering (conducted by utility or third party)****
- ☐ There are no water access regulations in place.
- ☐ Other type (please specify):***** _____
- ☐ I don't know.

* Permit/license required: Check box if you need any form of authorization to use this source. Such authorizations may be called, for example, permits, licenses, water rights, allocations, or licenses.

** Volumetric limits (regulatory): Check box if there are any regulatory limits on daily, monthly, or yearly volumes that may be withdrawn. Leave unchecked if there are no regulatory limits. Please note this does not include technical limits due to meter size, pipe diameter, or other technical specification of infrastructure.

*** Mandatory metering (self-conducted): Check box if you are legally required to measure and report to your service provider the amount of water that is taken from the source.

**** Mandatory metering (conducted by utility or third party): Check box if your utility measures the amount of water that you receive or take from the source.

***** Other: Select this option if you would like to supply information that is not offered in the question.

Inspection and Compliance

	YES, REGULARLY (MORE THAN TWICE A YEAR).	YES, SOME OF THE TIME OR IRREGULARLY (LESS THAN TWICE A YEAR).	NO, NEVER.	I DON'T KNOW.
6.4. Are inspections of the meters, pipes, and permits performed by your self-extracted surface water service regulator in your area?	○	○	○	○

6.5. Do surface water users surrounding your facility comply with existing regulations on self-extracted surface water use?

- ○ Yes.
- ○ Some.
- ○ No.
- ○ I don't know.

7. Crisis Response

7.1. Has a water crisis* resulting in water shortages occurred in the past five years?

- ○ Yes, an acute (short-term) crisis has occurred.
- ○ Yes, a prolonged (1+ year) crisis has occurred.
- ○ Yes, multiple crises of an acute and/or a prolonged nature have occurred.
- ○ No.

* Water crisis: Refers to any condition where water resource availability is insufficient for demand, relative to normal conditions of water availability and demand. Please select "yes" even if a crisis has not directly impacted facility operations.

7.2. Are there any mechanisms* imposed by government, utilities, or regulators to limit and prioritize water access during a water crisis in your area?

- ○ Yes.
- ○ No.
- ○ I don't know.

* Mechanisms: Any policy, regulation, and/or technological tool that establishes limits or priorities during a water crisis. For example, contingency plans by water service providers, legal norms that specify priority, or administrative bodies that are tasked with allocating water under crisis conditions. This would not include voluntary, company-led initiatives to limit water withdrawal.

7.2a. *[If "Are there any mechanisms* imposed by government, utilities, or regulators to limit and prioritize water access during a water crisis in your area?" is answered with "Yes"]* You stated there is a mechanism to limit and prioritize water access during a water crisis. Please provide a brief description of this government or utility mechanism, and who was responsible for its development and enforcement. _____

7.3. Was the mechanism you described above successful in achieving its stated aims?

- ○ Yes.
- ○ No.
- ○ I don't know.

Response Validation

8.1. How confident are you in your understanding of the public water management context around your facilities, and the corresponding answers to the questions above?

- ○ Very confident.
- ○ Somewhat confident.
- ○ Not confident.
- ○ I don't know.
- ○ Other (Please specify): _____

ENDNOTES

1. For more detailed discussion of what indicators are measured and why these indicators were selected, see Kölbel et al. (2018).

REFERENCES

Araral, E., and Yahua Wang. 2013. "Water Governance 2.0: A Review and Second Generation Research Agenda." *Water Resources Management* 27: 3945–57. https://link.springer.com/content/pdf/10.1007%2Fs11269-013-0389-x.pdf.

GWP (Global Water Partnership). 2000. *Towards Water Security: A Framework for Action*. https://www.gwp.org/globalassets/global/toolbox/references/towards-water-security.-a-framework-for-action.-mobilising-political-will-to-act-gwp-2000.pdf.

Hofste, R.W., S. Kuzma, S. Walker, E.H. Sutanudjaja, M.F.P. Bierkens, M.J.M. Kuijper, M.F. Sanchez, et al. 2019. *Aqueduct 3.0: Updated Decision-Relevant Global Water Risk Indicators*. Washington, DC: World Resources Institute. https://www.wri.org/publication/aqueduct-30.

Kölbel, J., C. Strong, C. Noe, and P. Reig. 2018. "Mapping Public Water Management by Harmonizing and Sharing Corporate Water Risk Information." Technical note, March. Washington, DC: World Resources Institute. www.wri.org/publication/mapping-public-water.

Logg, C.A. 2018. "Crowdsourcing Corporate Water Data: A Validity Test of a Pilot Survey Instrument to Map Public Water Management–Related Risk Worldwide." Master's thesis, Massachusetts Institute of Technology. https://dspace.mit.edu/handle/1721.1/118242.

OECD (Organisation for Economic Co-operation and Development). 2015. "OECD Principles on Water Governance." http://www.oecd.org/governance/oecd-principles-on-water-governance.htm.

UNEP-DHI (UN Environmental Programme—Centre on Water and Environment). 2018. *Step-by-Step Monitoring Methodology for SDG Indicator 6.5.1*.

WEF (World Economic Forum). 2019. *The World Risk Report 2019.* https://www.weforum.org/reports/the-global-risks-report-2019.

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ABOUT PACIFIC INSTITUTE

The Pacific Institute envisions a world in which society, the economy, and the environment have the water they need to thrive now and in the future. In pursuit of this vision, the Institute creates and advances solutions to the world's most pressing water challenges, such as unsustainable water management and use; climate change; environmental degradation; food, fiber, and energy production for a growing population; and basic lack of access to freshwater and sanitation. Since 1987, the Pacific Institute has cut across traditional areas of study and actively collaborated with a diverse set of stakeholders, including policymakers, scientists, corporate leaders, international organizations such as the United Nations, advocacy groups, and local communities. This interdisciplinary and nonpartisan approach helps bring diverse interests together to forge effective real-world solutions. More information about the Institute and our staff, directors, and funders can be found at www.pacinst.org.

ABOUT UNGC CEO WATER MANDATE

The CEO Water Mandate is a UN Global Compact commitment platform—implemented in partnership with the Pacific Institute—that mobilizes a critical mass of business leaders to address global water challenges through corporate water stewardship, in partnership with the United Nations, governments, civil society organizations, and other stakeholders. Endorsers of the CEO Water Mandate recognize that they can identify and reduce critical water risks to their businesses, seize water-related opportunities, and contribute to the Sustainable Development Goals. The Mandate offers a unique platform to share best and emerging practices and to forge multi-stakeholder partnerships to address challenges related to water scarcity, water quality, water governance, and access to water and sanitation.

UN GLOBAL COMPACT CEO Water Mandate

ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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