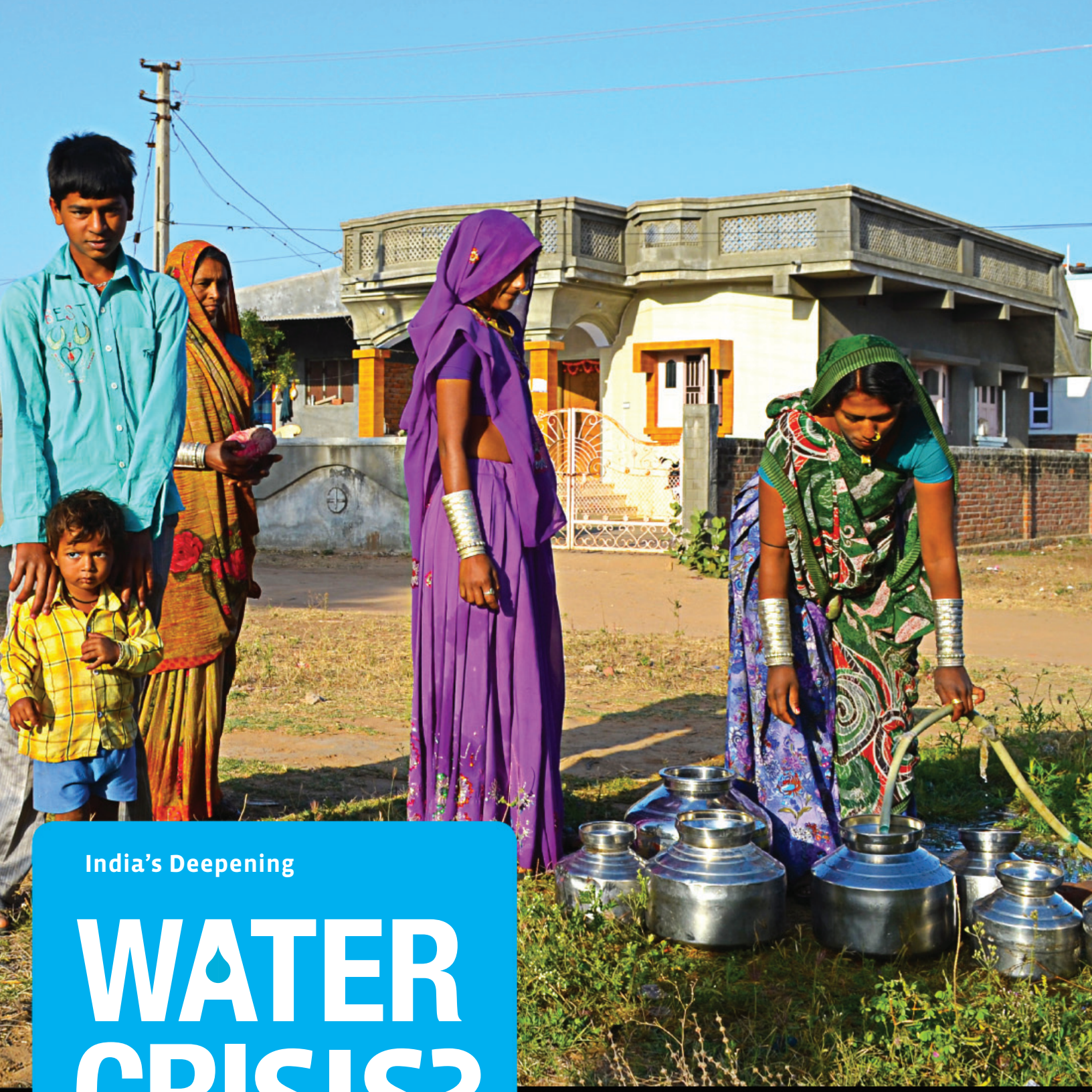

India's Deepening

WATER CRISIS?

Water Risks for Indian Industries

A Preliminary Study of 27 industrial sectors

Shama Perveen
Romit Sen
Mayuri Ghosh

February, 2012

FICCI

Columbia Water Center
Earth Institute | Columbia University

Federation of Indian Chambers of Commerce and Industry (FICCI) and Columbia University Water Center (CWC) Report

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MESSAGE FROM THE CHAIRPERSON, FICCI WATER MISSION

Naina Lal Kidwai
Senior Vice President, FICCI
Country Head HSBC India and
Director HSBC Asia Pacific

Water is fast becoming a scare resource. India's growing economy will translate into increased demand for water across different sectors. Various estimates and projections indicate an increasing trend in water demand for agriculture, industrial and domestic uses in the coming decades.

While we grapple with developing ways and means to address the problems of safe water availability, managing water quality and sustainable use of freshwater, particularly groundwater resources, there is a debate on - who should be considered most responsible for the growing water stress and whose primary responsibility is it to take measures for preserving and protecting our water resources. The normal argument will certainly be that it is the responsibility of every user to see that water is not wasted, rainwater is harvested, wastewater is recycled and reused, and pollution of water is prevented.

Indian industry is realizing the importance of water, its conservation and management. This is not only because of the growing scarcity and poor water quality impacting industrial operations, but also the fact that Indian companies are becoming conscious of their responsibility to conserve natural resources.

FICCI constituted a Water Mission to work with its membership on water management. The Mission is developing programmes of research and advocacy to promote the cause of water conservation and efficiency, and water recycling and reuse practices within companies.

In this context, the study on Water Risks for Indian Industries with Columbia Water Centre is an important initiative. Preliminary findings presented in this report indicate that water availability and poor water quality are becoming important concerns for Indian businesses. The fact that more and more companies are undertaking water audits indicate the growing interest to measure water utilization in units and take measures for plugging leakages.

The study will also make an attempt to better understand the risks facing each of the water intensive industrial sectors. My best wishes to the study team at FICCI and Columbia University.

MESSAGE FROM THE DIRECTOR, COLUMBIA WATER CENTER

Upmanu Lall
Director
Columbia Water Center
Earth Institute,
Columbia University

Of all countries in the world, India is special. It is special in the will and skill of its people, in their sense of community, and in their composure in the face of enormous diversity and adversity.

It is special in the resource challenges it faces, in the number of people so challenged, and in how these challenges may affect the aspirations of the Indian industrial sector which is excited about the prospects of a growing Indian economy and its reach to distant corners of the world, from Europe to the Americas to Africa to Asia and Australia.

India's domestic companies- long used to constraints related to minerals, energy and other primary materials — are just waking up to the persistent and growing shortage of water, and to the potential challenges recurrent and extreme floods pose to the emergence, stability and competitiveness of their supply chains whether they are focused on the domestic or the international market. Deteriorating water quality and its chronic health impacts on the populace emerge as a sinister side issue that brings with it regulatory and labor productivity risks.

These challenges are not unique to the Indian industrial sector only. The water-energy-food-climate nexus has grabbed worldwide attention. It is at the center of the discussion of global risks at the World Economic Forum, and at the major Global Policy forums such as Rio+20. The insurance industry and the Supply Chain Risk Leadership Council are also converging on water and climate as interlinked portfolio risks to manage for supply chains and for cities, especially in the context of bonds and other lending instruments.

In the Indian context, the key issues to understand are how efforts to achieve food security through irrigation lead to subsidy systems that promote egregious groundwater pumping, and how the energy and water use thus stimulated impacts all sectors of the economy through poorer water and energy reliability for industry and households. How much of the increased cost of self generation of electricity, and the additional cost of purifying polluted water is due to practices in agriculture or other sectors, and what is the social or actual cost of reducing these impacts. Do they impact the competitiveness of the Indian industrial sector and its ability to innovate products that could be delivered at more attractive price points to the Indian or global consumer? At what point would the water and energy constraints and associated climate risks force the Indian industrial sector to look to production and sourcing in other countries, even if there is an untapped and inexpensive domestic labor market?

While skilled Indian labor is inexpensive by international standards in raw terms, its competitiveness is hampered by low productivity. Is this low productivity partially related to the negative health impacts arising from poor access to water and energy? What should companies in India do proactively to stimulate government and other efforts to economically, efficiently, and equitably address these issues and contribute to the country's sustainable economic development — as well as their own?

It is in this context that I am particularly pleased that FICCI and the Columbia Water Center are collaborating on a formal look at the current industry perceptions of the water crisis, to identify which problems are clearly identified, what is being done about them, as well as to help the industrial sector at large get a grip on what data should be formally collected, how it should be analyzed and how the sector should collectively address the internal and external policy frameworks to quickly address the existing and emerging risks.

I congratulate the authors on an important step in what promises to be a significant effort to bring the best thinking in industry and academia to address India's water challenge.

FOREWORD

Romit Sen
Senior Assistant Director,
Water Division, FICCI
romit.sen@ficci.com

Shama Perveen
Scientist, Columbia Water Center
Earth Institute,
Columbia University
sp2972@columbia.edu

Companies globally are increasingly focused on the emerging risk of water scarcity, and so are their investors. The combination of rising populations, rapid economic growth in developing countries, and climate variability is triggering enormous water availability challenges around the world. We are at a critical juncture where the crises of food, energy and water, commodity price volatility, energy reliability, and fears of whether food production will be enough calls for a rethinking of our business-as-usual approaches.

As part of corporate social responsibility and certification efforts, companies are already promoting water conservation and reuse, rainwater harvesting, and wastewater treatment among other initiatives. While this is undoubtedly a good start, a truly strategic environmentally and financially sustainable management plan requires a better understanding of the climate risks and a finer level understanding of water use patterns in industrial operations and supply chains. This becomes especially important for water intensive sectors and where the probability of impacts in the supply chain operations and the communities surrounding it are much higher.

Unfortunately, there are very few assessments of how and where different industrial sectors, consisting of small, medium and large enterprises are managing climate and water related risks and challenges, and their response strategy for risk mitigation/adaptation. This gap arises due to sparse public domain data, inconsistent standards in data management, lack of useful analytical tools and the absence of a transparent mechanism to assess the relevance and accuracy of existing information. As a result, the development of sector-specific policies that could influence a sustained growth strategy for industrial sector amidst competing demands from the agriculture and domestic sectors is seriously impaired.

Based on this understanding, if the macro-level information for water supply and use can be combined with locally-relevant information and presented to businesses in a value-added manner (e.g. local water availability and pricing trends, changing agriculture production policies, and information about other local complementary businesses and markets, reuse and recycle opportunities and associated tax benefits), then the individual business person will be able to make significantly better decisions and cope with eventual changes in a robust manner.

Columbia University's Water Center (CWC) is engaged in cross-cutting and leading research on climate-water risk analysis and pioneered techniques for seasonal to inter-annual climate and hydrologic forecasts. Experience from multiple engagements at the Central, State and local levels (including farmers and corporates) in India and elsewhere provide a useful building block for laying out an informed and strategic approach for such an analysis.

FOREWORD

The Water Mission launched by FICCI encourages industry players to focus on water conservation in their organizations. The Mission is engaged in research and documentation of best practices, policy advocacy and capacity building activities with its members. It is also engaged in collaborating with institutions working on industrial/corporate water management.

In partnership with FICCI, CWC undertook a preliminary national level geospatial study of water risks perceptions and responses across 27 industrial sectors in India, including food processing, textiles, energy, oil and gas, retail, pharmaceuticals, information technology and health services.

The overwhelming response from the study was that industries do realize that water risks are real and a number of them are already conducting regular audits to figure out avenues for conservation and efficiency. However, given the lack of much information, ensuring that the industrial sector and the policymaker are seeing the same data and interpreting the data in the same manner is the first step to ensuring that both the policymakers and industry move in lockstep with each other in response to foreseen changes.

The next phase of our study is oriented towards conducting comprehensive within-industry sector-specific surveys for detailed risk assessments. This will help us develop risk models that can be useful at local scales and permit informed decision making. Corporates, with their motivation for entrepreneurship, innovation and technology, with the added goal of positive social impact have the capability to stimulate capacity development that has a real near term impact.

The fact much water-related infrastructure is still to be developed in India provides an opportunity. This study will identify such opportunities for the private and public sector to jointly address the potential water challenges for improving water stewardship and competitiveness in the global setting.

WATER RISKS FOR INDIAN INDUSTRIES: MOTIVATION FOR THIS STUDY

India is facing serious and persistent water resource crisis owing to a growing imbalance of supply and demand. The simultaneous effects of agricultural growth, industrialization and urbanization coupled with declining surface and groundwater quantity, intra and interstate water disputes, and inefficiencies in water use practices are some of the crucial problems faced by India's water sector. The effects of climate variability and change, including reduced water flows from melting glaciers and increasing frequency of extreme phenomena such as floods, tropical storms or droughts, are also creating pressures on scarce water supplies (Pegram, 2009).

With a population of more than 1.2 billion, an agricultural economy based on intensive irrigation, and fast developing large urban industrial centers, there are a wide range of activities that have the potential to jeopardize the sustainability of available water resources in India. Poor and unreliable surface water supply has led farmers and urban dwellers to resort to unchecked groundwater pumping as an adhoc adaptation mechanism.

Around 92 percent of India's irrigation needs and 85 percent of its domestic water supplies alone comes from groundwater (Planning Commission, 2002). While this practice has been remarkably successful in helping people deal with variability in both municipal water supply and climate – the deep groundwater levels are consistently dropping, and flow in major rivers has been decreasing in the dry season.[1] The critically depleted and (polluted) aquifers signal a risky future for India's sustained economic growth and development (Lall et al., 2008).

Rainfall variability plays a significant role in economic growth and is a costly source of vulnerability. Brown and Lall (2006) have demonstrated that globally, greater rainfall variability is statistically associated with lower per capita incomes. In the context of India, the uneven distribution of water resources in time and space is a critical challenge for water management.

As seen in Figure 1, there are several zones of excessive rainfall comprising the Western Ghats and the outer slopes of the Himalayas, nearly the whole of Assam and the eastern fringe of the Gangetic delta. The annual rainfall in these areas varies from 1250 mm to greater than 2500 mm. The arid and semi-arid western and north western parts of India have less than 750 mm of rainfall per year, and in certain limited tracts as little as 250 mm per year.

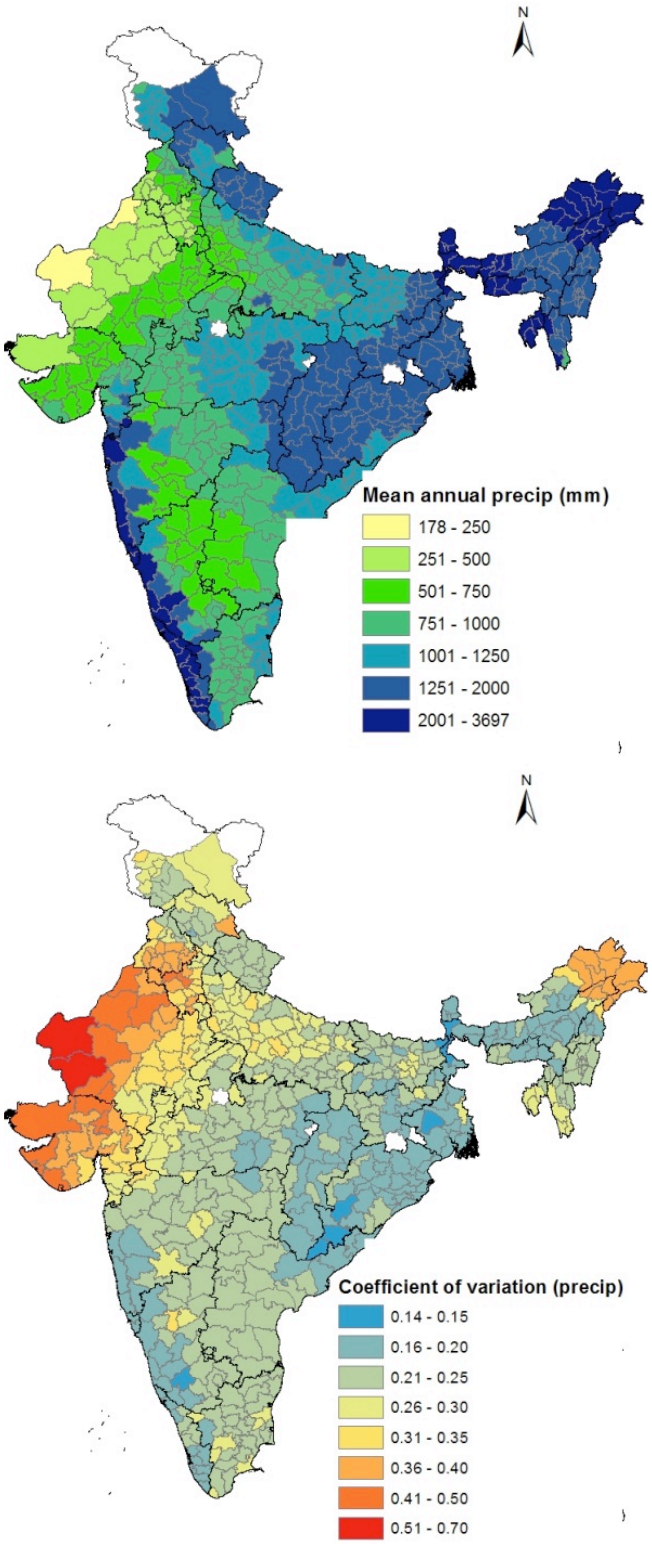


Figure 1: Spatial distribution of (a) mean annual precipitation and (b) variability in precipitation across the country (Source: Devineni, Perveen and Lall, 2011)

1 The Columbia Water Center is currently designing scalable interventions in Central Punjab and Northern Gujarat to help farmers reduce their groundwater irrigation. For more information, see CWC's website: http://water.columbia.edu.

WATER RISKS FOR INDIAN INDUSTRIES: MOTIVATION FOR THIS STUDY

A perusal of the past 100 years of meteorological data shows that the variation in rainfall across years and within the year is a more significant concern. High interannual variability in mean precipitation (Figure 1b) is found in parts of North and North Western India (which receives a low average annual rainfall) and in some parts of Eastern India (which is home to the highest average annual precipitation in the country). Coupled with the fact that much of the country also experiences strong monsoon seasonality in rainfall during the short span between June and September; it becomes evident that while on average sufficient water may be available, periods of excess are followed by periods of deficit (CWC, 1998).[2]

The water challenge in India is fundamentally related to agriculture. Lately however, the interdependence of water and industrial use has been emerging as a critical issue, as awareness of the diverse ways in which water use can pose substantial threats to businesses in certain regions and sectors grow.

In many developing countries and emerging markets, providing a sufficient supply of drinking water or ensuring working waste water systems is a daunting challenge. Even as businesses seek to secure long-term prosperity, to maintain competitive advantage and brand differentiation, and to secure stability and choice in supply chains, depending on the type of business there will be different levels and types of risks related to increasing scarcity of water (WWF, 2009).

While the provision and management of water has typically been a responsibility of the Government, a paradigm shift around water has emerged, which focuses on the concept of corporate water risk. The CEO Water Mandate which was launched in July 2007 under the United Nations Global Compact recognizes that the industrial sector impacts water resources both directly and through supply chains; and that in order to operate in a more sustainable manner the organization has a responsibility to make water-resource management a priority.

Recycling wastewater for non-potable use

Recharging aquifers through rainwater harvesting

2 This analysis of the spacial and temporal distribution of India's rainfall suggests that while many parts of India can provide for water needs through small scale catchment, there are areas that require larger, longer-term storage infrastructure to buffer precipiation variability. In addition, preliminary study suggests that if the national cropping patterns were optimized in relationship to available water, India could save 33 trillion liters of water while adding $10 billion to its national agricultural revenue. For more a more detailed explanation, please see the Columbia Water Center's water stress web page. http://water.columbia.edu/research-projects/india/india-water-stress-index/

WATER RISKS FOR INDIAN INDUSTRIES: MOTIVATION FOR THIS STUDY

The Government of India faces an immediate challenge of designing incentive structures for the industrial sector that would promote water-neutral and/or water-positive technologies, and ensure a multitude of co-benefits in the future. Few incentives are currently provided to industries for efficient water use.

The industrial sector in India is the second highest user of water after agriculture but there is a lack of quantitative assessments and data that can help gauge the actual magnitude of industrial water use and impacts, and especially its impacts on sustainability of agricultural growth in the nation.

While the need for water better management is well known, there is a lack of reliable information on water consumption at the enterprise level and almost no consensus on the range of industrial water demands by sector and the price elasticity. The nature of risk in different socio-economic and geographic settings has not been articulated beyond a first order analysis of the potential imbalance between estimates of average annual supply and demand.

The central question then is no longer who is threatened by water scarcity, but given the diverse interests how can industry and agriculture adapt for co-evolution through investments in water, food or economic transfers, and water storages, considering a hierarchy of geopolitical units, river basins and institutions.

Against the limitations identified above, this preliminary survey of 27 major industrial sectors (see inset) was conducted jointly by the Columbia University Water Center (CWC) and the Federation of Indian Chambers of Commerce and Industry (FICCI) — to gauge the industrial perceptions and impacts pertaining to water-climate risks.

The main aim was to identify the major risks faced by the different industrial sectors, how they were responding to it, and identifying those at high risk. The preliminary findings are presented here and form the basis of planned larger sector specific comprehensive surveys by CWC and FICCI that will finally lead to the development of a near real time information analysis and monitoring cyber infrastructure to support data-driven, judicious and equitable water security decisions for industrial sectors and long term water policy in India.

27 Industrial Sectors Surveyed
Agriculture & Food Processing
Automobile & Automotive
Banking
Cement
Chemicals/Fertilizers/Petrochemicals
Education
Electronics
Engineering & Construction
Fast Moving Consumer Goods (FMCG)
Health Care Diagnostic
Horticulture
Hospitality
Information Technology (IT)
Infrastructure
IT Services
Manufacturing
Metals and Mining
Mobile Manufacturing
Oil & Gas
Petroleum and Natural Gas
Pharmaceutical & Life Sciences
Power & Power Transmission
Real Estate
Steel
Textile & Machineries

RESULTS AND FINDINGS FROM THE PRELIMINARY SURVEY

CWC along with FICCI conducted a preliminary water risks study across multiple industrial sectors and geographies. The study was aimed at understanding the perceptions of and estimates of water related risks in the direct as well as supply chain operations of small, medium and large enterprises. The survey addressed the basic issues of:

(i) Water availability and use (e.g. What is the primary source of water for your industry? What is the scenario with regard to availability of water?);
(ii) Risks associated with water (e.g. Do you consider the availability of water impacting your business significantly today and 10 years later? What is the nature of water risks that you perceive impacts your business?); and
(iii) Water treatment and reuse (e.g. Have you undertaken treatment of wastewater in your industry? What is treated wastewater used for in your industry?).

The findings from the survey are addressed here:

WATER AVAILABILITY AND USE

It was found that groundwater is the major source of water for different industrial sectors across India. 55% of those surveyed used groundwater with or without some other source of water (Figure 2). Surface water, with or without another source of water accounted for 51% of water sourcing; while municipal water, with or without another source accounted for 44% of water sourced.

About 48% of the companies surveyed mention the easy availability of water for running their operations while 28% of the companies mention paying a higher[3] price for getting water (Figure 3).

Of those which mentioned that water is easily available and do not mention paying a higher price - it was found that maximum use only groundwater (31%), or a combination of groundwater with another source (62%). These organizations were spread across key sectors: viz., manufacturing (electronics, heavy machinery, automobile, chemicals and fertilizers), power and power transmission, pharmaceuticals and life sciences, agriculture and food processing, consumer goods and services (banking, education, diagnostics).

Only about 8% of the companies voiced their concern that water is not easily available, with 15% mentioning that they pay a higher price for getting water (See Figure 3). Of the companies which mention that water is not easily available, but do not mention the price factor — the majority have operations in Western India (Mumbai, Nasik, Wadala Pune (Maharastra), Ahmedabad (Gujarat)) and Southern India (Bangalore (Karnataka), Hyderabad/Secunderabad, Vijaywada, Visakhapatnam). Of those operating in Western India only, the source of water is mostly the groundwater; and for those with multiple operations in India- including the South, sourcing is done from surface as well as groundwater.

Of the companies which indicate that water is not easily available, due to which they have to pay a higher price — 55% are using surface water and belong to the power, steel, and oil and natural gas transmission sectors. These units were found to be located in Raigarh (Chhattisgarh), Ramagundam (Andhra Pradesh), Jajpur (Orissa), Bharuch (Gujarat) and Raigad (Maharastra). None of them were using municipal water as a source, except the IT services sector located in Bangalore.

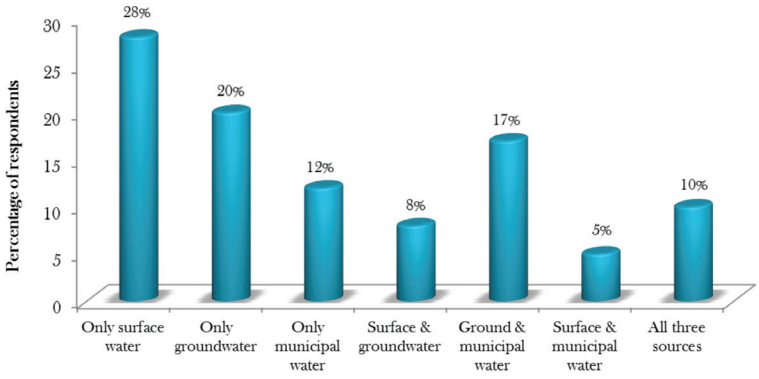


Figure 2: Source of water for industrial uses

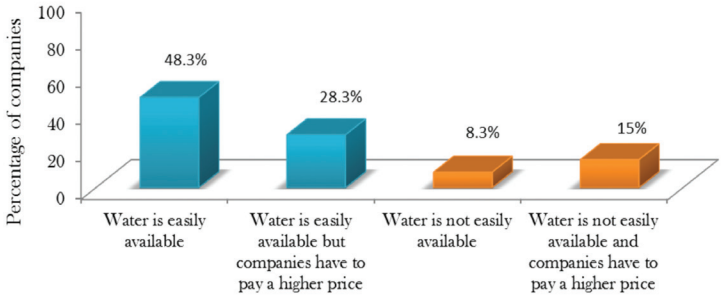


Figure 3: Industrial sectors' response to ease of water availability and pricing

3 The three components to water cost for industries are typically: Water cess paid to Central Pollution Control Board (CPCB) and/or State Pollution Control Board (SPCB) based on the amount of wastewater discharged; cost of purchasing water from municipal or private water suppliers; and capital investment cost of self-sourced water from river or groundwater where municipalities allow such sourcing for industries.

WATER AVAILABILITY AND USE

As competition for water increases across different sectors, the temporal variability in available supply leads to increasing pressure to develop surface storage, or to use groundwater resources unsustainably. Consequently, while it is interesting to explore (the magnitude and extent of) water stress at a national or continental scale, ultimately one can benefit from analyses that directly highlight the water stress faced locally by the industrial and agricultural sectors given endogenous supplies (i.e, at the district scale).

Keeping this in mind, the water stress index conducted by the Columbia Water Center and presented in Figure 4 was posited on the presumption that the appropriate choice for water development and management in India needs to be made on the basis of clear scientific criteria of the spatial locations (and the magnitude) of water deficits in terms of variability in supply and demands.

The new measure of water stress developed by CWC (Devineni, Perveen and Lall, 2011) is spatially distributed and integrated over time variations in water supply and demand to provide metrics to specifically assess water risk posed by within-year and over-year variations in renewable water supply. The indices reflect the maximum cumulative deficit in a regional water balance within-year and over year.

This index can also be interpreted as the storage requirement to meet the current demand patterns, given a variable climate and renewable water supply. Quite a few studies have suggested that water storages can enhance both water and economic security and agricultural productivity (White, 2005). In this context the various thresholds of the computed index (as demonstrated in Figure 4), are directly useful for indicating whether small or large surface storage or the extent of groundwater storage or external transfers, or changes in demand are needed to achieve a sustainable solution. We explore the application of such indices at a district level in India considering over a hundred year data set of rainfall - endogenous to each district as the renewable supply, and the current consumption pattern.

The districts shown in blue typically have high mean annual precipitation between 1250 and 3500 mm and low inter-annual variability in rainfall. This implies that within year storage that can tap the seasonal rains will be sufficient to meet the water demands. This can preferably be met by small scale and decentralized storages such as rain water harvesting, small reservoirs and water demand management – all of which are sufficient to meet within yearly demands and require no infrastructural planning for carry over storage.

The districts in red normally have high water deficits, experience periodic multiyear droughts and require large inter annual or carry over storages to meet the existing demands. The storage plans most suitable for these regions should therefore include capacity to buffer the variability in current supply with enough carry over storage keeping in mind the drought and deficit patterns.

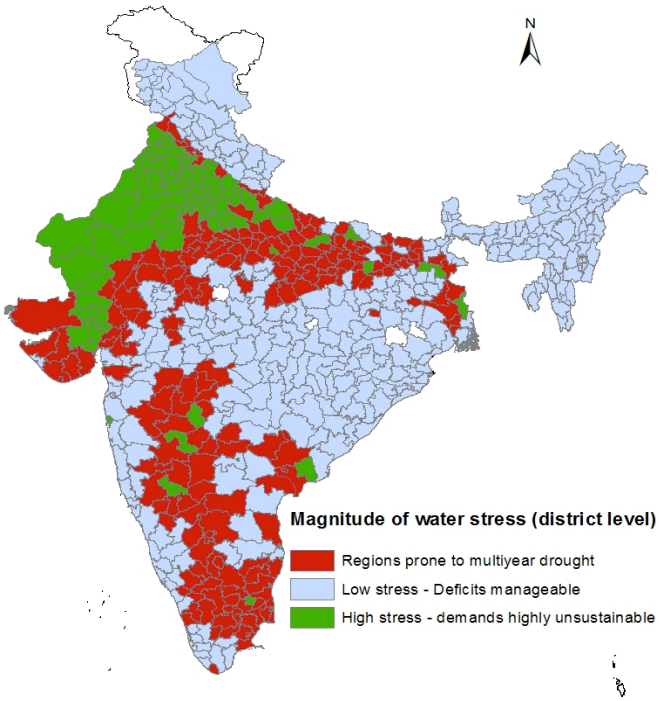


Figure 4: Spatial distribution of the magnitude of water stress at the district level in India (Devineni, Perveen and Lall, 2011)

The regions in green have very large cumulative deficits where the average demand persistently exceeds that of supply. These districts in the North West also happen to be the seat of the Green Revolution in India and are consequently one of the most intensively irrigated and populated in South Asia. Based on the excessive water deficits, these areas typically demonstrate unsustainable use patterns as is evidenced by high groundwater extraction rates in the region (Tiwari et al., 2009).

When the survey responses from the industrial sectors were analyzed in conjunction with the water stress index (refer Figure 4) it was found that about 43% of the companies surveyed were located in districts experiencing periodic multi-year droughts (i.e. regions in red) and requiring large inter-annual or carry over storages to meet the existing demands for water (including agricultural water use). Furthermore, about 21% of the companies were located in districts where the average demand for water persistently exceeds annual supply (regions in green). This showed that a large percentage of the companies responding to the survey, were physically located in regions already facing water stress. This was further corroborated by the fact that a majority of those (75%) had indicated difficulty in water availability and/or high water pricing as issues.

RISKS ASSOCIATED WITH WATER

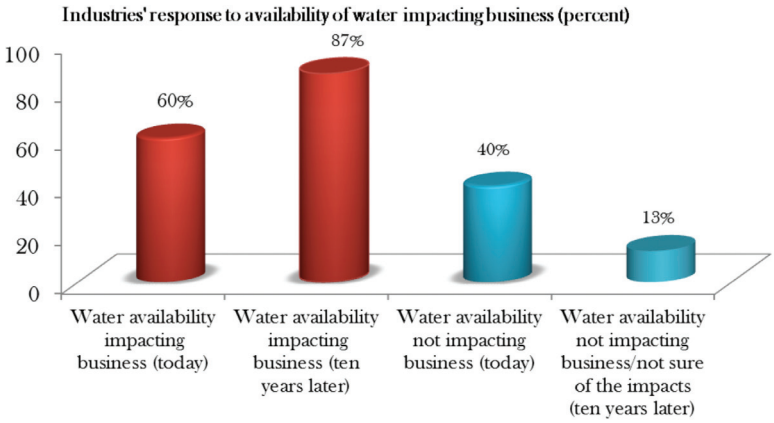


Figure 5: Availability of water impacting business currently and in the near future

With regard to water as an input constraint for industrial production, about 60% of the survey respondents agreed that availability of water is impacting their business today. However, 87% of the companies believe that limitations in water will affect their business within the next decade (Figure 5).

Different industrial sectors of India's rapidly transitioning economy have different risk profiles and exposure in a specific geographic context. At least one in five multinationals in the most water-intensive sectors is already experiencing damage to their business from drought and other shortages, flooding, and rising prices.[4] Thus, even as businesses seek to secure long-term prosperity, to maintain competitive advantage and brand differentiation, and to secure stability and choice in supply chains -- depending on the type of business there will be different levels and types of risks related to increasing scarcity of water.

When the industrial sectors were asked about the nature of risks associated with water – 83% cited inadequate water availability as a major risk affecting the companies' bottom line, followed by regulatory and/or policy framework in the state (53%). Increased competition from other sectors was not seen as a threat to industries as yet, with only 15% of the respondents in that category (Figure 6). A small fraction of respondents who saw increased competition from other sectors primarily hint at agriculture and lobbying by environmental groups and communities, as a risk to water availability. Additionally, 47% of the industry respondents cited the high cost of obtaining water as their major concern.

Regulatory policies in respect of allocation of water (mainly in the state water policy) was also an important risk that corporates see will have a bearing on their functioning in the coming years with 53% of the industries mentioning it as a major risk. Some corporates have suggested a dual allocation system for companies that have undertaken water conservation measures and have shown prudence in their water use.

Around 38% of the respondents also feel that environmental changes over the past few decades have had an impact on freshwater availability. A realization is gradually emerging that rectifying measures need to be taken by the industrial sectors to augment freshwater through rainwater harvesting and wastewater treatment and reuse.

Figure 6 also shows the distribution of organizations' perception of risks to their business. Inadequate water availability was found to be the most potential and severe risk across sectors and locations. Interestingly, as seen from the above, increased competition from other sectors was not perceived as a potential risk across most organizations and was definitely not considered a severe risk.

Environmental changes also pose a risk but are definitely not perceived as a "severe" risk even though a larger percentage feel the pinch of inadequate water availability and 87% cite this factor as the predominant risk in the next 10 years (Figure 5). This illustrates what may be best described as a lack of awareness on these matters amongst industry members. Allocation policy and pricing - which are tangible and affect the "present" are seen as potential risks, but not as severe. This may suggest that industries have the resources and the infrastructure or are willing to dole out higher water prices and adjust to policy changes with regard to water allocation.

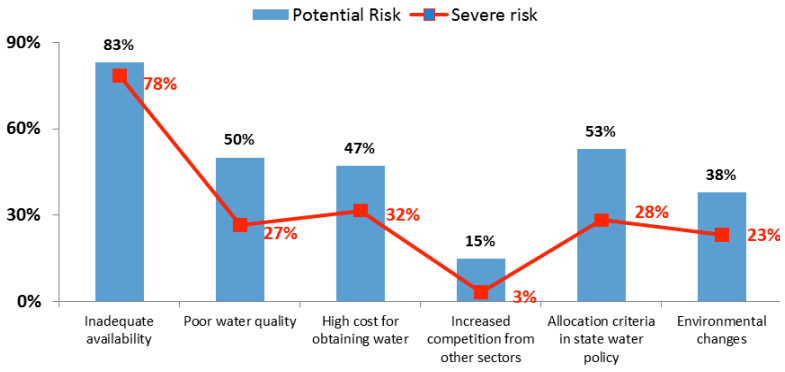


Figure 6: Nature of risks and distribution of organizations' perception of risks

4 Devestating floods in Thailand—which hammered both the global electronics and auto industries among many others--are only the latest dramatic example of flood risk to industries. However, recent advances in climate science's understanding of both short- and long-term global circulation patterns such as El Nino/La Nina-Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO) and other "climate precursors" such as ocean temperatures, or the amount of regional snowpack offers new hope for predicting and managing extreme floods. Please see the Columbia Water Center's Global Flood Initiative for more information. http://water.columbia.edu/research-projects/the-columbia-global-flood-inititiative/

WATER TREATMENT AND REUSE

Indian industry is becoming responsive to the fact that it should be the role of every user to undertake measures for water conservation. The respondents see it as the shared responsibility of companies across sectors to join hands with communities and governments to work on programs for water conservation, recharge and wastewater treatment. Nearly 80% of the industries surveyed have reported to have undertaken wastewater treatment and reuse (Figure 7).

One of the major drivers for companies undertaking wastewater treatment was the declining availability of freshwater. The companies see a merit and an economic value in reusing wastewater for purposes where water quality is not an important criterion.

Using the treated wastewater for horticulture and gardening was the most preferred choice for the industrial sectors surveyed (Figure 8). A large percentage of companies (37%) use treated wastewater for industrial processes such as ash handling (in case of thermal power plants) and washing of ore. Treated wastewater was also used for flushing toilets, cleaning, fire-fighting and dust suppression activities.

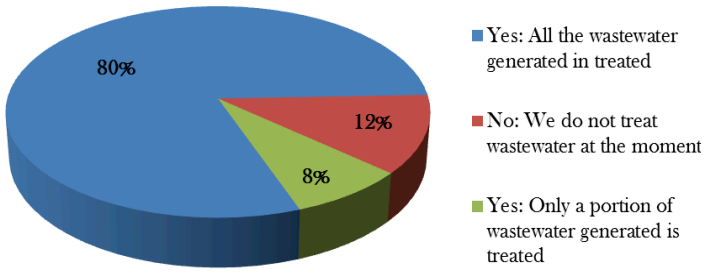


Figure 7: Wastewater treatment by industries

Today, there is an increased awareness of the diverse ways in which water use can pose substantial threats to businesses in certain regions and sectors. As a result, several corporates have become involved in water risk assessment studies and begun taking initiatives on designing tools which would help them understand how to mitigate such risks. It was found that owing to the pressing need for judicious water management, companies have been conducting water audits regularly. 65% of the respondents surveyed had undertaken water audits to understand the complete water use pattern in their operations and to find avenues for water saving and efficiency. In majority of the cases water conservation measures have been implemented by the companies and the results were being regularly monitored.

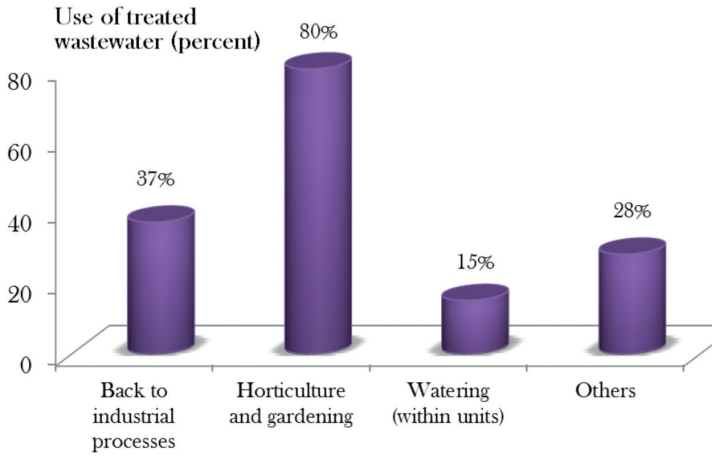


Figure 8: Wastewater use by industries

A large number of respondents felt that efforts toward water conservation- which were previously limited to senior management- have now trickled down to plant and operations managers and employees as well. Efforts were being made at the plant level to implement water saving measures. FICCI member companies showed eagerness to inculcate water saving practices in their workforce though trainings and awareness programs. The member companies also expressed a need to undertake large scale and well-monitored interventions to better understand and document efforts for water harvesting, recharge, and treatment in the industrial sector.

LOOKING FORWARD: NOTICEABLE GAPS AND HOW WE CAN ADDRESS IT?

Agriculture is the largest consumer of water resources in India, followed by domestic consumption. However, water insecurity is expected to affect industrial sectors that depend strongly on agricultural produce, such as food processing and textiles. Most importantly, industrial sectors also have to compete with the agricultural and domestic sectors for water. Increasing urbanization exacerbates the conflicts in already water stressed regions. As a result, supporting industrial sectors such as logistics, finance, foreign trade and insurance could also be affected. The potential economic impact resulting from shifts in water insecurity is thus complex due to the interdependencies between various industrial segments in the larger economic web.

In recent years businesses have started looking at their water use more comprehensively than done previously (when they simply looked at the water usage for directly producing the company's products), and have started investigating the water usage throughout their supply chain.

As per Arjen Hoekstra, director of the Netherlands based Water Footprint Network, though we know relatively well how crops are produced and the water needed to produce them, we have less data about how much water is consumed; waste of water occurs all over the supply chain, such as in the field, in transport and in processing, and finally at home, and the longer the chains the more the waste is.[5]

WWF had published a report in which it discusses water risks to governments and businesses. Even as businesses seek to secure long-term prosperity, to maintain competitive advantage and brand differentiation, and to secure stability and choice in supply chains, depending on the type of business there will be different levels and types of risks related to increasing scarcity of water.[6]

Hence though industrial sectors account for a small percentage of water use directly, their supply chain is exposed to more water risk which is an indirect yet extremely crucial risk to them.

India is fortunate that national planning bodies recognize the importance of collecting necessary information for shaping resource procurement and allocation policies and local recommendations. The census is the only means currently available to understand the very local nature of groundwater exploitation with respect to areas irrigated, groundwater levels, and mechanisms used for raising groundwater. In combination with land use surveys, the census is the primary instrument to estimate the water balances at multiple scales, and serves to elucidate the shifts from surface to groundwater irrigation and the constraints that the industry or agricultural sector faces. However, the census data are neither available at the spatial resolution needed nor available in a timely fashion for national/state level water resources planning and management. Only district-wide averages are made available to the public, which are devoid of locally relevant changes occurring over time.

To make information locally relevant and available in real-time, the means of gathering and sharing water utilization data needs to be rethought. The World Wide Web now makes it possible to reduce the turnaround time between conducting surveys and making the data available in real time while simplifying curation and rigorous statistical analysis of the data by automating the entire process. In addition to collection and analysis, the data can be made accessible to public and private analysts for government-level and individual level planning and decision-making.

In the development of an open access water risk analytical framework, the biggest challenge is always that of procuring, curating and organizing data into a machine-readable format. Data collection in India is a complex endeavor, and considered to fall within the domain of government agencies. Moreover, much of this data is collected in a format to allow for macroeconomic calculations. When published as a summary statistic, much of the granularity is lost. This situation makes it very difficult to provide a risk analysis framework using the available data. Through the preliminary water-risk study and interaction with the industrial sectors and water agencies in India, the following major gaps have been identified and will form the basis of the future comprehensive cross-sectoral study planned by CWC and FICCI:

1. There is no ready availability of industry-agriculture related resource use and pollutant loading data in the public domain. Data, when available, vary enormously in content, quality, granularity, detail and format.
2. No openly-accessible database management and curation systems exist yet. Consequently, there is a lack of standardization of core information even within a sector. Such inconsistencies in water performance reporting make it difficult to compare or even get useful information from any available data.
3. The connection between local (e.g. NGO-driven) activities such as water conservation and macro-level measures such as irrigation development is not easily estimable. In majority of the cases water conservation measures (water harvesting, groundwater recharge, etc.) have been implemented by disjointed organizations and the results are being monitored. However, there is little correlation of the interventions in water savings by industries to the positive impacts created.
4. There is considerable lack of agreement among practitioners on the appropriate range of social and environmental impacts that must be addressed, as well as lack of consensus on the methods by which such impacts are characterized.
5. Various governmental and non-governmental organizations, industry associations and academic institutions do not have a "go to" resource to engage with each other, despite the fact that all of these agencies have a shared goal of improving water management.

5 Tasha Eichenseher of National Geographic, "365 Trillion Gallons of water thrown away with our food every year", 2010: http://newswatch.nationalgeographic.com/2010/09/09/water-footprint-food-waste/ - last accessed 6th April, 2011

6 WWF, "Understanding water risks: A primer on the consequences of water scarcity for government and businesses", 2009

NEXT STEPS: COMPREHENSIVE STUDY OF WATER RISKS ACROSS INDUSTRIAL SECTORS IN INDIA

The preliminary study as showcased here will ultimately evolve into a comprehensive cross-(industry) sectoral and geography specific water risk analysis. This endeavor would be the first of its kind in India and will provide the necessary information base for understanding the inherent and complex water and climate related risks and uncertainties - key in planning for water resources management for sustainable industrial, agricultural and economic growth.

A data driven risk modeling and analysis package would be made possible through spatially specific data on industrial and agricultural water use and impacts, along with data on the socio-economic factors, and other data such as reliability of supply, implications of droughts and floods, energy usage, and environmental and human health impact measures. These results will ultimately be coupled with hydrologic, climate, and economic models for access to real-time streaming data from networked field sensors or multiple data centers.

However, it is not sufficient to merely educate the industry on the proper interpretation of the risk models. Macroeconomic risk models are rarely useful to local/regional governing bodies, and are entirely impenetrable to an individual actor such as a farmer, processor or supplier for the purpose of running their business. For instance, how can a food product business make use of the information and trends contained in a national-level groundwater survey? What does it mean for the business? What are the opportunities and threats presented by climatological changes to their supply and distribution network? Consequently, if the same macro-level information were combined with locally-relevant information and presented to the business in a value-added manner then the individual business person will be able to make significantly better decisions and cope with eventual changes in a robust manner.

In a Columbia Water Center (CWC) and Punjab Agricultural University (PAU) led field study[7], it was found that farmers attribute the groundwater decline in Central Punjab to the decrease in rainfall over the past few years. In reality, however, there has only been a slight observed reduction in rainfall based on 100 years of metrology data. The effect of this reduction on groundwater recharge was likely to be small relative to the observed drop in groundwater levels (Perveen et al., 2012). Additionally, 78% of farmers surveyed by CWC-PAU cited "awareness" and "practical issues" as matters of significant importance when it comes to improving water efficiency, as opposed to only 10% citing the "cost of implementing" a more efficient approach as an issue. A significant percentage of farmers (32%) were aware of more water efficient alternatives, but only 8% of farmers surveyed had actually used them.

As it follows, if the crucial information gaps were left unaddressed, the magnitude and complexity of problems that may manifest due to water insecurity will be beyond the capacity of any governmental, non-governmental, industrial or academic institution alone to solve. However, by facilitating a powerful nexus between academia, industry, NGOs and governmental agencies, the planned comprehensive industrial water risk study will be a crucial step towards ameliorating the problems related to lack of sufficient and timely data, and usable information for industrial water use efficiency and management.

7 http://water.columbia.edu/2012/03/07/columbia-water-center-released-new-white-paper-restoring-groundwater-in-punjab-indias-breadbasket/

The computational tools that we build will allow the registered industries to estimate various measures of risk (e.g. availability and price of supplied goods, costs of processing, opportunity costs for different markets, costs under projected energy and water prices) using region-wide models, perceived risks and the supplier structure. These measures can be calculated against their existing business practices as well as under hypothetical probable scenarios.

Our long term objective thus is aimed at the following broader questions:

(i) Which industrial sectors are at most risk and what kind of data needs to be collected and updated i.e. how frequently?
(ii) Which stakeholders, from central and state agencies should be participating on a regular basis?
(iii) How can existing ministries and agencies (Ministry of Water Resources, Ministry of Environment and Forests, Ministry of Agriculture) – who collect data periodically – be actively involved in this process?
(iv) How can we make this process of near real time data access self-sustaining throughout India?

Low cost prefabricated tensiometer for testing soil moisture in fields

As discussed earlier, the key building block will be the implementation of state-of-the-art information technology infrastructure to acquire industry specific water use and management data. Subsequently we will develop a robust, geographically-aware supply chain management network, superimposed on information layers representing current projections of climate variability and resource demands.

The proposed intervention (as shown below in Figure 9) will aim to train operational/field staff across multiple organizations about available IT tools/technologies for water use, risk and impact analysis. We will introduce easy-to-use, database management systems and data monitoring techniques with broad applicability and relevance to organizations that have disparate water sources spread across different geographies and climates. Furthermore, custom data-access and analysis tools will be developed for individual organizations based on public-domain data for fine-grained knowledge management and future discourse. Engagement with the member companies belonging to various sectoral committees of FICCI will be sought to broaden the applicability of the tools for various industrial categories and geographical locations. Integration and collaboration with various ministries and agencies will be ensured to seamlessly allow multi-party transfer of information.

BENEFITS OF THE STUDY FOR THE INDIAN INDUSTRY

Through the technical expertise and academic rigor provided by Columbia University and involvement of FICCI's Water Mission, it's sectoral committees and various task forces – this study will advance the agenda for specifying industry's role in water conservation and sustainability.

Noticeable benefits for the Indian industrial sector include the following:

(i) Prioritization of water risks (i.e. which are the most significant ones for the sector) linked to organization's water uses, depending on the geographic assessment of the vulnerability of the key water sources;

(ii) Provision of sector specific information of the key water uses, sources and impacts, so the relevant organization may take concrete, measurable and time-defined steps towards optimal water use and savings;

(iii) Identification of opportunities that exist to address the potential risks arising from the sector's water use and impacts and opportunities for increasing business value by improving water stewardship (i.e. by tending to community/local water needs);

(iv) Identification and documentation of corporate water policy and objectives that explain how water issues affect the different industrial sectors and how the company manages the identified water risks;

(v) Contribution to more relevant and transparent disclosure of industries' exposure to water risk and assessment of the business case for strategic direction and action in water sustainability;

(vi) Provision of a platform for industry chamber to help identify and manage water risks affecting industrial and competing and/or allied water uses (notably agriculture) through spatial planning, investments and policy reforms that better reflect water's scarcity value;

The industry cross-sectoral analyses will be disseminated through several national level Water Summits to actively engage and train various stakeholders in furthering sustainable water outcomes in a rapidly transitioning Indian economy.

Technologies for water purification

Use of wastewater for horticulture reduces the freshwater intake

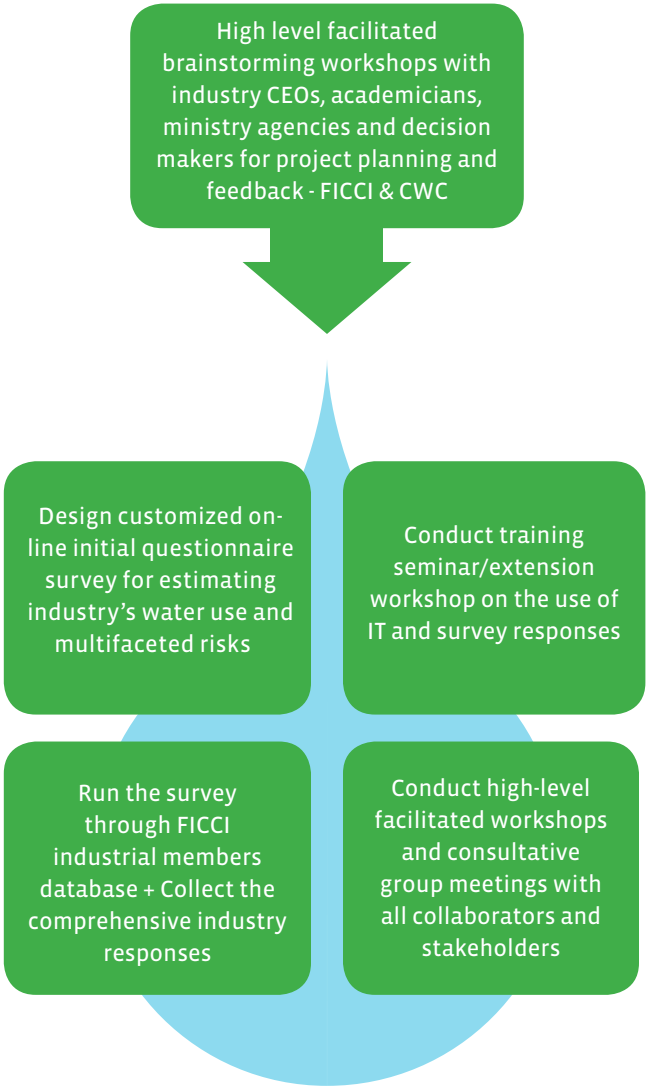
Figure 9: Proposed plan for the comprehensive survey on industrial water use and impacts

KEY RESEARCH QUESTIONS:

- How and where do water limitations constrain potential development and expansion of industries in India? How is the agricultural sector responding?
- In which locations and stages of the agricultural value chains is the highest exposure to water and climate risk?
- How can particular industrial sectors conduct contingency planning to be prepared to respond to water risks, such as loss of production, supply disruption, price increases and more stringent regulations?
- How can data-driven models, mobile technologies, and computing infrastructure provide the tools for risk management in agriculture and industries ensuring water sustainability and food security?

KEY POLICY/VISION QUESTIONS:

- How best can opportunities be created for private sector financed development and management of urban and rural water resources while regulating the use to ensure social and ecological goals, including equity in water allocation and access for the impoverished?
- What are the incentives that can be offered for private sector involvement in wastewater collection, treatment and reuse?
- What are the monitoring systems necessary to manage and regulate a mix of public and private sector water supply networks, and how should they be financed and administered?
- How should holistic analyses that protect the common social interests be developed and used in the policy framework to support National planning and policy reform?



CONCLUSIONS

Considering the tremendous risks that Indian businesses face due to water scarcity and the significant opportunities that exist therein, this study proposes to document the multifaceted climate and water risks associated within the operations and supply chain of major industrial sectors. Few operational managers frame policy, strategy or management decisions in such comprehensive terms. Rather the focus is on reconciling the demand and supply, with some attention to inter-sectoral allocations against social and economic considerations. Operations managers tend not to engage into the broader political and economic context of how water facilitates or constrains macro-economic decisions around trade and investment that are fundamental to businesses. Hence, these issues do not easily make their way into strategic planning or operations, thus leaving the corporation exposed to the nascent risk. Attempting to inform this disjuncture is a critical element of this study.

Water should be high on the agenda of corporates because the future of businesses depends on the sustainability of water resources, which are increasingly under pressure. Clear implications of a water-constrained world include loss of license to operate, increased production costs, tainted brand image and adverse impact on the health of employees and the communities of operations. Despite clear signs of a pending global crisis, only a few large corporates have made addressing the challenge a high priority.

A majority of the corporate water-related reporting has been qualitative, with companies providing descriptions of various water stewardship initiatives, principles, policies and programs, with a goal to reducing their internal water usage. The quantitative data however, has been more limited and limit comparison across similar or different sectors. At the national scale, data collection, assimilation and dissemination have been the exclusive role of government departments handling water. However, there are several problems with this mechanism. Problems range from lack of data in a digital form that can to be used, non-availability of primary data in the public domain, to the inability for a real time analysis and feedback on the accuracy.

A corporate water risk and sustainability framework for quantification and analysis of water risks within organizations and their supply chains needs to be developed. Thus, in addition to the qualitative water accounting in the supply chains, quantification of water use and impact is the necessary step forward which would establish a decision-making and management framework for water risk reduction and over the long term successful engagement of the stakeholders in accurate sustainability reporting and disclosure.

Water Jugs, Delhi

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