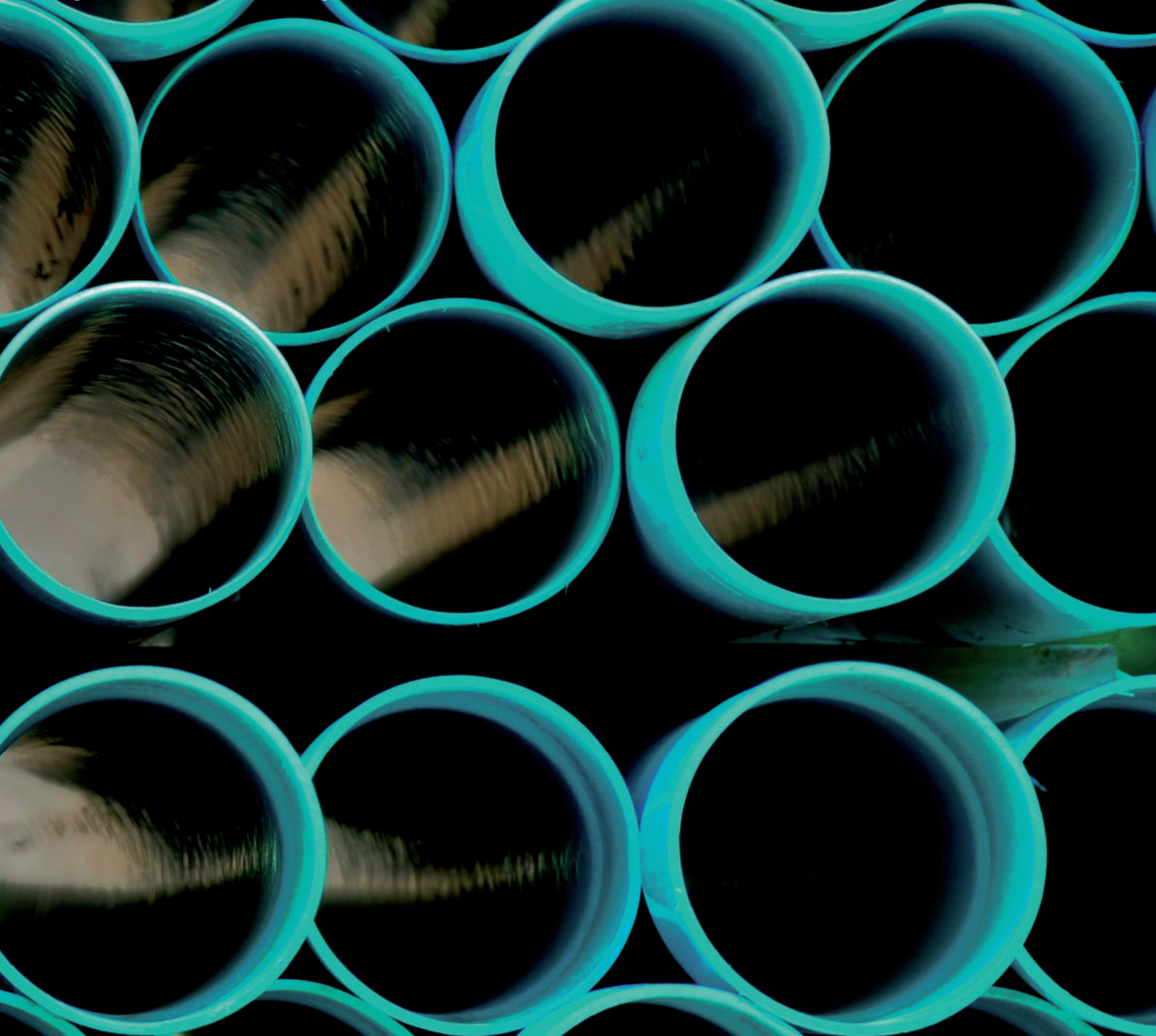
EARTH SECURITY GROUP

CEO Briefing: Global Depletion of Aquifers

Global companies must take an active role in groundwater governance to avoid existential risks



Content

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The Earth Security Group
Business advisors for sustainable growth
earthsecuritygroup.com
info@earthsecuritygroup.com

Note
All currency $ refers to US dollars unless otherwise stated.

Alejandro Litovsky
Founder & CEO,
Earth Security Group

"The depletion of aquifers is creating a geopolitical challenge that is beyond a corporation's sole ability to fix. It is a risk so great, countries and multinationals must come together to collaborate on solutions. This CEO brief provides companies with an analysis of the risks, which challenge the viability of their operations, and practical recommendations for companies to support governments to improve groundwater governance."

Ambassador Pio Wennubst
Assistant Director General,
Swiss Agency for Development and Cooperation, SDC

"In a crisis, decisions made based on fear undermine trust and cooperation that is needed to enable change. With this CEO brief, the Earth Security Group is helping to activate the corporate sector towards a fact-based dialogue. It proposes to embed new collaborations in a much needed process of business diplomacy that goes beyond corporate philanthropy and corporate social responsibility."

Philippe Joubert
Chair, Prince of Wales's Corporate Leaders Group; former President of Alstom Power & Deputy CEO of Alstom Group

"Water shortages have been seen for years as a key systemic challenge for business. However, water, because of its societal and emotional content, must be looked at in a different way from other resources. On a systemic level, the highest priority will be to put a governance model in place to preserve precious aquifers, and sensibly administer water use going forward. This is no easy task, especially for groundwater where multi-country governance will be needed. This report provides business leaders with critical thinking and intelligence on the risks and opportunities ahead."

Introduction

The exposure of multinational companies to depleting and degrading groundwater is increasing. The rapid depletion of aquifers is a systemic risk to one billion people in the world's growing economies. Aquifers are shared across national borders and have the potential to spark conflict. Companies must act beyond their site operations and help improve groundwater governance if they are to ensure their sustainable growth.

Groundwater
Water that is found beneath the earth's surface.

Aquifer
Underground layers of porous rock that act as usable reservoirs for groundwater.

The underground water crisis is hidden from corporate view, but companies are already acutely affected across three global sectors: food and agriculture, power and water infrastructure, and extractives.

Water wells are drying up in groundwater 'hotspots' and trade-offs between companies and locals are becoming acute. From northern China and India, to the Middle East, and the west coast of the United States, a more complex context is eroding the social license to operate of companies.[1] We identify eight regional hotspots that pose an urgent risk to global companies and put forward a call to action for business leaders.

Our review of 75 of the world's largest resource-intensive companies shows that concerns vary across sectors: extractive companies are concerned with groundwater pollution, while agriculture companies are most concerned with security of supplies. While companies are acting at an operations-level on groundwater issues, their awareness of the materiality of this risk is low. These sectors must now work together to help advance a new generation of governance mechanisms that stabilise the use of groundwater resources in key hotspots.

Globally, groundwater provides almost half of water for irrigated agriculture, a third of supplies for industry and for drinking.[2] Of the largest 37 aquifers in the world, 21 are being depleted. These reserves are still largely unregulated and unmonitored.

The challenge ahead is significant: these reserves lie invisible under the ground, in many cases crossing national borders. They involve multiple countries, supply many industries, and are subject to increasing pressures from intensive farming, new extractive technologies and booming population centres.

The spotlight on aquifers

Aquifers contain almost 96% of the planet's freshwater. The majority is held in 37 of the largest aquifer systems globally.[3/4] Many fast-growing regions of the world that are subject to greater water stress are pumping their aquifers faster than these can replenish.[5]
20% of the global agriculture that is irrigated is reliant on key aquifers that are showing falling water levels.[6]

Over the past 10 years, according to satellite data, 21 of the 37 major aquifers have declined at an unsustainable rate.[7] Their replenishment, if at all possible, could take hundreds of years. Groundwater storage is declining across all continents.[8/9]

More than 2.5 billion people depend on groundwater for their basic water needs.[10] Some countries are more reliant than others: aquifers account for between 75%-95% of water use in Saudi Arabia, Tunisia and Morocco.[11] Countries over-pumping their aquifers include China, India, United States, Pakistan, Iran, and Mexico.[12/13]

Groundwater is an essential buffer in periods of drought.[14] However, as climate change impacts intensify, aquifers are projected to undergo increased erosion and reduced recharge rates.[15] Increased frequency of flooding of coastal areas will also augment the salinity of aquifers, reducing water quality and usability.[16]
In California's Central Valley, intense drought has increased the state's reliance on groundwater from 40% to 65%.[17]

The fastest depletion of aquifers is taking place in semi-arid and arid countries with a high dependency on irrigation for agriculture. These trends are most significant across Northern India, the United States, Saudi Arabia, North China and North Africa.[18] India alone draws 230 km^3 of groundwater per year, more than a quarter of the global total, driven by agriculture and industry.[19]

Global estimates of the depletion of groundwater storage are uncertain.[20]
It is not just a question of their depletion: overuse can increase the rate of pollution and salinization of remaining groundwater reserves, increasing the costs of water supply.[21] For example, in the Ganges basin in India, at least 70 million people are at risk from arsenic poisoning of groundwater due in part to increased fertiliser application, coal-fired power generation, leaching from coal ash tailings, and mining activities.[22]

Global aquifer hotspots

Companies face high exposure to the depletion of aquifers because groundwater resources are so poorly regulated. The absence of effective governance frameworks and enforcement has led to a free-for-all, pitting large companies against small farmers. Pollution due to the overuse of fertilisers and industry discharge are affecting drinking water for hundreds of millions of people. This confronts companies with existential threats.

Out of the 37 largest aquifers in the world studied recently using NASA's satellites, eight hotspots stand out for being in some of the most water-stressed areas globally. They provide freshwater reserves to at least one billion people, and are subject to growing industry and population pressures.[23] The Earth Security Index highlights the most critical human-related pressures affecting the aquifer, covering water withdrawals and water pollution, land degradation and demographic pressure.

Linking aquifers to the Global Goals for Sustainable Development

An internationally agreed monitoring framework is currently being developed by UNESCO's International Hydrological Programme. The purpose is to track country-level progress towards the achievement of the Global Goal for Sustainable Development 6 (SDG 6) on Clean Water and Sanitation by 2030. The Target 6.5 of the SDG 6 is to 'implement integrated water resources management at all levels, including through trans-boundary cooperation as appropriate.'

The monitoring framework will assess operational arrangements for cooperation in transboundary aquifers, and is currently being tested in Jordan, Netherlands, Peru, Bangladesh and Uganda. The methodology will create an internationally-recognised approach to the development and assessment of targets on sustainable groundwater use and transboundary cooperation on aquifers. It will raise the issue with national governments, and help unify public and private sector approaches.

Featured: A big data approach

Big tech companies are weighing in on the issue to provide solutions to industry and governments that seek to overcome the data gap surrounding aquifers.

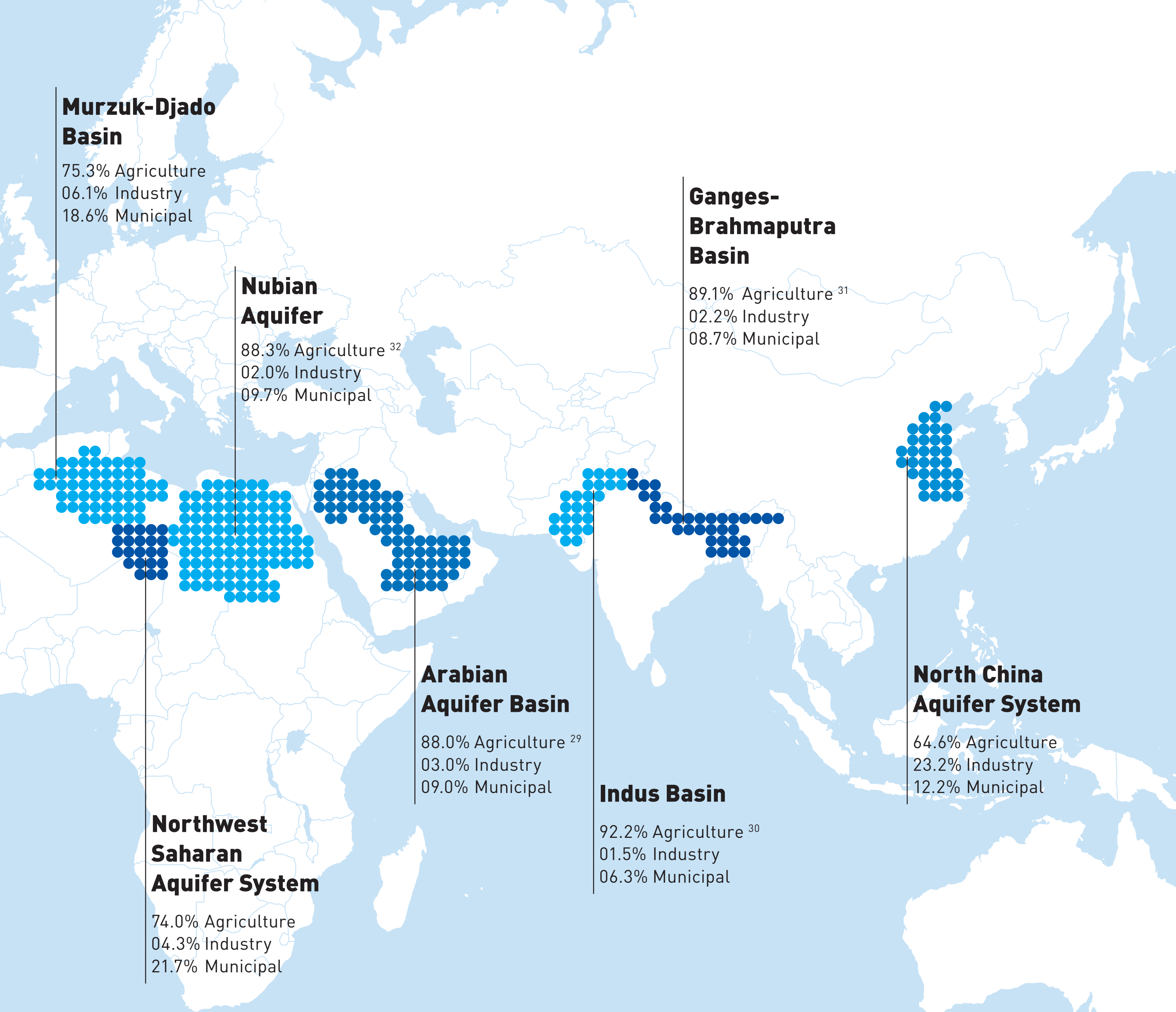
IBM's Digital Aquifer project being developed in Kenya with a university will map and analyse the status of underground water supplies, combining it with weather information to design management strategies for coping with periods of drought. To source data, IBM is seeking to collaborate with management operators, borehole drillers, donor organisations, insurance companies, government officials, and farmers.

In 2015, Qlik, a leader in big-data and visualisation partnered Twitter, Columbia University's Water Center, The Pacific Institute, Circle of Blue and UCI scientists to create a comprehensive groundwater data dashboard. With cutting edge data analytics it will inform crisis responses and infrastructure planning in the US State of California.

Further information
www.research.ibm.com
www.qlick.com

Figure 21
8 global aquifer hotspots

	Californian Central Valley Aquifer System	Murzuk-Djado Basin	Northwest Saharan Aquifer System	Nubian Aquifer
Countries Number involved [24]	1	3	3	1
Recharge Rates Negative, Low, Medium, High [25]	Medium	Negative	Negative	Negative
Stress Level Withdrawal versus Recharge [26]	Variable	Extreme	High	High
Governance Transboundary framework [27]	N/A	None	Cooperation Institution	Cooperation Agreement
Key Pressure Pressures affecting the aquifer's future according to the Earth Security Index	Land Degradation	Land Degradation	Water Withdrawal	Demographic Pressure



Arabian Aquifer Basin	**Indus Basin**	**Ganges-Brahmaputra Basin**	**North China Aquifer System**
10	4	4	1
Negative	Negative	High	High
Extreme	Extreme	Variable	Variable
None	None	None	N/A
Demographic Pressure	Land Degradation	Water Pollution	Land Degradation

Sources
'Quantifying renewable groundwater stress with GRACE' and 'Uncertainty in global groundwater storage estimates in a total groundwater stress framework', Richey et al, Water Resources Research (51), 14 July 2015.
'Transboundary Aquifers of the World: 2016 Update', IGRAC & UNESCO, 2012.
Note: The NASA research has provided stark evidence of aquifer stress at very large regional scales, but is not as accurate for smaller aquifers.[33] More observational data on aquifers and groundwater will be needed to ground-truth NASA's conclusions as well as to better predict the lifespan of the groundwater resources at operational scales.

8 global hotspots of aquifer depletion [34]

1 Arabian Aquifer System

Saudi Arabia, Bahrain, Iraq, Jordan, Kuwait, Oman, Qatar, Syria, UAE, Yemen

Groundwater accounts for 84% of total freshwater use in the Arabian Peninsula.[35] Saudi Arabia stretches over most of this system.[36] Almost 90% of water withdrawn from aquifers is used for agriculture, where oil revenues subsidise for pumping groundwater.[37] A mix of groundwater, and energy-intensive desalinated water, provides more than 55% of municipal water needs in Gulf states.[38]

Over-exploitation of the aquifer has forced Saudi Arabia to halt wheat production, moving to secure land and agriculture investments abroad to import wheat. Recent agricultural investments have included Saudi projects in drought-prone states in the US, such as California and Arizona.[39] Arab states in the Gulf and North Africa are drafting a 'Framework Convention on Shared Water Resources between Arab States' to address water scarcity, including their high dependence on this aquifer.[40]

2 Indus Basin

India, Pakistan, China, Afghanistan

300 million people rely on the aquifer, with the majority in Pakistan and India. These two countries rely on groundwater for 48% of their total water withdrawals.[41] Almost all the region's agricultural area is irrigated, with groundwater providing half of the total.[42] Subsidised electricity and poor regulation have led to the proliferation of water pumps and free-for-all water use. The water table has dropped up to 20 feet in some areas of Pakistan, threatening the future of agricultural production.[43/44]

The Indus Water Treaty signed by Pakistan and India in the 1960s does not include provisions on groundwater resources and there is no regional data sharing agreement. Furthermore, the ongoing territorial dispute over Kashmir is seen as a key threat to the existing fragile hydro-diplomacy between the two countries, both of which have nuclear weapons, and is cited by intelligence agencies as a major concern to regional and global stability.[45]

3 Ganges-Brahmaputra Basin

India, China, Nepal, Bangladesh, Bhutan

The Ganges-Brahmaputra Basin (GBM) is home to approximately 10% of the world's population. Irrigation accounts for 90% of the total water withdrawals in the basin, of which 68% is met through groundwater.[46] The GBM has the highest depletion rates globally according to NASA-Grace data, but stress levels are currently buffered by a high annual recharge.[47] However, groundwater pollution has already degraded large areas of the aquifer system.[48]

In Bangladesh, 97% of the population relies on wells to meet their drinking water requirements, exposing 75 million people to arsenic pollution in the aquifer.[49] The stress levels of the aquifer are set to increase as climate change affects the aquifer's recharge rate.[50] The GBM does not have a transboundary agreement or institution in place, while national groundwater regulations are poorly enforced at the local level. All countries involved lack an effective water quality monitoring network.[51]

4 Nubian Aquifer System

Egypt, Chad, Libya, Sudan

The Nubian Aquifer has been referred to as a 'virtual liquid gold mine' because it is the largest non-renewable aquifer in the world.[52] It is predominantly situated below Egypt and Libya, with Libya relying on the aquifer for 95% of its water needs.[53] While Egypt has historically focused on the Nile as a water source, population growth and developments such as the Golden Triangle Mining project mean that Northern Egypt is set to increase its reliance on the aquifer.[54/55]

In 2013, the four countries above the aquifer signed the 'Regional Strategic Action Programme' to coordinate groundwater pumping and share management responsibilities for this transboundary aquifer. It is one of the world's only agreements for a transboundary aquifer.[56] Political unrest and civil war in Libya meant that the country did not sign the renewal of the pledges in 2015, damaging the regional hydro-diplomacy effort to sustainably manage the region's shared resource.[57] Political instability across the region combined with demographic pressures and more severe droughts due to climate change will make this aquifer a critical feature of the region's future development.

8 global hotspots of aquifer depletion

5 North China Aquifer System

China

The North China Aquifer sits below a region that comprises 11% of the Chinese population, including Beijing. The region supports 13% of China's agricultural production and 70% of the country's coal production.[58] Northern China relies on groundwater for half of its total water use, which is mostly used for agriculture and municipal supply.

In Beijing (population 21 million), groundwater use accounts for around 60% of water supply.[59] In non-renewable parts of the aquifer, water levels had dropped by over 100 metres in 2005.[60] In response, the South-North Water Diversion project, the largest inter-basin transfer scheme in the world, is transferring 25 billion m^3 of water from the Yangtze river along 1000 km to the northern area of China at a cost of USD 80 billion.[61] Once complete, Beijing is set to phase out the city's 40,000 private water wells.[62] China's Water Ten Plan has also been introduced to set strict groundwater targets to control extraction and pollution by 2020 by changing agricultural practices and targeting specific industries to reduce their water consumption.[63]

6 Californian Central Valley Aquifer System

United States

The Central Valley Aquifer area accounts for 25% of domestic food production and 75% of irrigated land in California, with an estimated value of USD 17 billion/year.[64/65] During drought periods, groundwater supplies 65% of California's freshwater demand compared to 40% during normal periods.[66] Since the 1960s, heavy aquifer depletion has been primarily driven by irrigation use during droughts.[67] It is estimated that 1.5 million acres of agricultural land will go out of production in the coming years as a result.[68] Over-pumping of the aquifer has caused some areas in the Central Valley to sink by up to 10 metres, costing the state up to USD 1 billion in damage repairs.[69]

Further stress is expected from the development of the Monterey Shale play beneath the aquifer, one of the largest in the country.[70] California's 100,000 groundwater wells have to date been unregulated and unmetered. In 2014, the state introduced groundwater legislation for the first time, the Sustainable Groundwater Management Act to achieve sustainable management by 2042 followed by the 2016 Aquifer Protection Act for stricter permitting conditions and prohibitions.[71/72]

7 Murzuk-Djado Basin

Libya, Chad, Niger

The majority of the Murzuk-Djado Basin lies under Libya. The country considers it a strategic resource to supply cities, agriculture and industry projects but the lack of control and coordination over its use could exacerbate regional instability.[73] Groundwater represents about 52% of total water consumption in Libya, of which 80% is for irrigation.[74/75] Water from the aquifer is being pumped for the USD 30 billion 'Great Man-made River Project', a 4,000 km network of pipes that provided 61% of the total freshwater supply in 2009, primarily to cities along the Mediterranean coast.[76/77] Libya aims to ramp-up the development of irrigation, targeting a 40% increase in its agricultural area under irrigation by 2050.

No requirements for water-saving have been properly recorded.[78] There is no transboundary agreement in place between the countries to regulate the management of the Murzuk-Djado aquifer. Libya's recent civil war led to armed separatists controlling most of the country's aquifer areas, as a potential strategic leverage point, increasing the potential to disrupt regional stability.[79]

8 Northwest Saharan Aquifer System

Algeria, Libya, Tunisa

Almost 5 million people are dependent on the Northwestern Sahara Aquifer System (NWSAS), which is a non-renewable aquifer.[80] Algeria stretches over the majority of the system (60%), with Libya (30%) and Tunisia (10%) minority aquifer States.[81] Between 2000 and 2008, the number of wells pumping water from NWSAS more than doubled to over 18,000, while total withdrawal increased from 300 million m^3/year in 1950 to almost 2.8 billion m^3/year in 2012.[82/83] About 90% of total water withdrawals in the region are for agricultural irrigation, while industry accounts for up to 15% in Algeria, 4% in Tunisia and 4% in Libya.[84] As the climate continues to dry in the region, both Algeria and Libya are planning to increase their levels of extraction by 2030.[85]

The NWSAS is one of the few transboundary aquifers with active transboundary cooperation. The flagship project of the Sahara and Sahel Observatory prioritised the development of a joint database, basin modelling, and implementing a joint consultation mechanism for the NWSAS.[86] While gaps remain on the data and monitoring priorities, the joint Consultation Mechanism was formalised and comprises a Council of Ministers of the riparian States.[87]

Industry sector context and cases of corporate action

Industry exposure to context pressures

Food & Agriculture

The food and agriculture sector is the largest user of water globally and the sector most dependent on groundwater. Up to 100 million hectares — or 40% of the world's total irrigated land, are supplied either fully or in part by groundwater.[88] Agricultural demand for water is expected to increase by 20% by 2050.[89] At current rates, aquifer depletion threatens to undermine harvest production in three of the world's largest grain producers: the USA, China and India.

Combined, these countries produce half of the world's grain supplies. Grain production has already plateaued or declined in a number of countries that are over-pumping their aquifers, including Saudi Arabia, Syria, Iraq, Yemen and Iran.[90] In India, 89% of irrigation systems depend primarily on groundwater resources, while 15% of India's food supply is produced by pumping groundwater.[91]

Falling groundwater levels have ignited conflicts over groundwater resources between farmers and food and agriculture companies across the country. Following years of protest from local farmers, in 2014, Coca-Cola's bottling factory in the north Indian state of Uttar Pradesh, was ordered to close by the Uttar Pradesh Pollution Control Board for over-pumping of groundwater, despite the company's insistence that they had the necessary permits for groundwater use.[92]

Power and water infrastructure

Approximately 90% of global electricity demand is already highly dependent on water. The water needs of thermal energy production alone are expected to increase by 140% by 2050.[98] Conventional thermal electricity production can be highly reliant on groundwater, depending on the location. Water consumption to generate electricity is expected to more than double over the next 40 years.[99] At the same time, groundwater abstraction is highly energy-intensive.

Energy consumption of irrigation water wells is estimated at 15% of total global energy use.[100] In 2012, power failures affected over 670 million people in northern and eastern India as a result of a weak monsoon that forced farmers to excessively pump groundwater resources using subsidised power for electric pumps, driving up electricity demand. In addition, the drought affected the availability of water to fossil and nuclear fuelled thermal power plants.[101]

In the US, groundwater accounts for roughly 30% of water used by municipalities, while 44% of the US population depends on groundwater for its drinking water supply.[102] Water utilities in the US are increasingly facing water supply constrictions from decreasing groundwater availability and increasing levels of pollution or salt-water intrusion, leading to rising capital costs.[103]

Extractives

The sector's water risks are growing due to increasingly water-intense unconventional extraction methods, growing costs of treating water, growing water stress in extraction regions, and pressure to improve the sustainability of oil reservoirs.[109] Unconventional fuel sources, such as shale and tar sands are expected to increase the sector's underground water exposure.[110] For example, 38% of the world's shale resources face high to extremely high water stress or arid conditions, including the Lower Indus shale play in the Pakistani part of the Indus basin.[111/112] In 2014, state-owned China Shenhua Group, the world's largest coal producer, stopped abstracting groundwater resources at the Shenhua Ordos project in Inner Mongolia due to new government requirements and disputes with local farmers. Groundwater levels had dropped by 62% in comparison to 2004 due to its operations.[113] Rio Tinto's USD 6.6 billion Oyu Tolgoi mine in Mongolia is set to use approximately 20% of the Gunii Hooloi aquifer.

The company has estimated that aquifers in the region could supply up to 500,000 m^3 of water daily. However, by 2020, it is estimated that population growth will compete for these water sources.[114] In 2013, the Umnugobi province, also in Mongolia, passed a resolution to prohibit groundwater extraction for mining purposes from 2016 onwards. However, following a court dispute between the national government and mining companies, the resolution was suspended.[115]

Industry sector context and cases of corporate action

Corporate action cases

Reducing impacts
In Mexico, Nestlé invested USD 7 million in 'zero water' technology at a dairy factory in order to reduce groundwater and surface water withdrawals. By extracting and recycling water from milk, the technology enabled the factory to reduce groundwater withdrawals to zero in 2014. The company is now implementing the technology at the Mossel Bay dairy factory in South Africa.[93]

Regeneration
Coca-Cola, in partnership with local NGOs and communities, has developed a series of 'water replenish projects' in India to improve to improve groundwater supply reliability for local communities. This includes installing rainwater harvesting and artificial aquifer recharge structures, as well as restoring ponds and other natural bodies of water, and supporting agricultural improvements.[94]

Private-public cooperation
The California Water Action Collaborative (CWAC) was launched in 2014 by a group of major food and beverage companies (AB Inbev, General Mills, Nestlé, Coca-Cola) and NGOs (Alliance for Water Stewardship, The Nature Conservancy, The Pacific Institute and WWF) to scale watershed solutions in response to growing stress facing companies and communities in the state.[95] CWAC has devoted one working group to improving groundwater management planning and supporting upstream projects to restore groundwater.[96]

Research
As part of an initiative to replenish local groundwater near its Aurangabad plant in India, PepsiCo conducted a water resource assessment study in partnership with a local civil society organisation. The study enabled the replenishment of 100 groundwater wells in the local area. The brewer group SAB Miller has also reported on commissioning similar studies on local aquifers in India.[97]

Reducing impacts
In India, Caterpillar implemented a rainwater harvesting project in the water-stressed state of Tamil Nadu, in order to replenish the groundwater wells that supply the majority of the facility's water, as well as recharge and improve the area's groundwater supplies.[104]

Regeneration
Veolia Environment's Research and Development arm has been working with the Berlin Centre of Competence for Water, an international centre for water research and knowledge transfer, to develop artificial recharging systems for aquifers.[105]

Private-public cooperation
Duke Energy, together with the public water utilities in North and South Carolina, established the Catawba-Wateree Water Management Group (CWWMG) in order to improve water governance in the region.[106] This includes improving the groundwater monitoring network for the basin to assist water supply assessments.[107]

Research
General Electric undertook extensive groundwater data collection as part of its clean-up strategy of a former industrial site. GE's 76-acre Bridgeport Works property in Connecticut had been used for industrial purposes for 90 years.[108]

Reducing impacts
In South Australia, BHP Billiton's Olympic Dam project is 100% reliant on the aquifer in the Great Artesian Basin. To ensure water abstraction did not affect the groundwater boreholes of other land users or the basin's natural springs, the company reassessed existing groundwater data-sets and implemented a series of water-use efficiency projects that improved industrial efficiency by 15% between 2004 and 2009.[116]

Regeneration
ConocoPhillips has committed USD 25 million to the joint development of the Global Water Sustainability Centre in Qatar. The Centre will pioneer technology for facilitating the use of treated water for irrigation in order to reduce the pressure on water supply in the country, where 36% comes from groundwater aquifers.[117/118]

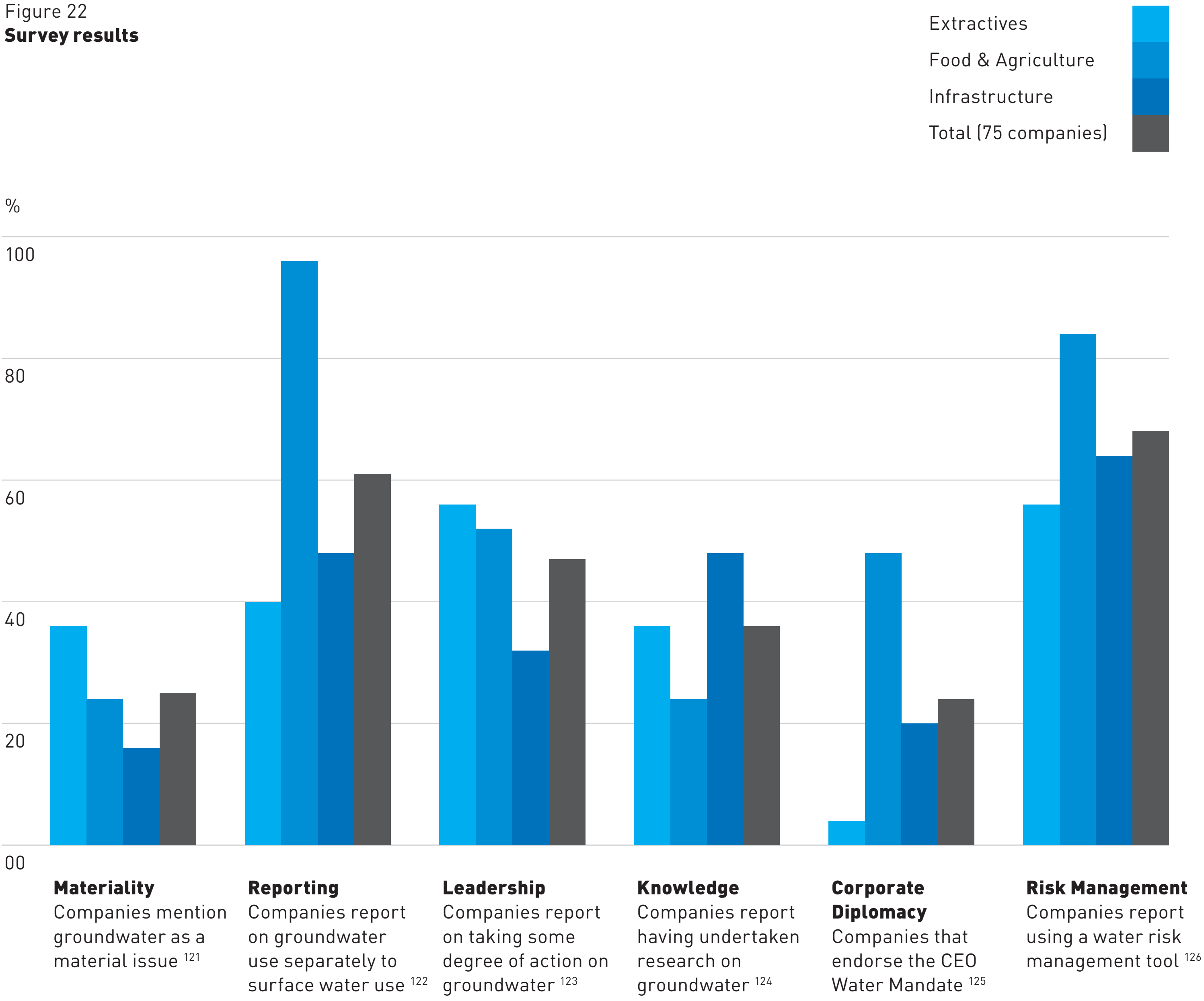
Private-public cooperation
Rio Tinto's Mongolian subsidiary, Oyu Tolgoi, has collaborated with the Government of Canada, the 2030 Water Resources Group, the International Council on Mining and Metals (ICMM), and 7 other mining companies operating in the Southern Gobi region committing to a voluntary 'Code of Practice' for improving water management practices at the catchment level. This includes the support of training and awareness-raising on groundwater protection.[119]

Research
Shell Global Solutions, in collaboration with the American Petroleum Institute, has developed the GroundWater Spatiotemporal Data Analysis Tool (GWSDAT) for the analysis of groundwater monitoring data and the design and management of groundwater monitoring or remediation activities.[120]

Business survey How are companies communicating groundwater risks?

We have reviewed the approach that large companies are taking towards communicating groundwater risks. The review included 75 of the largest publicly-listed multinationals in the extractives, power and infrastructure, and food and agriculture sectors. The study analysed corporate reporting on six strategic areas: materiality, reporting, leadership, knowledge, corporate diplomacy and risk management.

Figure 22
Survey results



Business survey Key findings

1

Companies should communicate more about the work they are already doing on groundwater risks.

Only 25% of the companies reviewed show that groundwater to be a material issue for their business. However, 47% of companies report on taking action to reduce groundwater use or remediate groundwater and aquifers at a site or watershed level. Companies should consider improving their external communication of the risks from groundwater depletion, as a means to educate their stakeholders on the nature of the problem and the solutions. Besides taking action on groundwater, more than half (61%) are monitoring and reporting on groundwater use separately from surface water use. The knowledge that is already available within companies should be used to communicate the position of companies on this matter more effectively.

2

Companies must collaborate to improve their understanding of their systemic risks from depleting aquifers.

61% of companies may monitor their groundwater withdrawals, but are likely to be missing the bigger picture on the systemic exposure of the aquifer itself. Companies are making important efforts to understand their water risks. Of the water risk management tools being used, only the WRI Aqueduct and WWF's Water Risk Filter integrate groundwater stress separately to overall water stress, but neither capture data on deep aquifers. Far fewer companies (36%) report on commissioning studies to understand groundwater and aquifer stress, such as groundwater quality surveys and monitoring, groundwater use monitoring and installing and sampling groundwater monitoring wells for specific projects (such as power plants, water production facilities, bottling plants, mines, oil-fields). For example, while 84% of food and agriculture companies use water risk tools, less than half (48%) say they have undertaken groundwater assessments.

3

Companies must prepare to increase their public engagement as public concern with aquifers grows.

There are significant variations by sector in how companies report their groundwater activities. Comparatively as a more consumer-facing industry, the food and agriculture companies reviewed lead in publicly-visible activities: reporting on groundwater (96%), use of corporate water risk tools (84%) and endorsing the CEO Water Mandate (48%). In comparison, only 1 out of 25 extractive companies reviewed has endorsed the CEO Water Mandate. However, extractives report the most actions to reduce their groundwater use or pollution impacts, given their direct exposure in project sites. On the other hand, while only 20% of infrastructure companies surveyed endorse the CEO Water Mandate, and just 48% report on groundwater use, they are ahead of the other sectors on reporting undertaking research on groundwater for their own and client operations.

4

Corporate concerns indicate groundwater pollution and depletion are leading material issues.

Of the extractive companies that consider groundwater a material issue, the majority (78%) are concerned with water contamination risks. By comparison, of the food and agriculture companies that report taking groundwater action, 92% are most concerned with supply security to their factories or supply chains. For extractive and infrastructure companies, pollution risks are mentioned in equal measure as depletion risks. This suggests that while companies recognise the risks from depleted groundwater reserves, the risks of pollution and associated water costs are also a core business concern that should be factored into corporate engagement.

Governance gaps affecting corporate strategies and international frameworks

The root cause of the problem of ground water depletion is a governance deficit. The regulation, oversight and understanding of groundwater systems have not kept pace with the extreme increase in their use over the past 50 years.[127]

Unlike surface waters, groundwater is often not regulated, not monitored, and not paid for.[128] Three key gaps in governance that affect the operating environment for companies. For each of these we identify the leading international frameworks, which collectively form the basis to guide companies operating on a global scale.

1
Governance gap
Absent or weak institutions

Groundwater abstraction has happened faster than the rights and regulatory regimes needed to regulate it, leaving groundwater systems under-regulated, undervalued and poorly understood.[129] Ownership rights have historically been linked to land rights.[130] Where permit-based rights to groundwater have come into effect, challenges of law enforcement or baseline definition to allocate permits remain a challenge.[131] Only a few countries have set up dedicated groundwater agencies for monitoring and permitting, such as India's Central Groundwater Board and Authority.[132] However, implementation capacity is insufficient given the complexity of the systems.[133]

International framework
A Global Framework for Action

In 2015 the World Bank, the UN Food and Agricultural Organisation (FAO), UNESCO, the International Association of Hydrogeologists, and the Global Environment Facility concluded a 4-year programme to guide countries on a vision for groundwater governance. They have committed to integrate the framework into their country programmes.[134] Key elements that drive their global vision for good groundwater governance include: [135]

1 A widely-shared understanding of groundwater systems.
2 A legal system that puts groundwater under public control.
3 Government agencies with authority and adequate resources.
4 Stakeholder participation mechanisms.
5 Co-management with surface water and land-use.
6 Coordination with urban, agriculture and energy sectors to address issues.
7 Science-based programmes that implement priority management plans.

2
Governance gap
Transboundary jurisdictions

There are over 500 transboundary aquifers, but only five of these are covered by formalised transboundary agreements or institutional arrangements. These include the treaties on the Geneva Aquifer between Switzerland and France, the Guarani Aquifer Agreement in South America, and the Al Sag/Al Disi layer between Jordan and Saudi Arabia. Non-treaty based cooperation frameworks include the Strategic Action Programme for the Nubian Sandstone Aquifer in North Africa, and the consultation mechanism for the North Western Sahara Aquifer System.[136] Within countries agencies face the difficulty of managing trade-offs between multiple industries and populations using land and water.[137] The ability to process this complexity of issues and levels usually exceeds the capacity of individual agencies.

International framework
Law of Transboundary Aquifers

In 2009, the UN General Assembly endorsed the 'Law of Transboundary Aquifers'.[138] A non-binding framework prepared by UNESCO's International Hydrological Programme (IHP) and the UN International Law Commission. The resolution is intended to guide governments to develop bilateral or regional arrangements for the peaceful and effective management of transboundary aquifer resources. It was first applied in the Guarani Aquifer System by Argentina, Brazil, Paraguay and Uruguay in 2010.[139] The articles provide guidance on the equitable and reasonable use of water resources and the exchange of data and information, which is to be overseen by a dedicated multilateral commission.[140] In addition, in order to improve cooperation across transboundary aquifers UNESCO-IHP's Internationally Shared Aquifer Resources Management (ISARM) project brings together an inventory of transboundary aquifers and their challenges, with an online GIS-based website.[141/142]

3
Governance gap
Insufficient data

The limited availability of data and information on groundwater reserves, abstraction and quality is a major obstacle to their management.[143] The cost and complexity of groundwater monitoring systems means that information on groundwater and aquifers remains a frontier challenge.[144] Even where governments do collect data on groundwater, the information may not be made public given concerns for national security. Californian legislation still prohibits public access to logs compiled by drilling companies and does not mandate data collection on groundwater withdrawal, quality or aquifer characteristics.[145]

International framework
Hydrogeological Mapping and Assessment Programme

UNESCO-IHP, in collaboration with its centre on groundwater (UNESCO-IGRAC), has been developing the Global Groundwater Information System (GGIS)[146] an interactive, web-based portal to groundwater-related information and knowledge; and the Global Groundwater Monitoring Network (GGMN), a network to facilitate periodic assessments on groundwater quantity and quality by aggregating data from existing groundwater monitoring networks and knowledge.[147] However, many countries still fail to collect, maintain or publish groundwater data. NASA's Gravity Recovery and Climate Experiment (GRACE) has allowed scientists to track groundwater levels in basins that do not have access to monitoring wells or where groundwater data is not shared publicly.[148] While the research has provided stark evidence of aquifer stress at very large regional scales, it is less accurate for smaller aquifers.[149] More observational data on aquifers and groundwater will be needed to ground-truth NASA's conclusions as well as to better predict the lifespan of the groundwater resources at operational scales.

Recommendations for business leadership

The scale and complexity of the crisis surrounding aquifers requires companies to take a leadership position in working with governments at national, transboundary, and global scales to improve the governance of aquifers.

An initial set of steps can be taken to bring companies, corporate networks and government initiatives closer together in addressing this challenge.

1 Business endorsement of principles for groundwater governance

The lack of effective policies and regulations for groundwater leaves companies exposed to a complex context. Business must send a clear signal to national governments that the effective, equitable and sustainable management of groundwater resources is vital to their sustainable growth and investment. We recommend companies to come together under the auspices of a major global corporate network, to develop a 'business declaration on groundwater governance'. Through it companies will endorse the Global Framework for Action on Groundwater Governance, developed by multilateral agencies, including the World Bank, FAO and UNESCO. The pledging companies would have a common framework to engage with national governments for them to integrate the principles into national policy and regulatory frameworks.

A useful precedent for this already include two companies, Thames Water and Vitens, that have participated in the Groundwater Governance Project's Permanent Consultation Mechanism.[150] Also, Nestlé Waters, Vitens, Heineken, EDF, Thames Water, Schlumberger Water Services and Shell have participated in a UNESCO regional consultation in 2013.[151] A community of global companies endorsing the declaration can then focus on exchanging knowledge, helping individual companies to set corporate targets, and develop working groups that bring companies together to focus on key countries or regions.

2 A business leadership role in transboundary aquifer governance

Transnational companies can play a positive role in the governance of transboundary aquifers. Companies that are already operating in countries that are part of the same aquifer system (e.g. India and Pakistan) can create enabling conditions for governments to engage across borders. They should start by creating an internal working group that involves the sustainability and corporate affairs teams across the subsidiaries of the countries involved. Subsequently, through these cross-border business teams, companies can define cross-border corporate targets across the businesses and improve their coordination of their existing policy initiatives and government relations in each country. UNESCO's International Hydrological Programme (IHP) is driving a global project to advance the management of internationally shared aquifer resources.

These are key resources that can inform corporate strategy on a transboundary level. Companies can deepen their collaboration with UNESCO-IHP on a case-by-case basis, as well as second company staff to UNESCO's team to act as a focal point. On the other hand, by cooperating with companies through a private sector coordinating mechanism, UNESCO-IHP can act as an interface helping improve the engagement of companies with multiple governments on transnational aquifers.

3 A global open data partnership for aquifers

The depletion of aquifers creates shared risks for all water users and should therefore create incentives to cooperate and share information. Large technology companies, like IBM and Qlik, have shown models to help to solve the data gap that stifles action on aquifers. Coca-Cola set a global precedent when it shared their global water risk data in order to improve global public water management. Many other companies in the extractives sector (mining, oil & gas), power utilities, and food and beverage companies have data on groundwater which is not currently public.

A pre-competitive global partnership facility is needed to coordinate these approaches organised around geographically-specific groundwater 'hotspots'. A dialogue is needed that helps to overcome the competitive dynamics and foster communication and collaboration. The 2030 Water Resources Group (WRG) is already operating in a number of key groundwater hotspots to facilitate collective action between government, the private sector and the civil society. Its work, for example, includes water data gathering projects in Mongolia, Jordan and Bangladesh. WRG could serve as a convening platform for an open data partnership, bridging interests and data capabilities, and creating common data sharing protocols that build on existing groundwater monitoring and data-sharing initiatives, including UNESCO-IHP's groundwater monitoring network and data sharing platforms.

The scoping stages of such a partnership should build out of a core group of companies interested in advancing this agenda, which could include those companies that have already shared data on groundwater with public agencies. The initiative should involve industry and engineering companies that are developing data on aquifers as well as technology companies that are advancing the analytics of aquifer data.

Partner

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ESG Team

The team at Earth Security Group that has developed this report included Alejandro Litovsky (lead author), Margot Hill Clarvis, Caroline Hambloch, Pablo Orvananos, Rupert Bassett (information designer), Orlaith Delargy and Alvise Lisca.

Global Expert Group

Andreas Spiegel, Swiss Re; Angel Hsu; Yale University; Chris Lambe, Columbia University; Claudia Ringler, International Food Policy Research Institute (IFPRI); Cynthia Rosenzweig, NASA Goddard Institute for Space Studies; Ephraim Nkonya, IFPRI; Marengo, Brazilian National Institute for Space Research; LaiLai Li, World Resources Institute, China; Laura Cozzi, International Energy Agency; Professor Arjen Y. Hoekstra, University of Twente & Water Footprint Network; Will Steffen, Australian National University.

Photography

Interviews

Alex Mung, World Economic Forum; Alexis Morgan, World Wildlife Fund; Alice Aurelie, UNESCO; Alyssa Barrett, World Resources Institute; Andrew Allan, UNESCO; Aniket Shah, Sustainable Development Solutions Network; Brian F. Thomas, California Institute of Technology; Bruno Lanvin, INSEAD; Cadmond Dadzie, Sekondi-Takoradi Chamber of Commerce and Industry Ghana; Caroline Sullivan, Southern Cross University Australia; Cho Khong, Shell International; Chris Brown, Olam International; Claire Devineau, Bureau de L'aide Publique au Développement; Geraldine Wessing, Shell International; Giulia Guidi, JP Morgan; Hua Xie, IFPRI; Ian Hope-Johnstone, Pepsico; J. Carl Ganter, Circle of Blue; Jan Cassin, Forest Trends; Jason Morrison, CEO Water Mandate; Jason Zibarras, Argo Infrastructure Partners; Jens Sedemund, OECD; Johan Gely, Swiss Agency for Development and Cooperation; Karina Litvack, ENI; Katalyn Voss, University of California, Santa Barbara; Ken Caplan, Partnerships in Practice; Luigi Sampaolo, ENI; Marina Rubio, UNESCO; Martin Murillo, Notre Dame Global Adaptation Index; Matt Nixon, Disraeli Group; Michaela Saisana, European Commission; Michael Wilkins, Standard and Poors; Paul Reig, World Resources Institute; Peter Chamley, Arup; Peter Eigen, Transparency International; Peter Williams, IBM; Philippe Joubert, World Energy Council; Pio Wennubst, Assistant Director General, Swiss Agency for Development and Cooperation; Rafael Escalona Reynoso, Cornell University; Robert Spencer, Aecom; Sean Kidney, Climate Bonds Initiative; Sophia Sandstroem, World Economic Forum; Surampudi Sivakumar, ITC Limited; Swenja Surminski, Grantham Research Institute; Tales Carvalho Resende, UNESCO; Tom Burke, E3G & Rio Tinto; Yoshihide Wada, Columbia University; Wolf Grossman, University of Graz.

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[27] See Table 1 for sources. Data point shows level of transboundary cooperation for transboundary aquifers: 1) transboundary treaty in place, 2) transboundary institution or cooperation agreement in place, 3) no cooperation (N), 4) not-applicable (NA) because it is not a transboundary aquifer.

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