WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

World Economic Forum Water Initiative

Managing Our Future Water Needs for Agriculture, Industry, Human Health and the Environment

The Bubble Is Close to Bursting: A Forecast of the Main Economic and Geopolitical Water Issues Likely to Arise in the World during the Next Two Decades

Draft for Discussion at the World Economic Forum Annual Meeting 2009

World Economic Forum
January 2009

“Take one world already being exhausted by 6 billion people. Find the ingredients to feed another 2 billion people. Add demand for more food, more animal feed and more fuel. Use only the same amount of water the planet has had since creation. And don’t forget to restore the environment that sustains us. Stir very carefully.”

Margaret Catley-Carlson
Patron Global Water Partnership,
2008-2009 Chair of World Economic Forum Global Agenda Council on Water Security

Draft for Discussion at the World Economic Forum Annual Meeting 2009

An Initiative of the World Economic Forum
January 2009

In collaboration with
The Coca-Cola Company
The Dow Chemical Company
Hindustan Construction Company
International Federation of Agricultural Producers (IFAP)
Nestlé
PepsiCo
RioTinto
SABMiller
Syngenta
Swiss Agency for Development and Cooperation (SDC)
Water Center, Earth Institute, Columbia University
WWF
The World Economic Forum Global Agenda Council on Water Security

This document was prepared by the World Economic Forum Water Initiative to support the Industry Partnership Programme. Industry Partners are select member companies of the World Economic Forum that are actively involved in the Forum’s mission at the industry level. Partnerships bring visibility and insight to strategic decision-making on the most important industry and cross-industry related issues and the opportunity to engage in actions of global corporate citizenship.

The views expressed in this publication do not necessarily reflect those of the World Economic Forum or the contributing companies or organizations.

WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

Contents

Preface

Twelve months ago, business leaders at the World Economic Forum Annual Meeting 2008 set out a Call to Action on Water; developing a geopolitical forecast to raise awareness was one of their key recommendations. At the same Meeting, Ban Ki-Moon, Secretary-General, United Nations, New York, set business a challenge: to raise awareness and help engage governments in the water discussion.

This draft forecast document is a product of last year's Annual Meeting discussions, setting out the challenge we face if nothing is done to improve water management in the next two decades. There is a 12 point summary, 12 specific action points for the year ahead and further details on the challenges each pillar of the economy faces (food, trade, energy, business, cities, health and the financial sector). The data and text it contains is the product of a unique and unprecedented international public-private alliance to address the water challenge.

This is a draft document, prepared for discussion among business and government leaders at the World Economic Forum Annual Meeting 2009. The intent is fourfold:

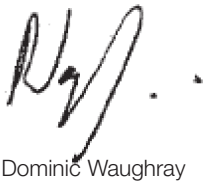
- To gain feedback to revise the forecast and recommendations as appropriate
- To identify a set of business, political and civil society leaders who will provide supporting commentaries to the forecast
- To publish the collective work as a high profile book/multimedia tool on the topic of water by late fall 2009, with an associated awareness-raising campaign
- To support a series of high-level multistakeholder activities on water reform issues, as the actions overleaf indicates.

A broad network of partners has contributed to the ongoing success of this project. This initiative has been driven by the Industry Partner community of the World Economic Forum. We express sincere appreciation for the Project Board and members of the Global Agenda Council on Water Security for their continuous input to the overall initiative and this discussion document. This document also represents the collective input of more than 100 individuals who attended our meetings in Sharm-el-Sheikh, Egypt; Cape Town, South Africa; New York City, USA; Dubai, UAE; and New Delhi, India.

Finally, should you need further information, please contact water@weforum.org

Sincerely,

Richard Samans
Managing Director
World Economic Forum



Dominic Waughray
Senior Director, Environment Initiatives
World Economic Forum

Overview[1]

Water security is the gossamer that links together the web of food, energy, climate, economic growth and human security challenges that the world economy faces over the next two decades.

There is a structural problem in how we manage water across the web of our global economy. Worsening water security will soon tear into various parts of the global economic system. It will start to emerge as a headline geopolitical issue. The volatility in food prices in 2008 should be treated as an early warning sign of what is to come.

In many places around the world, we have consistently under-priced water, wasting and overusing it as a result. We have depleted stocks of groundwater at the expense of our future water needs. In effect, we have enjoyed a series of regional water "bubbles" to support economic growth over the past 50 years or so, especially in agriculture. We are now on the verge of water bankruptcy in many places with no way of paying the debt back. In fact, a number of these regional water bubbles are now bursting in parts of China, the Middle East, the south-western US and India; more will follow. The consequences for regional economic and political stability will be serious.

This set of regional challenges becomes a fast-approaching global crisis, when placed against future needs for water. As the world economy expands, demand for water will rise and continue to outpace population growth. This means that there will not be enough water to do all the things we want as inefficiently as they are done now. Unlike energy, water has no substitutes or alternatives. We simply cannot manage water in the future as we have in the past or the economic web will collapse.

If we are to ensure sustained economic growth, human security and political stability over the next two decades, how we manage water is fast becoming an urgent political issue. While businesses and nongovernmental organizations do what they can, water has potent social, cultural and religious dimensions; it can never be viewed only as a pure economic good. Water requires government engagement in its management and reform. An unfettered reliance on markets will not deliver the social, economic and environmental outcomes needed. Good regulation in water is indispensable.

The current context of a sharp economic downturn, where national governments are playing an increased role in economic management and where businesses face challenging times, offers some lessons and an opportunity on how to address the water challenge. The financial crisis gives us a stark warning of what can happen if known economic risks are left to fester. It shows us that, in today's world system, wide collaboration, although difficult, is the only effective way to address a systemic crisis. It also offers us an opportunity: led by government, a multistakeholder effort to improve the management of our future water needs stands out as an urgent, practical and resolvable issue that, in times of economic hardship, can bring state institutions, business and civil society together to address a commonly (and often locally) felt challenge. Growing water problems are recognized by rich and poor alike around the world as real issues that impact our business, our lives and our health. While some trade-offs will be inevitable, all can tangibly benefit from improvements in how water is managed.

"As the global economy grows, so will its thirst. This is not an issue of rich or poor, north or south. All regions are experiencing the problem of water stress. There is still enough water for all of us – but only so long as we keep it clean, use it more wisely and share it fairly. Governments must engage and lead, and the private sector also has a role to play in this effort."

Ban Ki-Moon, Secretary-General, United Nations, New York

Twelve Economic and Geopolitical Water Issues for the Next Two Decades

1. Water scarcity will increase dramatically in many parts of the world. This will have significant social and economic repercussions. Global grain harvests will be threatened, more countries will rely on food imports and the livelihoods of many people will be threatened. This is on top of the billion or so people who do not have access to improved water supply today.

2. Meanwhile, global demand for food, especially meat, will rise sharply, placing more pressure on water for agriculture. Unless we change how we manage agricultural water, we will not be able to provide the food for tomorrow's consumer demands.

3. At the same time, and compounding the problem, fast-growing economies, especially in the Middle East and Asia, will likely allocate less water to agriculture over the next two decades and more to the growing demands of their urban, energy and industrial sectors.

4. Domestic reform of water for agriculture is therefore urgently required in many water-stressed countries, in order to produce "more crops with fewer drops". But there is currently little political interest in this.

5. The over-extraction of freshwater is also compromising the environment severely in many parts of the world. Climate change adds to the urgency; its impacts play out most prominently in water resources.

6. Engaging in global trade can also help countries to manage water security issues, but the global trade system for agriculture is outdated and in urgent need of reform.

7. With agriculture remaining a thinly-traded good, gains from trading so-called "virtual" water are limited. Changes in the geopolitical landscape will start to occur, as water-scarce countries seek their own water solutions.

8. Simultaneously, the US and EU will also seek to improve energy security. Energy policy decisions have strong connections to water, climate and food security policy, which can spin negatively or positively. Energy policy must take into account these interlinkages. Domestic energy security should be seen as a decision to switch from relying on foreign oil to relying on domestic water.

9. Improving water infrastructure for cities, energy and industry will become urgent across all economies, especially in Asia. Poor quality and inefficient water supply services will be seen as a brake on economic growth. Private finance will be required, as public funds will not be able to fill the water investment gap. Governments that introduce reforms in water supply management will attract private finance. This does not mean taking water supply out of public ownership, but undertaking reforms to ensure private investor risks are reduced and rates of return become more desirable. International aid for water will be increasingly used to access credit for private investments into public infrastructure on the back of these reforms.

10. The raw economics of water are both compelling and challenging: water security, economic development and GDP are interlinked. Business and capital will be attracted to those economies in water-scarce regions with sound water management. New technologies, new markets and new financing ideas will be attracted to solving the water challenge. Water will become a mainstream theme for investors. Governments in water-scarce regions that undertake water reforms will strengthen and position their economies well. Global financial regulators will have to develop clear rules to manage the inevitable appearance of innovative water funds.

11. The overall conclusion is clear: governments in water-scarce regions will be in a weaker position if they choose not to engage in water management reforms, whether in their agricultural, energy and municipal sectors, or through multi-country discussions on trans-boundary issues, international trade and investment flows. The global water forecast for the next two decades, if no reform actions are taken, is chilling; water scarcity will have a profound effect on global and regional systems, whether from an economic growth, human security, environmental or geopolitical stability perspective.

12. The current economic downturn offers an opportunity to start addressing the emerging water crisis. Management of future water needs stands out as an urgent, tangible and fully resolvable issue, which can only be improved by a multistakeholder effort led by government. Governments can bring business and civil society together to help address a commonly (and often locally) felt challenge. While some trade-offs will be inevitable, all can benefit from improvements in how water is managed. Now, when a suite of reforms is required to fix systemic problems in the economic system, is the perfect time to start the water reform dialogue.

> "One of the many things I learned as president was the centrality of water in the social, political and economic affairs of the country, the continent and the world."
>
> **Nelson Mandela**, Founder, Nelson Mandela Foundation, South Africa, at the World Summit on Sustainable Development, 2002

Three Themes, 12 Actions for the Year Ahead

Raise Awareness

1. We will finalize the draft of this forecast and publish it worldwide as a book/multimedia product. We invite interested parties from all parts of the Davos community to contribute to this publication.

2. We will work with the external relations departments of our Water Initiative Project Board and our resource Partner, Ogilvy Public Relations Worldwide, to formulate an awareness-raising campaign for the forecast publication and its core messages. We invite interested media companies who form part of the Davos community to help us.

3. We will seek to have the short film that accompanies this forecast, made by Circle of Blue, disseminated as widely as possible. A webpage linked to the World Economic Forum website will enable the film and the forecast to be downloaded free of charge. Project Board members of the Water Initiative and organizations that have contributed to the forecast will also be asked to place the files on their websites.

4. We will use this forecast to raise awareness among business and government leaders involved in the energy sector in particular. We welcome the associated report on water that CERA has produced for the World Economic Forum Energy Community for the World Economic Forum Annual Meeting 2009, and look forward to working closely with them on this issue.

Improve Management

5. We will work with our Water Initiative Project Board, members of the Global Agenda Council on Water Security and others to provide a global and regional discussion platform that helps the development of better analytics for water. A private session at the Annual Meeting 2009 will help to catalyse this process. We invite interested members of the Davos community to join this process.

6. We will support our regional partners in the Middle East to develop a water policy benchmarking tool to enable a comparison of the effectiveness of government water reform activities in the region.

7. We will support our regional partners in Southern Africa to develop public-private water management plans that link to the SADC/African Union commitment to development of a number of growth corridors in the region.

8. We will invite our Water Initiative Project Board, members of the Global Agenda Council on Water Security and other organizations and initiatives such as the CEO Water Mandate, the World Business Council for Sustainable Development, the Global Water Footprint Network, the Carbon Disclosure Project, the Columbia University Water Centre, Yale University *inter alia* to help us create an international public-private workshop on unifying water data collection, management and disclosure approaches for business. We will support this as a side event at the Stockholm World Week, August 2009, or in Dalian, People's Republic of China, September 2009 as part of the World Economic Forum Annual Meeting of New Champions.

Promote Investment and Reform

9. We will work with our Water Initiative Project Board, members of the Global Agenda Council on Water Security and regional stakeholders of the water initiative from the Middle East, Southern Africa and India, to launch three regional multistakeholder conclaves. These high level roundtables will use this forecast document to help catalyse regional discussions on reform to the water sector. Public-private discussions during 2008 in each region identified both the desire for these conclaves and a core group of participants. The conclaves will each convene twice during 2009, once as part of a World Economic Forum regional event, and at one other time during the year, perhaps linked to a relevant regional water event. Participants will be eligible to use the WELCOM platform of the World Economic Forum to help sustain their discussions via a Wiki, interactive electronic chat rooms and videoconference facilities. We invite interested regional leaders who form part of the relevant Davos community to join these conclaves.

10. We will use the convening power of the World Economic Forum to help our Water Initiative Project Board and our members of the Global Agenda Council on Water Security have bilateral discussions about the importance of water reform with relevant ministers, other officials and civil society leaders from key water-stressed regions of the world. These meetings will link to Forum regional events throughout the year.

11. We will use the convening power of the World Economic Forum to stage an Informal Gathering of Asian Water Leaders (inspired by the Forum's IGWEL sessions). The session will discuss, at the highest political level, the need for water reform across Asia, using this forecast document as a starting point. The session will take place in Dalian, People's Republic of China, in September as part of the World Economic Forum's Annual Meeting of the New Champions 2009.

12. We will work with our Water Initiative Project Board, members of the Global Agenda Council on Water Security and partners from international development agencies to launch a global alliance on public-private partnerships in water. Evidence from a World Economic Forum-supported pilot initiative in India and South Africa shows that over US$ 20 million can be leveraged for water projects from a grant 100 times as small, when a neutral discussion platform is created that enables key stakeholders from business, government, banks, the aid industry, civil society and foundations to jointly design, finance and execute a mutually-acceptable project pipeline. This work has been short-listed for a Harvard University Prize. The aim is now to scale up the platform: a private session at the Annual Meeting 2009 will launch this activity. We invite interested members of the Davos community to join us and our partners in this process.

We believe this set of activities offers a tangible and practical response to the many questions raised by the forecast document, especially in the context of the structural economic problems the world economy currently faces. Please contact water@weforum.org for more information.

Given the scope and breadth of the activities proposed, we also welcome inquiries from members of the Davos community (Industry Partner, governmental organizations or NGOs) interested in providing staff to help the Forum's Water Initiative execute these tasks over the coming year.

The Story

1. Water scarcity will increase dramatically in many parts of the world. This will have significant social and economic repercussions. Global grain harvests will be threatened, more countries will rely on food imports and the livelihoods of many people will be threatened. This is on top of the billion or so people who do not have access to improved water supply today.

The Evidence

From 1900 to 2000, global freshwater withdrawals grew ninefold against a population increase of factor four.

According to the OECD, 2.8 billion, or 44%, of the world's population lives in areas of high water stress. This figure is expected to rise to 3.9 billion by 2030 under business-as-usual. If present trends continue, the livelihoods of one-third of world's population will be affected by water scarcity by 2025.

> *"Globally, our human pattern of water usage is unsustainable. Why? Population, prosperity and pollution. We have today the same basic amount of water as the Earth of the dinosaurs or Julius Caesar. But we have grown and grown from Caesar's world's population of about 400,000, to today's almost 6.5 billion people, heading for 8.5. With increasing prosperity, people in many places use upwards of 2,500 litres of water a day. Do the math."*
>
> **Margaret Catley-Carlson**, Patron, Global Water Partnership (GWP), Sweden; Chair, Global Agenda Council on Water Security

70% of global freshwater withdrawals are used for agriculture, but inefficiencies in water use are high. Traditional irrigation, in most water-scarce countries, consumes only a fraction of the water it withdraws (about 50%); the rest is wasted or evaporates.

With business-as-usual water use practices, by 2025, water scarcity could affect annual global crop yield to the equivalent of losing the entire grain crops of India and the US combined (30% of global cereal consumption).

A quarter of India's harvest alone could be at risk by 2025 as groundwater is depleted beyond recovery.

> *"The clearest thing about the history of water is that people use a lot more now than they used to."*
>
> **J. R. McNeil**, Author, An Environmental History of the Twentieth Century.

Across much of Central Asia, Latin America and South Asia, glaciers act as huge water banks. The glaciers of the Himalayas and Tibet alone feed seven of the world's greatest rivers – providing water supplies for more than 2 billion people. Today, these glacial banks are melting at an accelerating rate. Most analyses suggest the majority of these glaciers will disappear by 2100 under current trends.

55% of the world's population will be dependent on food imports by 2030 as a result of insufficient domestic water.

> *"A similar amount of water to what we have been used to in the past will be available for future generations? No more. Climate change with the increase in temperatures in the temperate and arid zones means that there will be less water for much of the heavily populated areas of the Earth. Growth in food production must therefore come from more efficient use of the available water."*
>
> **Don Blackmore**, Chair, eWater, Australia

2. Meanwhile, global demand for food, especially meat, will rise sharply, placing more pressure on water for agriculture. Unless we change how we manage agricultural water, we will not be able to provide the food tomorrow's consumer demands.

Food demand is projected to grow 70-90% by 2050. More than 25% of the increase in grain demand will be due to changes in diet rather than population growth.

A typical meat-eater's diet requires about 5,400 litres of water a day, twice that which a vegetarian requires for the same nutritional value. Global production of meat is projected to more than double from 229 million tonnes in 1999-2001 to 465 million tonnes in 2050, notably across Asia.

> *"Our ability to meet current and future food production needs is seriously challenged by increasing water scarcity, climate change, and volatile energy costs and supplies. Unless we change how we do it, we will not be able to supply our future food needs."*
>
> **Josette Sheeran**, Executive Director, United Nations World Food Programme (WFP), Rome; Chair, Global Agenda Council on Food Security

3. At the same time, and compounding the problem, fast-growing economies, especially in the Middle East and Asia, will likely allocate less water to agriculture over the next two decades and more to the growing demands of their urban, energy and industrial sectors.

When 40% of renewable water resources is devoted to irrigation, fast-growing economies are often forced to decide between allocating water to the agricultural sector or to the urban municipal and industrial sectors. By 2030 under business-as-usual, all of South Asia will reach the 40% threshold; the Middle East and North Africa region will have hit 58%.

Consequently, the percentage change in demand for water between 2000 and 2030 for industrial and domestic use will crowd out any growth in agricultural water use: in Asia, a 65% increase in water for industrial use and a 30% increase in water for domestic use is forecast, against a 5% increase in water for agriculture. Similar ratios apply across the EU, Latin America, the US and West Asia. Around the world, water for agriculture will be squeezed as the water needs of cities and industry grow to 2030.

> *"Arguably, the foremost challenge facing policy-makers is to strike a balance between conflicting objectives: financial, economic, social, environmental. This calls for a mix of well-integrated policy measures, which is difficult in a context of fragmented institutional responsibilities at national level, and the need to link decision-making at different geographical levels …"*
>
> **Angel Gurría**, Secretary-General, Organisation for Economic Co-operation and Development (OECD), Paris

The Story

The Evidence

4. Domestic reform of water for agriculture is therefore urgently required in many water-stressed countries, in order to produce "more crops with fewer drops". But there is currently little political interest.

Although the economic effects are profound, the political impacts of water scarcity are both gradual and local, so government desire to respond is weak and fragmented. There is no obvious crisis event for national government to react to. WWF describes water scarcity as an "invisible event".

> *"Somehow we must put water at the very top of the agenda of politicians at federal and local levels. They need to have a continuous stake in the process of conserving and managing our water resources – they don't today, and we need to tell them why (and how) they must."*
>
> **Arjun Thapan**, Director-General, South-East Asia Department, Asian Development Bank, Manila

In Yemen, parts of India and northern China, water tables are falling more than one metre per year. In Mexico, extraction rates in a quarter of the country's 459 aquifers exceed long-term recharge by more than 20%. The Ogallala aquifer in the western United States and the Edwards aquifer for the city of San Antonio, Texas, have mostly disappeared. Political action across all of these regions has been limited.

In most countries, groundwater is not monitored, so understanding when crisis levels are being reached is poorly understood. Also, as data is poor, it is difficult for the public to benchmark government responses between regions and countries.

> *"The water crisis is not the result of a lack of resources, or money, or brains. We are a rich world: rich in money, and education, and ingenuity, and good will. Those things, like water, are not evenly distributed. But the uneven distribution of this wealth gives some of us a special responsibility to act."*
>
> **Peter Gleick**, President, Pacific Institute, USA

5. The over-abstraction of freshwater is also severely compromising the environment in many parts of the world. Climate change adds to the urgency, as the impacts of climate change play out most prominently in water resources.

The 2005 Millennium Ecosystem Assessment warns that it is not possible to sustain food production or poverty reduction when the environment is being compromised too severely. The study found that water-based ecosystems are now the world's most degraded natural resource. Seventy major rivers around the world are near maximum extraction levels to supply water for irrigation systems and for reservoirs, including the Colorado, Ganges, Jordan, Nile and Tigris-Euphrates rivers.

An estimated 25% of the flow of the Yellow River in China is needed to maintain the environment. Human withdrawal currently leaves less than 10%. In 1997, the Yellow River was famously dry up to 600 kilometres inland for 226 days,

> *"Quantitative indicators make it possible to spot problems, track trends, identify leaders and laggards, and highlight best management practices … What is shocking is how little water data is available on a methodologically consistent basis across countries. Much of the existing water data has been collected without regard to cross-country comparisons."*
>
> **Daniel C. Esty**, Director, Yale Center for Environmental Law and Policy, USA

causing agricultural losses of US$ 1.6 billion.

In Australia's Murray Darling basin, about 30% of the flow is needed to maintain the environment. Irrigated agriculture uses almost 80% of available water flow. Extensive environmental damage is occurring as a result, including salinity, nutrient pollution and the loss of floodplains and wetlands. In recent years, virtually no Murray River water has made it to the sea.

> *"The first signs of water stress are experienced through environmental degradation of natural ecosystems that depend substantially on the availability of fresh water. The second sector that will feel the effects of water stress is the agricultural sector."*
>
> **Pasquale Steduto**, Chief, Water Development and Management Unit, Food and Agriculture Organization, United Nations (FAO), Rome

The upper reaches of the Orange River in Southern Africa have been so modified that the combined reservoir storage in the basin exceeds annual flows.

Across the Andes, Central Asia, China and Tibet and Nepal, analysis suggests that most glaciers could disappear by 2100 at current rates of retreat.

Need for humanitarian assistance will increase to an unprecedented scale if, as commentators foresee, large scale migration results from climate change and water scarcity. The IPCC suggests that 150 million environmental refugees could exist by 2020. Currently, in international law there is no such thing as an environmental refugee. The human, economic and political implications of a mass movement due to water security could be profound.

6. Engaging in global trade can also help countries to manage water security issues, but the global trade system for agriculture is outdated and in urgent need of reform.

By importing cereal, meat and other food products, countries can reduce their direct agricultural water use. This is especially true for fast-growing economies in the Middle East and Asia. By 2025, an increase in cereal imports could save Asia 12% of irrigation water consumption.

However, there is less overall trade in agriculture today, when we need more. Agriculture as a share of exports in international trade decreased from 46% in 1950 to 9% in 2000, Food prices have become much more volatile, as recent price rises has proved.

Furthermore, three of the world's top-10 food exporters are water-scarce countries, and three of the top-10 food importers are water rich countries.

> *"Historic agricultural policies have proven costly to governments and consumers alike because of the labyrinth of subsidies, price supports and trade barriers that they entail."*
>
> **Mohamed Ait-Kadi**, President, General Council of Agricultural Development, Morocco

The Story

The Evidence

7. With agriculture remaining a thinly traded good, gains from trading so-called "virtual" water are limited. Changes in the geopolitical landscape will start to occur, as water-scarce countries seek their own water solutions.

In 2008, Saudi Arabia gave up being self sufficient in wheat production. It has set up an investment fund to acquire land overseas to grow crops, possibly in Pakistan or the Horn of Africa. China is acquiring agricultural land in Southern Africa for similar purposes. And Daewoo Logistic is looking to lease land from the government of Madagascar to grow food for South Korea. Other countries in South Asia and the Gulf are considering similar moves.

If forecasts for future water demand are accurate, and reforms to trade do not occur, rapidly industrializing economies across South Asia, the Middle East and North Africa, supporting approximately 2.5 billion people, will be looking elsewhere to acquire water-rich land for their food.

> *"The potential for conflict over water will only increase with current global economic tensions. The current reaction to economic failure has seen nation states adopt a 'go-it-alone' strategy. There is a fragmentation of global governance structures, a blurring of the public-private boundary lines (look at the nationalization of banks across the world), and a functional breakdown of regional architecture. The same reactions are foreseeable when water scarcity (considered in the broadest sense) starts to affect economic development."*
>
> **Patricia Wouters**, Director, UNESCO Centre for Water Law, Policy and Science, University of Dundee, United Kingdom

8. Simultaneously, the US and EU will also seek to improve their energy security. This policy must be seen as a decision to switch from relying on foreign oil to relying on domestic water. Increased competition for water for energy within these economies will result in potentially negative outcomes unless energy policy reforms take into account the associated water, food and climate change connections.

Energy production currently accounts for about 39% of all water withdrawals in the US and 31% in the EU.

Under business-as-usual, energy production in the US is forecast to grow by about 50% between 2000 and 2025 and about 50% in the EU between 2000 and 2030.

> *"There are strong water connections to energy, climate and food security policy issues. These can be negative or positive. Policy decisions made on energy, climate and food policies have determinate impacts on water, and the reverse is also true. Tackling energy security without considering the related food and water impacts can create bad outcomes as we have seen with the push to first generation biofuels that displaced food crops and intensified water demands. On the other hand, tackling energy security though a water lens can create good outcomes such as the promotion of energy alternatives that are water sparing and have low carbon footprints."*
>
> World Economic Forum Global Agenda Council on Water Security, Dubai Statement 2008

Under business-as-usual, water consumption for energy production is expected to grow by as much as 165% in the US and by as much as 130% in the EU over the same period.

> *"I am convinced that, under present conditions and considering the way water is being currently managed, we will run out of water long before we run out of fuel."*
>
> **Peter Brabeck-Letmathe**, Chairman of the Board, Nestlé, Switzerland; Member of the Foundation Board of the World Economic Forum

9. Improving water infrastructure for cities, energy and industry will become urgent across all economies and especially in Asia. Poor quality and inefficient water supply services will be seen as a brake on economic growth. Private finance will be required, as public funds will not be able to fill the water investment gap. Governments that introduce reforms in water supply management will attract private finance. This does not necessarily mean taking water supply out of public ownership, but undertaking reforms to ensure private investor risks are reduced and rates of return become more desirable. International aid for water will be increasingly used to access credit for private investments into public infrastructure on the back of these reforms.

60% of the global population will live in cities by 2030. A shortage of clean water for people and business in the urban environment is becoming a problem of global proportions.

> *"The history of men is reflected in the history of sewers … The sewer is the conscience of the city."*
>
> **Victor Hugo**, Les Miserables, 1862. Book II, Chapter 1.

60% of China's 669 cities suffer water shortages and nearly half of China's cities lacked wastewater treatment facilities in 2005.

> *"The seriousness of the water crisis will impinge on our lives much earlier than climate change. Under-pricing of water encourages waste and blocks the avenues for essential investments in conservation and efficient use."*
>
> **Ajit Gulabchand**, Chairman and Managing Director, Hindustan Construction Company, India

In cities such as Delhi, Dhaka and Mexico City, about 40% of the water pumped into the system leaks out of corroded pipes or is sold illegally.

Billions of people in urban environments in the developing world, especially the poorest, are unconnected to a municipal water supply and rely on water vendors. In Dar-es-Salaam, fewer than 30% of households are connected to a water delivery system.

The poorest people play as much as 10 times more than richer households for water, and often receive poorer quality water. Regulatory authorities in the United Kingdom define any expenditure on water above 3% of total household spending as an indicator of hardship.

> *"How should the infrastructure that water provision depends upon be financed? Water has been described as a 'gift from God' – but somebody has to put the pipes in the ground, maintain the pumps and purify the water."*
>
> UNDP HDR report, p. 96

The US EPA estimates that US$ 68 billion will be needed over the next two decades just to restore and maintain existing utility assets in major US cities.

An investment of US$ 10 billion annually is necessary to reduce by half the number of people in developing countries without adequate access to freshwater and sanitation by 2015, according to the OECD.

The global market for water and sanitation infrastructure has been estimated at US$ 400 billion a year and growing.

> *"Market mechanisms will help in many water operations but unfettered reliance on markets will not deliver the social, economic and environmental outcomes we need. Water has potent social, cultural and religious dimensions and should never be viewed as only a pure economic good or as a commodity. To protect the resource everywhere, and especially the poorest billions who lack regular access to safe water and adequate sanitation, good governance and good regulation are also indispensable."*
>
> Global Agenda Council on Water Security, Dubai Statement

The Story

The Evidence

The central role for the public sector in improving water systems will be consolidated. Government reforms can work: Uganda reformed water policy in the 1990s. Budget allocations increased from 0.5% of public expenditure in 1997 to 2.8% in 2002. Coverage levels increased from 39% in 2006 to 51% in 2003. In Morocco, a rural water reform programme since 1995 has boosted coverage to 50% with many economic multiplier effects.

10. The raw economics of water are both compelling and challenging: water security, economic development and GDP are interlinked. Business and capital will be attracted to those economies in water-scarce regions with sound water management. New technologies, new markets and new financing ideas will be attracted to solving the water challenge. Water will become a mainstream theme for investors. Governments in water-scarce regions that undertake water reforms will strengthen and position their economies well. Global financial regulators will have to develop clear rules to manage the inevitable appearance of innovative water funds.

International aid will help governments in developing economies to mobilize credit through local markets for private investments into public water infrastructure, on the back of policy reforms.

> *"Not having access to water and sanitation is a polite euphemism for a form of deprivation that threatens life, destroys opportunity and undermines human dignity."*
>
> UNDP Human Development Report 2006, p. 5

Historically, the availability of easily accessible freshwater has proven a key determinant in economic development. The reverse is also true. Increases in water insecurity can affect GDP. The ongoing drought in Australia cost the country around 1% of GDP in 2007. Environmental degradation and pollution in China is estimated to cost between 8% and 12% of annual GDP: water issues form a large part of this calculation. Poor water and sanitation services are estimated to cost sub-Saharan Africa 5% of its annual GDP, more than the region receives in overseas aid.

> *"We believe that companies urgently need to change the way they currently manage water to take a longer term, strategic approach to water management. We have developed a global water strategy to identify and manage water risk and opportunity."*
>
> **Paul Skinner**, Chairman, Rio Tinto, United Kingdom

It is estimated that spending US$ 10 billion a year in developing countries to meet the MDG target would provide US$ 38 billion in economic benefits annually.

Water security and pollution in water-stressed countries is a growing concern to many companies, especially in the power, mining, food & beverage and semiconductor sectors. The last few years have seen a plethora of reports from business associations, financial analysts and companies on the strategic importance of water

> *"We believe that providing sustainable resolution to the global water challenge requires a collaborative approach from governments, businesses and humanitarian organizations. Technology enables purification and distribution of water, but technology alone – without a sound strategy that includes water management, infrastructure, investment, agricultural/industrial/consumer use, and education – has limited power to address the crisis."*
>
> **Andrew Liveris**, Chairman and Chief Executive Officer, The Dow Chemical Company, USA

security. The UN Global Compact CEO Water Mandate is a good example of this emerging trend.

> *"Will companies relocate en masse from resource-poor countries to resource-rich countries, similar to the situation in the last 20 years where lower wages in emerging countries such as China and India became much more attractive locations for manufacturing? Will water security drive economic decisions?"*
>
> Gray, David and Claudia Sadoff, 2007, Water Policy, Vol. 9 No. 6 p. 545-571

Companies will increasingly be asked to provide details of their water related risks to investors and of their water use efficiency measures to the public. They will be attracted to countries with sound water management policies.

Governments and regions in water-scarce areas that take a lead in progressive water policy reform will enjoy an economic triple win: they will retain and attract companies; they will attract more inward investment into their water infrastructure and their economy will be strengthened as a result of improved water management.

> *"We believe water is one of the biggest issues facing the world in the next few decades. Water is an attractive investment because of the lower volatility, compared to other commodities such as oil. Since it began, our water fund has performed much better than the market."*
>
> **Ivan Pictet**, Senior Managing Partner, Pictet & Cie Private Bankers, Switzerland; Member of the Foundation Board of the World Economic Forum

Are water-themed infrastructure funds a better pick than oil? Since 1989, the annual price increase of oil has been 6.2% versus 6.3% for water. On the other hand, price volatility during the same period rose by 42.9% for oil, versus only 4.2% for water. Water price volatility is capped because the water market for the most part, unlike oil, is publicly run.

New technologies and business models abound. New membrane technologies mean that wastewater treatment plants can be local, small scale and safe. The market for toilets in the developing world, for example, is an opportunity, possibly worth billions of dollars. The market for clean-energy/zero water use energy sources to power desalination or wastewater treatment plants could be huge.

> *"Water sits at the nexus of so many global challenges, including health, hunger and economic growth. And sadly, water scarcity takes its greatest toll on society's least fortunate. I am absolutely convinced that the only way to measurably and sustainably improve this dire situation is through broad-scale collaborative efforts between governments, industry, academia, and other stakeholders around the world."*
>
> **Indra Nooyi**, Chairman and CEO, PepsiCo, Inc.

> *"Leading businesses have put in place water strategies with challenging efficiency targets. However water scarcity is a complex issue and acting alone is not enough. That's why we are working with NGOs and other stakeholders to gain improved insight into local water resource risks and developing new partnership models to provide solutions"*
>
> **Graham Mackay**, Chief Executive, SABMiller plc

The Story

11. The overall conclusion is clear: governments in water-scarce regions will be in a weaker position if they choose not to engage in water management reforms, whether in their agricultural, energy and municipal sectors, or through multi-country discussions on trans-boundary issues, international trade and investment flows. The global water forecast for the next two decades, if no reform actions are taken, is chilling; water scarcity will have a profound effect on global and regional systems, whether from an economic growth, human security, environmental or geopolitical stability perspective.

The Evidence

Some innovative investors are also selecting opportunities today in water, which may be both a sign of a possible future and a signal for clearer government rules in the water market. T. Boone Pickens has purchased over US$ 100 million in land and water rights in Texas to sell water onto Dallas-Fort Worth at a profit by taking advantage of a lay groundwater law that allows landowners to pump as much water as they can. Sextant Capital Management, a hedge fund based in Canada, almost entirely owns two Luxembourg companies with rights to glaciers in Iceland. The plan is to use the melting glacier waters for bottled water and to ship it to companies or countries that may pay for it in the future. The Sextant Capital Fund increased by over 730% since its inception in February 2006. (In December 2008, the Ontario Securities Commission alleged that these returns had been inflated. On 15 December 2008, Sextant Capital Management Funds were frozen under an order by the Ontario Superior Court of Justice. The founder of the fund denies the allegations).

"There is no doubt that water will emerge as an investment class for venture capitalists. Water related technologies are currently part of the Green-Tech theme, but a Blue-Tech theme will appear. These things usually take 15 years or so to reach critical mass."

Joseph P. Schoendorf, Partner, Accel Partners, USA; Member of the Foundation Board of the World Economic Forum

"Public goods, like clean water and sanitation, will not be provided solely by the market. What is needed in economic development is the equivalent of venture capital in the marketplace. The field is witnessing an explosion of new ideas."

Jacqueline Novogratz. Founder and Chief Executive Officer, Acumen Fund, USA

"We have the finance, technology and capacity to consign the water and sanitation crisis to history. What has been lacking is a global plan of action to galvanize political will and mobilize resources."

Kemal Dervis, Administrator, United Nations Development Programme (UNDP), New York, in HDR report

"The diversity of public-private partnerships in water cautions against lumping all private sector involvement under the general heading of 'privatization'."

UNDP Human Development Report, 2006, p. 91

12. The current economic downturn offers an opportunity to start addressing the emerging water crisis. Led by government, a multistakeholder effort to improve the management of future water needs stands out as an urgent, tangible and fully resolvable issue. Governments can bring business and civil society together to help them address a commonly (and often locally) felt challenge. While some trade-offs will be inevitable, all can benefit from improvements in how water is managed. Now, when a suite of reforms is required to fix systemic problems in the economic system, is the perfect time to also start the water reform dialogue.

"We are intelligent beings: we've decoded the human genome; manipulated substances at the subatomic level; eliminated some diseases permanently. We have the intellectual resources to tackle the water problem."

Peter Gleick, President, Pacific Institute, USA

"Resistance to reforms can be addressed by, among other things, sequencing reforms properly; identifying 'losers' and designing compensation mechanisms for them; involving different interest groups in decision-making; and building coalitions around reform packages."

Angel Gurría, Secretary-General, Organisation for Economic Co-operation and Development (OECD), Paris

"When it comes to water and sanitation, the world suffers from a surplus of conference activity, and a deficit of action."

UNDP Human Development Report 2006, p. 70

"To make a difference on the water challenges we all face, governments, civil society and businesses must work together as never before. For business leaders in particular, we need to speak up, stand up, and scale up our efforts on water sustainability."

Muhtar Kent, President and Chief Executive Officer, The Coca-Cola Company

"Every decision, including no decision, will have an impact on the future. Freshwater is limited; we have to value it accordingly! Food security will need an efficient use of land and water resources and free trade of agricultural produce to better share the embedded water. Farmers need incentives to invest in water efficiency and they need access to technologies that increase productivity."

Michael Mack, Chief Executive Officer,, Syngenta, Switzerland

Concise Forecast For Eight Components of the World Economy

1. **Food and Agriculture**
2. **Energy**
3. **Trade**
4. **National Economic Stability**
5. **Cities**
6. **People without Water and Sanitation**
7. **Business**
8. **Financial Sector**

The following series of short forecast notes has been prepared by combining the thoughts of water experts, data prepared by Columbia University Water Center and information drawn from the existing literature.

Each forecast is not intended to be comprehensive. Instead, they aim to provide an overview of the main trends and implications that will play out due to water security issues.

They are drafts. They will be corrected, revised and developed during the course of 2009 to become ready for publication.

1. Food and Agriculture

Why is the issue important?

The Comprehensive Assessment of Water Management for Agriculture (Water for Food, Water for Life) was published in 2007. Seven hundred leading scientists collaborated to produce it and its 645 pages were peer reviewed by 50 experts. It is the best scientific sourcebook available on the challenge of water for agriculture. It asked the basic question: is there enough land, water and human capacity to produce food for a growing population over the next 50 years? Its answer is no, unless we act to improve water use in agriculture. Today's food production and environmental trends, if continued, will lead to crises in many parts of the world.

The publication expresses the pressure on our freshwater supplies powerfully:

"Imagine a canal 10 metres deep, 100 metres wide and 7.1 million kilometres long (enough to go around the world 180 times). That is the amount of water it takes each year to produce food for today's 6.5 billion people. Add 2-3 billion more people and accommodate their changing diets from cereals to more meat and vegetables and that could add another 5 million kilometres to the channel of water needed to feed the world's people." [2]

Josette Sheeran, Executive Director of the World Food Programme, agrees. She writes in a summary of the 2008 Environment and Sustainability Global Agenda Council discussions:

"To feed ourselves the world will need to double food production in the next 40 years to meet projected demand. Among the middle classes, global demand for meat alone is expected to increase by 50% between now and 2025. Among the poorest today, over one billion people – one-sixth of the world's population – do not have access to adequate food and nutrition. And an increase in two billion people is expected by 2025, with population growth highest in the poorest parts of the world. In contrast, an estimated 33% of food in richer countries gets wasted. Still, we will have to produce even more food in the future and food of higher protein content. But our ability to meet current and future production needs is seriously challenged by increasing water scarcity, climate change, and volatile energy costs and supplies. Unless we change how we do it, we will not be able to supply our future food needs."

What are the trends?

Global population growth: from 6.7 billion today to 8 billion in 2025.

70% of global freshwater withdrawals are used for agriculture, (up to 90% in growing economies) but inefficiencies in water use are high. Traditional irrigation, in most water-scarce countries, consumes only a fraction of the water it withdraws (about 50%); the rest is wasted or evaporates.

A doubling of food production is required in the next 40 years. More than 25% of the increase in grain demand will be due to changes in diets rather than to population growth.

Total world cereal demand is projected to grow from 585 million tonnes today to 828 million tonnes by 2025, a rise of 42%.

Global demand for meat will increase by 50% between now and 2025, doubling from 229 million tonnes in 1999-2001 to 465 million tonnes in 2050. Milk demand will grow from 580 to 1,043 million tonnes over the same period.[3] (While high proportions of meat in European and American diets have been the case for many years now, this trend is also catching on in emerging markets that have seen an increase in their per capita consumption. In China, consumption of meat has increased from less than 20 g per capita per day to 150 g.[4] This is still far behind the 350 to 400 g consumed per capital per day in the US).

Meat, on average, requires about 10 times the water required per calorie from plants. As a result, the average daily diet in California requires some 6,000 litres of water in agriculture, compared to 3,000 litres in countries such as Tunisia and Egypt.

The livestock sector is a key player in increasing water use, accounting for over 8% of global human water use, mostly for the irrigation of feed crops.

In Yemen, parts of India and northern China, water tables are falling more than 1 metre per year. In Mexico, extraction rates in a quarter of the country's 459 aquifers exceed long-term recharge by more than 20%. Approximately 10% of grains produced in India is already from unsustainable groundwater extraction. The

groundwater overdraft is more than 25% in China and 56% in India.[5]

International aid to improve agricultural productivity in developing countries has fallen by one-third since the early 1990s, from 12% to 3.5% of total aid.[6]

A significant new factor is biofuels. Countries around the world have set ambitious targets to replace a significant part of their energy consumption by biofuels. Since the energy market, measured in calories, is twenty times the size of the food market, replacing 5-6% of energy consumption by biofuels would risk doubling water withdrawals for agriculture.

What will likely happen?

Even when world population peaks around 2050 at about 9 billion people, demand for higher production from world agriculture will continue to grow due to changing diets.[7]

There will not be enough water to grow the food needed to meet the population growth and changing diet demand; there will not be enough water to grow the food needed, given current business-as-usual water use practices.

Projected water withdrawals in developing countries will be 27% higher in 2025 than in 1995,[8] but consumption of irrigation water will increase by less than this amount.

Under a business-as-usual scenario, projections to 2025 show that potential irrigation demand will grow by 12% in developing countries, while it will actually decline in developed countries by 1.5%.

More crops will be required with far fewer drops.

Much of the increase in food production in major developing countries (including India and China) will come from the unsustainable use of groundwater. One-quarter of India's harvest could be at risk by 2025 as groundwater is depleted beyond recovery.

The world could face annual losses equivalent to entire grain crops of India and the US combined by 2025 (30% of global cereal consumption).[9]

The irrigation water supply reliability index (IWSR) for developing countries will decline from 0.81 in 1995 to 0.75 in 2025.[10]

A dampening effect could be achieved as economic development helps to reduce waste in the food supply chain: from 40-50% of crops lost with unpacked food in traditional supply chains to less than 3% in modern chains. But it may also lead to richer consumers throwing away more of the food they purchase than before (up to 33%).[11]

What are the political and economic implications?

Agriculture is still important to the economy for most developing countries, especially in sub-Saharan Africa. It can employ up to 70% of the labour force; its share of GDP can be up to 33%. If present trends continue, however, the livelihoods of one-third of world's population will be affected by water scarcity by 2025.

Although the economic effects are profound, the political impacts of water scarcity are both gradual and local, so government desire to respond is weak and fragmented. There is no obvious crisis event for national government to react to. WWF describes water scarcity as an "invisible event".

Another key political implication of these trends will be the greater reliance on agricultural trade. 55% of the world's population will be dependent on food imports by 2030 as a result of insufficient domestic water.

What are the glimmers of hope?

- Crop technology. Engineering crops to deal with changing conditions must play a role.[12]

- Irrigation technology. Technology transfer for drip irrigation systems and rainwater harvesting. Localized irrigation systems, like drip irrigation or mini-sprinklers to provide water only to limited soil surface area, rather than to the whole soil surface, reducing evaporation.

- Fix what exists. Examine inefficiencies and the costs of irrigated agriculture. Evidence suggests huge failures in public irrigation systems, with a majority of systems, certainly in Asia, operating at suboptimal levels, with excessive amounts of water wasted through puddling and evaporation. Water conservation and management has its highest prospects for returns in irrigation, evolving from flooding to pivot to drip irrigation. While the issue requires detailed examination, there is, nonetheless, enough diagnostic work to tell us that a dedicated focus must be given to the efficiency gains to be achieved in irrigated agriculture. The costs of not doing so urgently and rigorously will be high. More scientific irrigation. Methodologies can be chosen to limit the non-beneficial use of water in irrigation, including, for example, deficit irrigation (where crops are watered only in critical periods instead of providing full irrigation during the whole growing season).

- Demand management. In large-scale irrigation systems, water can often be saved by improving water management practices and focus on demand management rather than on augmenting supply management of water. Traditional irrigation, in most of the water-scarce countries, consumes only a fraction of the water it withdraws (about 50%); the rest is being lost or evaporated in unproductive areas. These losses represent an untapped potential that, if well controlled, could free important amounts of water for productive use.

- Use untapped potential, such as urban wastewater, which can be re-used in agriculture. In many countries, however, where wastewater is not treated enough to be used for food production, it should be used in non-food agriculture only, such as for wood or biofuel production.

- A renewed national focus on agriculture and water use efficiency investments from key grain producing countries. “For example Brazil, which has taken a long-term, consistent view and has put money behind this for decades, and where agricultural production has grown at 4% a year for 35 years, with 90% of this due to increased total factor productivity.”[13]

- Reforms to agricultural water rights and price incentives. Understanding that water is not a single input, but one in which reliability (and quality) are of prime importance. Changing the incentive structures for water management so that AAA water goes to high-value uses in ways that are practical and in which those who give up their water also win. Such as in the Murray Darling River Basin, Australia.

- Case study: Israel has become the world’s leader in maximizing agricultural output per drop of water. The Israeli government strictly regulates how much water farmers can use and requires many of them to irrigate with treated sewer water.

- Case study: Aflaj in Oman, where tradable water rights among farmers have led to efficient and sustainable agricultural irrigation systems for more than 4,500 years.

- Water for Food, Water for Life recommends that reforms cannot follow a blueprint. They are specific to local institutional and political contexts. They require negotiation and coalition building. The state is the critical driver, but civil society and the private sector are important actors. Informed multistakeholder negotiations are essential.

Figure 1 in the annex shows that much of the increase in agricultural water demand come from the Middle East, North Africa, India, and China.

2. Energy

Why is the issue important?

Water and power are more closely related than most people realize – it takes a substantial amount of water to produce energy (hydropower generation, thermal and nuclear cooling, cultivating biofuels), and it requires a substantial amount of energy to deliver water (to pump groundwater, treat water and wastewater, distribute water and desalinate sea water). Shortage or mismanagement of either can have very large implications for both.

Energy production accounts for about 39% of all water withdrawals in the US (and 3% consumption) and 31% of all water withdrawals in the EU.[14] Most water withdrawn is not consumed but returned to a river or lake after a rise in temperature, thereby creating thermal pollution.

4% of total power generation in the US is used to supply, purify, distribute and treat fresh water and wastewater. Typically, electricity accounts for approximately 80% of municipal water processing and distribution costs in the US.[15]

Limits to energy are beginning to affect water systems and limits to water are beginning to affect energy systems. Yet energy issues and water issues are rarely integrated in policy-making.

The entire energy "fuel" cycle requires water, from mining to generation and distribution of energy. The end use of energy and waste disposal also use or contaminate water resources.

Water consumed to produce 1 MWh of electricity:[16]

Wind turbines	0 m^3/MWh
Solar	0 m^3/MWh
Natural gas	0.2 m^3/MWh
Coal	0.7-3.0 m^3/MWh
Nuclear	0.9-3.3 m^3/MWh
Oil/petroleum	0.1-6.5 m^3/MWh
Hydropower (from evaporation)	17.0 m^3/MWh
First generation biofuels*	32.3-360.0 m^3/MWh

** The amount of water consumed does not indicate whether the crop is irrigated or rainfed. The water intensity of biofuel feedstocks depends on the feedstock used and where and how it is grown. Irrigated crops are much more water intensive than non-irrigated ones. The higher numbers shown represent crops that are irrigated, while the lower numbers represent non-irrigated crops.*

Water supply systems require substantial energy, from collecting water at a source, to conveyance, treatment, distribution, end use and wastewater treatment. For example, the California Aqueduct, which transports snowmelt across two mountain ranges to the coastal cities, is the biggest electricity consumer in the state. Local municipalities use approximately 3.5% of the US's electricity for the treatment of water and wastewater.

Energy costs are the principal barrier to the greater use of desalination.

What are the trends?

The tension between water and energy is already visible in the US and Europe. Consider the following recent examples:

- The Department of Energy report to Congress on the interdependency of energy and water stated that energy production is very much at the mercy of water availability[17]
- Utilities in the US recognize that water quantity is becoming a significant permitting issue – Maryland County denies cooling water to proposed power plants[18]
- Tennessee Valley Authority shut down one of three reactors at its Browns Ferry nuclear plant to avoid heating the Tennessee River to dangerous levels. Due to a drought that reduced the river level and hottest temperatures in 50 years, the plant could not discharge the cooling tower water since it would have crossed the permissible limit.[19]

- The summer of 2003 in Europe was the warmest on record and the high temperatures were particularly hard on France's nuclear reactors, which generate approximately 75% of the country's electricity. In some regions, river levels were too low for the plants to operate at all. Demand for electricity soared as the population used more air conditioning due to the heat, but total electricity generation was down due to the lack of water. France cut its power exports in half to make up for the difference.

- Desalination plants in San Diego and London cannot be built because the facilities would consume too much energy and the power supply is too thin.[20]

- Cities in Uruguay must choose whether they want the water in their reservoirs to be used for drinking or for electricity.

Globally, the International Energy Agency (IEA) predicts that world energy demand is set to rise by around 5,000 Mt of oil equivalent, or 45% by 2030. Coal will account for one-third of the overall rise. Demand in China dwarfs all other countries, accounting for 2,000 Mt of oil equivalent, about 60% through coal. Aside from the CO_2 implications, the water use implications in an already water-stressed country are huge.[21]

Under the same IEA reference scenario, hydropower will strengthen its role as the world's dominant renewable energy source by 2030, providing about 1,100 TW hours of electricity; more than double the amount of its nearest rival, onshore wind power. About 170 GW of hydropower is currently under construction, 76% of this across Asia (55% in China, 9% in India and 13% in other parts of Asia). A rough calculation suggests the water this new hydropower capacity in Asia will consume through evaporation will be around 8,800 cubic kilometres of water per MW/hour.

One of the Millennium Ecosystem Assessment scenarios foresees that, by 2050, 25% of global energy supply will be met by energy from biomass (Alcamo and others, 2005). Producing the necessary 8 billion tonnes of biomass to achieve this will require 5,500 cubic kilometres of crop water consumption, roughly 75% of what is needed for the production of global food today (Kemp-Benedict, 2006a, 2006c).[22]

In terms of energy demands for providing water supply, desalination is a key trend. Worldwide, 52% of desalination capacity is in the Middle East, largely in Saudi Arabia, where 30 desalination plants meet 70% of the Kingdom's present drinking water needs. North America has 16%, Asia 12%, Europe 13%, Africa 4%, Central America 3% and Australia 0.3%.[23] Across all of these regions, the forecast is for widespread growth in desalination plants. Global Water Intelligence, a UK-based industry publication, estimates the global desalination market will grow 12% annually through 2015 – and then accelerate. Predictions are for 20% or more growth in China, India, Australia and the US. Total investment in new plants could top US$ 56 billion.

Yet, energy costs remain the principal barrier to greater use of desalination. It would be ironic if high carbon, high water use energy sources are installed to provide the power for desalination plants. Better would be to make explicit the policy link between desalination and zero water use, and clean energy sources such as solar and wind.

What will likely happen?

Under business-as-usual scenario, energy production in the US is forecast to grow by about 50% between 2000 and 2025 and about 50% in the EU between 2000 and 2030. Water consumption for energy production is expected to grow by as much as 165% in the US and by

as much as 130% over the same periods.[24] If more domestic energy solutions are sought, unless they are non-water using renewable sources, extra pressure on water resources will be created.

In addition, if the potential exploitation of shale oil and tar sands for energy takes off, this will require significant additional amounts of water for processing.

Lake Mead, which provides water and electricity to regions surrounding Las Vegas, Nevada, is 100 feet lower than historic levels – if it dropped another 50 feet, the city would have to ration water use, the huge hydroelectric turbines inside the Hoover Dam on the lake would provide little or no power. Scientists recently declared that Lake Mead could become dry by 2021.[25]

Rapid energy growth in the non-OECD countries, especially across Asia will have a significant impact on water resources, under a business-as-usual scenario, especially as a result of increased hydropower plants and coal.

What are the political and economic implications?

The dependency of electricity supply and demand on water availability has a clear social, economic and political link.

Under drought conditions, a generating plant may have to shut down or severely curtailed its operations because of its inability to withdraw a sufficient amount of water to meet its thermal discharge permit.

Plans to switch from gasoline to electricity or biofuels to increase energy security are effectively a strategic decision to switch dependence from foreign oil to domestic water. Attempts to alleviate some serious problems – such as energy security and climate change – can aggravate an even more serious problem, acute water shortages.

Across Asia, there will be increased competition for scarce water resources from the energy sector. A 65% increase in water for industrial use and a 30% increase in water for domestic use are forecast, against a 5% increase in water for agriculture.

The issue of climate change is, of course, very much linked to future global energy policies. The prospect of breaking the 2°C rise by 2050 if global greenhouse gas emissions are not reduced by at least 50% against a 1990 baseline, offers widespread impacts on water resources. Among many other implications, climate change impacts on water will further compound the energy-water links outlined above. There is a clear win-win to be gained from pursuing low carbon emitting and low water using energy technologies.

What are the glimmers of hope?

The exploration of linkages between water and energy is still in its infancy. Water and energy are tightly linked, but these links are poorly understood and rarely used in policy. It is clear that decision-makers and corporations will need to better integrate energy issues into water policy; and water issues into energy policy, given future water constraints. Considering water and energy together can offer substantial economic and environmental benefits.

While there are some suggestions on how best to approach the issues, there are few actual proven solutions. Ideas include the following:

- Water consumption by power plants can be reduced by switching from water cooling to air cooling or other new technologies integrated gasification combined cycle.

- Clean energy and clean water should go hand in hand – the city of Perth has recently constructed the world's first large-scale desalination plant using renewable energy. It will be important to explore new types of renewable energy (solar, wind and wave) to fuel the new energy demands for desalination, as energy costs are the principal barrier to desalination greater use.

- Combining water and energy efficiency efforts can save substantial water and energy at lower cost and faster than new supply – water efficiency should be given a higher priority by energy planners.

- One of the challenges of renewable energy is storage. Pumped storage (involving hydropower) is a well-established method for translating low-value (unreliable) power into high-value (reliable) power. Every place is different, however, and while hydropower remains a cheap, environmentally friendly energy option for many developing countries, simply extrapolating the potential from rich countries (who have developed 80% of their hydro) to developing countries (who have developed on average 30% of theirs, with just 3% in Africa) is a big danger.[26]

- Wind power firms are now marketing wind as a zero-water, rather than just a low carbon power alternative.

Solving the energy and water security challenge will require new policies that integrate energy and water solutions and innovative technologies that help to boost one resource without draining the other. Discussions between water and energy professionals and decision-makers need to be encouraged with some urgency, so as a mutual understanding of the water and energy security issues the world faces can be achieved and low carbon solutions sought.

Figure 2 in the annex shows that much of the increase in industrial water demand from 2000 to 2030 will be from parts of North America, India, Europe and China.

3. Trade

Why is the issue important?

Approximately 1,300 litres of water are necessary to produce one kg of wheat. One kg of wheat is much easier to ship than 1,300 litres of water. By importing cereal, meat and other food products (so-called imports of "virtual" water), countries can reduce their agricultural water use. Fast-growing economies in Middle East and Asia could dramatically increase their reliance on food imports, thus saving water. By 2025, an increase in cereal imports could save Asia 12% of irrigation water consumption. However, the current trade system does not take account of this. There is no correlation between the places that are hydrologically best suited to grow food and those that actually do. Three of the world's top-10 food exporters are water scarce, and three of the top-10 food importers are water rich. Notwithstanding these environmental issues, the overall share of agricultural exports in global trade has also decreased sharply over the years. There is less overall trade in agriculture, when more is needed. Food prices have become much more volatile, as recent price rises has shown.

What are the trends?

Total world cereal demand is projected to grow from 585 million tonnes today to 828 million tonnes, by 2025, a rise of 42%.

Agricultural exports have decreased in the share of international trade from 46% in 1950 to 9% in 2001.

In 2001, 60% of global agricultural export was from the US, EU and Canada; and 60% of agricultural import was from the US, EU and Japan, with average tariffs at 30%.

Agricultural policies have proven costly to governments and consumers alike because of the labyrinth of subsidies, price supports and trade barriers that they entail.[27]

This year, Saudi Arabia gave up being self-sufficient in wheat production. It has set up an investment fund to acquire land overseas to grow crops it needs, possibly in Pakistan or the Horn of Africa. Similarly, China is acquiring agricultural land in Southern Africa. Daewoo Logistic is looking to lease land from the government of Madagascar to grow food for South Korea. Other countries in South Asia and the Gulf are considering similar moves. Middle East and North African countries have been the most active investors seeking overseas farmland, with Saudi Arabia, the United Arab Emirates, Egypt and Libya leading the group.[28] These countries do not need extra land, but they do need water. They require well watered, underdeveloped land elsewhere because they can no longer grow all their own food at home. This is a new and potentially significant trend. It reflects the failure of national governments and the international trade system to address a water crisis.

What will likely happen?

When water availability drops below 1,500 cubic metres per capita per year, countries begin to import food, and particularly water intense crops. Twenty-one countries fell below this threshold in 2000 and another 14 will join them by 2030. This represents 55% of the world's population that will be dependent on food imports as a result of insufficient domestic water.

Although water is usually categorized as a local resource, one important response to a local water crisis is to establish political, economic and agricultural links with other places that have more water.[29] These local water crises will necessitate a major reconfiguration of international trade to enable the trade in "virtual water" to alleviate domestic water constraints.

There are serious implications if an increase in trade for agriculture due to water scarcity does not take account of water scarcity.[30] Consider this "virtual water trade" as maps that can be constructed between and within countries and other geographies. Imagine the damaging impact of growing a water-intensive crop in a country that is water scarce, and then exporting that commodity to a

country that is water abundant. Not only does the "virtual" or "embedded" water leave the watershed where it was grown, but it is no longer available to recharge the aquifers, thereby worsening the long-term scarcity outlook for the exporter.

It is equally likely that the global trade system for agriculture will not get fixed at all. Under these circumstances, by 2030 we could see multiple countries from South Asia and the Middle East competing with each other to secure bilateral land-for-water deals: cash-rich, water-poor nations competing to secure deals with water-rich nations around the world.

What are the political and economic implications?

If the global trade system for agriculture is not fixed, the geopolitical implications emerging from the various crises of national water security will be large. More nations will focus on resolving their water "interests" through unilateral rather than multilateral arrangements; the world system will witness a plethora of new alliances between water-poor, cash-rich nations and water-rich (and likely cash-poor) nations. The Food and Agriculture Organization warns that the race to secure farmland overseas risks creating a "neo-colonial" system. A rapid retreat from a globalized, 21st century world back into a 19th century style network of bilateral alliances and trade deals, with all of the associated political and economic complications and conflicts, is very possible.

The corollary to this is that multilateral trade requires peace. When there is peace, trade in water intensive commodities can address local water scarcity and the local famines caused by occasional droughts and floods. Peaceful trade can avert further conflict.[31]

What are the glimmers of hope?

Water supply crises have easily been addressed by highly developed societies and economies. Consider Singapore: it only has 5% of the water it needs; it has no energy resources, yet it has a very advanced economy.[32]

Trade in virtual water holds real promise for better spatial location of water-intensive production. The risk of relying

on the current trade system for basic staples, however, has been highlighted by the current food crisis.

But fair terms of trade are central to resolving the issue – tariffs and low food prices for key global markets have prevented a sensible transition to improved productivity in poor rural areas of the world, particularly in Africa.

Can the current focus on improving global economic governance as part of the international response to the economic crisis, revitalize and re-orient global trade discussions on agriculture?

4. National Economic Security

Why is the issue important?

Historically, the availability of easily accessible freshwater has proven a key determinant in development (Sachs, 2006), Those countries, which 25 years ago had low incomes (below US$ 750 per year per person) yet had access to adequate safe water and sanitation, grew on average 3.7% per year, whereas countries with the same per capita income and limited water access grew at only 0.1% per year in the same period. Accessible freshwater cannot be factored out of economic growth.

The converse is also true. Water insecurity, whether caused by environmental trends, economic growth or a combination of both, may limit a country's ability to remain competitive economically or to become more competitive.

The ongoing drought in Australia is expected to shave 1% off the country's GDP in 2006-2007.[33] In the US, water shortages are reported to have cost the agricultural sector US$ 4 billion a year over the past two years. California's current water crisis management will cost taxpayers an estimated US$ 1.6 billion per year by 2020. Some estimates conclude that environmental degradation and pollution cost the Chinese economy between 8% and 12% of its GDP annually.[34] China's water consumption per GDP is still five times the world's average level and eight times the American level. The crisis in water and sanitation holds back economic growth in sub-Saharan Africa, losing 5% of GDP annually, far more than the region receives in aid.[35]

If present national water use patterns and withdrawals are not sustainable, water security will become an increasingly important factor limiting socio-economic development. Countries will need to reinvest in infrastructure to improve water delivery and quality, and/or shift towards different types of economies, better suited to the water resource base.

Environmental security is important, too. The over-abstraction of freshwater is compromising the environment severely in many parts of the world. The 2005 Millennium Ecosystem Assessment warns that it is not possible to sustain food production or poverty alleviation when the environment is being compromised too severely. Climate change adds to the urgency, as the impacts of climate change play out most prominently in water resources.

Water plays a key role, therefore, in national economic security. Will companies relocate *en masse* from resource-poor countries to resource-rich countries, similar to the situation in the last 20 years, where lower wages in emerging countries such as China and India became much more attractive locations for manufacturing? Will water security drive economic decisions?[36]

What are the trends?

From 1900 to 2000, water use grew ninefold against a population growth of factor 4. In 1950, with a global population of around 2.5 billion people, about 1,400 km^3 of freshwater was withdrawn. In 2000, with a global population of around 5.2 billion, about 5,200 km^3 of freshwater was withdrawn, an increase of about factor 3.8, compared with a population increase of just over factor 2 in the same period.[37]

In the US, however, total water use peaked around 1980 and declined by one-tenth by 1995, despite the simultaneous addition of some 40 million to the American population.[38]

Societies and nations that have inherited a legacy of difficult hydrology have remained poor – global findings confirm that greater rainfall variability is statistically associated with lower per capita incomes.[39] There is a direct correlation between investments in irrigation and significant declines in poverty in India – irrigated districts average 25% poverty rates against 70% poverty rates in un-irrigated districts.

Over 1.4 billion people currently live in river basins where the use of water exceeds minimum recharge levels.[40]

The number of people living in water-stressed countries will increase from about 700 million today to more than 3 billion by 2025 (about 35% of the predicted global population).[41]

Compounding the water security problem for many nations is the fact that fast-growing economies especially in the Middle East and Asia will likely allocate much more to the growing demands of their urban, energy and industrial sectors over the next two decades. When 40% of renewable water resources are devoted to irrigation, fast-growing economies are often forced to decide between allocating water to the agricultural sector or to the urban municipal and industrial sector. By 2030 under business-as-usual, all of South Asia will reach the 40% threshold; the Middle East and North Africa region will have hit 58%. In Asia, the forecast by 2030 is for a 65% increase in water for industrial use and a 30% increase in water for domestic use is forecast, against a 5% increase in water for agriculture. Similar ratios apply across the EU, Latin America, US and West Asia. Figure 3 in the annex shows locations where competition for water between different sectors will be most intense. Around the world, the fastest growth in water use to 2030 will be for the needs of cities and industry. (Figure 4 in annex)

Environmental trends related to economic growth compound the security challenge for water insecure nations.

The Millennium Ecosystem Assessment found that water-based ecosystems are now the world's most degraded natural resources. 70 major rivers around the world are close to being totally drained in order to supply water for irrigation systems and for reservoirs, including the Colorado, Ganges, Jordan, Nile and Tigris-Euphrates. In China, the Yangtze and Yellow Rivers are dry in their lower reaches for much of the year.

An estimated one-quarter of the flow of the Yellow River is needed to maintain the environment. Human withdrawal currently leaves less than 10%. In 1997 it was dry 600 kilometres inland for 226 days, causing agricultural losses of US$ 1.6 billion.

In Australia's Murray Darling basin, irrigated agriculture uses almost 80% of available water flows. The environment needs about 30% of the flow. Extensive environmental damage is occurring as a result including salinity, nutrient pollution and the loss of floodplains and wetlands. In recent years virtually no Murray River water has made it to the sea.

The upper reaches of the Orange River in Southern Africa have been so modified that the combined reservoir storage in the basin exceeds annual flows.

In 1960, the Aral Sea was the size of Belgium. After 50 years of water engineering projects, it has shrunk to 20% of its former size, with severe ecological consequences. Lake Chad has shrunk to 10% of its former volume. In China, 543 medium size and large lakes disappeared between 1850 and 1980 due to irrigation projects.

In many parts of the world, glaciers act as water banks. Across much of Central Asia, Latin America and South Asia rural livelihoods depend on glaciers. The glaciers of the Himalayas and Tibet alone feed seven of the world's greatest rivers – the Brahmaputra, Ganges, Indus, Irrawady, Mekong, Salween and Yangtze – that provide water supplies for more than 2 billion people. Today, these glacial banks are melting at an accelerating rate. In the 1990s, glacial mass fell at three times the rate of the previous decade. Despite the flash flooding this melt causes (river flow increasing by 30%), the most profound consequences of this will be experienced in the decades ahead when the banks are gone. Most analysis suggests the majority of these glaciers will disappear by 2100 under current trends.[42]

- The Andes: In Peru, glacial coverage has shrunk by 25% over the past 30 years. Small and medium size glaciers in the Andes are predicted to disappear by 2100.

- Central Asia: Almost all freshwater in Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan originates from permanent snowfields and glaciers in the mountains of Kyrgyzstan and Tajikistan. Satellite images show that glaciers in this area have shrunk by 33% since 1949. Under current trends, Tajikistan's glaciers will disappears within a century.

- China and Tibet: Glacial retreat in Tibet has been described as an ecological catastrophe. Most glaciers could disappear by 2100.

- Nepal: Glaciers are shrinking up to 70 metres per decade.

What will likely happen?

Increased economic and political tension. The symptoms of water stress are generally felt first in those sectors where the economic return of water is the lowest. This means that the first signs of water stress are experienced through environmental degradation of natural ecosystems that depend substantially on the availability of fresh water. The second sector that will feel the effects of water stress is the agricultural sector. The industrial sector follows agriculture and the domestic sector is the one that generally suffers in the last instance of water scarcity.[43] However, this distinction between sectors is somewhat simplistic as they are interconnected and a crisis in the, for example, the agricultural sector may propagate in the agro-industry (or the energy production industry) and, in turn, in the food security of the population. The above-mentioned symptoms may lead to conflicts and increased competition between and within the different economic sectors and between and within states.

More large hydraulic projects, not all good. Governments will devote more time, energy and resources to think about moving water from where there is a lot of it to where there is not enough. Government decisions on how to create new water supplies or from investment in technologies are not always based on good, transparent cost-benefit analysis. Too often, a decision is made based on short-term political gain – not the longer term values of society.

Trans-boundary tensions. The depth of interdependence on international water basins that more than one nation-state shares is huge. One hundred and forty-five countries in the world, accounting for more than 90% of the world's population, are in shared basins: more than 30 countries are located entirely within trans-boundary basins.[44] As government response to water security issues increases, so too will tensions between nations sharing the same water basin.

Some states may fail. Humanitarian assistance will increase to unprecedented scale if, as commentators foresee, large-scale migration results from climate change and water scarcity. The International Red Cross estimates that there are 25 to 50 million climate change/water security refugees already, compared to the official refugee population of 28 million. The IPCC suggests that 150 million environmental refugees could exist by 2020. Currently in international law there is no such thing as an environmental refugee. The human and political security implications of a mass movement of this nature could be profound.

What are the political and economic implications?

Will the 21st century world system see an emergence of water "haves" and "have-nots" nation-states, similar to the 20th century geopolitics of oil?

Those countries that have not achieved water security will find it increasingly difficult to do so. Those that have may find it slipping from their grasp. All countries will need to attain a reasonable measure of water security to compete effectively in global markets. Unlike money, water cannot be physically accessed from the world markets to pay off the hydro debt. Actual hydrological water bankruptcy is a real threat for some of these economies.

As economies grow and diversify, countries with more natural water resources will become more attractive locations for investments. At some point, will water resource scarcity limit the competitive advantage of a state?

What are the glimmers of hope?

On a country-level, while some countries are blessed with abundant natural water resources (Canada and Northern Europe), others have a naturally difficult hydrologic legacy (such as Middle East, India and China). Water security is a significant economic risk to most countries, but to achieve it, there are often associated social and environmental costs. Although it is complex and involves trade-offs, it is a problem that can be fixed.

The immediate options for governments to improve their water security include:

- "Create water" desalination for close-to-coast cities (pros and cons)
- "Make more of what you have" – undertake domestic reforms to adjust to water scarcity

- "Import water" – engage in regional water trading (buy water or rights to water from nearby water rich nations)

- "Import embedded water" – increase trade in virtual water (buy in water-intense products rather than producing them domestically)

- "Outsource water" – invest in water-rich land outside of the state (lease land elsewhere to grow crops)

However, water scarcity is caused more by the nature of demand and the allocation of water rather than availability. Addressing these water shortages involves better water management, water governance and, often, financial investment. Water scarcity is a "governance crisis, not a [water] resource crisis." (Rogers, 2004)

The demand for water does not need to be connected to population and economic growth. The United States uses less water today for all purposes than it did 25 years ago. Per capita water use in the US has dropped 20% since 1980 by improving water use efficiency through improved water use technologies, appropriate pricing, education and structural changes in the economy.[45] Similar improvements are possible everywhere and are often the cheapest sources of "new" supply. So rethinking demand with a focus on improving water efficiency and productivity must be a key element of sustainable water policy.

Importantly, the absence of physical water scarcity alone does not mean that an economy will be water secure. It is the institutional and adaptive capacity of the society and the economy that determines water security. Studies have shown that the only historically demonstrated path to achieving water security at the national level has been through investment in complementary institutions and infrastructure.

It is important therefore to establish good institutions (governance, policies, laws and rights) to address the water challenge (such as Australia, Spain and the Netherlands) and to invest heavily in resources to improve water use efficiency: the portion of GDP allocated to water resources management can become substantial under these approaches.

Smart countries will also look to encourage more diversified types of industries that are less dependent on water. For example, India's economy has shifted away from agriculture and the expansion of manufacturing, communications and transport, making the structure of the economy less vulnerable to water.

In all countries, a broader and longer term view is needed of water's role in economic development. Proactive, adaptive management of water resources will minimize the economic, environmental and social disruptions of the impending water crisis.

Countries that are the most constrained with respect to future development because they have neither the extra water nor the financial resources to restructure consumption patterns away from wasteful low-value water intensive uses may no longer have a choice – they must make a decisive break from past policies and management practices to embrace a holistic water sector approach that is economically, socially and environmentally sustainable.

Governments and regions in water-scarce areas that take a lead in progressive water policy reform will enjoy an economic triple win: they will retain and attract companies; they will attract more inward investment into their water infrastructure; and their economy will be strengthened as a result of improved water management.

5. Cities

Why is the issue important?

60% of the global population will live in cities by 2030.

Historically, cities have been built where water is plentiful. A shortage of clean water for people and for business in the urban environment is becoming a problem of global proportions.

In the future, should water come to cities? Should cities go to where water is located? Which choice would be less economically crippling?

What are the trends?

Southeast United States: In October 2007, Atlanta had 87 days of drinking water left; Raleigh, North Carolina, had 97 days. The culprits were both historically low rainfall and unbridled growth of the Southeast region over the past 50 years. While population growth increased by 20%, with 15% of water consumption, demand from traditionally large water customers (ranches, mines, factories, etc.) declined during that period) – the drop was overshadowed by increasing demand for tap and lawn water.

Of China's 669 cities, 60% suffer water shortages and nearly half of China's cities lacked wastewater treatment facilities in 2005. Lake Tai, which borders the city of Wuxi near Shanghai, was covered in bright green algae sludge that thrived on the pollutants being dumped into the water by chemicals factories. The situation became acute when the city had to cut off water supplies for days.

Many cities lose vast quantities of water through leaks in their water transport systems where 30-40% of the water supply is wasted due to leakage. In cities such as Delhi, Dhaka and Mexico City, about 40% of the water pumped into the system leaks out of corroded pipes or is sold illegally.[46]

Barcelona shipped in tankers of drinking water during the summer of 2008 – it paid about US$ 3 per cubic metre – more than triple the "average" cost. The city saw it as a stop-gap and is now building desalination plants instead.

Billions of people in urban environments in the developing world, especially the poorest, are unconnected to a municipal water supply and rely on water vendors. In Dar-es-Salaam, fewer than 30% of households are connected to a water delivery system.

The poorest people pay as much as 10 times more than richer households for water, and often receive poorer quality water. Regulatory authorities in the United Kingdom define any expenditure on water above 3% of total household spending as an indicator of hardship.

The global market for water and sanitation infrastructure has been estimated at US$ 400 billion a year and growing. By 2015, an average annual investment of US$ 772 billion will be required for water and wastewater services around the world.

Total investment in new desalination plants alone could top US$ 56 billion by 2030.

The US EPA estimates that US$ 68 billion will be needed over the next two decades just to restore and maintain existing utility assets in major US cities.

An investment of US$ 10 billion annually is necessary in developing countries just to meet the water and sanitation MDGs by 2015, according to the OECD.

Figure 5 in the annex shows that much of the increase in water demand to 2030 will be felt throughout the world. Decrease in domestic water demand (in green) indicates a decrease in rural population due to migration to urban areas and/or general decrease in population.

What will likely happen?

The urban population will increase to 4.6 billion by 2025, increasing faster in developing countries than in more-developed countries.

Domestic demands on water will rise quickly.[47] Under a business-as-usual scenario, total domestic consumption will increase 75% from 1995 to 2025, of which 90% will be in developing countries.

Poor quality and inefficient water supply services in urban areas will be seen as a brake on economic growth. Private finance will be required, as public funds will not be able to fill the water investment gap. Governments that introduce reforms in water supply management will attract private finance. This does not necessarily mean taking water supply out of public ownership, but it does mean undertaking reforms to ensure private investor risks are reduced and rates of return become more desirable. International aid for water will be increasingly used to access credit for private investments into public infrastructure on the back of these reforms.

International aid for urban water supply will increasingly be used to help governments in developing economies mobilize credit through local markets for private investments into public water infrastructure, on the back of policy reform.

What are the political and economic implications?

Governments will have to implement reforms in how city water supplies are financed and managed in order to attract in the private capital that will be required for investment. This will require a political discussion that makes it clear the role of managing water remains in public hands, but more private capital and expertise will be required to help fund the investment.

A wide range of public-private partnerships will emerge as different arrangements of state, private sector and civil society partners find ways to build and deliver urban water services. The public-private debate about water services will become much more nuanced.

The role of the city as a major consumer of water will have economic and political implications. As cities start to seek water from farther away, the debate will arise about whether it is, in fact, economical to bring water to cities. Which will be the first inland city to move close to secure water supplies?

What are the glimmers of hope?

This draft still needs to identify a range of good examples of urban water supply and wastewater treatment breakthroughs: sustainable, affordable, cost recovering services that have emerged on the back of government reforms in the urban water sector, and that have attracted private investment into urban water infrastructure as a result.

6. People without Water and Sanitation

Why is the issue important?

There is no human life without water.

"By means of water," says the Koran, "we give life to everything."

Today, there are[48]:

- 1.1 billion people live without clean drinking water
- 2.6 billion people lack adequate sanitation
- 1.8 million people die every year from diarrhoeal diseases
- 900 children die every day from waterborne diseases

The Millennium Development Goal (MDG) 7, Target 10, is the target which the international community has set itself to improve water conditions for the world's poor. The aim is to halve the proportion of the world population without sustainable access to safe drinking water and basic sanitation by 2015 against a 1990 baseline.

There is consensus that improved water and sanitation conditions are essential for achieving each of the other Millennium Development Goals as well, including poverty, hunger, gender equality, health, education and environmental degradation.

"Not having access to water and sanitation is a polite euphemism for a form of deprivation that threatens life, destroys opportunity and undermines human dignity."[49]

What are the trends?

Poor hygiene and sanitation kills more people in the world than HIV/AIDS and malaria combined; and more than any war claims through guns.[50]

Dirty water and poor sanitation account for the vast majority of the 1.8 million child deaths each year from diarrhoea – about 5,000 a day – making it the second largest cause of child mortality. Diarrhoea caused by unclean water is one of the world's greatest killers, claiming the lives of five times as many children as HIV/AIDS.

Disease and productivity losses linked to poor water and sanitation amount to 2% of GDP, rising to 5% in sub-Saharan Africa, which is more than the region receives in aid.[51]

Ironically, the poor in developing countries generally pay more for their water than the affluent, and receive poorer quality water.[52] The poorest people pay as much as 10 times more than richer households for water.[53]

US$ 10 billion annually to 2015 would meet the MDGs for water and sanitation, according to the OECD. Current aid to water and sanitation sector is less than 5% of the total aid budget, creating a gap to meet the MDGs in water and sanitation of over US$ 5 billion a year.[54]

For comparison, the amount richer countries are preparing to spend on economic stimulus packages is about US$ 1,000 billion, In 2004, the world spent US$ 1,100 billion on its military budgets.

Figure 6 in the annex shows that the percentage of population living under water scarcity from 2000 to 2030 increases dramatically in parts of India, Middle East and North Africa.

What will likely happen?

Nothing.

Under business-as-usual, the water and sanitation MDGs will not be met. The sanitation target will be missed by 430 million people, with 74 countries off track from around the world.

South Asia will need to provide sanitation coverage for 43 million people a year compared to current 25 million, to reach the MDGs by 2015.

Under business-as-usual, sub-Saharan Africa will reach the water MDG in 2040 and the sanitation MDG in 2076.

What are the political and economic implications?

Meeting the MDG target for water and sanitation would provide US$ 38 billion economic benefits annually.[55]

Every US$ 1 spent in the water and sanitation sector creates on average of another US$ 8 in costs averted and productivity gained (school attendance, time savings).

Political desire to meet the MDGs for water and sanitation is low.

It is recognized that access to water and sanitation is largely a political, not an environmental issue: the global water crisis for the poor is rooted in power, poverty and inequality, and not in physical availability.[56]

If the powerful have running water and a toilet, then there is little political imperative to do more.

However, the politics of this issue may change as economic development continues.

In richer countries in the 19th century, large amounts of public investment were spent on sanitation, as a growing awareness of the human cost of urban industrial life forced water onto the political agenda.

"The annual cost of life from filth is greater than the loss of death or wounds from any war in which the country has been engaged in modern times."[57]

The *Report on the Sanitary Condition of the Labouring Population of Great Britain* (1842) recommended a private tap and a latrine connected to a sewer for every household and municipal responsibility for providing clean water.

The analogue of how the money was raised to pay for the investments is also interesting. New approaches to financing played a critical role. The challenge of how to finance large upfront payments from a limited revenue base without raising taxes was met by cities in the 19th century supplementing low-interest loans from central government with municipal borrowing on bond markets. At the end of the 19th century, water and sanitation accounted for about one-quarter of local government debt in Great Britain.[58]

So, if political demands for improved water and sanitation services grow, especially in fast-developing countries, then the implications will be increased governmental and municipal borrowing on the global markets.

Do today's economic circumstances offer an opportunity? Could an element of the stimulus packages on offer be spent on raising the capital to deliver a "blue new deal" for the urban poor?

What are the glimmers of hope?

Government reforms can work: Uganda reformed water policy in the 1990s. Budget allocations increased from 0.5% of public expenditure in 1997 to 2.8% in 2002. Coverage levels increased from 39% in 2006 to 51% in 2003. In Morocco, a rural water reform programme since 1995 has been boosted coverage to 50% with many economic multiplier effects.[59]

International aid can help governments in developing economies to mobilize credit through local markets for private investments into public water infrastructure, on the back of policy reforms.

New technologies and business models abound. New membrane technologies mean that wastewater treatment plants can be local, small scale and safe. The market for toilets in the developing world, for example, is an opportunity, possibly worth billions of dollars. The market for clean-energy/zero water use energy sources to power desalination or wastewater treatment plants could be huge.

Innovations are required among aid agencies, foundations, charities and the private sector, working with governments to unlock new markets and new opportunities for water services and sanitation deliveries among the poor.

Public goods, like clean water and sanitation, will not be provided solely by the market, and yet, they are extremely valuable to society as a whole. In these cases, solutions may require a combination of high-risk philanthropic capital at the onset to test new innovations and increasing levels of higher-return capital to enable the enterprise to scale effectively. What is needed in economic development is the equivalent of venture capital in the marketplace. The field is witnessing an explosion of new ideas.[60]

7. Global Business

Why is the issue important?

Water security and pollution in water-stressed countries is a growing concern to many companies, especially in the power, mining, food & beverage and semi-conductor sectors. The last few years have seen a plethora of reports from business associations, financial analysts and companies on the strategic importance of water security. The UN Global Compact CEO Water Mandate is a good example of this emerging trend.

Companies will increasingly be asked to provide details of their water related risks to investors and of their water use efficiency measures to the public. They will be attracted to countries with sound water management policies.

Water security risks are difficult for businesses and investors to assess, due both to poor information about the underlying supply conditions and to inadequate and irregular reporting and disclosure practices by individual companies.[61]

What are the trends?

Business leaders are becoming more aware of the exposure to water security risks they face, many of which lie well beyond the limits of their company's own influence.

The four main types of risks are: risk of business interruption; reputation risk; regulatory risk; and access to capital.[62]

- The risk of business interruption may range from availability of input from within the supply chain to the production process and, finally, product use.
- Reputation risk relates to higher level of scrutiny about water use and pollutants from various stakeholders and more pressure to help employees and local communities safeguard access to quality water over the long term.
- Businesses today face increasing government *regulations* surrounding water.
- Access to capital risk applies as the financial community adopts more rigorous investment and lending policies, based on water related uncertainties.

The increased focus on corporate water activities from organizations and initiatives such as the WBCSD, the Pacific Institute, the Global Water Footprint network and the UN Global Compact CEO Water Mandate reflect the growing concerns that business leaders have about the water risks to their operations and value chains.

Investors too are beginning to assess the reliance of their portfolios on water resources and the vulnerability of their clients to problems of water availability and pollution. An increasing range of analysts are producing water-related risk reviews on business activity, including Merrill Lynch (2007), Goldman Sachs (2008) and JPMorgan (2008). This trend will continue.

Companies will come under increasing pressure to provide detailed disclosure of their water-related risks to investors, including potential changes in supply or treatment costs, regulations and costs arising from supply chain disruptions.[63]

Companies involved in water and wastewater operations will see a growing market from both governments and large business operations. Water use efficiency technologies and orders for desalination plants will experience strong growth. Global Water Intelligence, a UK-based industry publication, estimates the global desalination market will grow 12% annually through 2015

– and then accelerate. Energy companies that market their products (solar, wind) as zero-water as well as low carbon, will find an increasing customer base in water-insecure, fast-developing countries.

What will likely happen?

If water security issues within the country of operation do not improve, there will be mounting financial losses across the value chain – loss of revenue due to the disruption of production process or higher input costs from a tightening of the water supply.

Companies could start to relocate *en masse* from water-poor countries to water-rich countries, similar to the situation in the last 20 years where lower wages in emerging countries such as China and India became much more attractive locations for manufacturing.

Leadership on water in both businesses and governments will be much talked about but difficult to achieve. Business successes are measured on a quarterly basis, while governments are generally elected every four years or so. There is a misalignment in incentives that makes it difficult for leaders to look long term at an issue such as water. Partnerships and collaborations will likely emerge as the most effective way for business leaders to tackle the water challenge, both with business peers across the value chain and with NGO and government partners.

The value of companies engaged in water services and infrastructure provision will rise.

What are the political and economic implications?

Business leaders and investors will become more water risk aware over the next two decades. More knowledge will be shared, new tools will be developed to benchmark water performance (public and private) and more pressure will be put on governments to reform.

Stable, water-abundant economies will become attractive places for company investment, provided other investment risk factors are not detrimental.

Conversely, with some improvements to infrastructure and political risk, water abundant countries previously seen as less attractive could become more so (for example, the Democratic Republic of Congo in sub-Saharan Africa). This offers a development opportunity.

Governments and regions in water-scarce areas that take a lead in progressive water policy reform will enjoy an economic triple win: they will retain and attract companies; they will attract more inward investment into their water infrastructure; and their economy will be strengthened as a result of improved water management. Laggards will lose.

What are the glimmers of hope?

Some companies that are issue leaders in water have developed longer term water strategies to prepare for the risks and take advantage of the opportunities ahead. These include making investments in water efficiency, developing a good understanding of where their water comes from and ensuring that the supply/input is reliable, while ensuring that water risks are mitigated through dialogues with communities, a thorough understanding of the supply chain and its water footprint.

New partnerships, coalitions and innovations are already arising between governments, business, NGOs and others to tackle common water challenges.

8. The Financial Sector

Why is the issue important?

Water is a unique commodity with no substitute or alternative, a high future demand and low price volatility. Is it a better pick than oil for the future? Given the year that the financial sector has had, investors will be looking for the next big theme. A surge of investor interest in water over the next two decades could offer either salvation or more complications for the economics and geopolitics of water.

What are the trends?

Investing in the water business

Currently, there are a number of water index and hedge funds that track performance in the water industry (producers of pipes, pumps, desalination, new hydro tech, etc.) necessary to deliver water and to clean sanitary waste. An increasing number of analysts view the high future demand for water and sanitation-related infrastructure in both the developed and developing worlds as an attractive investment opportunity.[64 65 66] Goldman Sachs estimates a total global market at US$ 400 billion/year, and set to grow.[67] New technologies and business models abound. New membrane technologies mean that wastewater treatment plants can be local, small scale and safe. The market for toilets in the developing world, for example, is an opportunity, possibly worth billions of dollars. Over the next 15 years or so, a blue-tech theme may well emerge from within the Californian VC community to support these new technologies and innovations.

Significant investments are also being made in "new" water sources such as desalination (Israel, California) and water reuse (Singapore, Namibia). The market for clean-energy/zero water use energy sources to power desalination or wastewater treatment plants could also be huge. Predictions for the desalination market are for 20% or more annual growth in China, India, Australia and the United States to 2015. Total investment in new desalination plants could top US$ 56 billion.

Inter-basin transfers are being considered on an unprecedented scale, such as the south-north transfer in China and the interlinking rivers initiative in India. This requires big hydro-infrastructure projects. The annual capital investment gap in the water industry worldwide is almost US$ 90 billion, a level which is likely to be maintained in the long term.

Water compared to other commodities

Water can be seen as a better pick than oil. Both oil and water as commodities have seen their prices increase at a similar pace. However, water prices have remained much less volatile.[68] Since 1989, the annual price increase of oil has been 6.2% versus 6.3% for water. On the other hand, price volatility during the same period rose by 42.9% for oil versus only 4.2% for water. Water price volatility is capped because the water market for the most part, unlike oil, is publicly run.

Water as a commodity in its own right

The raw economics of property rights attached to water are compelling from an investment point of view. The historic price of water rights in the Middle Rio Grande in New Mexico, for example, has risen from approximately US$ 1,000 per acre/foot in 1993 to over US$ 5,500 per acre/foot in 2006.

Some innovative investors are selecting opportunities today in water, which may be both a sign of a possible future market for water as a commodity in its own right, and – importantly – a signal for clearer government rules in the water market.

T. Boone Pickens has spent over US$ 100 million over the past eight years purchasing land and associated water rights in Texas, with the aim of selling US$ 165

million worth of water each year to Dallas-Fort Worth (over 250 miles away) by taking advantage of an unusually lax groundwater pumping law that allows landowners to pump as much water as they can. Since Pickens began to purchase water rights, the price of water in some places has doubled (to US$ 600 per acre/foot).[69]

PICO Holdings currently owns over 100,000 acre/feet of water rights in Nevada and Arizona – its business strategy is to find new water rights by legally establishing the water rights in property it already owns, or by purchasing outright already established water rights.[70]

Sextant Capital Management, a hedge fund based in Canada, almost entirely owns two Luxembourg companies with rights to glaciers in Iceland. The plan is to use the melting glacier waters for bottled water and to ship it to companies or countries that may pay for it in the future. The Sextant Capital Fund increased by over 730% since its inception in February 2006; The August 2008 return for its Strategic Global Water Fund Offshore was 9.5%, with a year-to-date return of 97%. The fund returned more than 191% in 2007.[71] (The Ontario Securities Commission recently alleged that these returns had been inflated. On 15 December 2008, Sextant Capital Management Funds were frozen under an order by the Ontario Superior Court of Justice. The founder of the fund denies the allegations).

What will likely happen?

It will be beneficial for managing future water security if venture capital, private equity and investment bank interest in water technologies, innovations and water-industry themed funds and businesses reach critical mass over the next two decades.

This investment interest however, will only be channelled to business opportunities in those economies or regions where there is sound water management. The role of government in undertaking reforms to attract these investments will be important, especially within the developing world so that private capital is not only attracted into water investments in the richer countries.

It is unlikely that water will emerge as a globally tradable commodity in its own right. Water does not have a global trading platform of its own. Furthermore, investors cannot trade water like other commodities, because it cannot be priced on a global market. It is also very heavy and the cost of transporting it is many times its value. All this lends water to regional or national markets. However, some argue that a global market in water *rights*, not physical water, is certainly feasible. Some investors speculate that exchanges for water rights could emerge, which could lead to a global market in water futures – they believe that values of water rights will start to climb over the next decade or so and a critical mass may be reached. A robust water rights trading market exists in Australia and could spread to Texas, China and India.

What are the political and economic implications?

Governments and regions in water-scarce areas that take a lead in progressive water policy reform will enjoy an economic triple win: they will retain and attract companies; they will attract more inward investment into their water infrastructure; and their economy will be strengthened as a result of improved water management. Laggards will lose.

The role of international aid should evolve, with development agencies shifting away from water projects towards helping governments in developing economies attract private finance into their water sectors by creating instruments to buy down risks on the back of national policy reforms.

Regional financial regulators must be aware today of the potential for water rights exchanges and futures markets to emerge, and must put in place clear rules and regulations to manage the trade.

What are the glimmers of hope?

Markets mechanisms can be developed to improve allocative efficiency and to raise investment in the water space.

As shown in Australia, water is good business. Establishing rights in water is a necessary first step without which water markets cannot be created. If efficiencies are to be achieved in optimizing water allocation and use, responsible markets must form.

Research demonstrates how water and wastewater are good business, and how water rights and markets are an integral part of the process.

Arrangements must progressively be put in place that will stimulate the market to make more efficient use of the water and value it correctly. Experience suggests that this is not simply about raising the price of water. A more complex reform agenda is required, including[72]:

- Clearly establishing the amount of surface and groundwater available
- Establishing and maintaining a stable and transparent arrangement of water allocations. In the West, this would be called a property rights regime, so individuals clearly understand how much water they have and what arrangements their access to water will change
- Establish cost recovery arrangements that cover the operations, maintenance and renewal costs of the assets
- Empower water trading between individuals (willing sellers and willing buyers) that will enable the transfer of water and set the true marginal value of the resource (this will normally be much higher than government is prepared to charge). This mechanism will drive efficiency but is not in itself the solution to all problems.

Three Regional Perspectives

Middle East
Sub-Saharan Africa
India

These perspectives are based upon briefing notes prepared for a private session on water security held in each region during 2008 as part of the relevant World Economic Forum regional meeting, plus the session summaries from these sessions. Participants in each session are also listed.

Middle East

The region controls 70% of the world's known oil reserves. Energy prices at historical highs had brought the Middle East the highest growth rate in nearly three decades. To feed the projected population growth, accommodate the diversification of the economy and alleviate potential geopolitical tensions, and to address the looming food crisis, strong water resources management is a critical underlying component to mitigate these threats to the region.

The area is defined largely by drought and desert, suffers from freshwater scarcity, uneven availability, a growing gap between supply and demand, deteriorating water quality, and a dominance of agricultural water use. Water resources vulnerability is heightened by conflicts and wars in the region.

The Middle East region is the most water scarce region in the world, as it has less than 1% of the world's renewable freshwater resources, with 5% of the world's population. There is large variability in water availability in the region as the average per capita annual supply of 900 m^3/person/year masks extreme shortages in places such as Gaza and Jordan where the water supply is less than 150 m^3/person/year.

Growing populations and accelerating urbanization, combined with the expanded commercial cultivation of crops and industrial growth with high water demand have stimulated over-abstraction of water resources and degrading water quality. All countries in the region rely heavily on water from other countries as the region already uses more water than they receive each year. Climate change is expected to further enlarge the growing gap between water supply and demand.

Except for Lebanon, agriculture remains the largest user of water resources (average 80%). Agriculture's contribution to overall GDP (<20%) decreases annually while employing a significant number of the population (25-30%).

Evidence of continued environmental degradation is evident by the deteriorated water quality and salinization of existing water resources. Existing pollution control and abatement programs are inadequate to address pollution caused by fast growing cities, industries, and agriculture use.

There has been some progress in meeting current demand for water and sanitation in general, but the region must expand water and sanitation systems to another 62 to 76 million people to meet the MDG goals for safe water and basic sanitation by 2015.

History has shown that little consideration is given to maintaining and protecting water quality and quantity, or protecting and managing ecosystem services of transboundary aquifers. Several important aquifers existing in the region are shared by two or more countries. While countries discuss the management of transboundary rivers, there are very few discussions held on the management of transboundary groundwater.

Water available per person in the Middle East is estimated by experts to fall by half by 2050 and the region is estimated to have absolute water scarcity by 2025. Given the region's history of conflicts, water insecurity further stokes smouldering religious, political and economic tensions, particularly between headwater and tributary countries. Agriculture in the Middle East is increasingly marginal as the region imports the majority of its agricultural products (and water).

Session Summary

Three broad categories of suggestions were proposed by the participants as key components to tackling water security in the region

1. National and regional master plans

The development and implementation of national and regional integrated water management master plans over a 15-year period is critical in moving forward. These plans would help inform pricing and allocation decisions. While these master plans have been attempted previously, powerful interests at stake and mismatch alignments between various stakeholders have prevented the plans from moving forward.

A good analogue for unlocking the logjam over the development of such integrated water plans can be found within climate change policy discussions. There

is an increasing call from the private sector to be invited to work with governments and other expert agencies to develop so called "bottom up" analyses of where the most cost effective green house gas emissions mitigation potentials lie along a projected pathway to 2020 and to discuss the policies that would best help catalyze these reductions. In this way, cost effective and pragmatic emissions reductions strategies can be developed. Similar public-private or multistakeholder approaches could be used in the water space, to help develop the likely national or regional water use picture to 2025, and then to identify the most cost effective water use efficiency actions that can be taken by both government and business to ensure that economic growth is sustainable.

2. Metering, Measurement, Pricing, and Enforcement

Participants commented that it is difficult to manage water without good measurements, particularly as it relates to water pricing and allocation. Several companies commented on their own water use efficiency. Water users generally do not have an intuitive sense of how much water has been consumed and therefore lack the incentive to conserve. Water metering, measurement, and pricing is especially politically difficult to suggest or implement in the agricultural sector. Despite the difficulties in implementation, the group still felt strongly that fair pricing is essential to underline the value of water and suggested efforts from South Africa and Chile as star examples. Finally, even the best-laid plans and laws will require a serious commitment to enforcement.

3. Education and Awareness

There is a clear need to increase the level of awareness and education on water to other non-traditional water actors such as Ministry of Finance or investors. Participants suggested that the sharing of knowledge and best practices with other institutions that are already in place such as the Arab Water Council, Arab Water Academy, MBA on water (Morocco) would be most beneficial.

Development of a regional index?

Participants suggested that a national report card that studies country or regional institutional capacity on water and assesses the competitive advantages of the region based on sustainable water policies would be a good first step in unlocking the barriers and encouraging movement in the 3 broad categories highlighted above.

Some key elements of the report card may include:

- To give incentives and information for governments to prioritize their water investments and allocations
- To help countries show their competitive advantage in a water constrained world
- To help inform investors to the best return on their water investments and/or key water risks to their overall investments
- To help inform the private sector in support and pushing for social and economic development
- To provide information to the private sector on water realities of their employees/communities where they work

A multistakeholder, multi-agency process could be launched to help collect and verify data. The combination of a regional political and economic forecast to 2025 under the business as usual scenario, with the development of the index would serve to inform regional and national governments on their future water constraints as well as their preparedness to tackle the water challenge.

List of Participants

Helmy Abouleish, Vice-Chairman and Managing Director, Sekem Group, Egypt

David Barth, Director,USAID - US Government Agency for International Development, Egypt

Margaret Catley-Carlson, Patron,Global Water Partnership (GWP), Sweden

Frits van Dijk, Executive Vice-President and Zone Director, Asia, Oceania, Africa and Middle East, Nestlé SA, Switzerland

Don Evans, Vice-Chair and Chief Marketing Officer, CH2M HILL Companies Ltd, USA

Timothy Fitzgerald, Managing Director, Cambridge Energy Research Associates (CERA), USA

Omar El Hamamsy, Partner, McKinsey & Company, United Arab Emirates

Khaled Irani, Minister of the Environment, Ministry of the Environment of Jordan, Jordan

Sir Mohammad Jaafar, Chairman and Managing Director, The Kuwaiti Danish Dairy Company KCSC, Kuwait

Essam Khalifa, Senior Advisor, Ministry of Water and Irrigation, Egypt

James A. Leach, Regional Director, Oxfam GB, United Kingdom

Francis Matthew, Editor-at-Large, Gulf News, United Arab Emirates

Amir Mirchi, Vice-President, Business Development, Middle East, Rio Tinto Alcan, United Arab Emirates

Lisa Schroeter, Director, International Policy, The Dow Chemical Company, USA

adi M. Shraideh, Deputy Regional Coordinator, Regional Water and Dry-Land Programme (REWARD),International Union for Conservation of Nature West Asia and Middle East (WAME), Jordan

Mohamed T. Tawfik, Managing Director, The Int'l Co. for Agricultural Devlopment Farm Frites - Egypt, Egypt

Eric Viala, Regional Water Advisor,USAID - US Government Agency for International Development, Egypt

Nejib Zaafrani, Managing Director,Shell Abu Dhabi B.V., United Arab Emirates

Sub-Saharan Africa

Africa is the second driest continent in the world, with 14 African countries already experiencing water stress. With the exception of South Africa and the Sahel, where there is physical water scarcity, much of sub-Saharan Africa suffers from severe economic water scarcity caused by a lack of human and infrastructure capacity to satisfy water demand. Twenty-five sub-Saharan countries will be water stressed by 2025, at which time nearly 50% of Africa's predicted population of 1.45 billion people will face water stress or scarcity.[73]

Only 4% of Africa's annual renewable water resources has been developed for irrigation, water supply and hydropower use, compared to 70-90% in developed countries.[74] More than 80 of Africa's river and lake basins are shared by two or more countries and many countries depend on water flowing from outside their national boundaries. The distribution of water withdrawal for Southern Africa is: 70% for agriculture; 24% for domestic use; 6% for industrial use.

About 340 million Africans lack access to safe drinking water and almost 500 million lack access to adequate sanitation. While there has been progress in access to water and sanitation in recent years, to achieve the water-related MDGs there would need to be an increase of funding by 30% for water and an increase of funding by 50% for sanitation.

Session Summary

With a diverse mix of participants, all agreed that **water security is a critical business risk to address today**. Business constraints and disruptions are happening now in the region and will only intensify in the future with the continued increase in competition for water resources.

One issue that emerged strongly from the discussion is the need for integrated planning, which includes input from the private sector into the processes to develop national, waterbasin and regional-level economic growth and water resource strategies, as well as the collection of good quality data to inform these decisions.

Other key issues include:

- The challenge of how to ensure becoming neutral consumers, in the sense that consumers give back as much water as they take
- The need to properly understand and determine the value of water
- The need for the private sector to contribute to the solutions, while not setting the expectation that industry has assumed the complete responsibility for water services, traditionally a role of government
- The need to understand, consider and address competing demands from stakeholders for water resources, as the way to proactively prevent points of conflict and build a basis for cooperation – for example, energy and water, and balancing the interests of subsistence farmers and domestic consumption against the need for job creation

Outcome of Group Discussions

From the discussion, it was clear that there still exists a need for continued constructive multistakeholder dialogue to enhance understanding and communication between all parties to foster more collaboration – but a key message that emerged is a desire to complement the dialogue with practical action and tangible projects to demonstrate commitment.

Participants suggested a number of ideas on how to take forward a regional sub-Saharan Africa workstream for the overall Forum water project. These included:

1) On Forecasts

- Develop economic and business relevant facts and figures for decision-makers on forecasts of water use in the region to 2025
- Create a platform for business to discuss with government and other stakeholders the implications of existing government plans and forecasts for future water development in the region from a private sector viewpoint (e.g. existing plans for water management at the SADC level; for key river basins – Zambezi/Limpopo/Okavango; for key countries)

2) On Business Competencies

- Encourage water-intensive companies operating in the region to sign the CEO Water Mandate
- Create a resource tool listing the various initiatives and innovations in water management that companies are undertaking in the region and the impact they are having
- Create a platform to enable government and other stakeholders to access this information and to suggest what else business could do to improve water management in the region

3) On Multistakeholder Dialogues

- Build on existing public-private innovations operating in the region for developing and implementing water infrastructure projects (e.g. the World Economic Forum-NEPAD Business Foundation initiative on water PPPs in South Africa and the Water and Sanitation for Urban Poor) by bringing the initiatives together to share insight and information
- Use the Forum's platform in the region to help bolster these efforts and stimulate the implementation of a greater number of innovative, bankable public-private partnership water projects

List of Participants

Christopher Anderson, Director, Corporate and External Affairs, Africa, Newmont Mining Corporation, USA

William Asiko, Director, Public Affairs and Communications, Coca-Cola Africa, South Africa

Taz Chaponda, Head, National Treasury Public-Private Partnership Unit, South Africa

Jean Chawapiwa-Pama, General Manager, Communications and External Affairs, Southern Africa, Rio Tinto, South Africa

Lynette Chen, Chief Executive Officer, NEPAD Business Foundation, South Africa

James Dark, Growth Team Manager, General Electric Company, South Africa

Lisa Dean, Principal Adviser, Community Relations, Africa, Rio Tinto, South Africa

Mangisi W. Gule, Chief Executive, ARM Coal, African Rainbow Minerals (ARM), South Africa

Lois M. Hooge, Senior Policy Adviser, Africa Metals and Minerals Sector, Ministry of Natural Resources of Canada, South Africa

Alexis Horowitz-Burdick, Director, Frontier Strategy Group, USA

Stephen Lussier, Executive Director, De Beers Group of Companies, United Kingdom

Mosa Mabuza, Acting Chief Director, Promotion, Department of Minerals and Energy, South Africa

Yves Manghardt, Chairman and Managing Director, Nestlé, South Africa

Jackie Mathebula, Corporate Affairs Executive, Harmony Gold Mining Company, South Africa

Richard Morgan, Corporate Relations and Communications Director, Unilever, United Kingdom

James T. Motlatsi, Deputy Chairman, Anglogold, South Africa

Stephinah Mudau, Deputy Director: Environment, Directorate: Mine Environmental Policy, Research and Development, Department of Minerals and Energy, South Africa

Theo Mxakwe, Director, Corporate Communications and Public Affairs, Nestlé (South Africa), South Africa

Themba G. Nkosi, Director, Human Resources, PepsiCo International, South Africa

Richard Parry, Managing Director, InfraCo, United Kingdom

Guy Pegram, Managing Director, Pegasus Strategic Management, South Africa

Dave Salmon, Principal Water Specialist, Technical Division, Anglo American, South Africa

Michael H. Solomon, Chief Executive Officer, Wesizwe Platinum, South Africa

James Suzman, Director, Corporate Citizenship, De Beers Group of Companies, United Kingdom

Nellie Swanepoel, Managing Director, General Electric Company, South Africa

Reginald Tekateka, Specialist Adviser, International Relations, Department of Water Affairs and Forestry (DWAF), South Africa

Andrew Wales, Group Head, Sustainable Development, SABMiller, United Kingdom

Malcolm White, Water and Sanitation Sector Adviser, Irish Aid, Embassy of Ireland, South Africa

Lindiwe Zikhali-Ngobese, Head, Regulatory Affairs, Anglo American, South Africa

India

The water situation in India is grim. Water availability per person is projected to fall by half by 2050 and over 25% of India's harvest will be at risk from groundwater depletion.[75] The percentage of overexploited watersheds will rise from 15% to 60% and the availability of cultivable land per capita will be cut by half current levels. The impact of water insecurity will be severe – The livelihoods of 200 million people will be at risk (mostly small farmers), which will stoke cultural, regional, political and economic tensions, particularly between headwater and tributary states and between local communities and industries.

Session Summary

The participants felt that the following obstacles are in the way of implementing potential solutions.

1) Lack of understanding and awareness of the issue

India is in a state of transition in its economic development as well as its politics. Participants strongly agreed that water security is already a critical issue for India as the problem becomes more visible, but the sense of urgency has yet to percolate through to the general public and political leaders. Better quality of data and data transparency through an independent authority or group may help provide further insight into the situation.

2) The problem of diffused ownership – across multiple entities

A key question is: Who owns the water problem? Governments rely on industry to help solve the problem, but the scope of the challenge is beyond the ability of any one actor. Public-private partnerships offer solutions but government must lead the charge, with communities and industry finding mechanisms to exert their influence. The situation is further complicated by the fact that water is principally a state and not a national subject and there is no effective governance on the issue.

3) It's about the behaviour of the many – all need to be influenced as there is a wide difference in the perception of the value of water

The difference in the perception of the value of water is leading to tension between water users. Critically, water and energy in India is heavily subsidized, which encourages excessive water use. With the livelihoods of two-thirds of India's population dependent on agriculture and contributing to one-third of the GDP, the farming community represents the country's biggest vote bank. Unless this group of voters is fully aware of the growing water problem and demand change immediately, it is difficult for government leaders to take the type of brave leadership required for reform.

Participants said that the first steps necessary to undertake a reform process are as follows:

1) The need for a multistakeholder process

"We need systemic solutions as opposed to unitary action."

Industry alone cannot provide the solution, but industry can be a thought leader that helps to bridge the gap between different stakeholders. There is a huge opportunity for industry leaders and relevant stakeholders to collaborate as one entity to start influencing governance and to raise awareness.

Water cannot be treated as a stand alone issue – a holistic approach is critical. The complexities of the water crisis cannot be solved by water managers alone – a multidisciplinary approach encompassing water, agriculture, energy and climate is important.

A framework is needed: Can we find a way of bringing all the knowledge to the table – to create a common ownership of a national issue in which everyone contributes needs to be created? Policies without institutions or incentives have no meaning. Integrated decision-making – bringing in a regulatory authority at different levels, from central government to state, city and rural levels, is required.

A clear understanding to each actor's roles, responsibilities and limitations as a first step in engaging in such discussions is vital. Industry's role is to work out how to create the right markets for water consumption, influence public policy and support NGOs in creating a ground-level desire among communities to conserve water. A mechanism or venue to share best practices between various stakeholders was also considered to be important.

2) Key discussion points for a multistakeholder dialogue

Identifying leaders for change/water heroes/a public face to the reform process. There is a need to create mass awareness, public uproar and informed noise. An "Al Gore for water" needs to be found – perhaps a Bollywood actor or cricket team – with the passion to promote the idea to the public. The issue needs to be demystified such that everyone realizes water security will impact him/her personally.

Engagement in developing new forms of policy: The development of a policy framework that incentivises collaboration and disincentivises poor water use and a concerted effort to turn fear and mistrust to a system where successes are rewarded at every level of government are important.

Data, Transparency and Analytics: The impact of the water problem will need to be quantified by different stakeholders so that they can understand the extent of the problem. Additional analytics need to be produced by independent actors that will help or pressure governments and other stakeholders into action (such as additional water metrics/index/benchmarking tools/water footprint).

Scaling up good solutions: Many capacity building programmes are underway but solutions up to now have been *ad hoc* and a platform to promote good ideas and look at how these efforts may be scaled up and strategized is important. Better physical infrastructure is an ongoing challenge in India and is another element that needs to be addressed.

List of Participants

Shekhar Banerjee, Vice-President, Corporate Affairs, Monsanto India Limited, India

Vivek Bharati, Executive Director, Agriculture and External Affairs, PepsiCo India Holdings, India

Rachel Cardone, Programme Officer, Global Development, Bill & Melinda Gates Foundation, USA

Chandan Chawla, Project Officer, Indian Business Alliance on Water, United Nations Development Programme (UNDP), India

Amy Christen, Vice-President, Corporate Affairs, Cisco, USA

Bakul Dave, Head, Corporate Safety, Environment and Energy, Hindustan Unilever, India

David T. Derrick, Vice-President, The Kuwaiti Danish Dairy Company, Kuwait

Gurbinder Gill, Director, Industry Affairs, Monsanto India, India

Ajit Gulabchand, Chairman and Managing Director, Hindustan Construction Company, India

Rajat Gupta, Director, McKinsey & Company, India

Mangesh Gupte, Deputy General Manager, UN Water Mandate, Hindustan Construction Company, India

Sir Mohammad Jaafar, Chairman and Managing Director, The Kuwaiti Danish Dairy Company, Kuwait

Christoph Jakob, Senior Adviser, Swiss Agency for Development and Cooperation (SDC), Switzerland

Dave Johnstone, Technical Director, SABMiller India, India

Deepak Jolly, Vice-President, Public Affairs and Communications, Coca-Cola India, India

S.S. Manhas, Head, North SBU, Syngenta India, India

Laxman Narasimhan, Director, McKinsey & Company, India

Kapil Kumar Narula, Associate Director, Water Resources Programme, The Energy and Resources Institute (TERI), India

Ajeet Oak, Director, PriMove Infrastructure Development Consultants, India

Asim Parekh, Vice-President, Technical, Coca-Cola India, India

Suneet Prakash, Project Manager, Fluor Daniel India, India

John Quarendon, Managing Director, ASEAN, India, CH2MHILL International, Singapore

Anand Rudra, Program Manager, CTO-Regional Urban, USAID - US Government Agency for International Development, India

Niyati Sareen, Deputy General Manager, Corporate Social Responsibility, Hindustan Construction Company, India

Meenakshi Sharma, Head, Corporate Communication, SABMiller India, India

Suresh Subramanian, Chief Operating Officer, International Development Enterprises (India) (IDEI), India

T. K. Vishwanath, Senior Manager, Corporate Planning, Ispat Industries, India

Ram Sai Yelamanchili, Innovation Manager, Bayer MaterialScience, India

Annex - An Issue Summary by the Global Agenda Council on Water Security

This statement is based on discussions by Council Members on Water Security at the Summit on the Global Agenda, Dubai, United Arab Emirates 7-9 November 2008

This work is still in progress, and will continue to be updated and revised. The views expressed here emerged from the Council meeting and do not necessarily reflect the views of the World Economic Forum or those of all the Council Members.

Our View of Water in the World

We are living in a water "bubble" as unsustainable and fragile as that which precipitated the collapse in global financial markets. We use water unsustainably. Groundwater levels drop; rivers dry up before they meet the sea; in many "hot spots", we have over-leveraged our water for the future; we have no means of paying this back. The bubble is bursting in some places (China, the Middle East, the south-western US) with more to follow. Millions die for lack of drinking water; ecosystems and food production are under threat.

There is not enough water to do all the things we want, as inefficiently as we do them now.

This is the peril – and the promise. The peril comes from overuse and the pollution of water resources: poor planning for economic growth and development, unplanned rapid urban expansion and uncontrolled deforestation; unregulated industrialization; inefficient water use; and lack of pollution control. As we try to feed and fuel a growing and more affluent world, the water situation shows every sign of getting much worse. Adding to water supply is no longer possible in most places – **historical approaches to water use will not work in the future.**

All people, all communities, all economic enterprises use water. Unsurprisingly, **there are strong water connections to energy, climate and food security policy issues. These can spin negatively or positively.** Policy decisions made on energy, climate and food policies have determinate impacts on water. Tackling energy security without considering food and water impacts can create bad outcomes (e.g. first generation biofuels). On the other hand, tackling energy security though a water lens can create good outcomes (e.g. promotion of energy alternatives that are water sparing and have low carbon footprints). Clean energy can help open the door to clean water via desalination.

Growing food is an imperative, but if irrigation systems drain the river, much more than food security is at stake. Seventy rivers are close to this stage. Doing nothing is not an option; the bubbles are bursting. We risk economic growth and political instability.

As the peril increases, the market begins to develop new mechanisms. Financial analysts and investors begin to track water risk profiles of companies, communities and investments. Investment houses publish new water indices. Cash-rich, water-poor countries are beginning to look for land elsewhere to grow food (such as Saudi Arabia in South/Central Asia and China in Mozambique).

Market mechanisms will help in many water operations but unfettered reliance on markets will not deliver the social, economic and environmental outcomes we need. Water has potent social, cultural and religious dimensions. It can never be viewed as only a pure economic good. To protect the resource everywhere, and especially for the poorest billions who lack regular access to water, good systems and good regulation are indispensable.

We can do better – what is the way forward?

To avoid the peril, we must stop managing water as inefficiently as we do. We must find the promise of solutions, tools and water management concepts that

exist now but that require – and do not receive – urgent and substantial attention at the highest level. We must do more with less water and we have the tools. We can do it.

- Now is the time to promote investment in water and wastewater infrastructure and **fix what exists**: failing municipal infrastructure and inefficient irrigation systems. This can provide jobs and help meet the MDGs.

- Now is the time for new investment in companies and public projects engaging in water infrastructure. Water and water technology development are a good pick and have sustained high returns. A "new blue deal" opportunity may exist. The market for toilets in the developing world – a true market opportunity – may be in the billions of dollars.

- We call for sustained discussion within and among governments on the essential elements of smarter water economics, which set incentives in the right direction.

- We call for renewed attention to protecting the water resource – the world now understands the need for good regulation and enforcement of the rules.

- We need to raise awareness that water security is an urgent issue and we need to communicate the message better.

- We need to put water in its rightful place on the green reform agenda. Our Council will begin with better messages to the World Economic Forum Annual Meeting 2009 in January.

- We need a series of regional, multistakeholder conclaves, especially in the world's key hotspot or water bubble areas. These reform and investment discussions can be started in 2009 and must be sustained.

- The world needs, and our Council will continue to work on, new analytics and better metrics to provide a clearer view of national and corporate water management performance, and to provide decision-makers with clearer information and methods to measure progress.

Annex - Figures

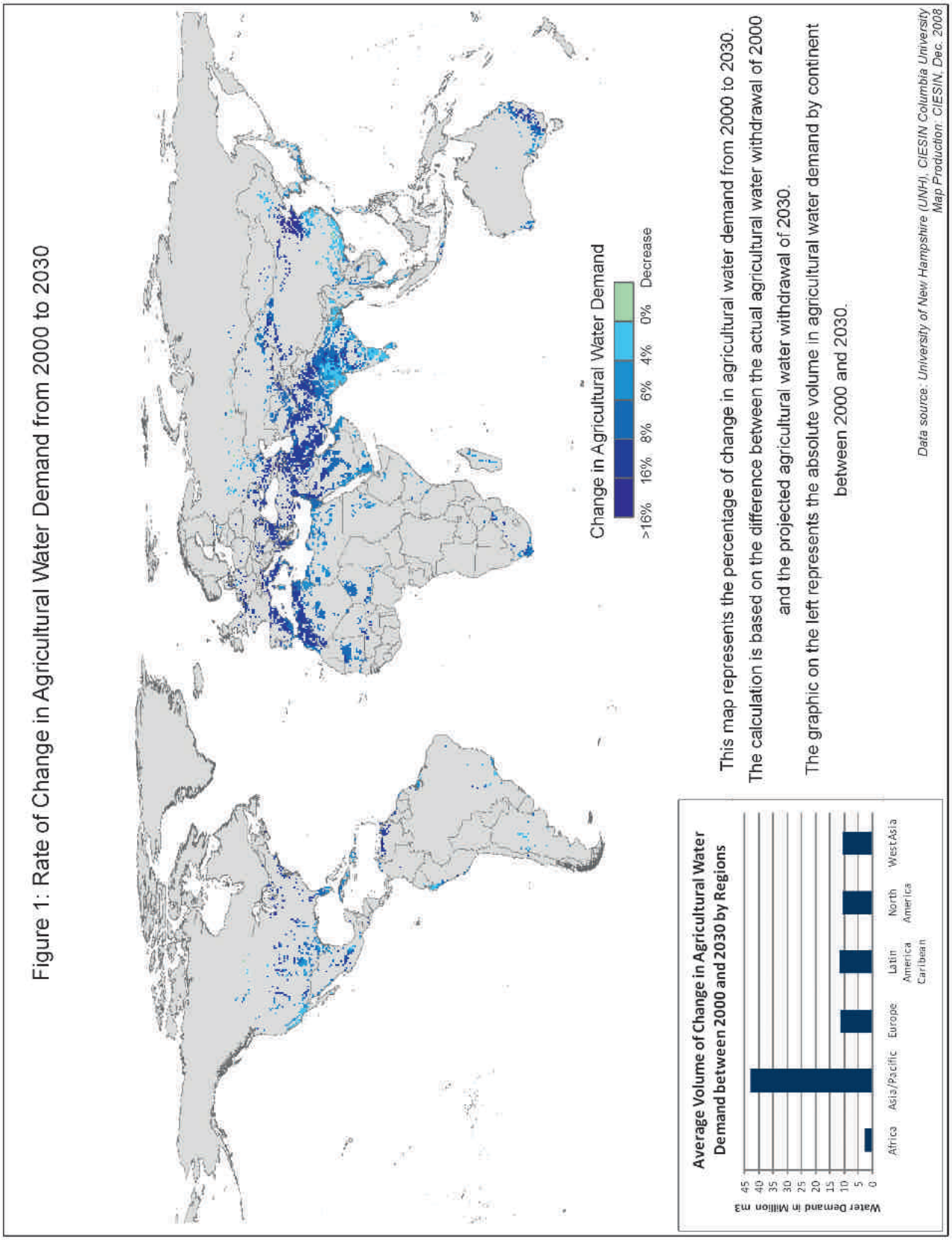
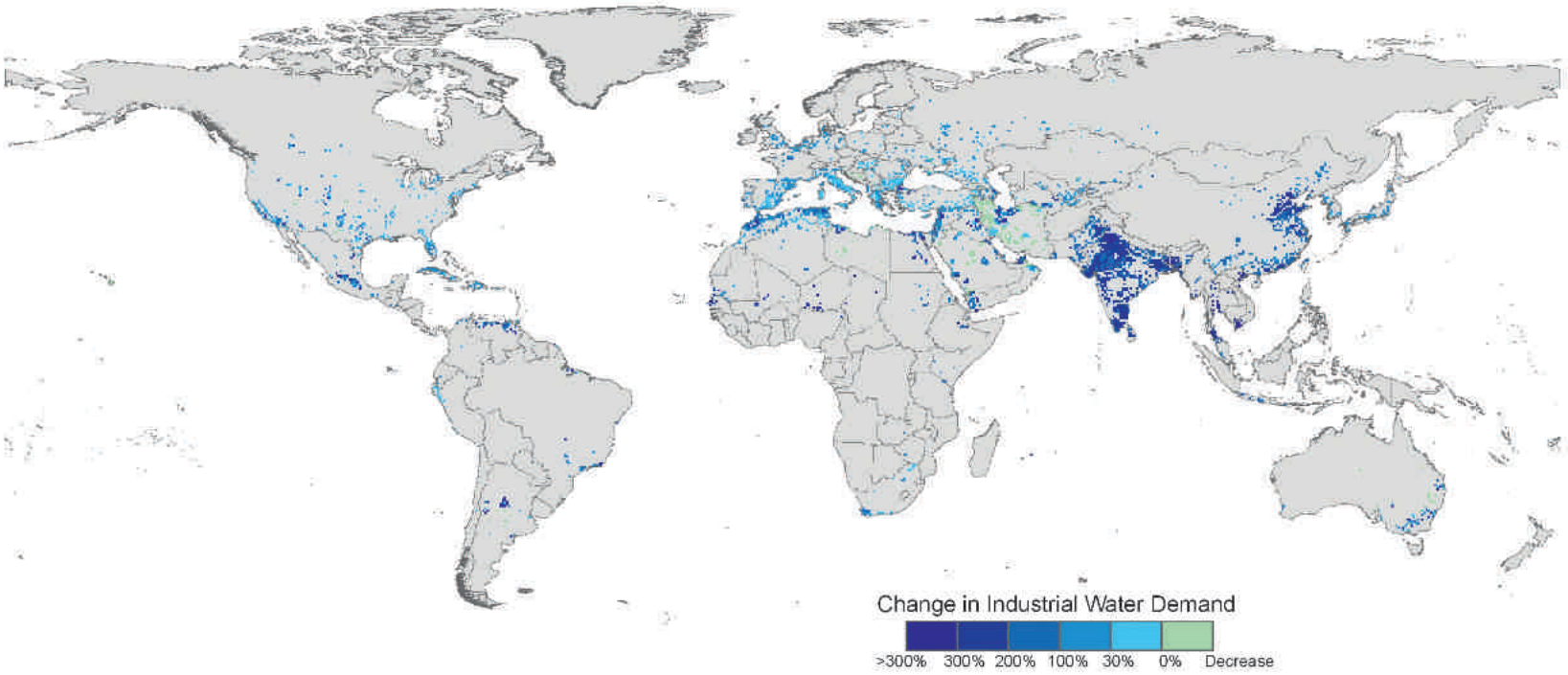
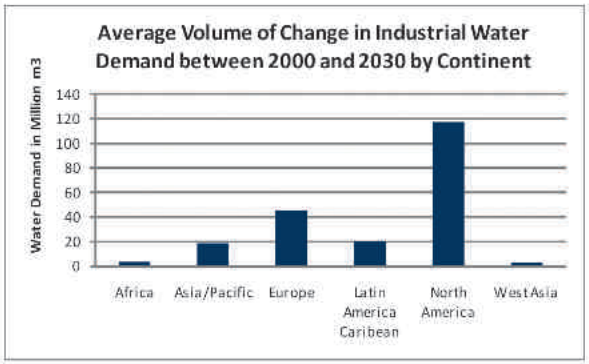


Figure 2: Rate of Change in Industrial Water Demand from 2000 to 2030





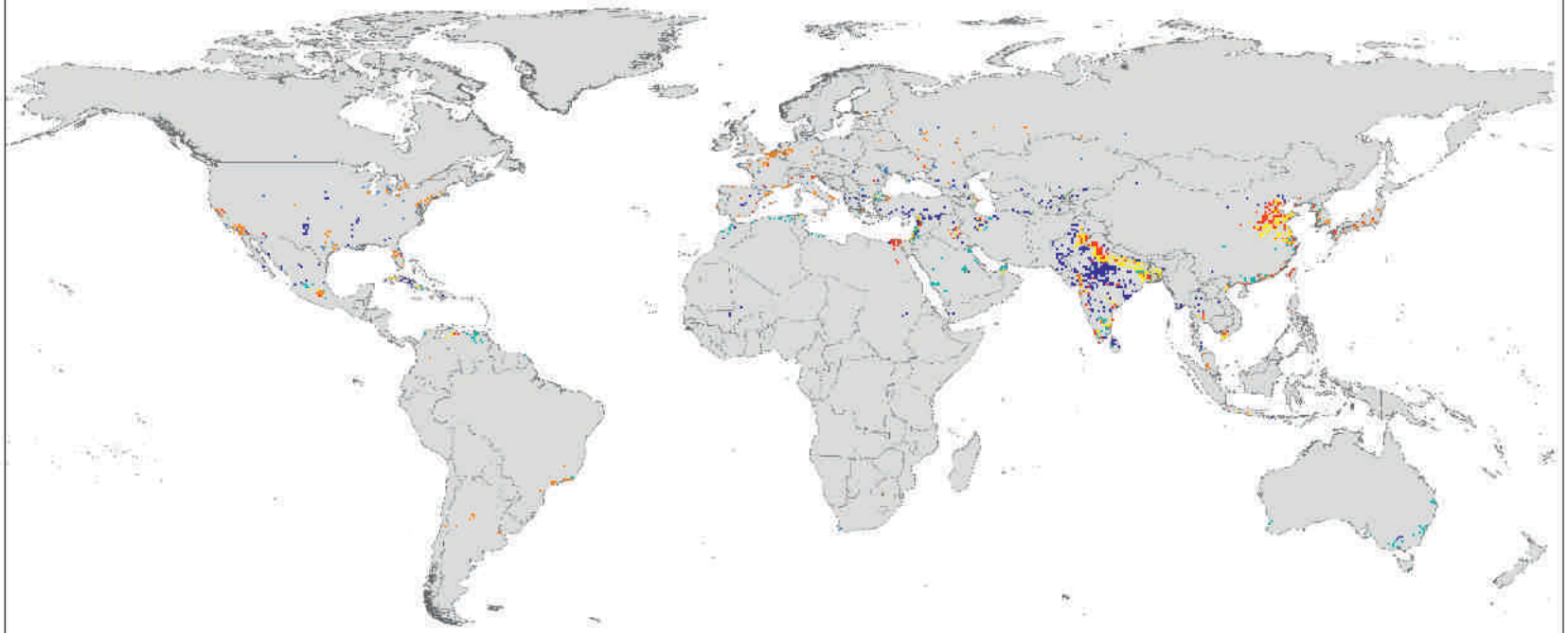
This map represents the percentage of change in industrial water demand from 2000 to 2030. The calculation is based on the difference between the actual industrial water withdrawal of 2000 and the projected industrial water withdrawal of 2030.

The graphic on the left represents the absolute volume in industrial water demand by continent between 2000 and 2030.

Data source: University of New Hampshire (UNH), CIESIN Columbia University
Map Production: CIESIN, Dec. 2008

Figure 3: Global Distribution of Highest Increase in Water Demand from 2000 to 2030 by sector in water scarce regions

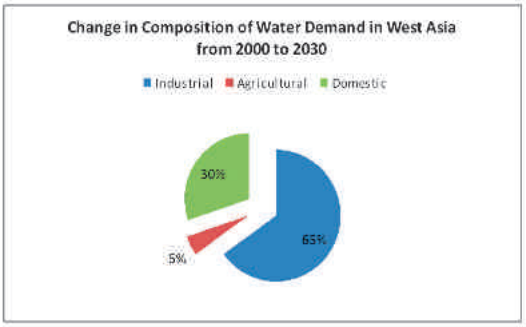
This map represents the global distribution of areas under water scarcity that will experience increase in water demand from 2000 to 2030. Domestic and Industrial demands are based on water withdrawal statistics applied to population for each year (Vorosmaty et al, 2000), and agricultural demands are derived from the Water Balance Model developed by the University of New Hampshire (UNH). Water scarcity is based on the 2000 grid using the United Nations measure of water stress.

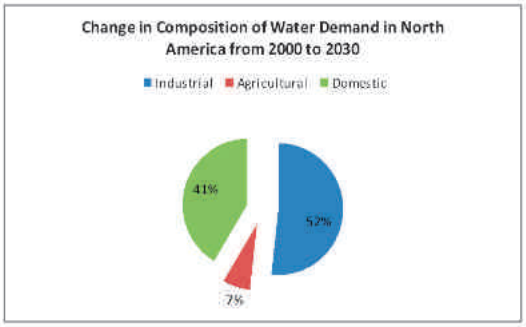


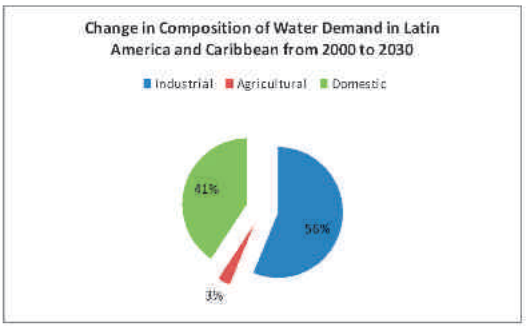
Data Source: University of New Hampshire, CIESIN Columbia University
Map Production: CIESIN, Dec. 2008

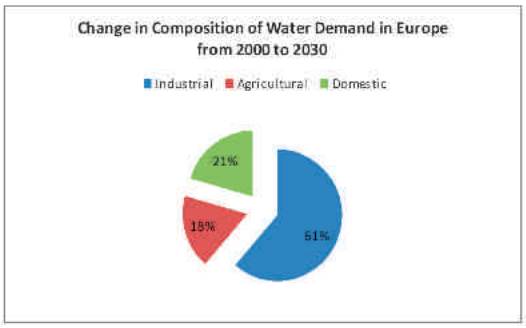
Figure 4: Increase in Water Demand per Sector from 2000 to 2030

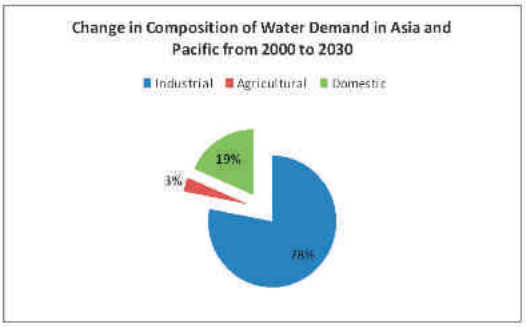
These graphs represent the rate of change in composition of water demand per sector per geographic regions from 2000 to 2030. Agricultural data were derived from the Water Balance Model developed by the University of New Hampshire. Industrial and Domestic data were derived from national statistics applied to the number of population.

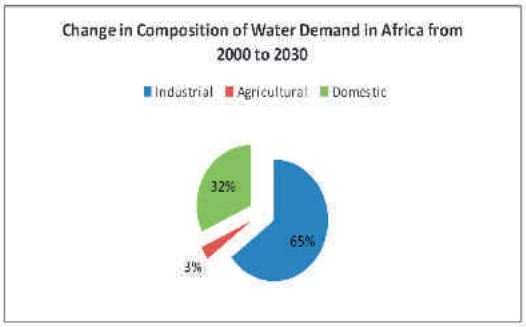






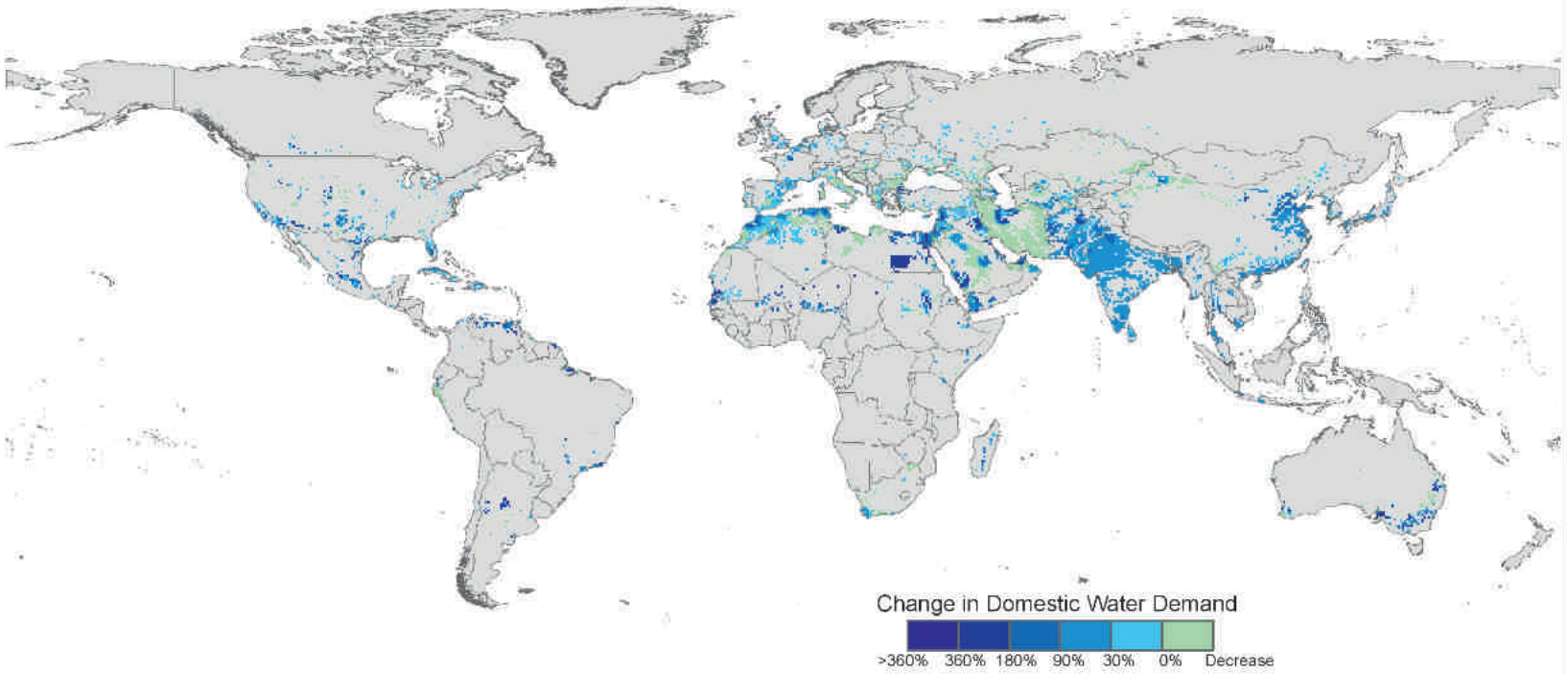


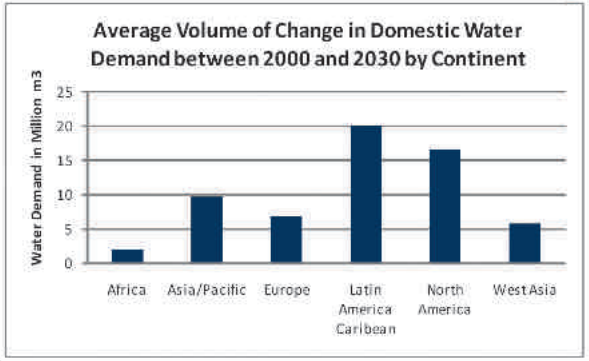




Data source: University of New Hampshire, CIESIN Columbia University

Figure 5: Rate of Change in Domestic Water Demand from 2000 to 2030





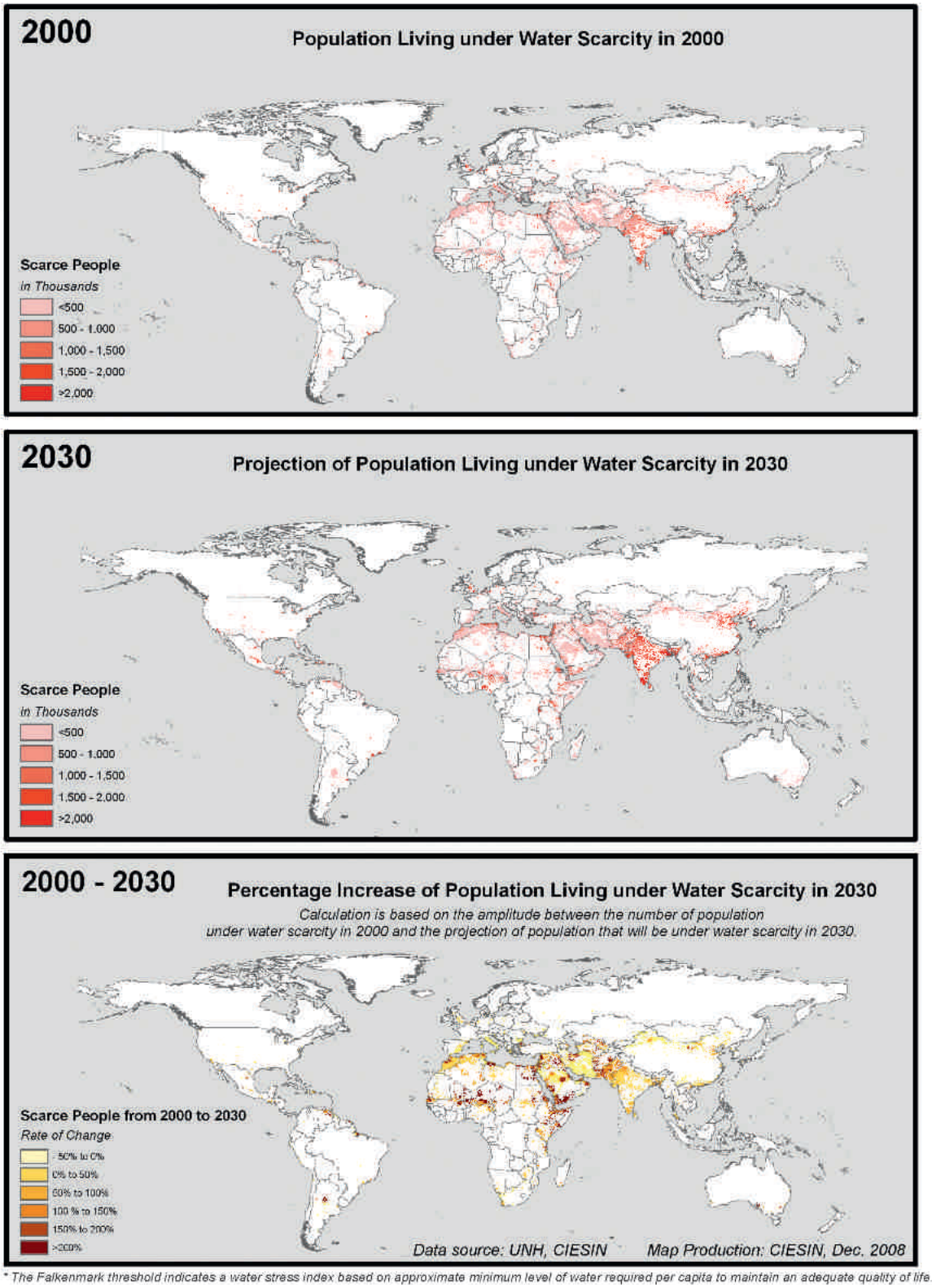
This map represents the percentage of change in domestic water demand from 2000 to 2030. The calculation is based on the difference between the actual domestic water withdrawal of 2000 and the projected domestic water withdrawal of 2030.

The graphic on the left represents the absolute volume in domestic water demand by continent between 2000 and 2030.

Data source: University of New Hampshire (UNH), CIESIN Columbia University
Map Production: CIESIN, Dec. 2008

Figure 6: Population Living under Water Scarcity from 2000 to 2030

(Falkenmark Threshold)*



* The Falkenmark threshold indicates a water stress index based on approximate minimum level of water required per capita to maintain an adequate quality of life.

Acknowledgments

This document was prepared by the World Economic Forum Water Initiative, in partnership with the organizations and companies listed below. The project team was comprised of Dominic Waughray, Senior Director of Environmental Initiatives and Sylvia Lee, Associate Director of Environmental Initiatives.

For more information, please contact water@weforum.org

This work would not have been possible without the substantial expert commitment of:

Jeff Seabright	The Coca-Cola Company
Lisa Schroeter and Peter-Paul van der Wijs	The Dow Chemical Company
Niyati Sareen and Mangesh Gupte	Hindustan Construction Company
David King	International Federation of Agricultural Producers
Herbert Oberhänsli	Nestlé
Dan Bena	PepsiCo
Kristina Ringwood	RioTinto
Andy Wales	SABMiller
Peleg Chevion	Syngenta
Stuart Orr	WWF UK

The following Global Agenda Council on Water Security Members and experts contributed and reviewed various summary reports and drafts. We wish to extend our sincere gratitude to all of them.

Margaret Catley-Carlson	Patron, Global Water Partnership (GWP), Sweden; Chair, Global Agenda Council on Water Security
Tony Allan	Professor and Head, KCL Water Research Group, King's College London, United Kingdom
Peter Brabeck-Letmathe	Chairman of the Board, Nestlé, Switzerland; Member of the Foundation Board of the World Economic Forum
John Briscoe	Country Director, Brazil, World Bank, Washington DC
Daniel C. Esty	Director, Yale Center for Environmental Law and Policy, USA
Peter Gleick	President and Co-Founder, Pacific Institute, USA
Angel Gurría	Secretary-General, Organisation for Economic Co-operation and Development (OECD), Paris
Franklin Fisher	Emeritus Professor, Massachusetts Institute of Technology, USA
C. S. Kiang	Chairman, Environment Fund, Peking University, People's Republic of China
Joe Madiath	Executive Director, Gram Vikas, India

Jacqueline Novogratz	Founder and Chief Executive Officer, Acumen Fund, USA
Herbert Oberhänsli	Head, Economics and International Relations, Nestlé, Switzerland
Claudia Sadoff	Lead Economist, South Asia Water Resources Group, World Bank, Nepal
Jeff Seabright	Vice-President, Environment and Water Resources, The Coca-Cola Company, USA
Ismail Serageldin	Director, Bibliotheca Alexandrina, Egypt
Jack Sim	Founder and Director, World Toilet Organization, Singapore
Pasquale Steduto	Chief, Water Development and Management Unit, Food and Agriculture Organization, United Nations (FAO), Rome
Alberto Székely	Ambassador, Border Resources Division, Ministry of Foreign Affairs of Mexico, Mexico
Arjun Thapan	Director-General, South-East Asia Department, Asian Development Bank, Manila
Patricia Wouters	Director, UNESCO Centre for Water Law, Policy and Science, University of Dundee, United Kingdom

Thanks for additional thoughts and contributions are also due to:

Don Blackmore	Chair, eWater, Australia
Mohamed Ait-Kadi	President, General Council of Agricultural Development, Morocco
Joseph P. Schoendorf	Partner, Accel Partners, USA; Member of the Foundation Board of the World Economic Forum
Ivan Pictet	Senior Managing Partner, Pictet & Cie Private Bankers, Switzerland; Member of the Foundation Board of the World Economic Forum

Finally, a special note of appreciation is due to **Upmanu Lall, Marc Levy, Lauren Berry and Liana Razafindrazay** of the Water Centre, Earth Institute, and CIESIN, Columbia University for providing the forecast data and projection maps.

Notes

[1] This overview is based upon the issue statement prepared from the Global Agenda Council on Water Security, developed at the Inaugural Summit on the Global Agenda, Dubai, United Arab Emirates 7-9 November 2008 (see Annex 1 for their full statement), plus further discussions with Water Security Council Members, industry representatives and other stakeholders involved in the World Economic Forum Water Initiative.

[2] Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture. 2007 p. 5.

[3] Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M., Haan, C. de . Livestock's Long Shadow: Environmental Issues and Options, FAO 2006. Access at http://www.fao.org/docrep/010/a0701e/a0701e00.htm

[4] FAO online database

[5] UNDP Human Development Report 2006 p.176

[6] UNDP Human Development Report 2006 p. 24

[7] Pasquale Steduto, FAO, Personal Communication

[8] UNDP Human Development Report 2006 p.176

[9] Frank Rijbersman, IWMI, 2003

[10] Rosegrant, M., X. Cai, and S. Cline. 2002a. *Global Water Outlook to 2025: Averting and Impending Crisis.* Washington, DC: International Food Policy Research Institute. Access at: http://www.ifpri.org/pubs/fpr/fprwater2025.pdf

[11] Pasquale Steduto, FAO, Personal Communication

[12] John Briscoe, World Bank, Personal Communication

[13] *ibid*

[14] Danish Hydraulic Institute 2007, A Water for Energy Crisis

[15] *ibid*

[16] World Economic Forum 2009, Energy Vision Update (to be published)

[17] Energy demands on water resources: report to Congress on the interdependency of energy and water. US Department of Energy, Dec 2006 http://www.sandia.gov/energy-water/docs/121-RptToCongress-EWwEIAcomments-FINAL.pdf

[18] *E-Water News Weekly,* October 2007

[19] Tennessee Valley Authority, Browns Ferry nuclear plant. http://www.knoxnews.com/news/2007/aug/18/heat-wave-ignites-problems-in-et/

[20] Energy versus Water: Solving Both Crises Together, Scientific American October 2008

[21] World Energy Outlook 2008, International Energy Agency

[22] *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture*, 2007

[23] http://www.iags.org/n0813043.htm

[24] Danish Hydraulic Institute 2007, A Water for Energy Crisis

[25] Scripps Institution of Oceanography/UC San Diego http://scrippsnews.ucsd.edu/Releases/?releaseID=876

[26] John Briscoe, Personal Communication

[27] Ait-Kadi, personal communication

[28] http://www.ft.com/cms/s/0/f7d297e6-b68f-11dd-89dd-0000779fd18c.html

[29] Pacific Institute 2006. The World's Water – The Biennial Report on Freshwater Resources

[30] WWF International, Water at Risk, 2009

[31] Allan, Tony, University of London, King's College, personal communication

[32] *ibid*

[33] WWF International, Water at Risk, 2009

[34] Elizabeth Economy, "The Great Leap Backward?" Foreign Affairs 86, no. 5 (September/October)

[35] United Nations Development Programme, Human Development Report 2006

[36] Gray, David and Claudia Sadoff, 2007, Water Policy, Vol. 9 No. 6 p. 545-571

[37] J.R. McNeil, An Environmental History of the 20th Century, p. 120

[38] *ibid*

[39] Gray, David and Claudia Sadoff, 2007, Water Policy, Vol. 9 No. 6 p. 545-571

[40] UNDP Human Development Report 2006 p. 24

[41] *ibid*

[42] UNDP Human Development Report 2006 p. 166

[43] Pasquale Steduto, FAO, Personal Communication

[44] UNDP Human Development Report 2006 p. 205

[45] Peter Gleick, Pacific Institute, personal communication

[46] UNDP Human Development Report 2006 p. 89

[47] http://www.ifpri.org/pubs/fpr/fprwater2025.pdf

[48] *ibid*

[49] UNDP Human Development Report 2006 p. 5

[50] *ibid*

[51] UNDP Human Development Report 2006 p. 22

[52] WWF International, Water at Risk, 2009

[53] UNDP Human Development Report 2006 p. 22

[54] UNDP Human Development Report 2006 p. 9

[55] UNDP Human Development Report 2006 p. 8

[56] ibid

[57] Report on the Sanitary Condition of the Labouring Population of Great Britain, p. 369, 1842.

[58] UNDP Human Development Report 2006 p. 30

[59] UNDP Human Development Report 2006 p. 105

[60] Jacqueline Novogratz, Acumen Fund, personal communication

[61] Watching Water: A Guide to Evaluating Corporate Risks in a Thirsty World. JPMorgan, 31 March 2008

[62] Little, Arthur D., The Water Margin, 2008

[63] Pacific Institute: Corporate Reporting on Water

[64] Merrill Lynch. Water Scarcity: A Bigger Problem than Assumed, 6 December 2007

[65] Sustainable Asset Management Study: "Water: A Market of the Future", December 2007

[66] Calvert White Paper: Unparalleled Challenge and Opportunity in Water, September 2008

[67] Goldman Sachs, The Essentials of Investing in the Water Sector, version 2.0, 24 March 2008

[68] Ivan Pictet, Managing Director, Pictet Private Bank, personal communication

[69] http://www.businessweek.com/magazine/content/08_25/b4089040017753.htm

[70] *ibid*

[71] Sextant Capital http://www.sextantcapital.com/

[72] Don Blackmore, personal communication

[73] UNDP Human Development Report 2006. Beyond Scarcity: Power, Poverty and the Global Water Crisis

[74] FAO Water Reports. Irrigation in Africa in Figures, Aquastat Survey, 2005

[75] Kapil Kumar Narula, Director, Columbia University Water Center India, personal communication

COMMITTED TO
IMPROVING THE STATE
OF THE WORLD

The World Economic Forum is an independent international organization committed to improving the state of the world by engaging leaders in partnerships to shape global, regional and industry agendas.

Incorporated as a foundation in 1971, and based in Geneva, Switzerland, the World Economic Forum is impartial and not-for-profit; it is tied to no political, partisan or national interests. (www.weforum.org)