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Water Security, Risk and Society

Key Issues and Research Priorities for International Development

June 2012

"Water security is tolerable water-related risk to society"

Professor David Grey
University of Oxford

"We have arrived at the age of consequences for our actions - a focus on water security provides a framework for developing appropriate response strategies"

Dr Letitia A Obeng
Chair, Global Water Partnership

"There is now both a compelling argument and a desire to tackle water insecurity head-on"

Stephen O'Brien
Parliamentary Under-Secretary of State for International Development, UK

This report is one in a series of outputs from the Water Security, Risk and Society conference which was held at Oxford University on 16-18 April 2012. For further information and materials, visit http://www.water.ox.ac.uk/events/water-security-risk-and-society/.

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Contents

1. Summary

Oxford University hosted the first International Conference on Water Security, Risk and Society on April 16-18th, which brought together over 200 of the world's leading thinkers and practitioners from relevant science, policy and enterprise communities. The conference took place at a key moment of wider reflection on uneven progress and future action towards meeting sustainable development and human development goals to create fairer and more open societies and economies. The conference was ambitious in seeking to advance and refine the concept of water security as a framework to i) cross the common divides of water resources and water services, ii) span the range of scales from local to national, regional and global, and iii) integrate the perspectives of all actors, from the family, farm and firm to governments and inter-governmental bodies. The specific aims of the conference were to i) assess the emerging evidence base about the status of and pathways to water security, ii) debate a risk-based framework as an approach to understand and achieve water security across scales and contexts, and iii) provide the foundation for collective global action by science, policy and enterprise communities to achieving water security.

This synthesis reflects a wide-ranging debate and significant convergence on key cross-cutting themes – a debate that will be sustained. This note identifies international development research priorities, gaps and opportunities based on conference findings to inform the UK Collaborative on Development Sciences (UKCDS) thinking in relation to the international agenda of the UK Water Research and Innovation Framework, emphasising linkages across science, policy and enterprise. Three major themes and ten sub-themes are identified:

- Decision-making risks for water security
    - Metrics, models and monitoring – a platform for decision-making
    - Political economy of energy, food and water security
    - Strengthening institutions to promote water security
- Delivering secure water for health and wealth
    - A bolder vision beyond a minimum service platform
    - Institutional transformations for securing urban water supplies
    - Reducing risk and increasing accountability for rural water security
    - The case for a global water security goal
- Transformational responses to water security risks
    - Enhancing science, policy and enterprise partnerships
    - One Water (water and sanitation services) and sustainable cities
    - Water security governance

2. Water security, risk and international development

Water security is a defining global challenge in the 21st century. The enduring struggle to cope with water access and shocks is now magnified by global change to societies, economies and climate at multiple scales. Living in poverty has long been synonymous with the precarious struggle for water security. Absent or unreliable water and sanitation services, unpredictable floods and droughts, and degraded ecosystems threaten the lives and livelihoods of many of the world's population. Rapid change – in populations, economies, geopolitics and climate – will make achieving water security by countries that are currently water insecure much more difficult, and could threaten the water security of long-secure nations. Globally, a multi-billion dollar investment gaps is growing to meet and maintain water services delivery systems in industrialised and developing countries. Escalating water competition, deteriorating water ecosystems, intensified flood and drought shocks, and related social tensions are all predicted. Current and future costs, in terms of human suffering, sustained poverty, constrained growth, migration, and social unrest are unacceptably high and largely avoidable.

Eighty percent of the global population faces a high level risk to water security. Many low-income countries face greater water security risks but have the least ability to mitigate such risk through appropriate and sequenced investments in infrastructure and institutions. The poorest live in the most vulnerable areas, such as urban slums, rural hinterlands and floodplains, yet have the least capacity to invest in resilient and flexible measures to mitigate risk. Private investors are risk averse, crowding in investment where water security is already largely achieved. Recent global assessments of climate risks, infrastructure finance and economic growth illustrate that water security risks are not being effectively addressed by current responses from science, government or enterprise[1].

3. Risk framework

Risk offers a unifying framework to link across multiple water security challenges. Opportunities stem from insights from social theory of a 'risk society' where modern society has 'manufactured risks', such as water pollution, closed river basins and groundwater over-abstraction, beyond or amplifying 'natural risks' of floods or droughts, which leads to a self-reflexive examination by society of the nature and process of modernity – a process that is in constant flux and contestation. Increased water security risks offer important opportunities for policy change (Bartram, Blackmore, Hall, Kelman, Muller, Obeng). Limits stem from the poor

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Professor David Grey
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1 See: Banerjee, S.G., and Morella, E. (2011), "Africa's Water and Sanitation Infrastructure: Access, Affordability and Alternatives", World Bank, Washington, DC.; IPCC (Intergovernmental Panel on Climate Change) (2012), "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation", A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, NY, USA.; WEF (2012) Global Risks 2012. Seventh Edition, World Economic Forum, Geneva.

2 This definitions builds on water security as: ""the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies." Grey, D. And Sadoff, C. (2007) Sink or Swim? Water Security for Growth and Development. Water Policy, Vol. 9, pp. 545-571.

or contested understanding of the socioeconomic aspects and politics of risk, as well as the high levels of residual uncertainty associated with rapid global change. Risk-based principles for defining and managing water security motivate interdisciplinary research to investigate: i) the framing of decisions in risk-based terms; ii) non-stationarity and uncertainty; iii) trade-offs and valuation of risks across multiple and often competing objectives; iv) working across scales to address social, environmental and economic externalities.

4. Key findings

Four research themes emerged that provided direction for research priorities, gaps and opportunities for water security and international development.

4.1. Decision-making risks for water security

4.1.1. Metrics, models and monitoring – a platform for decision-making

Political decisions may be evaluated *"not by their wisdom but by their consequences"*

Professor Jerson Kelman
Light S.A.

The explicit association between water security, growth and development was illustrated (Kelman, Brown, Grey, Hall, Muller, Blackmore). Risks to water security result in coping with local food security challenges related to dry-spells and drought (green water risk), increased sectoral competition between irrigation, energy and environment (blue water risk), regional risks related to food trade, and global risks related to the impacts of land use change on water resources (Falkenmark). Such challenges are not abstract and distant preoccupations but one of immediacy as global society has already arrived at a 'point of inflection' where severe water stresses has closed river basins, over-exploited non-renewable, groundwater, and reduced economic growth (Beddington, Koch).

Managing water security risks is underpinned by improved information which reduces uncertainty and prompts political action. While political decisions under uncertainty are inevitably made, decisions may be evaluated "not by their wisdom but by their consequences" (Kelman). Improved measurement can reduce data uncertainty to inform the political process of decision-making across multiple and often conflicting perspectives across science and society. New information and communication technologies that can remotely, accurately and reliably capture data are rapidly emerging and being tested (Annerose, Blackmore, Dadson, Hope, Mikkelsen,). New processes of data capture, transmission and analysis at scale can promote accountability and transparency in managing uncertainty to respond to water security challenges.

4.1.2. Political economy of energy, food and water security

Escalating energy demands and new sources of supply have significant implications for water security and business risk (Reinhardt). The politics of energy production in East Africa provide an urgent and unique set of development opportunities and challenges as new sources of

hydro-power, gas and oil are likely to disrupt fragile aquatic ecosystems and dependent livelihoods with regional rivalries amplified by global energy interests. Major and cheap new energy sources should provide a catalyst for growth and development if managed wisely to benefit Africa. Energy production is intimately related to water security. Crude oil uses five times more water than coal per unit of energy produced (Froggatt). Authorising and regulating new technologies such as hydraulic fracturing ('fracking') to release oil or gas from in rock layers have important but contested groundwater security implications globally. Where energy demands for water increase, trade-offs will occur for other competing land and water uses for food, livelihoods and ecosystems moderated by local, regional and global political economy questions (Pittock, Closas). Understanding and mitigating water security risks in areas of rapid energy expansion in developing regions is required to balance competing interests with unequal power and influence.

4.1.3. Strengthening institutions to promote water security

Lessons from global studies revealed significant challenges independent of environmental, economic and political contexts in managing risks, trade-offs and conflicts to promote and achieve water security (Obeng, Pahl-Wostl). Water secure river basins in Africa elude institutional design with conflicts between competing water uses for irrigation, energy and ecosystems (Franks). While the river basin remains the common management unit it is potentially restrictive compared to a more adaptive approach to respond to shifting and dynamic boundaries of water security as illustrated by the case of South Africa (Muller).

"We cannot continue to work on water security issues in 'silos'. Now is the time to establish how different sectors can work together"

Dr Letitia A Obeng
Global Water Partnership

Regardless of management scale, poor institutional performance has been hampered by political economy challenges of accountability and transparency in Africa (Hepworth). With insufficient information on resource availability, allocation and access over time, infrastructure investments weakly responded to resource variability and powerful but often invisible political processes in capturing benefits from external interventions (Calow, Franks, Hepworth). Even in resource-rich river basins with significant investments in institutions and infrastructure (Blackmore, Pittock, Closas), water secure outcomes are not guaranteed. Evidence of water security in resource-poor basins with weak governance performance challenged any simple relationship between good governance and water secure river basins. Water secure design principles might be conceived of where (irrigation) systems were as easy to manage as mismanage (Lankford).

Under increasing hydroclimatic and political risks of water security, polycentric governance systems with distributed but flexible institutional structures were promoted over normative principles of stationarity, which assume historical data are a reliable guide to future events (Hall, Lankford). Where institutions and strong leadership are not well-established, independent regulation which is free from political interference provides a necessary platform for promoting water security (Gakubia). A new politics of water governance in emerging economies reflected global economic and political power shifts with Africa, the Arab States, Brazil, India and China shaping new alliances and approaches to achieving water security within their developmental trajectories rather than those reflecting the industrialised nations, which have historically influenced global norms in contentious issues of water storage, water for energy, and water for growth (Kelman, McDonnell). In water-stressed countries where 'difficult hydrologies' pose increasing complex challenges across environmental, political, societal and financial risks, public institutions need to be strengthened to convene and effectively respond to multiple interest groups to gain mutual confidence for effective action (Muller).

4.2. Delivering secure water for health and wealth

4.2.1. A bolder vision to serve everyone beyond a minimum service platform

Despite achieving the Millennium Development Goal (MDG) for improved water supply access, over 780 million people remain water insecure and 2.5 billion without improved sanitation services (Bartram). The greatest inequity is in rural areas with four out of five people water insecure, but the world's future growth is urban. With the United Nations recognising the Human Right to Water of a safe, sufficient, affordable and proximate supply of water in 2010, the global challenge remains as pressing as at the start of the International Drinking Water Supply and Sanitation decade in the 1980s. The water MDG has been a clear, transparent and global call-to-action but has targeted those most easy to reach leaving many excluded and intractable problems unresolved (Roaf). Global society has responded inadequately to the known and intolerable risks for the hundreds of millions of water insecure over decades, which implies a risk-based logic is a useful but insufficient condition for transformative change, particularly for the most vulnerable (Slaymaker). The focus on delivering a minimum water supply has limited multiplier effects where productive uses of domestic water may promote wealth as well as health benefits, and, in turn, contribute to greater financial sustainability of water service delivery (Bartram).

4.2.2. Institutional transformations to secure urban water services

Evidence of transformative change was provided from the 24/7 model in urban India (Jalakam). Continuous supplies of piped water delivers more water to all residents reliably and at lower cost, with lower bulk water production as investments in improved infrastructure have reduced high leakage rates and metering has increased bill collection efficiency to underpin revenue sustainability. Scepticism borne of historical failures hampered the project as many thought 24/7 meant 7 hours per day every 24 days reflecting a pervasive pessimism amongst officials, utilities and civil society groups. 24/7 is now a model being adopted across Indian cities including Delhi where politicians and NGOs had earlier dismissed the approach as unrealistic. Another successful example is the transformation of Uganda's National Water and Sewerage Company from a low-performance public utility which reflects how quickly and effectively change can be achieved. Given that a "sick cow cannot be sold at market" the utility set out to first deliver good operational performance with a view to privatise the utility (Muhairwe). However, the successful transformation revealed that good institutional performance is independent of ownership structure and the utility continues to operate as a public utility but one that provides high consumer satisfaction from good service delivery link to financial sustainability. Both cases expose the myths of the poor not being able to pay for water services, the efficacy of rationing piped water, and tariff subsidies, which generally serve the better-off with piped connections and discriminate against low-income and vulnerable groups (Rouse). Using risk-based selection criteria the multi-billion dollar investment required in urban piped water infrastructure globally can be optimized (Cubillo).

4.2.3. Reducing risk and increasing accountability for rural water security

Rural water transformations were illustrated from private sector initiatives in Senegal and Kenya (Mikkelsen, Annerose). The initiatives were driven by using mobile networks and technologies to reduce the costs of data aggregation and promote increased accountability and transparency. Even with low network coverage in rural areas a model of mobile-enhanced maintenance programmes in India resulted in over 70 percent of handpumps being repaired in 24 hours. A new technology to remotely transmit groundwater use and handpump performance demonstrated how resource and operational risks could be reduced and government accountability increased (Hope). The rapid growth of mobile network coverage provides a platform for reliable, low-cost and universal data flows to address environmental, operational and financial risks limiting rural water security.

4.2.4. The case for a global water security goal

Despite significant achievements and transformations mentioned, the Millennium Development Goals have not delivered secure water supplies to all. The limitations of current monitoring data on water reliability and quality were highlighted in new research demonstrating that safe water provision is over-estimated (Bartram). With the UN General Assembly recognising the Human Right to Water and Sanitation, participants advocated a more ambitious approach both in terms of delivering water to all and moving beyond a basic water supply as a global goal (Slaymaker, Bartram). An effective but minimalist global approach to water service delivery has by-passed the most in need and the most difficult to reach. Domestic water supplies above a minimum platform as a means to health and wealth creation were raised (Gakubia, Bartram) though no empirical evidence was available to support the resource, financial or distributional access implications. Wider agreement related to latent opportunities to establish explicit links between Sustainable Development Goals (economic development) and Millennium Development Goals (human development) to provide a unified approach for economic, environmental and social concerns (Bucknall, Slaymaker). A water security goal could explicitly measure linkages and risks between sustainable water resource management and universal water service delivery. This would facilitate the evaluation of policy performance across competing goals of economic growth, human development and environmental sustainability.

4.3. Transformational responses to water security risks

4.3.1. Enhancing science, policy and enterprise partnerships for water security

Transformational change may be catalysed through coalitions between policy, business and science communities. For example, the mobile money revolution in Africa led by the private sector was supported by UK DFID which has resulted in over 50 mobile money platforms operating in a handful of years following the launch in Kenya in 2007. Over 7 out of 10 Kenyan adults now use mobile money with over half of low-income groups benefiting. This transformation has rapidly expanded into the water sector with 2.5 million urban water users able to use mobile payment services that are saving consumers time and costs of paying by traditional mechanisms (banks, pay-points), and for utilities to improve revenue efficiency and to reduce costs; for example, Uganda's National Water and Sewerage Company saves at least USD400,000 per year in reduced billing costs (Muhairwe). Rural transformations to reduce resource, operational and accountability risks are emerging and expanding across Africa, India and elsewhere (Annerose, Mikkelsen). Businesses are not unique in developing new technologies and models for water security as demonstrated by many initiatives by civil society and research groups working at grass-roots levels to test new approaches (Rajeev, Hope).

> *"Our business can only be as healthy as the communities where we operate"*
>
> Greg Koch
> The Coca-Cola Company

Corporate water security has rapidly mobilised significant attention with global demographic growth and economic opportunity firmly located in developing regions. Major multi-national companies with material dependency for growth on reliable water availability recognised and explored these issues and opportunities (O'Hagan, Koch, Grant). The inevitable diminishing marginal returns on water use efficiency targets for businesses by reducing water consumption 'inside the fence' was contrasted with more promising approaches on an outcome-based platform that included upstream and downstream water impacts (Money, Tickner). This represents unchartered and turbulent waters

for many large corporations which explicitly require new ways of thinking with government, research and community partners. As Coca-Cola's CEO stated "our business can only be as healthy as the communities where we operate". Similar sentiments were echoed by Diageo and SABMiller which also have significant water-related investments in emerging economies where growth is strongest. A global 'point of inflection' had been reached with the urgent need to respond to water security risks (Koch). Incremental change is unlikely to benefit the resilient poor; transformational change and thinking was required in new alliances of policy, enterprise and research communities to address water security risks.

4.3.2. One Water (water supply and sanitation services) and sustainable cities

Transforming sanitation services and hygiene behaviour is also central to water security (Bradley, Bartram). Where settlement density is high such as in urban landscapes in Africa where 70 percent of population growth to 2040 will occur in settlements of less than one million, the concept of One Water could be applied (Bradley). One Water explicitly recognises that water supply, waste water, sewerage and hygiene behaviour variables interact and treats them collectively not independently. This approach promotes the design, testing and wide-scale adoption of waterless toilets, not as a 'poor person's solution' but as a low-cost and universal approach that would be adopted as much by the rich as the poor to aid uptake and sustainable impacts at scale (Bartram).

4.3.3. Water security governance

Despite strong support for business engagement, the need to strengthen governance within which markets could operate efficiently and fairly was also emphasized. The UN General Assembly recognition of the Human Right to Water and Sanitation in 2010 provided one such global architecture within which government and business could productively and accountably interact. A non-discriminatory and universal agreement to the progressive realisation of water and sanitation services to all provided a clear legal basis to promote transformational change. Governing water resources in highly competitive and threatened systems was equally a domain where market allocation mechanisms could drive efficiency and protect primary allocations to domestic water supply and environmental flows (Muller, Blackmore). Surface water markets were most advanced in Australia (Garrick, Bjornlund) in contrast to a global dearth of credible groundwater monitoring data. Groundwater resources offer a buffer to increasing hydro-climatic risks in many drought-prone regions, the need and ability to better measure stocks and abstraction flows at scale with new technologies is central to promoting effective and accountable management strategies toward reducing water security risks (Edmunds, Hope).

No river basin provides evidence of a clear pathway for sequencing investments and design principles for institutions and infrastructure to deliver benefits sustainably (Pahl-Wostl, Pittock, Franks). The political economy of river basin change can be contested fiercely and destructively in strategic locations where equivalent decisions in different years can lead to dramatically different outcomes independent of the quality of decision-making (Kelman). If water security is to be achieved, the complex and diverse nature of water resource management, the intensification of water use and the resulting increase in water management challenges will require greater attention to deliver effective management and governance that can facilitate appropriate responses (Muller). Although many of the issues are local and their repercussions may be regional or global, the framework for addressing them is usually established at the national level. By the nature of water resources' diverse social, economic and environmental dimensions, water governance should be led by public agencies that can convene and inform discussions between different and increasingly competing interest groups to promote effective action. The identification, capacity-building and support of the national water agencies to achieve water security should be prioritised (Muller, Muhairwe, Gakubia).

5. Priority actions to reduce water security risks for international development

While the future of the planet is urban the greatest inequities are rural – this poses unique challenges in achieving water security. The conference findings present the latest evidence and key debates on water security risks from over 200 leading thinkers and practitioners in science, policy and enterprise globally. It is established that increasing levels of water security promotes economic growth and development. However, this process is not even, predictable or replicable. Context matters. Global maps and panaceas of water risks have neither the resolution nor dynamism to adaptively respond in a non-stationary world. Recent floods and droughts in industrialized and developing regions demonstrate the weak capacity for governments and businesses to cope. While the resilient poor find strategies to survive these enduring challenges, their prospects remain uncertain with significant and increasing health, welfare, income, mobility and political costs for global society. Developing regions have long been associated with 'difficulty hydrology', high levels of poverty and governance challenges, now they are equally associated with high economic growth, technology innovations and rapid urbanization – these present both old and new water security risks and opportunities. We conclude with three priority actions that gained traction and support, though not necessarily consensus, based on the material presented and discussed at the conference.

5.1. Establish and promote a coherent and shared agenda for global water security using a unifying risk-based approach to focus on the twin objectives of universal access to drinking water supplies and sustainable management of water resources. The agenda would aim to contribute to the delivery and reform of existing, water-related commitments at the global level, including the Sustainable Development Goals, the Millennium Development Goals and the Human Right to Water and Sanitation.

5.2. Establish new global goals and targets for water security which recognise a) the achievement of universal access to minimum water and sanitation services, and b) sustainable management of groundwater and surface water ecosystems as first-order priorities, complemented by adaptive institutional arrangements to manage risks and trade-offs in delivering water securely for economic growth, energy production, agriculture, and continuous improvement in domestic water and sanitation services to maximise health and economic outcomes.

5.3. Identify and promote mechanisms for sustained engagement and productive outcomes for policy, enterprise and research communities to address shared water security risks. Substantive areas of collaboration may include: strategic basins under pressure, infrastructure investment, sustainable cost recovery for water services, global data monitoring and analysis, and entrepreneurial models for waterless toilets, rural water delivery and 'One Water'.

6. Appendix – Alphabetical list of conference speakers

All presentations are available online at:
http://www.water.ox.ac.uk/events/water-security-risk-and-society/programme/

Annerose, Daniel. Rural water supply management and monitoring innovations from West Africa. In Mobile technology innovations and rural water security.

Bartram, Jamie. State of water and sanitation: how secure is water for people? In Water security and the global development challenge.

Beddington, John. Catalysing sustainable water security – role of science, innovation and partnerships.

Bell, Robert. Addressing water security risks: can we leapfrog carbon? In A risk perspective on water security.

Bjornlund, Henning. Water security and the irrigation sector. In Economic innovations to manage risk through water trading.

Blackmore, Don. River basin management pathways to water security. In Pathways to enhance water security.

Bradley, David. Water and sanitation planning: concepts, institutions and action. In In WASH: goals, targets and metrics for the next 25 years.

Brown, Casey. Water security and economic growth – an imperative for climate change adaptation. In Pathways to enhance water security.

Calow, Roger. A global water crisis? Conceptual and practical insights from an analysis of water security. In Water security in Africa.

Closas, Alvar. Solar water – ecosystem implications of the food/water/energy nexus in La Mancha, Spain. In Water and energy security.

Cox, Anthony. Economic innovations to manage water security risks and tradeoffs. In Pathways to enhance water security.

Cubillo, Francisco. Coping with risk-managing distribution networks. In Urban water services delivery.

Dadson, Simon. Changing land-atmosphere feedbacks in tropical African Wetlands. In Impacts of global change on water security.

Falkenmark, Malin. Growing water scarcity in agriculture – future challenge to global water security. In Global change and the evidence base for strategic policy and business decisions.

Franks, Tom. Water governance and security in the Usangu Plains, Tanzania. In Water security in Africa.

Froggatt, Antony. Resource implications of the move to non-conventionals in the energy and water sectors. In Water and energy security.

Gakubia, Robert. Water services regulation and water security. In Pathways to enhance water security.

Garrick, Dustin. Water reform in a transaction costs world: concepts, metrics and lessons learned. In Economic innovations to manage risk through water trading.

Gleick, Peter. Peak water and peak energy: implications for security. In Water security as a 21st century challenge.

Gober, Patricia. Decision making under uncertainty: a new paradigm for water security. In Global change and the evidence base for strategic policy and business decisions.

Grant, David. SABMiller's perspective on corporate water risk. In Corporate water security risk: harnessing science-enterprise partnerships.

Grey, David. Framing the agenda: the global case for science, policy and enterprise. In Water security as a 21st century challenge.

Hall, Jim. Risk-based principles for defining and managing water security. In A risk perspective on water security.

Hepworth, Nick. Embracing failure: diagnosing the causes of water insecurity to improve the design of future interventions – results of multiple case study research in East Africa. In Water security in Africa.

Hope, Rob. Smart handpumps and rural water security risk. In Mobile technology innovations and rural water security.

Jalakam, Anand. Continuous water supply – an essential component for achieving water security. In Urban water services delivery.

Kelman, Jerson. Small probability events that could cause water supply collapse – how to deal with them? In A risk perspective on water security.

Koch, Greg. Risk and response: a business perspective on water security.

Lankford, Bruce. Water (un)control and water (in)security; theorising an infrastructural framework for water apportionment and access. In Sustainable water infrastructure.

Mikkelsen, Rasoul. LIFELINK - Reducing financial and operational risks to rural water security. In Mobile technology innovations and rural water security.

Money, Alex. Measuring what you manage: corporate water risk. In Corporate water security risk: harnessing science-enterprise partnerships.

Muhairwe, William. Sustainable urban water service delivery: focusing on efficiency and leadership. In Urban water services delivery.

Muller, Mike. Rocks, hard places and road blocks: challenges on the paths to water security in Africa. In Water security and the global development challenge.

Obeng, Letitia. The case of the water insecure: building a national, regional and global coalition. In Water security as a 21st century challenge.

O'Brien, Stephen. Water security and the global development challenge. In Water security and the global development challenge.

O'Hagan, Gerry. Diageo's approach to water – supporting business growth In Water security and the global development challenge.

Pahl-Wostl, Claudia. Enhancing water security for the benefit of humans and nature – a multi-level governance challenge. In Pathways to enhance water security.

Pittock, Jamie. Managing risk from climate variability and change: lessons from Australia's Murray-Darling Basin. In Global change and the evidence base for strategic policy and business decisions.

Rajeev, K.J. Mobile-enhanced handpump maintenance innovations in rural India. In Mobile technology innovations and rural water security.

Reinhardt, Walter. Three things for the water security community to know about the energy sector. In Water and energy security.

Slaymaker, Tom. Joint Monitoring Programme Water Working Group. In WASH: goals, targets and metrics for the next 25 years.

Tickner, Dave. Beyond metrics: can water footprinting improve water security? In Corporate water security risk: harnessing science-enterprise partnerships.