Regional–global links: Impacts and challenges

- Saudi Arabia, one of the Middle East's largest cereal growers, announced it would cut cereal production by 12% a year to reduce the unsustainable use of groundwater. To protect its water and food security, the Saudi government issued incentives to Saudi corporations to lease large tracts of land in Africa for agricultural production. By investing in Africa to produce its staple crops, Saudi Arabia is saving the equivalent of hundreds of millions of gallons of water per year and reducing the rate of depletion of its fossil aquifers.
- India is growing maize, sugarcane, lentils and rice in Ethiopia, Kenya, Madagascar, Senegal and Mozambique to feed its domestic market, while European firms are seeking 3.9 million ha of African land to meet their 10% biofuel target by 2015 (Cotula et al., 2009).
- The Chinese government anticipates that by 2020, 15% of China's transport energy needs will be met by biofuels (Kraus, 2009).
- The amount of water required for biofuel plantations could be particularly devastating to regions such as West Africa, where water is already scarce (UNCTAD XII, 2008), given that 1 L of ethanol from sugarcane requires 18.4 L of water and 1.52 m^2 of land (Periera and Ortega, 2010).

Chapter 8

Working under uncertainty and managing risk

- Most modern flood management plans include the use of floodplains and wetlands. Key services of these lands include their ability to rapidly absorb and slowly release (regulate) water, and to increase ecosystems resilience by regulating sediment transfer. These services alone account for some of the highest land/nature values thus far calculated; for example, US$33,000 per ha of wetlands for hurricane risk reduction in the USA (Costanza et al., 2008).
- Potential damage from storms, coastal and inland flooding, and landslides can be considerably reduced by a combination of careful land-use planning and maintaining or restoring ecosystems to enhance buffering capacity. Tallis et al. (2008) showed that planting and protecting nearly 12,000 ha of mangroves in Viet Nam cost US$1.1 million but saved annual expenditures on dyke maintenance of US$7.3 million.

Chapter 9

Understanding uncertainty and risks associated with key drivers

- Water productivity for food production increased by nearly 100% between 1961 and 2001.
- The global population is likely to reach 9.1 billion in 2050, if not sooner. According to UNDESA (2009*b*), 68% of these 9 billion people will reside in urban settings.
- Water availability is expected to decrease in many regions. Yet future global agricultural water consumption alone (including both rainfed and irrigated agriculture) is estimated to increase by ~19% by 2050, and will be even greater in the absence of any technological progress or policy intervention. Current trends show that water withdrawals are expected to increase by at least 25% in developing countries (UNEP, 2007).
- While agriculture continues to use at least 70% of water resources globally, other economic sectors will continue to compete for water resources, and some intensely, without an explicit mechanism for allocation decision-making.
- Water used for cooling power plants in the USA represents 40% of the country's industrial water use. This figure is expected to reach 30% in China in 2030 (UNEP, 2011 and sources therein). Increased energy production using current technology, at current levels of efficiency, is therefore likely to exert multiplied pressures on scarce water resources.
- The development of sustainable urban agriculture could provide resilient avenues for ensuring local food supply.

Chapter 10

Unvalued water leads to an uncertain future

- World Bank research estimates that Indonesia lost US$6.3 billion (2.3% of GDP) in 2006 from poor sanitation and hygiene. The result was increased health costs, economic losses and offsetting costs in other sectors (World Bank, 2008*c*). Corresponding losses in the Philippines as part of the same overall study amounted to US$41.4 billion or 1.5% of GDP (World Bank, 2008*b*).
- Investment in safe wastewater collection and treatment, including industrial effluents, can remove a potential brake on economic activity. It has been

estimated that water pollution in South Africa costs the country 1% of its annual national income (Pegram and Schreiner, 2010). The principal benefits of wastewater treatment are avoidance of the costs of pollution and the use of contaminated water by downstream users, such as other municipalities, industries, farmers and the tourist industry. In serious cases, the pollution of water bodies has caused industries to be closed down and relocated at great cost.

Chapter 11

Transforming water management institutions to deal with change

- The inability to meet water supply demands and protect people and property against floods and droughts is a significant threat to all countries, but is felt most notably by developing states unable to build the infrastructure needed to reduce the adverse impacts of such events. The reality is that water management systems are not designed to satisfy all demands, given the full range of possible expected extreme events under what is understood to be contemporary hydrological variability. They are designed to minimize the combination of risks and costs of a wide range of hazards to society.

Chapter 12

Investment and financing in water for a more sustainable future

- Improving access to safe water and basic sanitation could have huge economic returns. World Bank studies in five South-East Asian countries estimate that ~2% of their combined GDP is lost because of poor sanitation, and in the worst case (Cambodia) this figure rises to over 7% (World Bank, 2008*a*). Economic benefits due to improvements in health include lower health system costs, fewer days lost at work or at school through illness or caring for an ill relative, and convenience time savings (Hutton et al., 2007). The prevention of sanitation- and water-related diseases could save ~US$7 billion per year in health system costs, and the value of deaths averted, based on discounted future earnings, would add a further US$3.6 billion per year (Hutton et al., 2007).
- The WHO estimates that the overall economic benefits of halving the proportion of people without sustainable access to improved drinking water and sanitation, by 2015, would outweigh the investment cost by a ratio of 8:1 (Prüss-Üstün and Corvalán, 2006).
- Total aid for all aspects of water fell from 8% to 5% between 1997 and 2008 (WHO/UN-Water, 2010). Domestic and foreign aid are not necessarily well targeted to where need is greatest. Less than half of the funding from external support agencies for water and sanitation goes to low income countries, and a small proportion of these funds is allocated to the provision of basic services, where it would have the greatest impact on achieving the MDG target (WHO/UN-Water, 2010).
- More than 70% of the 1.1 billion poor people surviving on less than US$1 per day live in rural areas, where they are directly dependent on ecosystem services (Sachs and Reid, 2006).
- Improved weather and flood forecasting is crucial to flood risk management and especially in reducing the impact of floods. In Kenya, losses from flooding from El Niño in 1997–1998 and drought from La Niña in 1998–2000 ranged from 10 to 16% of GDP during those years. Investment in weather forecasting and hydrometeorological services can be highly cost-beneficial.
- Estimates of measures to cope with climate scenarios imply an annual increase in adaptation costs of US$13–17 billion for developing countries as a whole. This represents 3% of their GDP.
- Projections are that the annual cost of climate change adaptation in developing countries in the industrial and municipal raw water supply sector would be between US$9.9–10.9 billion (net) and US$18.5–19.3 billion (gross). Costs for riverine flood protection are projected between US$3.5–5.9 billion (net) and US$5.2–7.0 billion (gross).[3]
- The Private Participation in Infrastructure (PPI) database, maintained by the World Bank and the Public-Private Infrastructure Advisory Facility, reported that in 2009 the number of water projects reaching financial or contractual closure had declined by 46% compared with 2008, and that annual investment commitments had fallen by 31% over the same period.
- In Africa, under-collection of water bills is valued at US$0.5 billion annually. Improving the collection rate is an obvious way of increasing water revenues without raising tariffs. Although the better performing water utilities in Africa normally manage collection rates of 80% or more (Mehta et al., 2009), persistent non-payment, especially by public departments and agencies,

3 Gross costs include all costs incurred by adaptation to climate change. Net costs allow for (i.e. deduct from gross) any negative costs (i.e. cost savings) that may arise from climate change. The method used in this study nets out positive and negative cost items for each country, but not across countries within a region (World Bank, 2010*c*).

leaves a big hole in the accounts of water authorities normally be expected to be self-sufficient.

- Although the share of water in total official development assistance (ODA) has declined since the mid-1990s, the absolute volume of ODA has started to increase. In 2007–2008, the bilateral annual aid commitments of DAC countries to water and sanitation rose to US$5.3 billion. Including concessional outflows of multilateral agencies, the total ODA for water and sanitation for that period was US$7.2 billion (OECD-DAC, 2010) compared with US$5.6 billion in 2006.

Chapter 13

Responses to risk and uncertainty from a water management perspective

- The International Water Management Institute (IWMI) predicts that climate change will have dire consequences for feeding an ever-expanding global population, especially in areas of Africa and Asia where millions of farmers rely solely on rainwater for their crops. In Asia, 66% of cropland is rainfed, while 94% of farmland in sub-Saharan Africa relies on rain alone, according to IWMI. These are the regions where water storage infrastructure is least developed and where nearly 500 million people are at risk of food shortages.

Chapter 14

Responses to risks and uncertainties from out of the water box

- A WHO study revealed that the return on investment from each dollar spent on water and sanitation in developing countries would be US$5–28 (Hutton and Haller, 2004).
- The International Energy Organization (IEA) predicts that 'at least 5% of global road transport will be powered by biofuel [by 2030] – over 3.2 million barrels per day. However, producing those fuels could consume between 20–100% of the total quantity of water now used worldwide for agriculture' (WEF, 2011*b*, p. 31) if production processes and technology remain unchanged.

References

Alcamo, J. et al. 2007. Europe. M. L. Parry et al. (eds), *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. New York, Cambridge University Press, pp. 541–80.

AMCOW (African Ministers' Council on Water). 2010. *A Snapshot of Drinking Water and Sanitation in Africa – 2010 Update: A Regional Perspective Based on New Data from the WHO/UNICEF Joint Monitoring Programme for Water and Sanitation.* Prepared for AMCOW as a contribution to the Third Africa Water Week, Addis Ababa, Ethiopia, 22–26 November 2010. http://www.childinfo.org/files/Africa_AMCOW_Snapshot_2010_English_final.pdf

APWF (Asia Pacific Water Forum). 2009. *Regional Document: Asia Pacific.* 5th World Water Forum.

AquaFed. 2010. *Access to Drinking Water is Deteriorating in the Urban Half of the World.* Press release issued 6 September 2010. Stockholm, AquaFed. http://www.aquafed.org/pdf/AquaFed_UrbanTrends_PressRelease_Stockholm_EN_Pd_2010-09-07.pdf

Bai, Z. G., Dent, D. L., Olsson, L. and Schaepman, M. E. 2008. Proxy global assessment of land degradation. *Soil Use and Management*, Vol. 24, No. 3, pp. 223–34.

Black, R. E., Cousens, S., Johnson, H. L., Lawn, J. E., Rudan, I., Bassani, D. G., Jha, P., Campbell, H., Walker, C. F., Cibulskis, R., Eisele, T., Liu, L. and Mathers, C. 2010. Presentation for the Child Health Epidemiology Reference Group of WHO and UNICEF. Global, regional, and national causes of child mortality in 2008: A systematic analysis. *The Lancet*, Vol. 375, No. 9730, pp. 1969–1987. http://www.who.int/child_adolescent_health/data/cherg/en/index.html (Accessed 3 October 2011.)

Boko, M. et al. Africa. 2007. M. L. Parry et al. (eds), *Climate Change 2007: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge UK, Cambridge University Press, pp. 433–67.

Bruinsma, J. 2009. *The Resource Outlook to 2050: By How Much do Land, Water and Crop Yields Need to Increase by 2050?* Prepared for the FAO Expert Meeting on 'How to Feed the World in 2050', 24–26 June 2009, Rome.

Carter, N. T. and Campbell, R. J. 2009. *Water Issues of Concentrating Solar Power (CSP) Electricity in the U.S. Southwest*. Washington DC, Congressional Research Service (CRS). http://www.circleofblue.org/waternews/wp-content/uploads/2010/08/Solar-Water-Use-Issues-in-Southwest.pdf

CEC (Commission for Environmental Cooperation). 2008. *The North American Mosaic: An Overview of Key Environmental Issues. Water Quantity and Use*. Montreal, Quebec, CEC Secretariat. http://www.cec.org/Storage/32/2366_SOE_WaterQuantity_en.pdf

Chapagain, A. K. and Orr, S. 2008. *UK Water Footprint: The Impact of the UK's Food and Fibre Consumption on Global Water Resources.* Volume 1. Godalming, UK, World Wide Fund for Nature (WWF).

Cline, W. 2007. *Global Warming and Agriculture: Impact Estimates by Country*. Washington DC, Center for Global Development and Peterson Institute for International Economics.

Comprehensive Assessment of Water Management in Agriculture. 2007. *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in*

Agriculture. London/Colombo, Earthscan/International Water Management Institute.

Corcoran, E., Nellemann, C., Baker, E., Bos, R., Osborn, D. and Savelli, H. (eds). 2010. *Sick Water? The Central Role of Wastewater Management in Sustainable Development. A Rapid Response Assessment*. The Hague, UN-Habitat/UNEP/GRID-Arendal.

Costanza, R., Pérez-Maqueo, O. M., Martínez, M. L., Sutton, P., Anderson, S. J. and Mulder, K. 2008. The value of wetlands for hurricane protection, *Ambio*, Vol. 37, No. 4, pp. 241–8.

Cotula, L., Vermeulen, S., Leonard, R. and Keeley, J. 2009. *Land Grab or Development Opportunity? Agricultural Investment and International Land Deals in Africa.* London/Rome, IIED/FAO/IFAD.

De Stefano, L., Duncan, J., Dinar, S., Stahl, K. and Wolf, A. 2010. *Mapping the Resilience of International River Basins to Future Climate Change-induced Water Variability*. World Bank Water Sector Board Discussion Paper Series 15. Washington DC, The World Bank.

ECLAC (United Nations Economic Commission for Latin America and the Caribbean). 2011. *Social Panorama.* Santiago, ECLAC.

EIA (US Energy Information Administration). 2010. *International Energy Outlook 2010: Highlights*. Washington DC, Office of Integrated Analysis and Forecasting, EIA, US Department of Energy. http://www.eia.gov/oiaf/archive/ieo10/highlights.html (Accessed 3 November 2011.)

ESCAP (United Nations Economic and Social Commission for Asia and the Pacific). 2010. *Statistical Yearbook for Asia and the Pacific, 2009.* Bangkok, ESCAP.
— 2011. *Population Dynamics: Social Development in Asia-Pacific.* Bangkok, ESCAP. http://actionbias.com/issue/population-dynamics

ESCAP, ADB (Asian Development Bank) and UNDP (United Nations Development Programme). 2010. *Achieving the Millennium Development Goals in an Era of Global Uncertainty.* Asia-Pacific Regional Report. Bangkok, ESCAP, ADB and UNDP. http://content.undp.org/go/cms-service/stream/asset/?asset_id=2269033

ESCWA (United Nations Economic and Social Commission for Western Asia). 2009. *Trends and Impacts in Conflict Settings: The Socio-Economic Impact of Conflict-Driven Displacement in the ESCWA Region.* Issue 1. E/ESCWA/ECRI/2009/2. New York, ESCWA. http://www.escwa.un.org/information/publications/edit/upload/ecri-09-2.pdf

EU (Council of the European Union). 2007. Energy efficiency and renewable energies. *Presidency Conclusions of the Brussels European Council (8/9 March 2007).* Brussels, EU, pp. 20–22.

EUROSTAT. 2011. Online database. Brussels, European Commission (EC). http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/

FAO (Food and Agriculture Organization of the United Nations). 2005. *Irrigation in Africa in Figures: AQUASTAT Survey – 2005*. FAO Water Report No. 29. Rome, FAO. ftp://ftp.fao.org/agl/aglw/docs/wr29_eng.pdf
— 2006. *World Agriculture: Towards 2030/2050 – Interim Report – Prospects for Food, Nutrition, Agriculture and Majority Commodity Groups*. Rome, FAO.
— 2008*a*. *Sustainable Land Management.* Rome, FAO. http://www.un.org/esa/sustdev/csd/csd16/documents/fao_factsheet/land.pdf
— 2008*b*. Mapping poverty, water and agriculture in sub-Saharan Africa. J.-M. Faurès and G. Santini (eds), *Water and the Rural Poor: Interventions for Improving Livelihoods in sub-Saharan Africa.* Rome, FAO. ftp://ftp.fao.org/docrep/fao/010/i0132e/i0132e03a.pdf
— 2011*a*. *The State of the World's Land and Water Resources: Managing Systems at Risk*. London, Earthscan.
— 2011*b*. AQUASTAT online database. Rome, FAO. http://www.fao.org/nr/water/aquastat/data/query/index.html

Foster, V. and C. Briceño-Garmendia (eds). 2010. *Africa's Infrastructure: A Time for Transformation.* Africa Infrastructure Country Diagnostic (AICD). Washington DC, The World Bank. http://siteresources.worldbank.org/INTAFRICA/Resources/aicd_overview_english_no-embargo.pdf

Guha-Sapir, D. et al. 2011. *Annual Disaster Statistical Review 2010: The Numbers and Trends.* Brussels, CRED. http://www.undp.org.cu/crmi/docs/cred-annualdisstats2010-rt-2011-en.pdf

Hoekstra, A. Y. and Chapagain, A. L. 2008. *Globalization of Water: Sharing the Planet's Freshwater Resources.* Oxford, UK, Blackwell Publishing.

Hoffman, A. R. 2011. *The Connection: Water Supply and Energy Reserves.* Washington DC, US Department of Energy. http://waterindustry.org/Water-Facts/world-water-6.htm (Accessed 10 May 2011.)

Huq, A., Xu, B., Chowdhury, A. R., Islam, M. S., Montilla, R. and Colwell, R. R. 1996. A simple filtration method to remove plankton-associated *Vibrio Cholerae* in raw water supplies in developing countries. *Applied And Environmental Microbiology*, Vol. 62, No. 7, pp. 2508–12.

Hutton, G. and Haller, L. 2004. *Evaluation of the Costs and Benefits of Water and Sanitation Improvements at the Global Level.* Geneva, World Health Organization (WHO). http://www.who.int/water_sanitation_health/wsh0404.pdf

Hutton, G., Haller, L. and Bartram, J. 2007. *Economic and Health Effects of Increasing Coverage of Low-cost Household Drinking-Water Supply and Sanitation Interventions to Countries Off-Track to Meet MDG Target 10*. Geneva, World Health Organization (WHO).

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 2008. *Climate Change and Desertification Put One Billion Poor People at Risk.* Hyderabad, India, ICRISAT. http://www.icrisat.org/Media/2007/media14.htm

IEA (International Energy Agency). 2006. *World Energy Outlook 2006*. Paris, IEA.
— 2007. *World Energy Outlook 2007*. Paris, IEA.
— 2009. *World Energy Outlook 2009*. Paris, IEA.
— 2010*a*. *Renewable Energy Essentials: Hydropower*. Paris, IEA. http://www.iea.org/papers/2010/Hydropower_Essentials.pdf
— 2010*b*. *World Energy Outlook 2010*. Paris, IEA.

IGRAC (International Groundwater Resources Assessment Centre). 2010. *Global Groundwater Information System (GGIS)*. Delft, The Netherlands, IGRAC.

ISARM (International Shared Aquifer Resources Management). 2009. *Transboundary Aquifers of the World* (2009 update). Presented during a special meeting at World Water Forum 5. Utrecht, The Netherlands, ISARM. http://www.isarm.net/publications/319#

Kraus, M. 2009. *Fuelling New Problems: The Impact of China's Biodiesel Policies.* Asia Paper. Brussels, Brussels Institute of Contemporary China Studies (BICCS).

MA (Millennium Ecosystem Assessment). 2005. *Living Beyond Our Means. Natural Assets and Human Well-Being: Synthesis from the Board.* Washington DC, World Resources Institute (WRI). http://www.millenniumassessment.org/documents/document.429.aspx.pdf

Margat, J. 2008. *Les eaux souterraines dans le monde.* Paris, BGRM/Editions UNESCO.

Mehta, M., Cardone, R. and Fugelsnes, T. 2009. *How Can Reforming African Water Utilities Tap Local Financial Markets?* Insights and recommendations from a practitioners' workshop in Pretoria, South Africa, July 2007 (Revised in 2009). Washington DC/Tunis, Tunisia, Water and Sanitation

Programme (WSP)/Public-Private Infrastructure Advisory Facility (PPIAF)/African Development Bank (AfDB).

Nachtergaele, F., Petri, M., Biancalani, R., Van Lynden, G. and Van Velthuizen, H. 2010. *Global Land Degradation Information System (GLADIS): Beta Version. An Information Database for Land Degradation Assessment at Global Level*. Land Degradation Assessment in Drylands Technical Report No. 17. Rome, Food and Agriculture Organization of the United Nations (FAO).

NEPAD (New Partnership for Africa's Development). 2006. *Water in Africa: Management Options to Enhance Survival and Growth*. Addis Ababa, United Nations Economic Commission for Africa (UNECA). http://www.uneca.org/awich/nepadwater.pdf

Neumayer, E. and Plümper, T. 2007. The gendered nature of natural disasters: The impact of catastrophic events on the gender gap in life expectancy, 1981-2002. *Annals of the Association of American Geographers*, Vol. 97, No. 3, pp. 551–66.

OECD-DAC (Organisation for Economic Co-operation and Development-Development Assistance Committee). 2010. *Focus on Aid to Water and Sanitation.* Paris, OECD. http://www.oecd.org/dac/stats/water

OSU (Oregon State University). n.d. TFDD: Transboundary Freshwater Dispute Database. Corvallis, Oreg., Department of Geosciences, Oregon State University. http://www.transboundarywaters.orst.edu

Pegram, G. and Schreiner, B. 2010. *Financing Water Resource Management: South African Experience.* A Case Study Report prepared by Pegasys Consultants for the OECD Expert Meeting on Water Economics and Financing, March 2010. European Water Initiative (EUWI) and Global Water Partnership (GWP).

Pereira, C. L. and Ortega, E. 2010. Sustainability assessment of large-scale ethanol production from sugarcane. *Journal of Cleaner Production*, Vol. 18, No. 1, pp. 78–82.

PRB (Population Reference Bureau). 2011. *World Population Data Sheet: The World at 7 Billion.* Washington DC, PRB. http://www.prb.org/pdf11/2011population-data-sheet_eng.pdf

Prüss-Üstün, A. and Corvalán, C. 2006. *Preventing Disease through Healthy Environments: Towards an Estimate of the Environmental Burden of Disease*. Geneva, World Health Organization (WHO).

Puri, S. and Aureli, A. (eds.) 2009. *Atlas of Transboundary Aquifers – Global Maps, Regional Cooperation and Local Inventories*. Paris, UNESCO-IHP ISARM Programme, UNESCO. [CD only.] http://www.isarm.org/publications/322

Renault, D. 2002. *Value of Virtual Water in Food: Principles and Virtues*. Paper presented at the UNESCO-IHE Workshop on Virtual Water Trade, Delft, The Netherlands, 12–13 December. http://www.fao.org/nr/water/docs/VirtualWater.pdf

Sachs, J. D. and Reid, W. V. 2006. Investments toward sustainable development. *Science*, Vol. 312, p. 1002. http://www.unmillenniumproject.org/documents/ScienceMag_19-05-06.pdf

Siebert, S., Burke, J. Faures, J., Frenken, K., Hoogeveen, J., Döll, P. and Portmann, T. 2010. Groundwater use for irrigation – a global inventory. *Hydrology and Earth System Sciences.,* Vol. 14, pp. 1863–80.

Steer, A. 2010. *From the Pump Room to the Board Room: Water's Central Role in Climate Change Adaptation.* Washington DC, The World Bank. http://www.d4wcc.org.mx/images/documentos/Presentaciones/andrew_steer_keynote_presentation_water_event_december_2_final.pdf

Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. and de Haan, C. 2006. *Livestock's Long Shadow: Environmental Issues and Options*. Rome, Food and Agriculture Organization of the United Nations (FAO)/LEAD. ftp://ftp.fao.org/docrep/fao/010/a0701e/a0701e.pdf

Strokes, J. R. and Horvath, A. 2009. Energy and air emission effects of water supply. *Environmental Science and Technology*, Vol. 43, No. 8, pp. 2680–87.

Tallis, H., Kareiva, P., Marvier, M. and Chang, A. 2008. An ecosystem services framework to support both practical conservation and economic development. *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*, Vol. 105, No. 28, pp. 9457–64.

TEEB (The Economics of Ecosystems & Biodiversity), 2009. *TEEB Climate Issues Update*. Geneva, United Nations Environment Programme (UNEP). http://www.teebweb.org/InformationMaterial/TEEBReports/tabid/1278/language/en-US/Default.aspx

UN (United Nations). 2011. *United Nations Secretary General Report to the 66th General Assembly on the Implementation of the International Strategy for Disaster Reduction*. New York, UN.

UN-Habitat (United Nations Human Settlements Programme). 2005. *Financing Urban Shelter: Global Report on Human Settlements 2005.* London/Nairobi, Earthscan/UN-Habitat.
— 2006. *Meeting Development Goals in Small Urban Centres: Water and Sanitation in the World's Cities.* Nairobi/London, UN-Habitat/Earthscan. http://www.unhabitat.org/content.asp?typeid=19&catid=555&cid=5369

UN-Water/Africa and AMCOW (African Ministers' Council on Water). 2004. *Outcomes and Recommendations of the Pan-African Implementation and Partnership Conference on Water (PANAFCON).* Presented in Addis Ababa, 8–13 December 2003.

http://www.uneca.org/eca_resources/publications/sdd/panafcon%20outcomes.pdf

UNCTAD XII (United Nations Conference on Trade and Development). 2008. *Biofuels Development in Africa: Supporting Rural Development or Strengthening Corporate Control?* UNCTAD XII Workshop held in Accra, Ghana 12 May.

UNDESA (United Nations Department of Economic and Social Affairs, Population Division). 2009*a*. *World Population Prospects: The 2008 Revision*, *Highlights*, Working Paper No. ESA/P/WP.210. New York, UN.

UNDESA (United Nations Department of Economic and Social Affairs). 2009*b*. *World Population Prospects, The 2008 Revision – Executive Summary*. New York, UN.

UNECA (United Nations Economic Commission for Africa). 2000. *Transboundary River/Lake Basin Water Development in Africa: Prospects, Problems, and Achievements.* Addis Ababa, UNECA. http://www.uneca.org/awich/Reports/Transboundary_v2.pdf
— 2006. *African Water Development Report*. Addis Ababa, UN-Water/Africa and UNECA. http://www.uneca.org/awich/AWDR_2006.htm

UNEP (United Nations Environment Programme). 2007. *Global Environment Outlook (GEO-4).* Environment for Development Home Page. http://www.unep.org/geo/geo4.asp (Accessed 10 October 2011.)
— 2010*a*. *Global Envvironment Outlook: Latin America and the Caribbean (GEO LAC) 3.* Panama City, UNEP, Regional Office for Latin America and the Caribbean. http://www.unep.org/pdf/GEOLAC_3_ENGLISH.pdf
— 2010*b*. *Africa Water Atlas.* Nairobi, UNEP, Division of Early Warning and Assessment (DEWA). http://na.unep.net/atlas/africaWater/book.php.
— 2011. *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*. Nairobi, UNEP. http://www.unep.org/GreenEconomy/Portals/93/documents/Full_GER_screen.pdf

UNISDR (United Nations International Strategy for Disaster Reduction Secretariat). 2011. *Global Assessment Report on Disaster Risk Reduction.* Geneva, UNISDR.

UNU (United Nations University). 2004. *Two Billion People Vulnerable to Floods by 2050: Number Expected to Double or More in Two Generations.* News Release. Tokyo, UNU.

WEC (World Energy Council). 2010. *Water for Energy*. London, WEC. http://www.worldenergy.org/documents/water_energy_1.pdf

WEF (World Economic Forum). 2009. *Energy Vision Update 2009: Thirsty Energy: Water and Energy in the 21st Century*. Geneva/Englewood, Colo., WEF/Cambridge Energy Research Associates. http://www.weforum.org/reports/thirsty-energy-water-and-energy-21st-century?fo=1 (Accessed 30 April 2011.)
— 2011*a*. *Water Security: The Water-Food-Energy-Climate Nexus: The World Economic Forum initiative*. Washington DC, Island Press.
— 2011*b*. *Global Risk 2011, Sixth Edition: An initiative of the Risk Response Network*. Geneva, WEF.

WHO (World Health Organization). 2008*a*. *Safer Water, Better Health: Costs, Benefits and Sustainability of Interventions to Protect and Promote Health.* Geneva, WHO.
— 2008*b*. *The Global Burden of Disease: 2004 Update.* Geneva, WHO.
— 2010. Cholera, 2009. *Weekly Epidemiological Record,* Vol. 85, No. 31, pp. 293–308. Geneva, WHO.

WHO (World Health Organization)/UN-Water. 2010. *GLAAS 2010. UN-Water Global Annual Assessment of Sanitation and Drinking Water: Targeting Resources for Better Results*. Geneva, WHO/UN-Water.

WHO (World Health Organization)/UNICEF (United Nations Children's Fund). 2006. *Meeting the MDG Drinking Water and Sanitation Target: The Urban and Rural Challenge of the Decade.* Geneva/New York, WHO/UNICEF. http://www.who.int/water_sanitation_health/monitoring/jmpfinal.pdf
— 2010. *Progress on Sanitation and Drinking-Water: 2010 Update*. Joint Monitoring Programme for Water Supply and Sanitation. Geneva/New York, WHO/UNICEF. http://www.who.int/water_sanitation_health/publications/9789241563956/en/index.html

Wild, D., Francke, C-J., Menzli, P. and Schön, U. 2010. *Water: A Market of the Future.* A Sustainable Asset Management (SAM) Study. SAM, Switzerland.

World Bank. 2004. *Natural Disasters: Counting the Costs.* Washington DC, The World Bank.
— 2008*a*. *Economic Impact of Sanitation in Indonesia: A Five-country Study Conducted in Cambodia, Indonesia, Lao PDR, the Philippines, and Vietnam Under the Economics of Sanitation Initiative.* Water and Sanitation Program. Washington DC, The World Bank.
— 2008*b*. *Economic Impacts of Sanitation in the Philippines. Summary.* Research Report published for the Water and Sanitation Programme (WSP). Jakarta, The World Bank.
— 2008*c*. *Economic Impacts of Sanitation in Indonesia.* Research Report published for the Water and Sanitation Programme (WSP). Jakarta, The World Bank.
— 2010. *The Economics of Adaptation to Climate Change: Synthesis Report*. Washington DC, The World Bank.

WWAP (World Water Assessment Programme). 2009. *United Nations World Water Development Report 3: Water in a Changing World.* Paris/London, UNESCO Publishing/Earthscan.

WWF (World Wide Fund for Nature). 2010. *Living Planet Report 2010: Biodiversity, Biocapacity and Development.* Gland, Switzerland, WWF. http://wwf.panda.org/about_our_earth/all_publications/living_planet_report
— 2011. *The Energy Report. 100% Renewable Energy by 2050.* Gland, Switzerland, WWF. http://wwf.panda.org/what_we_do/footprint/climate_carbon_energy/energy_solutions/renewable_energy/sustainable_energy_report/ (Accessed 2 May 2011).

Zimmer, D. and Renault, D. n.d. *Virtual Water in Food Production and Global Trade: Review of Methodological Iissues and Preliminary Results.* Food and Agriculture Organization of the United Nations (FAO), Rome, http://www.fao.org/nr/water/docs/VirtualWater_article_DZDR.pdf

WWDR4

The United Nations World Water Assessment Programme (WWAP) is hosted by UNESCO and brings together the work of 28 UN-Water members and partners in the triennial *World Water Development Report* (WWDR).

This flagship report gives is a comprehensive review that gives an overall picture of the world's freshwater resources. It analyses pressures from decisions that drive demand for water and affect its availability. It offers tools and response options to help leaders in government, the private sector and civil society address current and future challenges. It suggests ways in which institutions can be reformed and their behaviour modified, and explores possible sources of financing for the urgently needed investment in water.

The WWDR4 is a milestone within the WWDR series, reporting directly on regions and highlighting hotspots, and it has been mainstreamed for gender equality. It introduces a thematic approach – 'Managing Water under Uncertainty and Risk' – in the context of a world which is changing faster than ever in often unforeseeable ways, with increasing uncertainties and risks. It highlights that historical experience will no longer be sufficient to approximate the relationship between the quantities of available water and shifting future demands.

The WWDR4 also seeks to show that water has a central role in all aspects of economic development and social welfare, and that concerted action via a collective approach of the water-using sectors is needed to ensure water's many benefits are maximized and shared equitably and that water-related development goals are achieved.

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