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Water Resources: Balancing too Little Versus too Much

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1.1 Introduction

Why are we told to conserve water supplies and alter our attitudes towards water usage, yet our homes and businesses are increasing inundated with floodwaters? This is a question that is common to many communities in many countries around the world and is an ever-increasing issue being raised in the United Kingdom (Charlesworth and Booth, 2012).

1.2 Too Little Versus too Much

Being curtailed by a restricted water usage order, whilst standing knee-deep in floodwater inside your home is a confusing and perplexing scenario for society to comprehend – particularly when homeowners could be fined for using a hosepipe to clean out and sanitise their home after the destruction and devastation of a flood.

In the summer of 2010, with only ~300mm of rain falling in several months and reservoirs at less than half their usual capacity, the water company for north-west England (United Utilities Plc) gained permission in early July 2010 for a drought order to restrict nonessential use of water for seven million homes in Cheshire, Lancashire, Greater Manchester, Merseyside and parts of Cumbria. However, within a matter of days of the restriction being imposed, residents in parts of Lancashire (Preston, Leyland, Ribbleson, Lostock Hall, Bamber Bridge and Coppull) and Merseyside (Bootle, Seaforth, West Derby and Bromborough) were inundated with floodwater after torrential rain (~50mm in one hour) caused flash flooding. However, the drought order remained in place for many weeks later until mid August 2010 and, during which time, anybody caught breaching the ban would have been fined £1000 (~\$1600 USD or ~€1200 EUR). It is estimated that the water company saved about three billion litres of water during the drought order but the homes

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and businesses affected by the flooding were inconvenienced for many months later. This scenario highlights the problematic nature of attempting to report drought conditions to the general public so they will curb their water usage demands, when media reports are also screening the trauma and ruin of water excesses.

It would be wrong to have expected the water company to have envisaged or even anticipated the intensity of future rainfall events across its region and, furthermore, the rainfall did not bolster supplies because it fell in isolated places away from the main reservoirs. The company's decision to impose a drought order was an attempt to marry-up likely water demand with probable water availability, so as to maintain a regular and uninterrupted supply for its customers. However, the scenario clearly highlights the fact that water resources management decision-making is a complicated matter, which encompasses reliance upon nature to assist in the prediction of unknown rainfall events. Traditionally, it has been justifiable to assume that summer months will be warmer and drier than the other seasons. Unfortunately, for whatever reasons (and it is not our intention to persuade you to believe or disbelieve the climate change agenda; see Committee on Climate Change, 2012), there seems an ever-increasing shift in climate patterns towards extreme weather events with impacts that appear to be exacerbated by human activities in the built environment arena. As a result, this is causing widespread droughts and flooding to be commonplace for some countries. The following are examples.

Australia, the driest continent on Earth, is no stranger to drought conditions and through a host of measures they have dramatically reduced their water consumption over the last decade to address the issue. However, the Queensland floods in January 2011 served as a reminder that their highly variable climatic pattern of rainfall can have devastating effects (floodwater covered the equivalent area of France and Germany) on the coastal cities and towns, and their communities. In response, it has been proposed that new dams should be constructed to mitigate flooding and to provide a water resource for the growing population.

Many of the southern states of the United States are plagued by drought and flooding. New Orleans will always be remembered for the destruction caused by Hurricane Katrina (August 2005). However, by late 2011 and early 2012, much of the States of Louisiana and Mississippi were suffering extreme drought conditions. That was until heavy rainfalls brought ~180 mm to Louisiana State and ~250 mm to Mississippi State, causing flooding in many places. Elsewhere, in the State of Georgia, the City of Atlanta experienced its worst drought in living memory in 2007, yet within two years (September 2009) the city experienced an unprecedented 500-year flood event. Ever-demanding population growth and increasing urbanisation were highlighted as the precursors for these events.

Poorly maintained drainage systems were fundamental in causing flash flooding in Argentina's capital city, Buenos Aires, during February 2012, when torrential rains fell. However, the surrounding province, which suffered a lack of rainfall at this time, remained in drought for many months, until it rained ~200 mm in one night and caused extensive flooding (700 000 hectares) to the towns around Bolivar.

Many African nations are listed by the United Nations as being in a state of water stress (1700 m³ per person) or scarcity (1000 m³ per person). Ghana, like many other African countries, contends with the challenges of delivering a potable supply of water for its population, providing water for food production and growing its economy, confined within the constraints of its limited water resources. However, urban flooding in Ghana is becoming more frequent (February 2011, June 2011, October 2011) and with even greater impacts on communities and businesses.

India is a vast nation with extremes of water shortage and flooding. For instance, in 2002, more than 40 thousand villages in the State of Rajasthan were drought-stricken yet many millions of people in the States of Assam and Bihar were deep in floodwaters. Both scenarios caused suffering and the widespread destruction and failure of crops, together with associated poverty. Nearby, Pakistan was devastated by catastrophic floods (July 2010), which left some 20 million people homeless. Yet, in early 2012, many of the small communities neighbouring the River Indus were now suffering water shortages and were unable to irrigate their crops. Changes in glacial meltwater flows and upstream diversions were identified as compounding water resource issues and driving people into poverty. However, months later (August 2012) those same communities were once again forced from their houses when excessive rainfall caused the river to burst its banks and destroy many of their homes.

Elsewhere, also during August 2012, more than a million people were affected by flooding in the Philippine's capital, Manila, when two weeks' worth of rain fell in just 24 hours. As a consequence, about half the city was submerged with water up to 3–4 metres deep in places, which meant travel was impossible and some victims were stranded on the roofs of buildings. However, the memory of an earlier event in 2009 meant many people were well prepared and more organised when asked to evacuate.

Thailand was devastated in 2011 when it suffered its worst floods for several decades. Hundreds of people were killed, several millions of people were affected and the economic cost was estimated to be tens of billions of pounds (close behind Hurricane Katrina). However, several months later, 50 of its provinces were facing drought conditions. Nearby, severe drought also affected North Korea until heavy rains and flooding caused widespread damage, the deaths of >100 people, many thousands of people left homeless and a similar number of people in the City of Anju were left without potable water supplies (August 2012).

China has a water resources divide. The northern plain, with megacities such as Beijing and Tianjin, has endured severe water shortages to such an extent that reservoirs have diminished to only puddles (e.g. Shandong Province) and, as a consequence, to meet demand, groundwater aquifers are being abstracted faster than they can be replenished. In contrast, southern China is commonly afflicted by floodwaters. For instance, flooding in Sichuan, Guizhou, Hunan and Hubei Provinces (June 2011) caused enormous suffering and infrastructure damage, with many roads, bridges and buildings destroyed, and hundreds of thousands of people evacuated and many thousands of people left stranded. Recognising the imbalance of its water resources, the government is funding (~£37 billion) the North–South Water Project to build a series of massive pipes and canals to transfer water to where it is most needed.

Elsewhere, during June 2011, storms caused flooding in Hamburg, Germany, which inundated buildings and immobilised transport links. The rainfall, however, was welcomed because the country experienced its driest spring months on record. The previous year in Germany had brought extreme heat and drought (July 2010), yet it also brought the wettest August on record.

Spain has been a recent victim to both droughts and flash flooding. Following months of drought and scorching temperatures, the Andalusian Provinces of Almeria, Malaga and Murcia were inundated by a colossal amount of rainfall in only a few hours (September 2012). Such a large amount of rain in a short time meant streets were several metres deep with torrents of water that washed away cars and infrastructure, causing several deaths and mass evacuations.

The UK weather of 2012 can only be described as *topsy-turvy*. The early part of the year started with a second dry winter in succession, resulting in the implementation of drought orders across many parts of the country (affecting ~20 million people). Since then, the country has experienced some of the wettest periods since records began. Some places have reported up to 30 mm of rainfall in one hour and others have reported up to 100 mm in one day. As a consequence, flooding in June 2012 occurred in parts of Sussex (Bognor Regis, Bosham, Bracklesham, Earnley, Elmer, Felpham, Worthing, Middleton-on-Sea, Littlehampton and Hunston), West Wales (Dol-y-bont, Llandre, Machynlleth, Penrhyncoch and Talybont), the Midlands counties (Penkridge, Albrighton, Boningale, Frankley, Birmingham, Leicester, Kington, Kingsland and Eardisley), Greater Manchester (Wigan and Oldham), Lancashire (Croston, Darwen and Bacup), Cumbria (Kendal and Askam), Durham (Whitley Bay), Yorkshire (Mytholmroyd, Swillington, Todmorden and Hebden Bridge; during September 2012 in Boroughbridge, Catterick, Gilling and Tadcaster), Northumberland (Chester-le-Street, Durham, Morpeth, Newburn, Rothbury and Stockton-on-Tees) and Devon and Cornwall (Looe, Mevagissey, Bideford, Exmouth and Clovelly in October 2012).

The plethora of examples outlined above illustrate that droughts and flooding are concomitant global issues and, moreover, illustrate the necessity for water resources managers, water engineers and water policy-makers to ensure that they produce accurate and well-informed decisions to guarantee the sustained delivery of potable water supplies and the continued protection of society from floodwaters. Climate change may (or may not) transpire to be the root cause for droughts and flooding but perhaps there is also a need to reflect on a host of other reasons why these problems exist and concurrently learn to adapt the built environment and lifestyles for any predicted changes (Booth *et al.*, 2012).

The foremost reasons for water scarcity include population growth, food production, water quality, water demand, plus a host of legislative, policy, social, economic, political and management decisions, while the primary reasons for flooding include natural reasons, such as excessive rainfall or storm surge, and anthropogenic reasons, such as restricted infiltration and excessive runoff from impervious landscapes, again brought about through a host of legislative, policy, social, economic, political and management decisions. Further and more fruitful insights into these issues and potential solutions are deliberated in the remaining chapters of this book.

1.3 Structure of the Book

This book comprises three parts and eight sections, which are collated into twenty-nine chapters. The first part of the book (Sections 2, 3 and 4) addresses management issues and solutions to minimise water shortages and provide water security for society, whilst the second part of the book (Sections 5 and 6) addresses management issues and solutions to control excessive rainfall and minimise flooding impacts. The latter part of the book (Section 7) contextualises the issues of the earlier sections within international case studies from the developing world.

Section 1 forms the *introduction to the book* and provides insights into issues and examples of the need to balance water resources from the extremes of having too little (drought) versus having too much (flooding). Section 2 introduces *water demand, policy and cost* and gives insights into water strategy, policy and legislation for meeting water demand, whilst also looking at the issues of regulating, privatising and economics of water. Section 3

concentrates on *water infrastructure and supply* and presents insights into issues of large-scale water storage, the impacts of powering the water industry, treatment of water to meet potable supply standards and delivering supplies in buildings. Section 4 assembles chapters dealing with *water conservation* and bestows insights into the concept of achieving water-neutral housing developments, building regulation attempts to reduce water usage, reaping water from rainwater and greywater harvesting, and an innovative approach to utilising inland waterways. Section 5 centres on *flooding responses and reinstatement* and furnishes insights into measuring and monitoring rainfall, engineered schemes for managing and protecting communities from floodwater, the economic cost of flooding, burdens on the insurance sector and a holistic approach to property flood protection. Section 6 ponders on *flood solutions in the urban landscape* and proffers insights into sustainable drainage systems, together with pavement drainage and green infrastructure benefits, the role of constructed wetlands and the treatment of wastewater. Section 7 contextualises *international case studies* with insights into water resources issues in Africa and Asia. Section 8 converges with a *summary of the book* and offers insights into the lessons that can be learnt for the future of water resources management.

1.4 Conclusions

The wealth of global examples and information communicated in this chapter have been randomly collated by the authors, from a host of media sources (television, radio, Internet and newspapers) throughout the last few years, and whilst the journalism reports have not been interrogated for absolute accuracy or scrutinised through a peer-review process, like the references used in the subsequent chapters, they are reported here to simply convey the scale of the water resources message of the need to balance too little with too much.

Balancing our water resources requirements and its management is clearly a complicated and multifaceted responsibility. Societies will complain when there is not enough water and the same communities will protest when they are flooded. The examples used portray a global problem of hardship and an obvious sense of frustration that must be so readily apparent to those affected. Whether you believe in climate change is a cause, or not, evidence suggests there is a shift towards more extreme weather events and the extent, frequency and repetition of droughts and floods illustrates a need to understand and adapt our lifestyles and behaviour, our homes and businesses, and our towns and cities to accommodate these events.

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