Catalysing sustainable water security: the role of science, innovation and partnerships

Professor Sir John Beddington
Chief Scientific Adviser to HM Government and Head of the Government Office for Science
Currently 1.4bn people worldwide are without sufficient electricity. It is estimated that in 2030 1.2bn people will still lack access to electricity.

Source: Haddad 2010

Fundamental Challenges Remain: Food, water and energy poverty

Water Poverty Index (WPI)

Currently 884 million people lack access to clean water

Water poverty index
- Very high
- High
- Medium
- Low
- Very low
- No data

The global community will have to contend with a number of significant challenges over the next 20 years.

**Climate change:** GHG now in the atmosphere will drive changes up to 2030.

**Population increase:** An extra billion people by 2025.

**Urbanisation:** 2010 first year urban population exceeded the rural population ~55% 2025.

Consumption will increase with prosperity.
Challenge: Global Population Predictions

Historical progression of Global Population

<table>
<thead>
<tr>
<th>Total Population</th>
<th>Year</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 billion</td>
<td>1959</td>
<td></td>
</tr>
<tr>
<td>4 Billion</td>
<td>1974</td>
<td>15 years</td>
</tr>
<tr>
<td>5 Billion</td>
<td>1987</td>
<td>13 years</td>
</tr>
<tr>
<td>6 Billion</td>
<td>1998</td>
<td>11 years</td>
</tr>
<tr>
<td>7 Billion</td>
<td>2011</td>
<td>13 years</td>
</tr>
<tr>
<td>8 Billion*</td>
<td>2025</td>
<td>14 years</td>
</tr>
<tr>
<td>9 Billion*</td>
<td>2043</td>
<td>18 years</td>
</tr>
</tbody>
</table>

* Denotes predicted year

Source: UN DESA – Population Division, 2011
Challenge: Demographic trends

Total Population of Africa and China

- -- Africa
- -- China

Source: UN DESA – Population Division, 2010
Challenge: Urbanisation 2025

Map 1: Urban Agglomerations in 2025 (proportion urban of the world: 56.6%)

(UN DESA – Population Division, 2010)
Challenge: Urbanisation

<table>
<thead>
<tr>
<th>Population 2050</th>
<th>+2%</th>
<th>+98%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urbanisation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>China (%)</td>
<td>50</td>
<td>40.5</td>
</tr>
<tr>
<td>Africa (%)</td>
<td>73</td>
<td>62</td>
</tr>
</tbody>
</table>

World’s 12 biggest cities

<table>
<thead>
<tr>
<th>Year</th>
<th>City (1)</th>
<th>Population (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>Tokyo</td>
<td>26.61</td>
</tr>
<tr>
<td></td>
<td>N.Y.-Newark</td>
<td>15.88</td>
</tr>
<tr>
<td></td>
<td>Mexico City</td>
<td>10.69</td>
</tr>
<tr>
<td></td>
<td>Osaka-Kobe</td>
<td>9.84</td>
</tr>
<tr>
<td></td>
<td>São Paulo</td>
<td>9.61</td>
</tr>
<tr>
<td></td>
<td>L.A.-Long Beach</td>
<td>8.93</td>
</tr>
<tr>
<td></td>
<td>Buenos Aires</td>
<td>8.74</td>
</tr>
<tr>
<td></td>
<td>Paris</td>
<td>8.56</td>
</tr>
<tr>
<td></td>
<td>Kolkata</td>
<td>7.89</td>
</tr>
<tr>
<td></td>
<td>Moscow</td>
<td>7.62</td>
</tr>
<tr>
<td></td>
<td>Rio de Janeiro</td>
<td>7.56</td>
</tr>
<tr>
<td></td>
<td>London</td>
<td>7.55</td>
</tr>
<tr>
<td>2025</td>
<td>Tokyo</td>
<td>37.09</td>
</tr>
<tr>
<td></td>
<td>Delhi</td>
<td>28.57</td>
</tr>
<tr>
<td></td>
<td>Mumbai</td>
<td>25.81</td>
</tr>
<tr>
<td></td>
<td>São Paulo</td>
<td>21.65</td>
</tr>
<tr>
<td></td>
<td>Dhaka</td>
<td>20.94</td>
</tr>
<tr>
<td></td>
<td>Mexico City</td>
<td>20.71</td>
</tr>
<tr>
<td></td>
<td>N.Y.-Newark</td>
<td>20.64</td>
</tr>
<tr>
<td></td>
<td>Kolkata</td>
<td>20.11</td>
</tr>
<tr>
<td></td>
<td>Shanghai</td>
<td>20.02</td>
</tr>
<tr>
<td></td>
<td>Karachi</td>
<td>18.73</td>
</tr>
<tr>
<td></td>
<td>Lagos</td>
<td>15.81</td>
</tr>
<tr>
<td></td>
<td>Kinshasa</td>
<td>15.04</td>
</tr>
</tbody>
</table>

(UN DESA – Population Division, 2010)
Climate change is happening, even if precise impacts are uncertain – due to:

- Forecasting the actions of the global community
  - Setting targets, achieving international consensus and agreements
  - Keeping to targets
- Inherent uncertainty
  - Our limited knowledge
  - The chaotic nature of climate systems
• Arctic sea ice extent for December 2011 third lowest in the satellite record.

• The five lowest December extents in the satellite record have occurred in the past six years.

All images from US National Snow and Ice Data Centre
Natural catastrophes worldwide 1980 – 2010

Number of events with trend

Source: 2011 Munich Re, Geo Risks Research, NatCatSERVICE
2011: Unprecedented summer temperatures in Texas

Source: John Nielson-Gammon
Agriculture currently consumes **70%** of total global water withdrawals from rivers and aquifers, many are overexploited.

Demographic changes and societal trends will demand increased food production.

Global view: changing societal trends may result in increased meat production.

UK view: Imported food and fibre account for **62%** of the UK’s total water footprint

- **1kg** grain fed beef needs **15m³** water
- **1kg** grain fed poultry needs **5m³** water
- **1kg** root crops, pulses needs < **2m³** water

**Source:** UKWRIF (2011)
Most of world’s irrigated crop production is undertaken by small-scale farmers. 

70% of all irrigated areas are in S & SE Asia in particular China and India.

Globally, irrigation consumes nearly 1,800 km³ of blue water annually, with rainfed crops consuming an additional 5,000 km³ of green water.

Source: UKWRIF (2011)
In Russia worst drought since record began (130 years)

- 558 active forest fires, consuming 180 ha
- Moscow temperature record 37.4°C (99.3°F)
- 52 dead, 3000 homeless
- Grain harvest reduced by 30%.
- Global wheat prices risen 50% from June to August 2010 (fastest rise since 1973).
Floods in Pakistan, drought in Russia and excess rain in China

The upper tropospheric heights (late July)

All India daily rainfall for 2010

Source: UK Met Office
Recent food price volatility has thrown an additional 44 million people into extreme poverty.
A gap between water supply and demand

Source: Water 2030 Global Water Supply and Demand model; agricultural production based on IFPRI IMPACT- WATER base case
Our system is not sustainable....

Agriculture accounted for 88% of water use in Saudi Arabia.

At the current rate of water withdrawal: estimated that Saudi aquifers will be exhausted in 25-30 years.

The Ogalla aquifer is already depleted in places and in others showing a decline in water level of as much as 2 or 3 feet per year.

Source: Nina Federoff
All UK water basins are predicted to have a supply deficit by the 2020s.

A reduction in water availability of over 10% would start to impact upon essential supplies.

We need water abstractions to be sustainable now.

In the context of a rising UK population: ~73m by 2050 (UN-DESA medium fertility variant)

Source: UKCCRA (2012)
Examples of Innovation: Waste water

High Efficiency Aeration – Used by Anglian Water

By reducing the size of oxygen bubbles used in the system, less air is needed to treat wastewater

Source: Wastewater Treatment & Sewerage: ukwaterprojects.com

Advanced Primary Treatment – Salnes Filter Technology

Salnes filter can remove solids as fine as 15-30 micron, while also reducing volume of sludge generated

Used in:
• Primary Wastewater Treatment
• Fishing Industry
• Food & Dairy
• Pulp & Paper
• Manure Dewatering

Source: Evergreen Engineering and Salnes.ca
Examples of Innovation: low and high technology

Fog harvesting in rural South Africa

- Does not require electricity
- Is inexpensive
- For use in areas where fog occurs frequently

Source: University of South Africa, National Geographic, April 2010

New technologies for desalination

- Forward osmosis
- Carbon nanotubes
- Biomimetics

Source: National Geographic, April 2010
Partnerships: UK Water Research and Innovation Framework

Government Office for Science

Research Initiatives

Inputs, reporting, delivery

Policy

Inputs, reporting, delivery

Business

Inputs, reporting, delivery

NGOs

UK Water Research and Innovation Partnership

Independent Chair

Secretariat

Subgroups
Skills
Innovation
International
Six strategic aims:

1. **Convene stakeholders** concerned with water security to work together to achieve common goals;

2. **Develop a UK strategy** for water research and innovation

3. **Build on and enhance** UK capability in science and engineering in water

4. **Build bridges** between academic communities, policy, business and society for knowledge exchange, to develop solutions and to optimise business growth;

5. **Provide an international context** so that the UK can address both national and international goals

6. **Provide an overarching framework** and mechanism to deliver water research and innovation across the UK.
UKWRIF: Global Challenges and Opportunities

- Business and the Economy
- Environment and Climate Change
- Farming and Food
- Water Infrastructure
- Sanitation and Health
- Household Water Use

Opportunities
- Science and Technology
- Knowledge Exchange
- Cooperation

Outputs of UKWRIF feed into regional and global policy and initiatives to solve problems worldwide.