Water Security is Indeed a Global Issue

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Contributions from Joep Schyns, Rick Hogeboom, Arjen Hoekstra †, Marc Bierkens, Eelco van Beek

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Who am I

- Research Director Deltares, NL
- Professor Modelling Climate and water management. University Twente, NL
- MSc Quaternary Geology (Alps) (U-AMS, NL)
- PhD Effect of Climate change on the discharge of the River Rhine (UU, NL)
- Research: Water and flood management, Hydrology, Forecasting, sea level rise, climate adaptation
- Worked in: EU, Surinam, Egypt, Iran, HK, Mongolia, Bangladesh.
- Current topic of interest: Speed up climate adaptation

Adaptation Tipping Point & Use by date of policy action

A stress test: How much (climate) change can we cope with? When do start to achieve missing our objectives?
I work at Deltares:

- **Independent** research institute on water, soil and infrastructure
- 800 people, 114 M€ annual turnover
- Legal form: **foundation** under Dutch law (no shareholders)
- Activities targeted at extending our knowledge (**Not4Profit**)
- Doing **applied research** and specialized consultancy
- Working (inter)nationally for public and private sector
- Making use of large in-house **research facilities and software**
- Strong links with the Academia
- **Open source policy**
Our mission areas

Future deltas
Sustainable deltas
Safe deltas
Resilient infrastructure
Water management for security, many perspectives

• 1980s: Integrated Water Management (=> understanding that you need to assess an entire system (demand, supply, scale: basin/territory/country)

• 1990s: Sustainable water management (=> understanding that there are future needs (Brundtland))

• 2007: Adaptive water management (=> understanding that you need flexibility to adapt (Climate Change and other pressures)

• 2007-> Focus on future: Water-Food Nexus, Resilient water, Water-Proof, Water Risk


• Focus can be on: welfare, equity, sustainability and risk

• Scale can be from household, urban, basin, to global

Water security, at any level from the household to the global, means that every person has access to enough safe water at affordable cost to lead a clean, healthy, and productive life, while ensuring that the natural environment is protected and enhanced. (GWP, 2000)

Courtesy: Eelco van Beek and WL Arriens, 2014. Water Security: Putting the Concept into Practice. GWP Tec background papers no. 20
Adopted by the Asian Development Bank

- Satisfy household water and sanitation needs in all communities
- Support productive agriculture and industry
- Develop vibrant, liveable cities and towns
- Restore healthy rivers and ecosystems
- Build resilient communities that can adapt to change
Key Dimensions of Water Security

**KD1 – household water security**
- Access to piped water supply, improved sanitation and hygiene

**KD2 – economic water security**
- Broad economic development, water for agriculture, industry and energy

**KD3 – urban water security**
- Urban water supply, wastewater collection, drainage, urban river health

**KD4 – environmental water security**
- River health, flow alteration, environmental governance

**KD5 – resilience to water-related disasters**
- Floods and windstorms, droughts, storm surges and coastal floods

Deltiares
Fullfils the needs for application

- **Goal.** A broad statement of a desired, usually longer-term, outcome of a programme/intervention.
- **Key dimensions.** The main components of the goal.
- **Indicators.** A quantitative or qualitative variable that provides a valid and reliable way to measure achievement, assess performance, or reflect changes connected to an intervention for each of the key dimensions.
- **Targets.** The objective a programme/intervention is working towards, expressed as a measurable value; the desired value for an indicator at a particular point in time.
- **Monitoring.** Routine tracking and reporting of priority information about a programme/project, its inputs and intended outputs, outcomes and impacts.
Why this perspective

Strong
• It is a broad perspective on water
• Can be easily connected to well known Integrated Water Resources Management
• It has been put into practice
• It is adopted (although slightly different) by organizations (ADB, WB, UN) that can make a difference

Weak (/not that strong)
• It is about national water security, Global and river basin perspective is missing
• It is a snapshot, Future is not specifically addressed

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The innovation is not the science or the technology, it is what people do with it.

Free after Steve Jobs, at the release of the I-Phone
What about the weaker points, the global dimension
Water Security and GDP

Probably The Netherlands would be plotted near here.

Does that proof that they are doing well??

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Water Security is Indeed a Global Issue

\[
y = 12.553 \ln(x) - 52.355 \\
R^2 = 0.85
\]
It is about this, indirect consumption of water

1 sheet of A4 paper: 10 litres
1 slice of bread: 40 litres
1 egg: 140 litres
1 pair of leather shoes: 8,000 litres
1 pair of blue jeans: 11,000 litres
1 kg of beef: 15,400 litres
1 car: 150,000 litres

Source: Hoekstra and Chapagain (2008)
Production uses water, three colors (source)

Green water footprint
volume of rainwater evaporated or incorporated into a product

Blue water footprint
volume of surface or groundwater evaporated or incorporated into a product

Grey water footprint
volume of polluted water

Direct and indirect use, example meat

Virtual water flow through the supply chain

How much water do the Dutch use per person?

1562 m³ per year
Global water footprint of Dutch consumption

95% of the water footprint of Dutch consumers lies outside the Netherlands

The Netherlands get their cotton from heavily depleted groundwater resources

So, at the national level
The Netherlands score high at water security, but on a global scale...........??

Water saving through trade

National water saving (e.g. the Dutch)
A nation can save water by importing a water-intensive commodity instead of producing it domestically.

Global water saving
International trade can save water globally if a water-intensive commodity is traded from an area with high to an area with low water productivity.
Example Global water saving through maize trade from USA to Mexico

USA
Water footprint, $WF_{USA} = 760$ m$^3$/ton

Mexico
Water footprint, $WF_{Mexico} = 2270$ m$^3$/ton

Maize trade
$T = 5,386,000$ ton/yr

National water loss
$\Delta S_n = WF_{USA} \times T$
$= 760 \times 5,386,000$
$= 4.09 \times 10^9$ m$^3$/yr

Global water saving
$\Delta S_g = T \times (WF_{USA} - WF_{Mexico})$
$= 5,386,000 \times (2270 - 760)$
$= 8.13 \times 10^9$ m$^3$/yr

National water saving
$\Delta S_n = WF_{Mexico} \times T$
$= 2270 \times 5,386,000$
$= 12.23 \times 10^9$ m$^3$/yr

[Mekonnen & Hoekstra, 2011]
Water flows via international trade (virtual water)

<table>
<thead>
<tr>
<th></th>
<th>Volume (billion m$^3$/yr)</th>
<th>Percentage (%)</th>
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<tbody>
<tr>
<td>Crop products</td>
<td>1766</td>
<td>76</td>
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<tr>
<td>Farm animal products</td>
<td>272</td>
<td>12</td>
</tr>
<tr>
<td>Industrial products</td>
<td>282</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2320</strong></td>
<td><strong>100</strong></td>
</tr>
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= 26% of global water footprint

[Mekonnen & Hoekstra, 2011]
What about the weaker points, Future outlook
Historical trends

Global water demand more than doubled during the period 1960-2000

- Households
- Industry
- Livestock
- Irrigation

- 1960 km³/year: 828
- 2000 km³/year: 1848

<table>
<thead>
<tr>
<th></th>
<th>1960</th>
<th>2000</th>
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<tbody>
<tr>
<td>Households</td>
<td>57</td>
<td>199</td>
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<tr>
<td>Industry</td>
<td>116</td>
<td>257</td>
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<tr>
<td>Livestock</td>
<td>10</td>
<td>16</td>
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<tr>
<td>Irrigation</td>
<td>645</td>
<td>1376</td>
</tr>
</tbody>
</table>
Expected Global Groundwater Depletion 1900-2100

Global groundwater depletion rates

Depletion [km$^3$/yr$^{-1}$]

Time [year]

GWD past
GWD A1b [ECHAM5]
GWD A1b [HadGEM2]
GWD A2 [ECHAM5]
GWD A2 [HadGEM1]
GWD B1 [ECHAM5]
We are at the eve of the energy transition. The water efficiency of electricity. For the investments, should we turn left or right?

The water efficiency of biofuels from different crops [litre/litre]

WF of biofuels are about 100-1000x larger than WF of fossil fuels

Car driving on bio-ethanol from sugar beet: 20-300 litre/km

Source: Mekonnen & Hoekstra (2011) The green, blue and grey water footprint of crops and derived crop products, Hydrology and Earth System Sciences
Take home messages

The GWP perspective on Water security is valuable but:

For sustainability a global perspective should be taken into account:

- Increasing water security for a specific country or basin should not be at the expense of decreasing water security elsewhere.
- Be aware on the virtual water flows through the supply chain, water footprints help to address these and answer the question ‘water security for who?’

In a rapidly changing world it may provide a false feeling of security

- Increasing water security requires decisions on interventions and investment over long periods. Making these decisions requires answers to questions such as – How much change can we handle? How much water will be needed and will be available? When should we be prepared?
- Be careful what are considered sustainable solutions in the energy transition.

Deltar es
Pathways to go

Industry:
Towards full water recycling in industries: zero blue water footprint
Towards full recycling of materials and heat: zero grey water footprint

Agriculture:
Make rainwater more productive: lower green water footprint
Towards supplementary or deficit irrigation & application of precision irrigation techniques: lower blue water footprint
Towards organic or precision farming: zero grey water footprint
A lot we we know

**Water management and technology**
- Rainwater harvesting
- Enhanced and/or artificial recharge
- Artificial recharge and recovery
- Conjunctive groundwater and surface water use
- Re-use, cascading and re-circulation

**Economic measures**
- Water pricing
- Subsidies
- Investment: financial arrangements (e.g. ppp)
- Investment: tax arrangements
A framework to consider for investment decisions on water

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<thead>
<tr>
<th>Policy Disclosure</th>
<th>Water Accounting</th>
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<tr>
<td>A</td>
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<td>Supply Chain</td>
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<th>Efficient Water Use</th>
<th>Environmental Sustainability</th>
<th>Social Equity</th>
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Hogeboom, et al (2018), Journal of Cleaner Production
What we eat is relevant

- The WF of animal production is 29% of the WF of the agricultural sector.
- The WF of the agricultural sector is 92% of the total WF of humanity.
Planetary boundaries

But we better be quick as we are beyond our sustainable limits
We cannot afford this

THANKS

Source: Hoekstra and Wiedmann (2014) Humanity's unsustainable environmental footprint, Science