How Can Water Footprint Contribute to Climate Change Adaptation Strategies?

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Why Resources – A Water Problem?
A Water Problem?
Water Natural Cycle

Adapted from Source:
URL: http://ga.water.usgs.gov/edu/watercycle.html
A Water Problem?
Estimated Hydrosphere Volumes

Water storage in the atmosphere = water vapour
Water storage in oceans = saline water
Fresh water = lakes, rivers, groundwater, snow, ice, water in living things (animals, plants), soil moisture
Solid fresh water = ice, snow

BUT WHAT ARE THE RELATIVE QUANTITIES?
A Water Problem?
Estimated Hydrosphere Volumes

All water resources
1,400 million km³

Water Vapor
0.013 million km³

Saline Water
1,365 million km³

Fresh Water
35 million km³

Liquid
11 million km³

Solid
24 million km³

Ground & Surface water
Lakes: 0.09 million km³
Rivers: 0.002 million km³
Groundwater: 10.5 million km³

Living matter & soil moisture
Soil moisture: 0.016 million km³
Living matter: 0.001 million km³

Freshwater: How much is there?

Precipitation on land: 119’000 km³ / year (100%)

- Evaporation and transpiration (62%)
- Runoff (38%)
- Human water use (3%)

- 2.1%
- 0.3%
- 0.6%
A Water Problem?

The Good News

GLOBALLY HUMANITY HAS NO WATER PROBLEM (yet)

The Bad News

WATER IS NOT EQUALLY DISTRIBUTED IN TIME AND SPACE
Water quantity issues

Source: Boulay et al, 2013

Water quality issues

Source: Boulay et al, 2013
A Water Problem?
REGIONALISATION MATTERS

From a global perspective, there is no water scarcity

Different impacts – different regions/archetypes:
  Ecosystems
  Humans
  Stock/fund resources

Relatively new topic
  Water consumption mainly relevant in agriculture – regional aspect crucial
A Water Problem?

Water resource demand vs. replenishment, Projections to 2030

Source: FAO, Kiersh and Romàn, Lima, 2013
Economic Use of Water

Agriculture is the dominant water using sector - 74%.

Industrial and domestic water use account for 18% and 8% respectively (IWMI, 2007).

In Malaysia:

Per capita water consumption is > 300 liter per day* and is increasing

<table>
<thead>
<tr>
<th>Year</th>
<th>Growth Rate (%)</th>
<th>2010-2020</th>
<th>2020-2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>2.8%</td>
<td>4.1%</td>
<td></td>
</tr>
<tr>
<td>Mining</td>
<td>1.0%</td>
<td>2.9%</td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td>4.3%</td>
<td>4.7%</td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>3.5%</td>
<td>4.8%</td>
<td></td>
</tr>
<tr>
<td>Services</td>
<td>7.9%</td>
<td>5.1%</td>
<td></td>
</tr>
<tr>
<td>GDP total</td>
<td>6.5%</td>
<td>4.9%</td>
<td></td>
</tr>
</tbody>
</table>

*UN recommended value: 165 per capita per day

*Singapore value: 150 per capita per day

Malaysia Growth Outlook in term of GDP 2010 – 2050 (NWRS, 2011)
Water demand will increase to 55% globally by year 2050.

Manufacturing water demand increases 400% during year 2000 to 2050.

Industrial water demand will increase with increase Industrial GDP
Economic Use of Water

Shifting from middle income to high income country change water demand pattern.
A Water Problem?
Climate Change & Future Predictions

Looking ahead
Water & Climate Change

According to IPCC (2008), the challenges related to freshwater are:

- having too much water;
- having too little water; and
- having too much pollution.

Each of these problems may be exacerbated by climate change.

Water is vital for human existence and is considered as one of the primary transmitters of climate change impacts.
A Water Problem?
Climate Change & Future Predictions

Different model predictions for IPCC’s A1B scenario (different model runs)

Globally increased precipitation

Source: IPCC 2007
A Water Problem?
Climate Change & Future Predictions

But change in spatial distribution of precipitations by 2100

RCP2.6
RCP8.5

Change in average precipitation (1986–2005 to 2081–2100)

➔ Less precipitation in many arid regions

Source: IPCC 2013
A WATER PROBLEM?

Key Points...

In terms of volume, there is sufficient water to supply human needs, but:

• The supply chain of water intensive products are complex and are often distributed around the globe
• Water is unequally spread in time and space
• Population is not always in the most water abundant regions
• Ecosystems need sufficient water to be maintained
• Water demand is increasing, water availability is not
Why Use Water Footprint?
Why Use Water Footprint?

By 2025, 1.9 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world population could be under stress conditions


Climate change could profoundly alter future patterns of both water availability and use, thereby increasing levels of water stress and insecurity, both at the global scale and in sectors that depend on water

(The World Bank, 2009 "Water and Climate Change: Understanding the Risks and Making Climate-Smart Investment Decisions")
Why Use a Water Footprint?
Signs of Global Water Scarcity

Cotton for export

Former Aral Sea, Central Asia
The water footprint: making a link between consumption in one place and impacts on water systems elsewhere.

Endangered Indus River Dolphin
The Human Right to Water and Sanitation

UN assembly acknowledged this explicitly in 2010:
64/292. The human right to water and sanitation

Source: UN:
Motivation for Assessing a Water Footprint

Water scarcity is one of the most important environmental problems.

Increasing population is aggravating water problems.

Sustainability has become a key marketing factor.

Public pressure and operational risk make it relevant for business to assess the following risks (beyond “green pioneers”):

- Physical
- Regulatory
- Reputational
- Financial risk to business
What is Water Footprint?
What is the Water Footprint?

A consumption-based indicator of water use (e.g. m³/year) introduced by Hoekstra in 2002.

What’s new compare to traditional indicators:

direct and indirect use of water; in the case of crop production, it accounts for the use of irrigation and rain.

when and where; in the case of national WF, it accounts for the use of domestic and foreign water.
Water, Trade & Consumption

- **Crop Production**
  - Internal
  - Export
  - Import
  - Available Supply
    - Food
    - Feed
    - Seed
    - Processing
    - Waste
The Water Footprint of a Product

• It is defined as the volume of fresh water used to produce the product, summed over the various steps of the production chain.

• A water footprint includes a temporal and spatial dimension - It when and where the water was used:
The Water Footprint of a Product

Green water footprint
▷ volume of rainwater evaporated or incorporated into product.

Blue water footprint
▷ volume of surface or groundwater evaporated,

Grey water footprint
▷ incorporated into product or returned to other catchment or the sea.
Water Footprint
Sustainability Assessment
Water Footprint Assessment

Phase 1: Setting goals and scope
Phase 2: Water footprint accounting
Phase 3: Water footprint sustainability assessment
Phase 4: Water footprint response formulation

[Hoekstra et al., 2011]
Sustainability of the cumulative water footprints in different catchments

Sustainability of the WFs of specific processes

Sustainability of the WFs of specific products

Sustainability of the WF of a company

Sustainability of the WF of a consumer
Assessment of the Sustainability of the Water Footprint within a Catchment

Step 1: Identification of the (environmental, social and economic) sustainability criteria

Step 2: Identification of hotspots (specific sub-catchments, periods of the year)

Step 3: Identification and quantification of the primary impacts in the hotspots

Step 4: Identification and quantification of the secondary impacts in the hotspots
Step 1 - Sustainability Criteria

Environmental

• Environmental flow requirements
• Environmental green water requirements
• Ambient water quality standards

Social

• Basic human needs – min. drink-water, food security, employment
• Rules of fairness – fair allocation, water user & water polluter principle

Economic

• Efficient allocation and use of water
Environmental sustainability criteria:

- **Green** water footprint < available **green** water
- **Blue** water footprint < available **blue** water
- **Grey** water footprint < available assimilation capacity
Environmental sustainability criterion:
Blue water footprint < blue water availability

Blue water scarcity:
\[ WS_{blue}[x,t] = \frac{WF_{blue}[x,t]}{WA_{blue}[x,t]} \]
Environmental Sustainability Criterion:
Grey water footprint < available assimilation capacity

Grey water footprint < runoff → Assimilative capacity not fully used

Grey water footprint = runoff → Full assimilative capacity of the river used

Grey water footprint > runoff → Pollution exceeding the assimilative capacity of the environment
Water Footprint Sustainability Assessment

- Direct water
- Indirect water use (supply chain)
- Green water footprint
- Blue water footprint
- Grey water footprint

1 specific watershed

All watersheds

Global sustainability

Responsible, efficient water use

Geographic sustainability

Globally equitable & efficient sustainability
Water Footprint Response Strategies

- Response Strategies for Local Water Footprint & Impacts Reduction
- Instruments to Drive Water Footprint & Impacts Reduction
- Sustainable, equitable, efficient water use; water stewardship
- Water Footprint Sustainability Assessment
Steps 3-4 Primary and Secondary Impacts

**Primary impacts**
- Changes to hydrology
- Changes to water quality

**Secondary impacts**
- Effects on abundance of certain species
- Effects on biodiversity
- Effects on human health
- Effects on employment
- Effects on distribution of welfare
- Effects on income in different sectors of economy
WF & Climate Change Adaptation

Water footprint is highly valuable as an awareness-raising, educational and advocacy tool that leads to better understanding of water impacts and can demonstrate the case for better water management.

As part of a framework of climate impact assessment it can help [...] to assess the ability of hydrological systems to meet the demands being placed upon them.

Water footprint assessments should be recognized as the basis upon which water adaptation policies can be formulated:
  - changing crop varieties;
  - providing incentives for production and consumption with lower water demands;
  - developing robust IWRM plans that manage the competing demands on water resources within environmental constraints.

All countries should conduct sectoral water footprints studies

GPPN (2009:11)
Conclusions / Recommendations

Agriculture in Malaysia is the largest water using sector.

Food consumption depends on external water.

The existing crop matrix and the diet composition of Malaysians contribute to a high WF.

Climate change adaptation requires identifying production and consumption patterns with lower water requirements.

The WF is a powerful tool that can contribute towards this direction.
THANK YOU!

“If mitigation is about CARBON, then adaptation is about WATER”

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