Historical development of water footprint of crops & blue water scarcity in the Yellow River Basin

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1. Introduction: Yellow River Basin: a water scarce ‘Mother river’ basin

Currently:
• 2% national water resources v.s. 13% national crop production
• Annual water withdrawal ~ 77% renewable water resources.

During past half century:
• Irrigated area increased 1.5 times
• Blue water consumption increased 2 times

Location of Yellow River Basin
1. Introduction: Why water footprint?

Lack of good data on long-term variability of water use & water scarcity for the Yellow River Basin.

A multi-dimensional indicator of consumptive water use of both rainfall (green) and ground-surface (blue) water and the (grey) water required to assimilate anthropogenic loads of pollutants to freshwater bodies (Hoekstra et al, 2011).
1. Introduction: Study objectives

To assess for the Yellow River Basin:


5 by 5 arc-min (~7km × 9km)
17 crops (93% production)
2 Method: Study flow

Crop Water footprint

- Green water footprint
- Blue water footprint
- Grey water footprint

Blue water footprint (Industrial+domestic)

Natural runoff

INPUTS

AquaCrop

Hoekstra et al. (2011)
Franke et al. (2014)

Blue water scarcity

YRCC

Van Beek et al. (2011)
Wada et al. (2011)

PCR-GLOBWB

**Blue water footprint**

\[
\text{Blue water footprint} = \frac{\sum \text{blue ET}}{\text{Yield}}
\]

**Green water footprint**

\[
\text{Green water footprint} = \frac{\sum \text{green ET}}{\text{Yield}}
\]

**Grey water footprint**

\[
\text{Grey water footprint} = \frac{\text{Leaching nutrient}}{\text{Critical concentration}} \times \frac{1}{\text{Yield}}
\]

*Hoekstra et al. (2011); Franke et al. (2013)*
2. Method : Assessing blue water scarcity

Blue water scarcity = \frac{\text{Blue water footprint}}{\text{Max. sustainable blue water footprint}}

Max. sustainable blue water footprint = \text{Natural runoff} - \text{Environmental flow requirement}

<table>
<thead>
<tr>
<th>Blue water scarcity level</th>
<th>Low</th>
<th>Moderate</th>
<th>Significant</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue water scarcity</td>
<td>&lt;1</td>
<td>1 – 1.5</td>
<td>1.5 – 2</td>
<td>&gt; 2</td>
</tr>
</tbody>
</table>

Hoekstra et al. (2011, 2012)
3. Results: Water footprint of crop production in the Yellow River basin (1961-2009)

- 14% increase in decadal average green WF
- 37% increase in decadal average blue WF
- 24-folds in annual grey WF related to nitrogen
- 36-folds in annual grey WF related to phosphorus
3. Results: Water footprint per tonne of crop in the Yellow River basin (1961-2009)
3. Results: Monthly blue water scarcity (1978-2009)

- Annual blue water footprint = 19~52% Natural runoff
- Peak of monthly blue water footprint: May - July
- More natural runoff => Less blue WF
4. Conclusion

- The total water footprint of crop production in the Yellow River Basin increased for 1961-2009.
- The green-blue water footprint per tonne of crop reduced.
- The Yellow River Basin suffered moderate to severe blue water scarcity for 7 months a year (Jan-July).
- More than half of the basin faced severe blue water scarcity, even in the wettest month in a wet year.
Thank you very much!

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