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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

During past half century:

- **Irrigated area increased 1.5 times**
- **Blue water consumption increased 2 times**

Location of Yellow River Basin

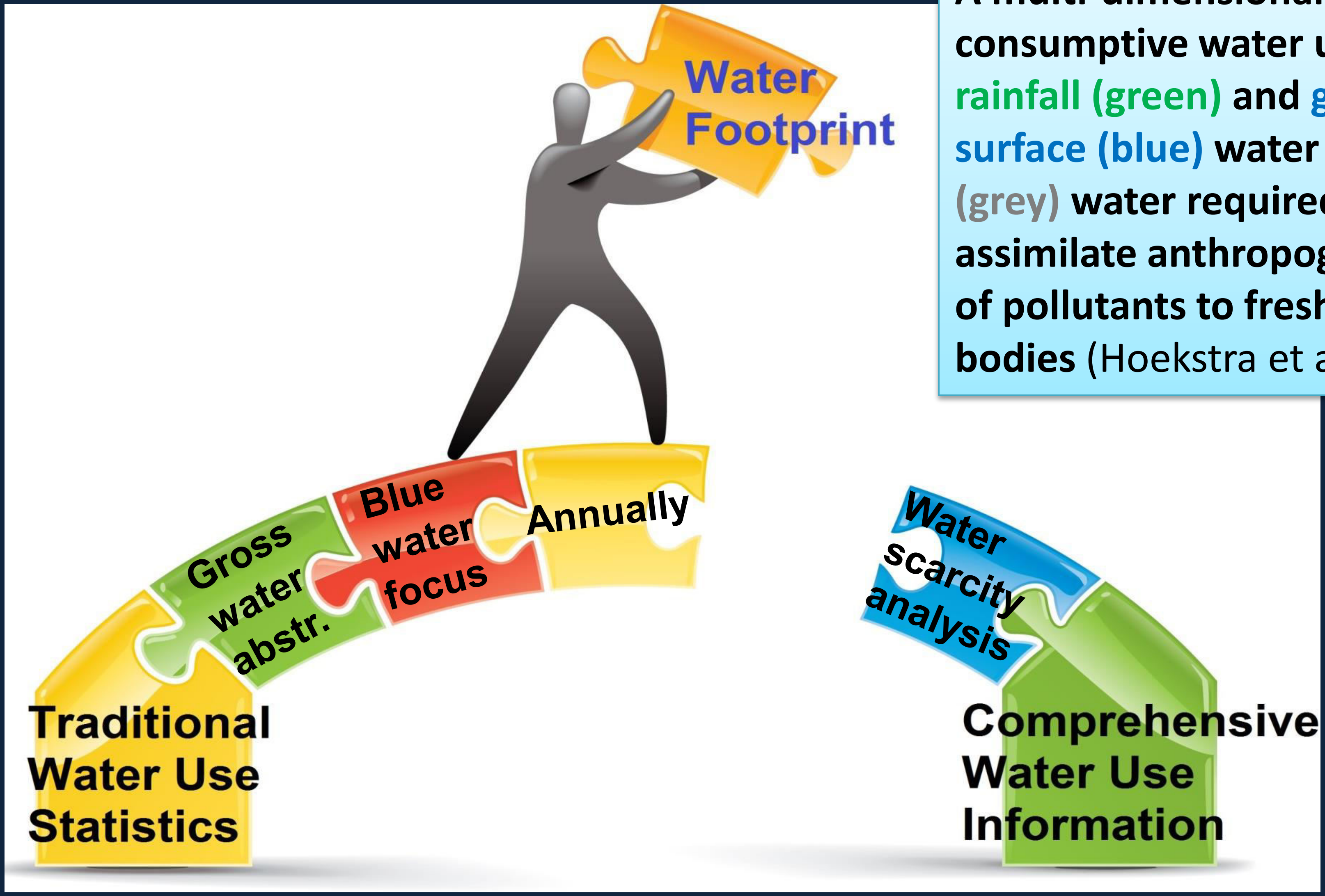
Currently:

- **2% national water resources v.s. 13% national crop production**
- **Annual water withdrawal ~ 77% renewable water resources.**

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).

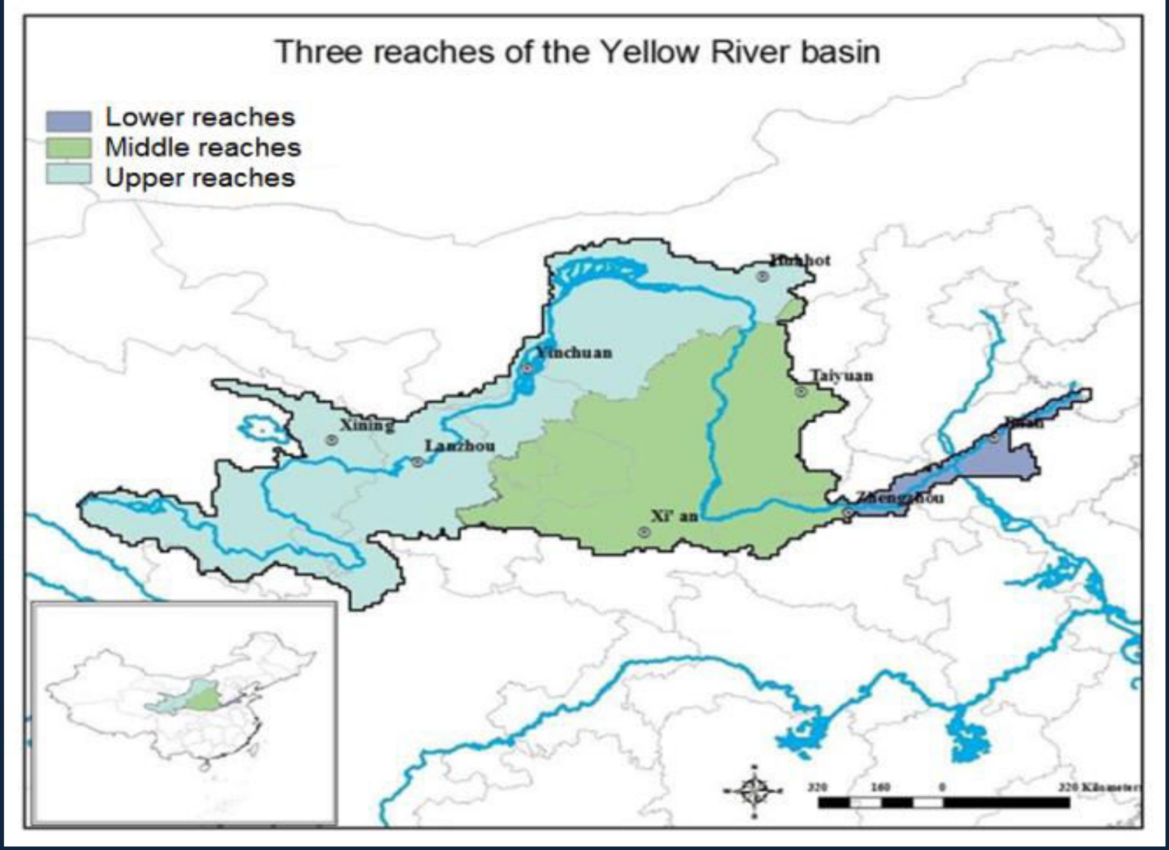


1. Introduction: Study objectives

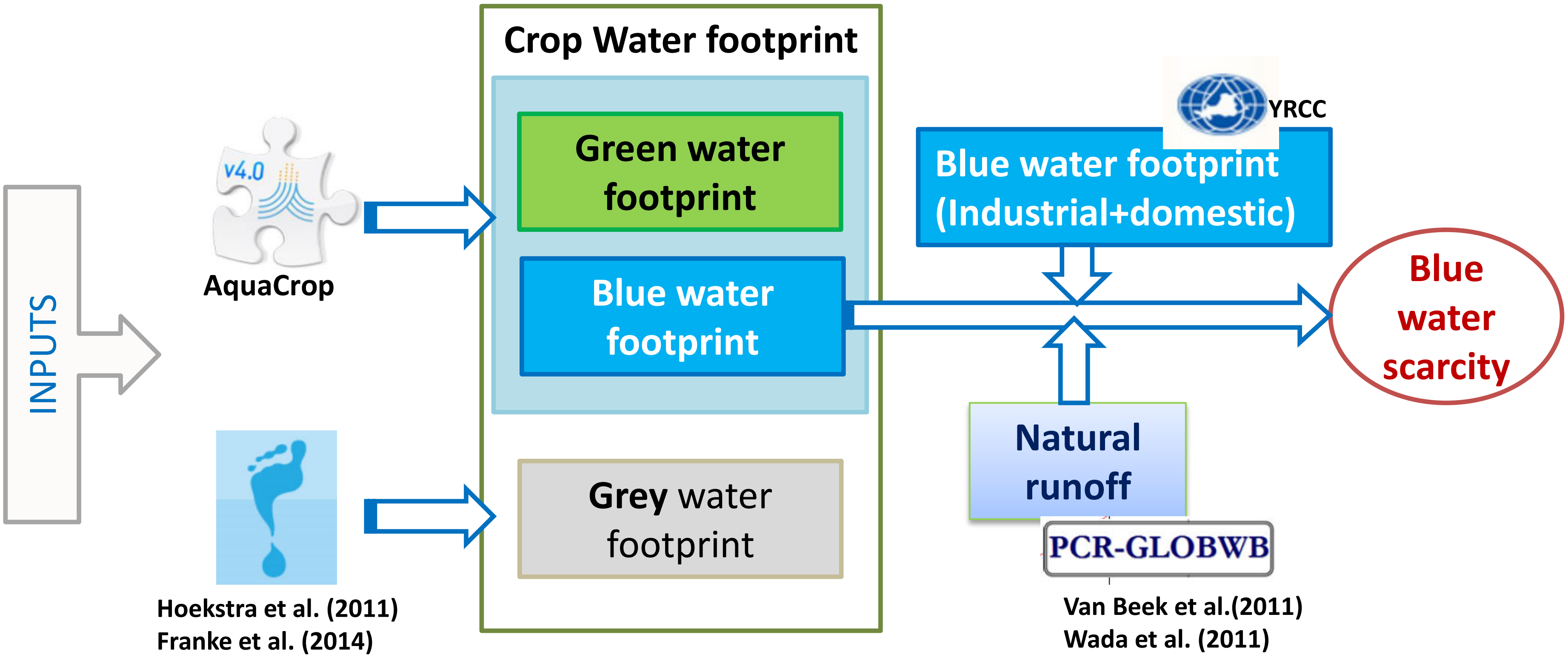
To assess for the Yellow River Basin:

- **Spatial-temporal variability of green, blue and grey water footprints of crop production (1961-2009).**
- **Spatial-temporal variability of blue water scarcity (1978-2009).**

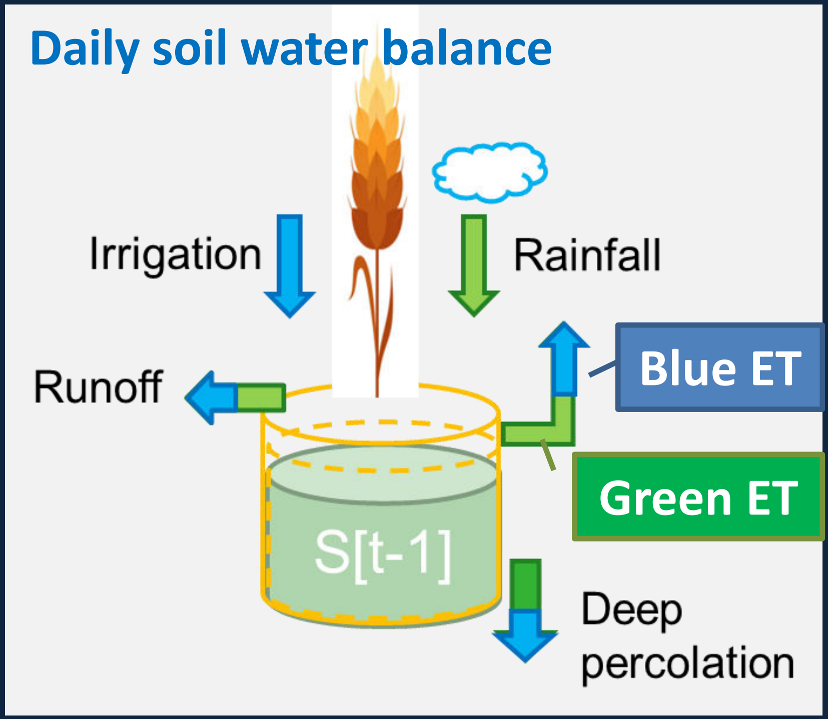
5 by 5 arc-min (~7km×9km)
17 crops (93% production)



2 Method: Study flow



2. Method : Estimating water footprint of crop production



$$\text{Blue water footprint} = \frac{\sum blue\ ET}{\text{Yeild}}$$

$$\text{Green water footprint} = \frac{\sum green\ ET}{\text{Yeild}}$$

$$\text{Grey water footprint} = \frac{\text{Leaching nutrient}}{\text{Critical concentration}} \frac{1}{\text{Yeild}}$$

Hoekstra et al. (2011) ; Franke et al. (2013)

2. Method : Assessing blue water scarcity

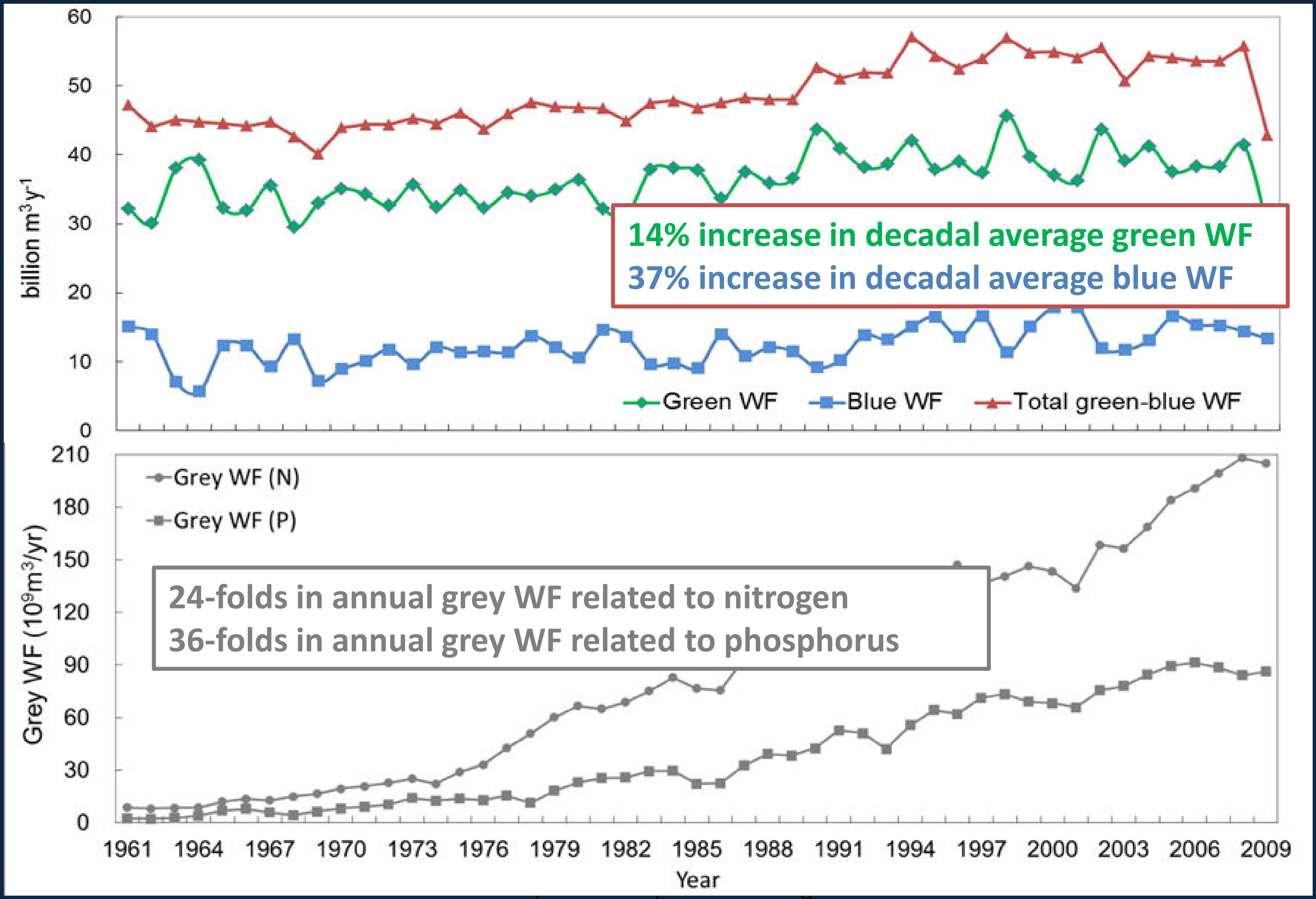
$$\textbf{Blue water scarcity} = \frac{\textbf{Blue water footprint}}{\textbf{Max. sustainable blue water footprint}}$$

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

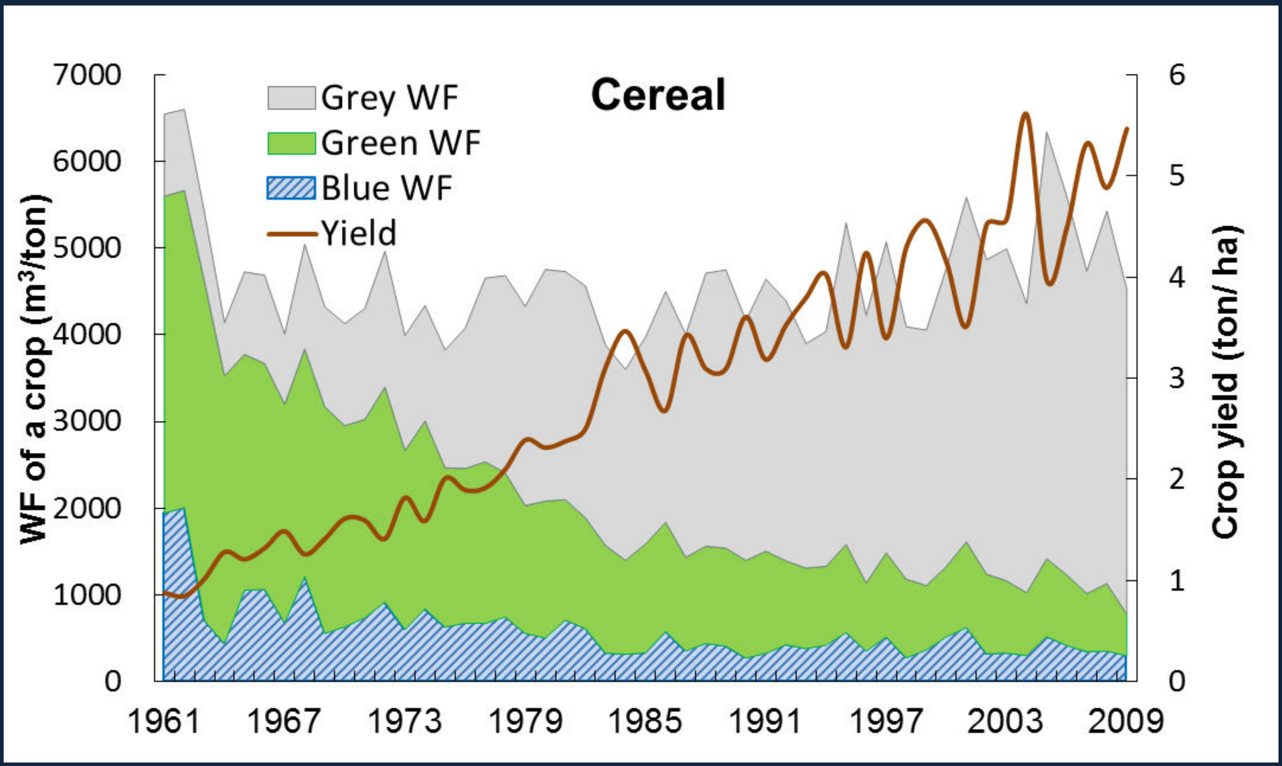
Blue water scarcity level	Low	Moderate	Significant	Severe
Blue water scarcity	<1	1 – 1.5	1.5 – 2	> 2

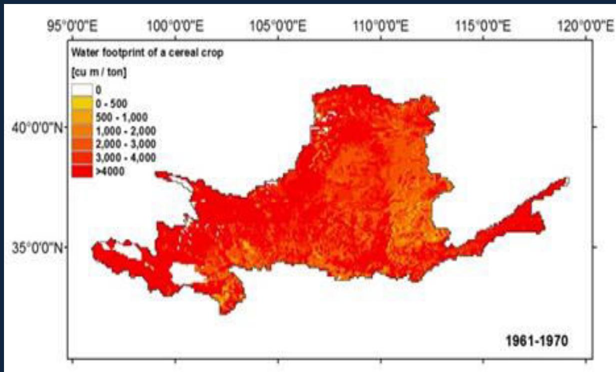
Hoekstra et al. (2011, 2012)

3. Results: Water footprint of crop production in the Yellow River basin (1961-2009)

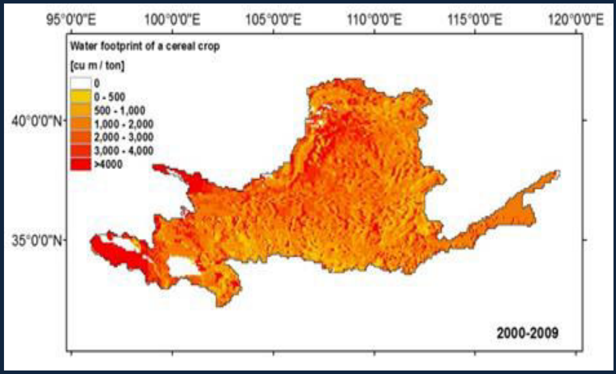


3. Results: Water footprint per tonne of crop in the Yellow River basin (1961-2009)



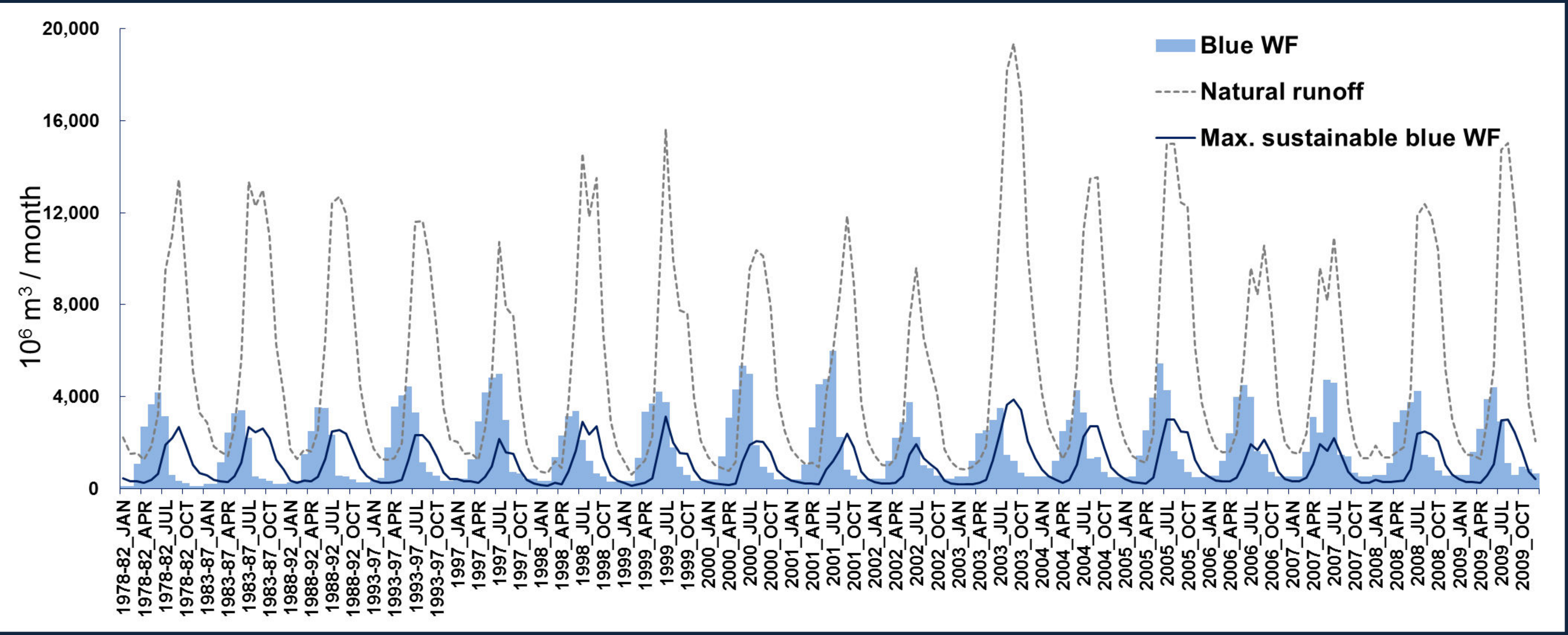


1961-1970

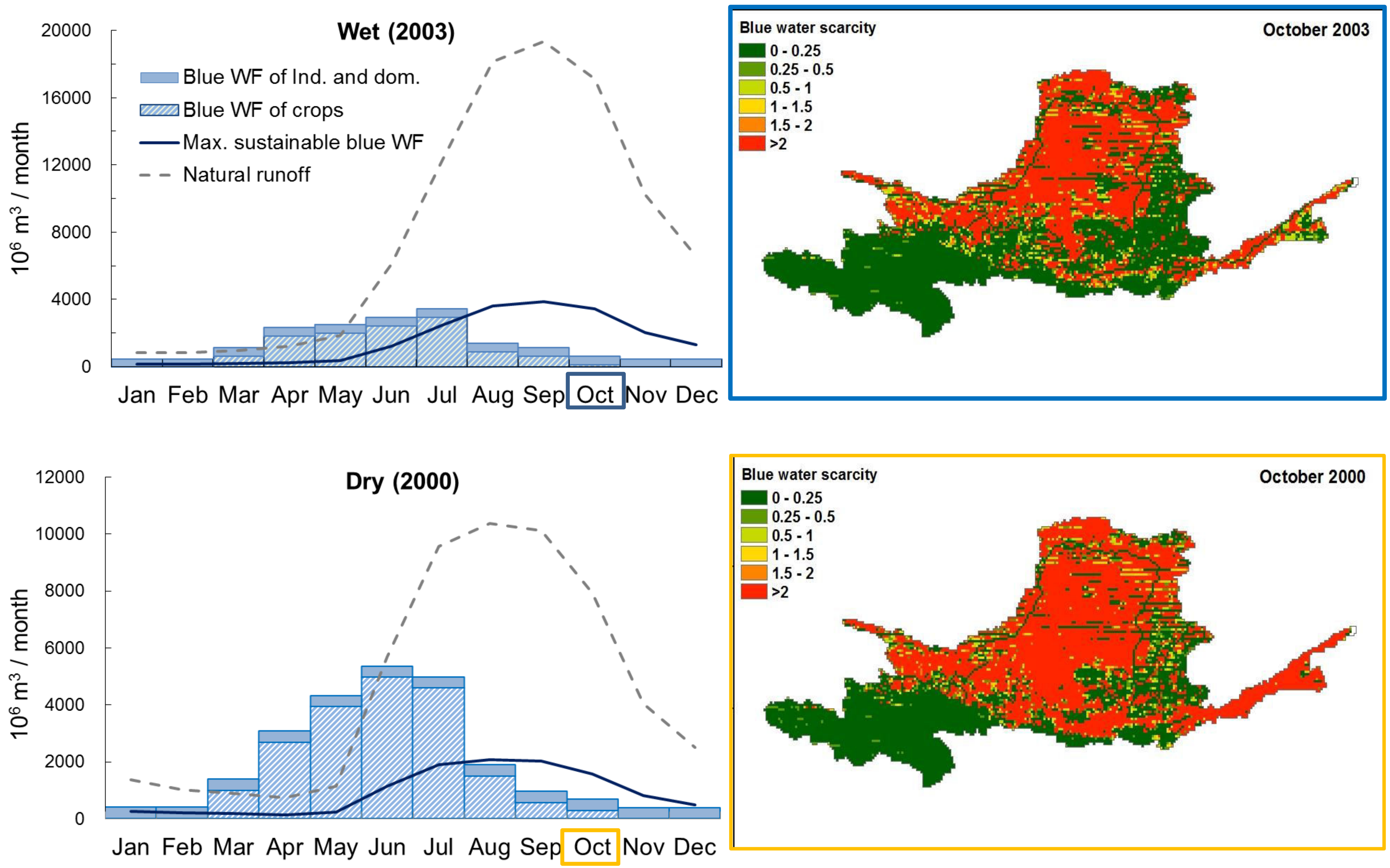


2000-2009

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



Wet (2003)
20000
16000
12000
8000
4000
0
10^6 m^3 / month
Blue WF of Ind. and dom.
Blue WF of crops
Max. sustainable blue WF
Natural runoff
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Blue water scarcity
October 2003
0 - 0.25
0.25 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
>2
Dry (2000)
12000
10000
8000
6000
4000
2000
0
10^6 m^3 / month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Blue water scarcity
October 2000
0 - 0.25
0.25 - 0.5
0.5 - 1
1 - 1.5
1.5 - 2
>2

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.

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Thank you very much!

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