

Global Food Production - Share from Sustainable and Unsustainable Groundwater Use

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A water-secure world



25-29th
September 2016

Montpellier, France
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Background

- Groundwater plays an increasing role in food production world wide
- 43% of irrigation water globally is derived from groundwater (*Foster et al., 2015; Döll et al., 2012*)
- Groundwater depletion (GWD) has tripled from 1960 to 2000 (*Wada et al., 2012*)
- Evidence of GWD exists from India, China, Pakistan, Northern Africa, Middle East, Mexico and USA

Objectives

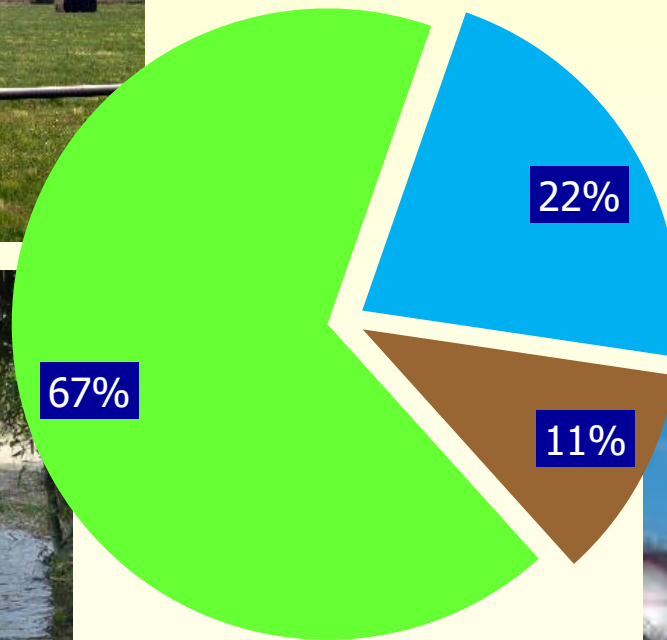
- Estimate the role of GW in global food production
- Estimate the contribution of unsustainable GW use
- Understand the regional and crop-wise distribution of global food production from GWD
- Provide pointers for policy

Earlier estimates of the role of groundwater depletion in (global) food production

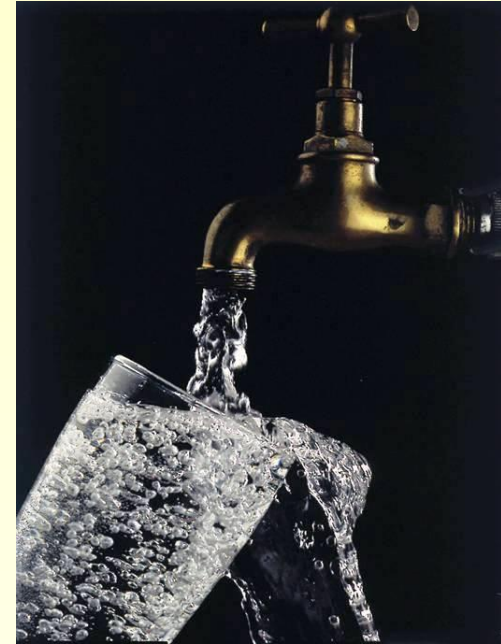
- 10% of the **world's** agricultural food production depends on using mined groundwater (*World Water Commission, 2000*)
- 15% of **India's** food supply is produced by mining groundwater (*World Bank, 2005*)
- Mined groundwater accounts for 15-27% of total crop production in **China** (*Grogan et al., 2015*)

Agriculture is the largest GW user

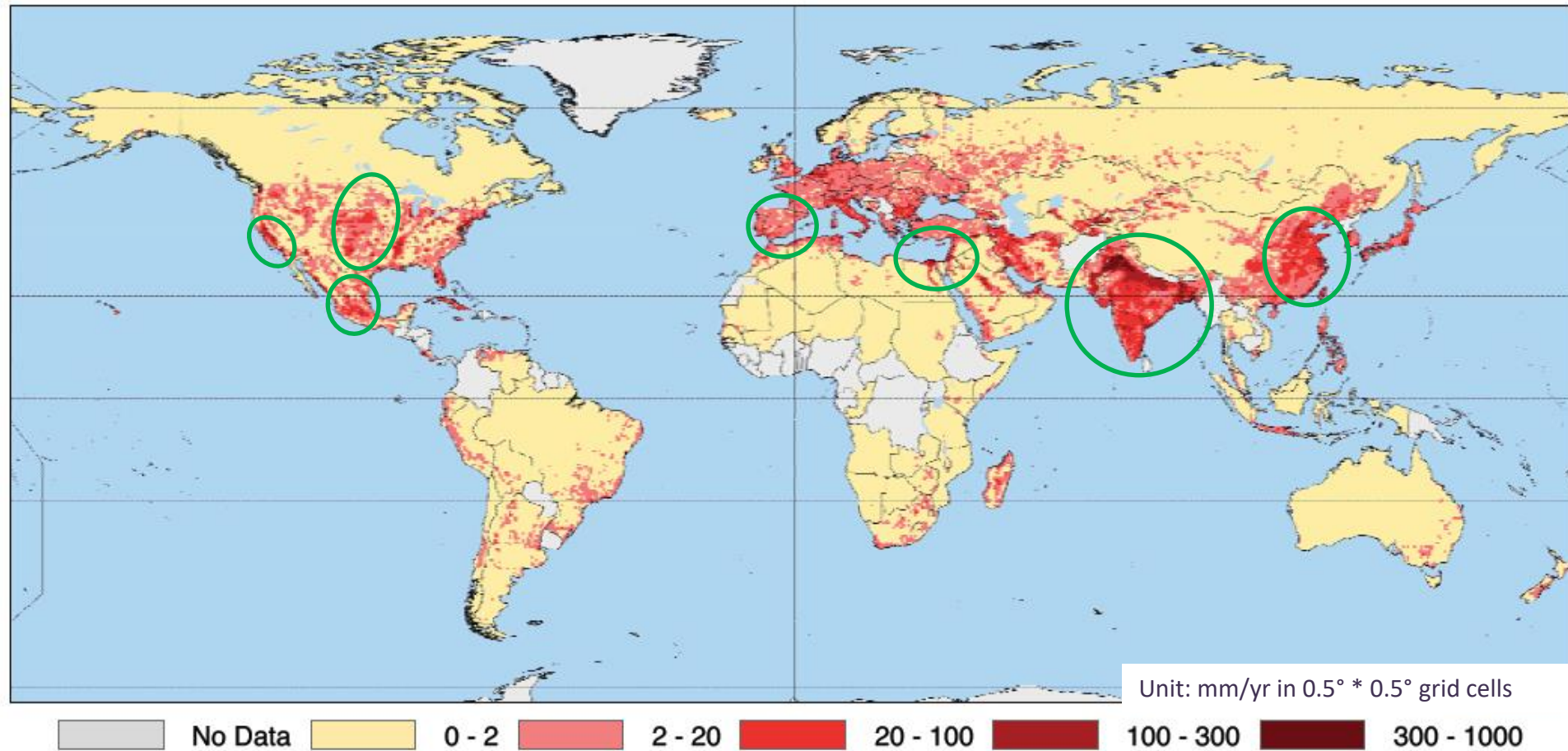
globally



van der Gun, 2012



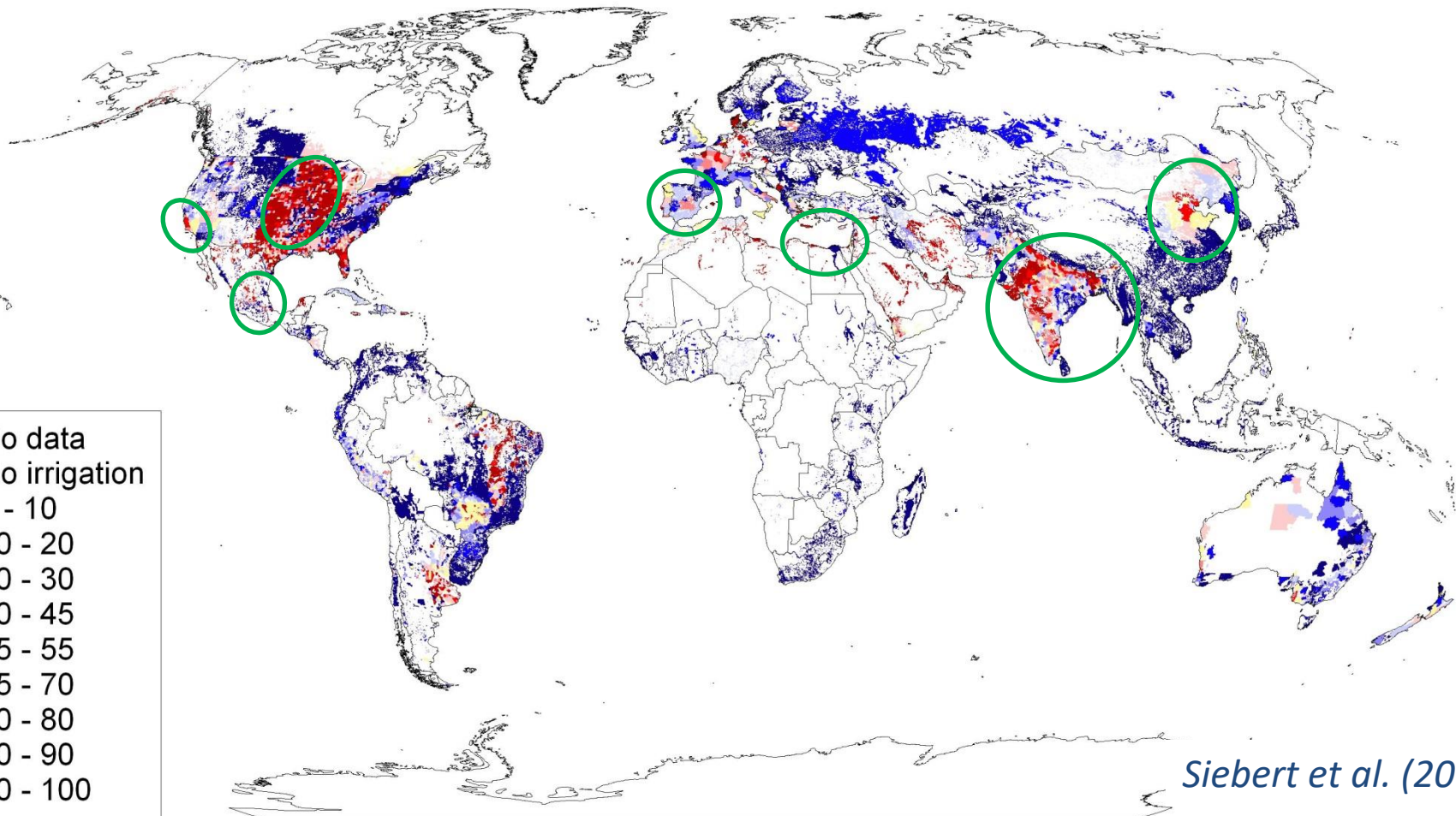
Global GW abstraction ...coincides with....



Wada et al. (2012)

..... Global GW irrigation intensity

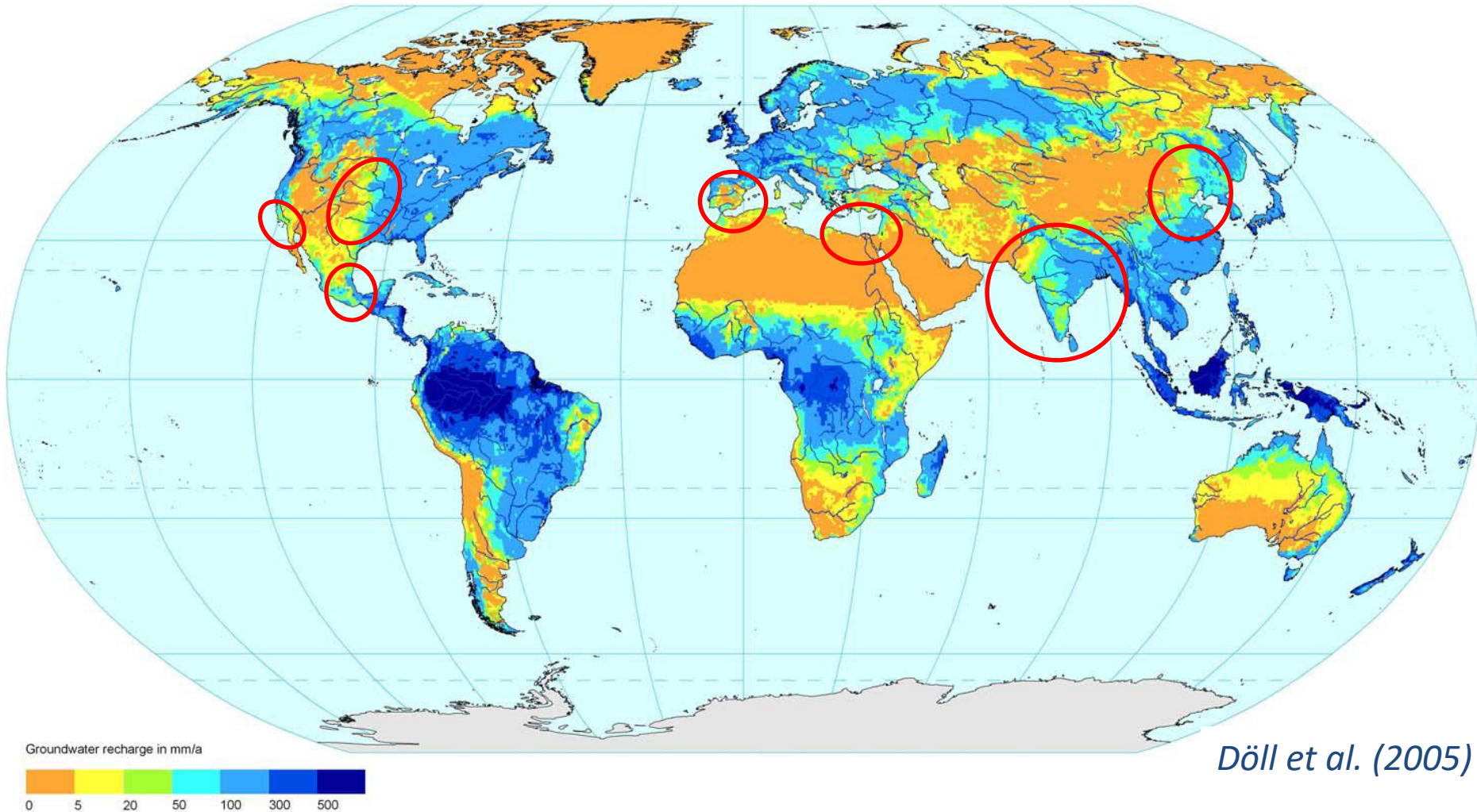
Percentage of irrigated area supplied by ground water (in irrigated grid cells)



Siebert et al. (2010)

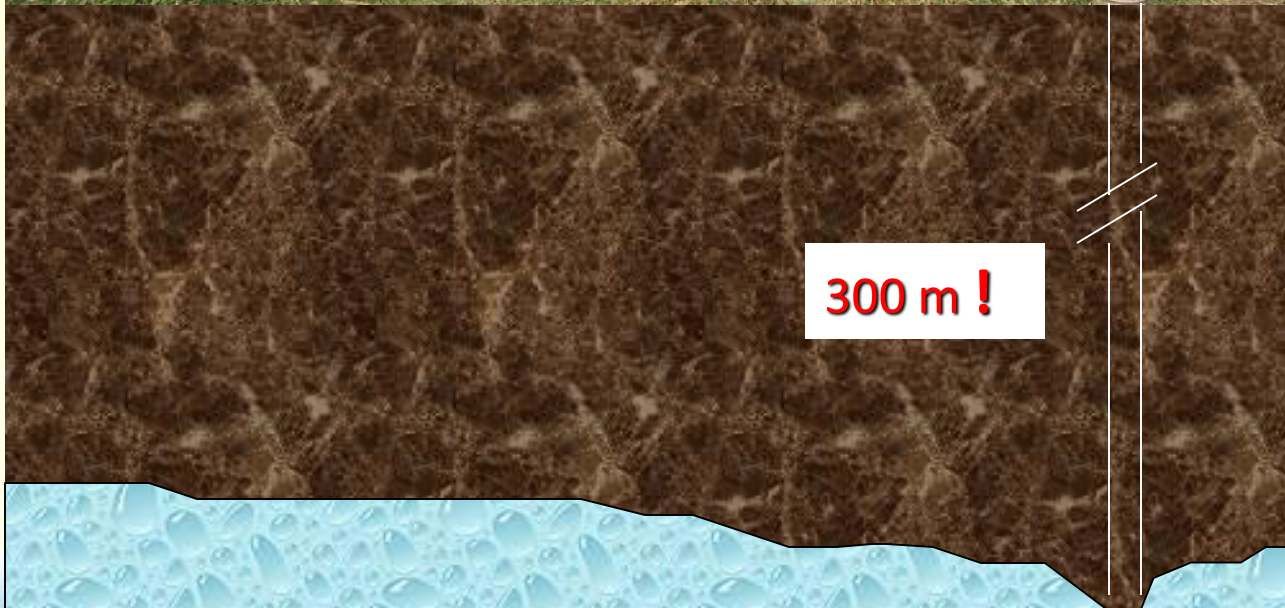
.... and limited renewability of GW

Average annual groundwater recharge 1961 - 1990



Döll et al. (2005)

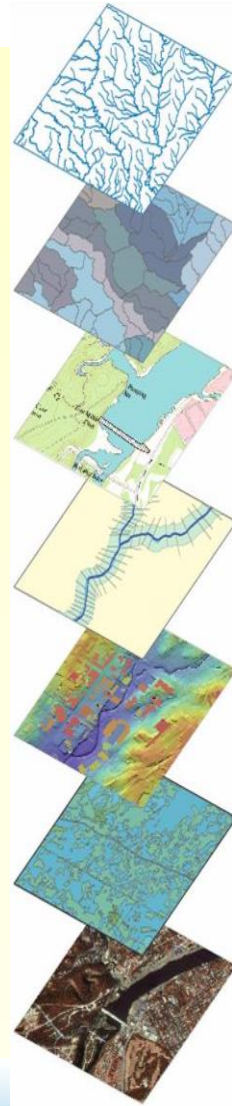
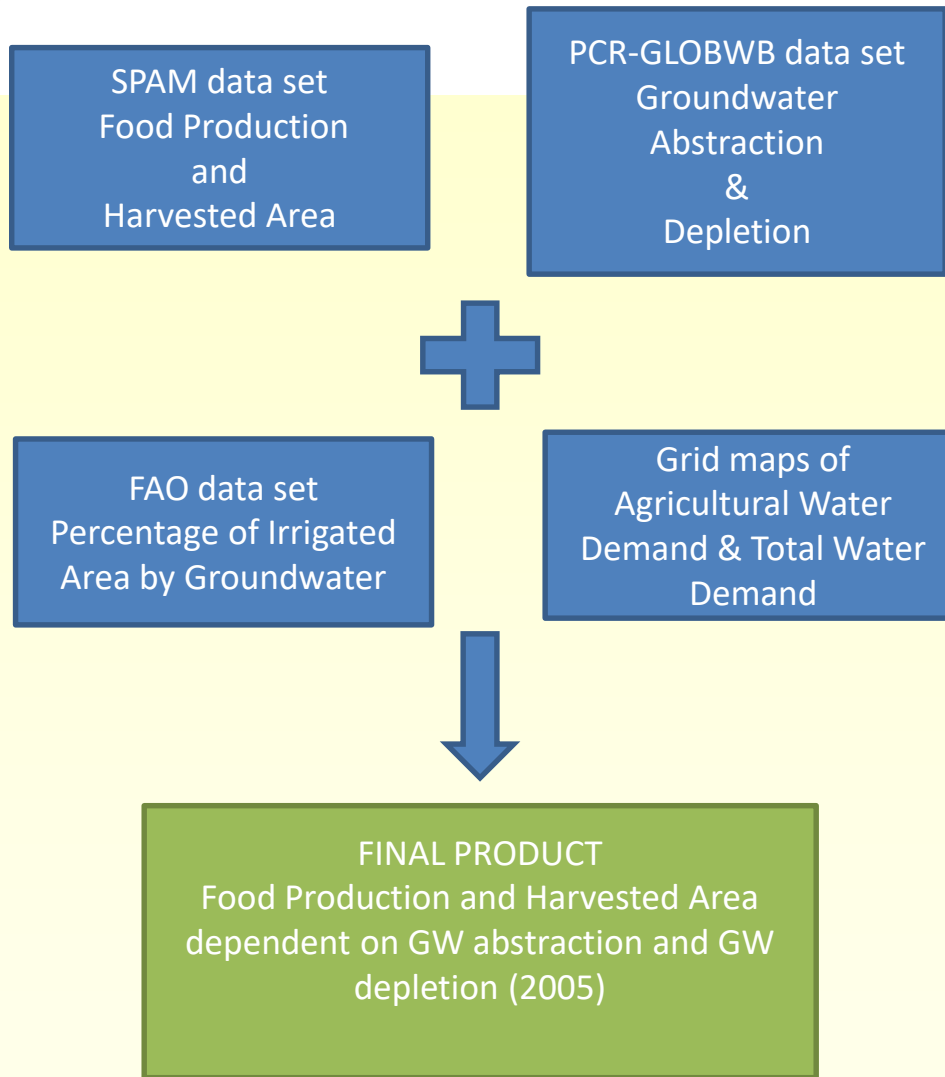
The hidden drought



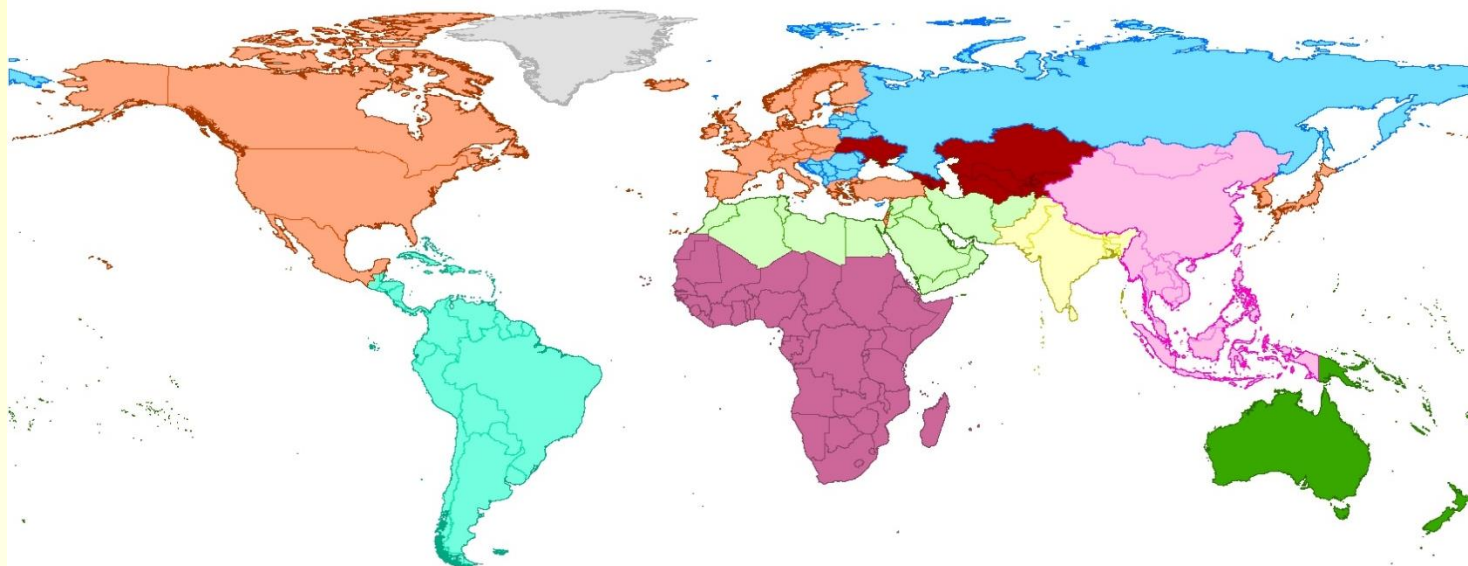
When GW depletion is felt



How much food derives from GW?



Regional aggregation



* without Australia, New Zealand & Chile



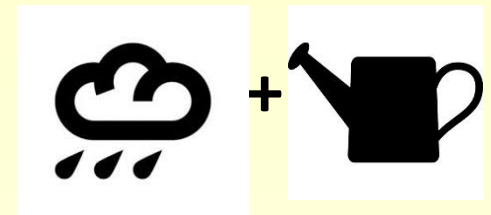
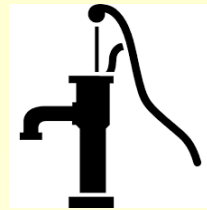
Crop aggregation

Crop Group	Crop Name	Crop Group	Crop Name
Beverage and spice crops	Arabica coffee	Oilseed Crop	Coconut
	Cocoa		Groundnut
	Robusta coffee		Oil palm
	Tea		Other oil crops
Cereals	Barley		Rapeseed
	Maize		Sesame seed
	Other cereals		Soybean
	Pearl millet		Sunflower
	Rice	Other Crops	Rest of crops
	Small millet	Roots and Tubers	Cassava
	Sorghum		Other roots
	Wheat		Potato
	Sweet potato		
Leguminous crops	Other pulses	Yams	
	Bean	Sugar Crops	Sugar beet
	Chickpea	Sugarcane	
	Cowpea	Vegetables and Fruits	Banana
	Lentil		Plantain
Pigeon pea	Temperate fruit		
	Tropical fruit		
Non-Food Crops	Cotton	Vegetables	
	Other fiber crops		
	Tobacco		

Key findings

- Groundwater irrigated areas globally comprise about 83.1 mill. ha, or about 41% of total irrigated areas
- Of the groundwater irrigated areas, 15.5 to 18.5% are supplied by depleting aquifers
- GW depletion rate in agriculture: 129.3 – 165.6 km³/a, accounting for approx. 89% of total GW depletion

Contribution of GW to global food production



From GW abstraction

100%

43.5%

13.0%

From GW depletion

14.0-16.9%

6.1-7.4%

1.8-2.2%

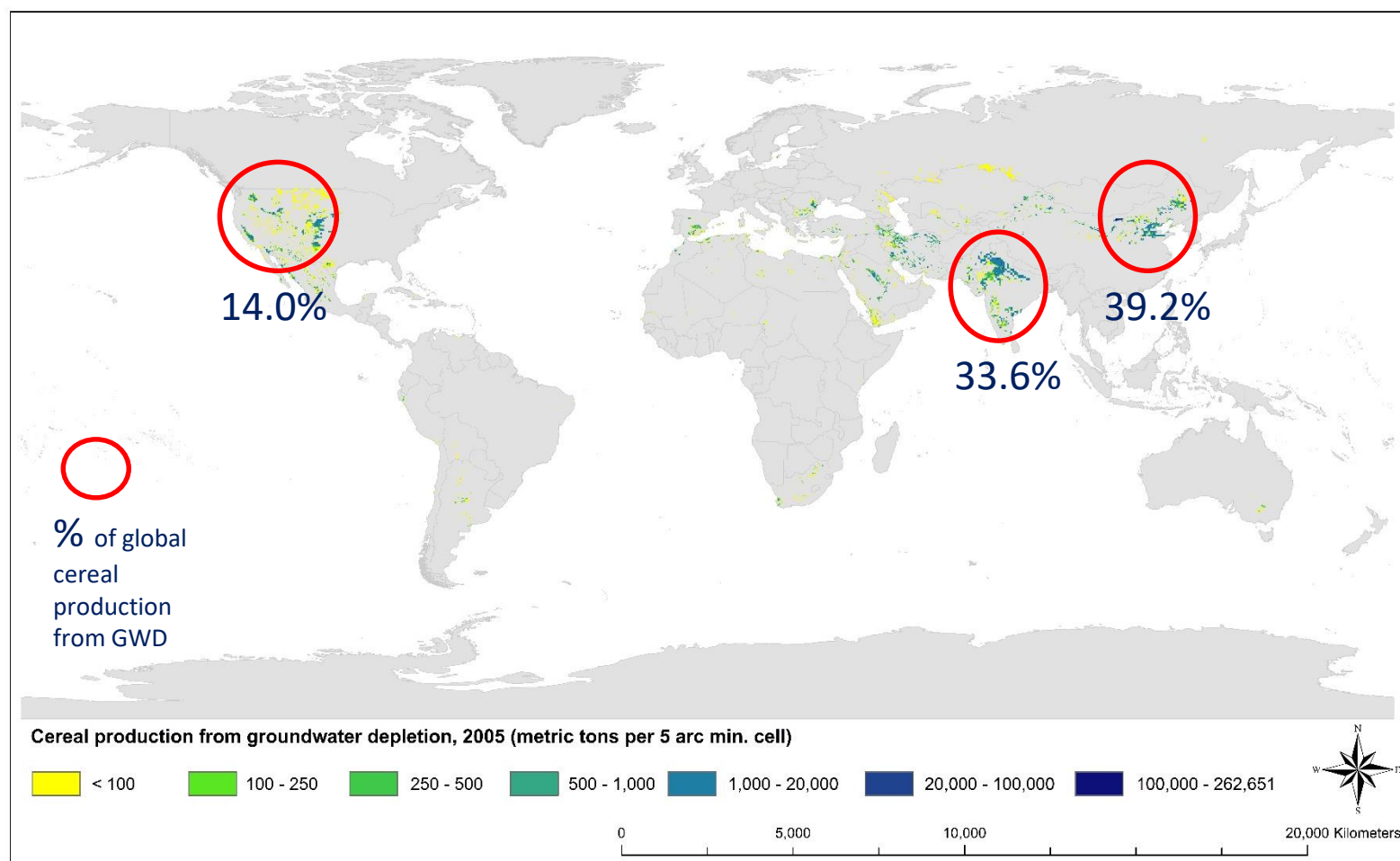
Regional distribution

Region	Food production (10 ⁶ t/a)				Food production from GWD as a fraction of	
	From GWD	From GWD (% of total)	From irrigation	From irrigation and rainfed	Irrigated production	Total production
Australia/Oceania	0.06	0.0%	28.58	96.28	0.2%	0.1%
Central Asia	0.12	0.1%	23.57	151.96	0.5%	0.1%
East Asia	30.55	22.3%	595.02	1997.86	5.1%	1.5%
Latin America and the Caribbean	0.66	0.5%	287.38	1063.58	0.2%	0.1%
Near East/North Africa	10.94	8.0%	113.04	207.72	9.7%	5.3%
OECD	32.77	23.9%	310.35	1593.73	10.6%	2.1%
Other European Countries	0.56	0.4%	16.09	277.09	3.5%	0.2%
South Asia	61.32	44.7%	605.73	904.33	10.1%	6.8%
Sub-Saharan Africa	0.20	0.1%	62.76	518.41	0.3%	0.0%
Total or average	137.17	100.0%	2042.52	6810.96	6.7%	2.0%

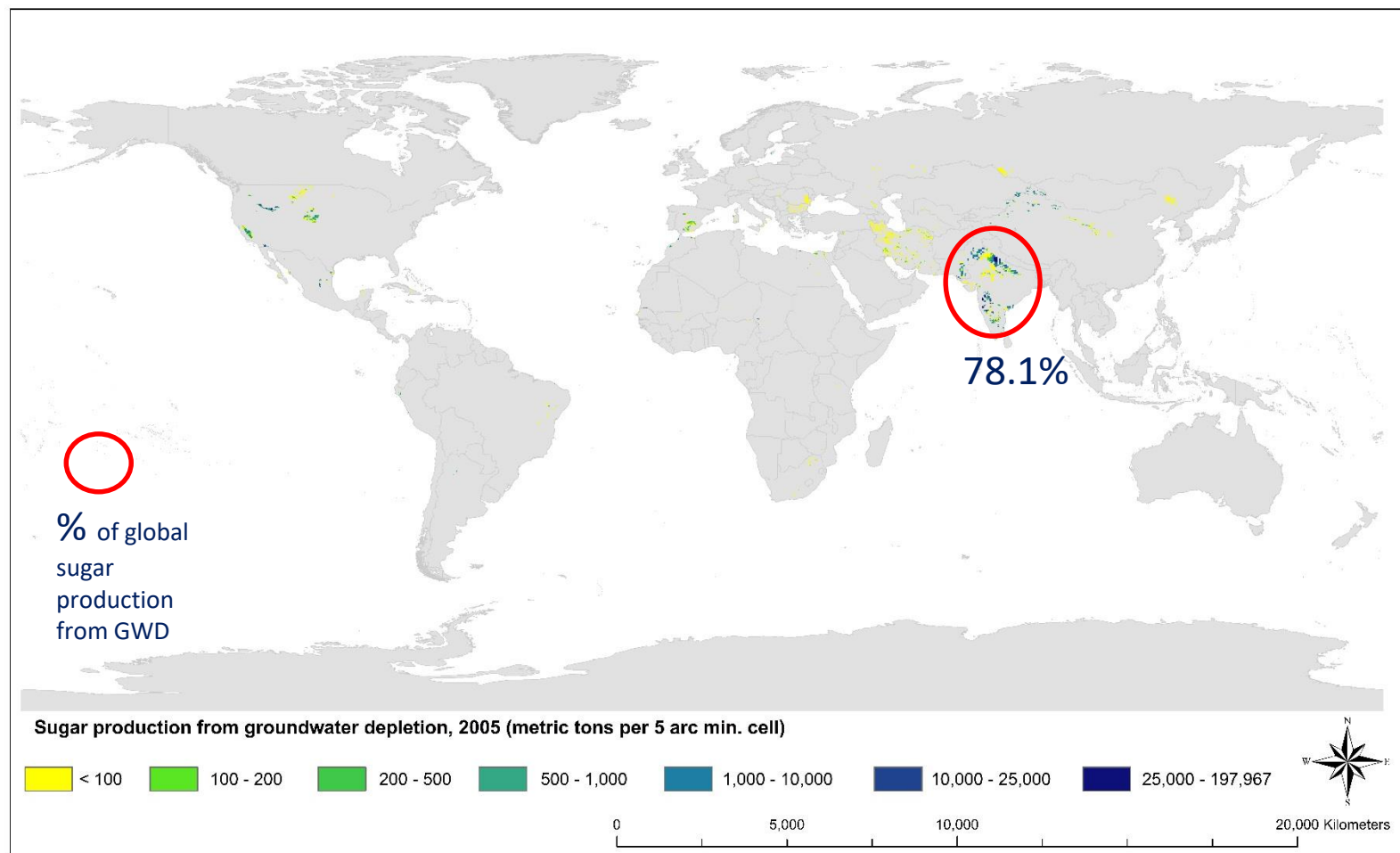
Crop distribution

Crop group	Food production (10 ⁶ t/a)				Food production from GWD as a fraction of	
	From GWD	From GWD (% of total)	From irrigation	From irrigation and rainfed	Irrigated production	Total production
Beverages	0.00	0.0%	0.63	15.32	0.0%	0.0%
Cereals	60.41	44.0%	902.23	2260.27	6.7%	2.7%
Leguminous crops	0.85	0.6%	9.25	60.63	9.1%	1.4%
Non-food crops	4.03	2.9%	41.16	82.64	9.8%	4.9%
Oilseed crops	2.65	1.9%	42.91	593.75	6.2%	0.4%
Other crops	0.32	0.2%	1.68	29.60	19.0%	1.1%
Roots and tubers	15.45	11.3%	109.17	723.58	14.2%	2.1%
Sugar crops	43.04	31.4%	801.26	1613.48	5.4%	2.7%
Vegetables and fruits	10.48	7.6%	134.21	1431.70	7.8%	0.7%
Total or average	137.21	100.0%	2042.50	6810.97	6.7%	2.0%

Cereal production from GWD



Sugar production from GWD



Conclusions

- Global food production depends on depleting GW for 2.0% of total, 6.7% of irrigated, and 15.4% of GW-irrigated fractions in 2005
- Reliance on non-sustainable GW for increasing parts of global food production requires urgent attention
- Solutions to be found in broader global food policies and interventions in both developing and developed part of the world

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Thank you!

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