

**Global fluxes of virtual water:
Tele-connection of impacts on water resources**

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Globalisation

WTO statistics

1. volume of international trade in agricultural products has increased during the past 50 years with an average of 3.6% per year
2. agricultural production itself has grown with an average of 2.4% per year

Globalisation

FAO statistics

1. global irrigation area has increased
2. rice production has increased
average of 1.5% per year
rice exports worth \$10 billion per year.
3. the Aral Lake in Central Asia gets dry as a result of water subtraction from the Amu-Dar and Syr-Dar rivers for cotton production; the region supplies more than 6% of the cotton demand of the world.



Globalisation

Trigger for the current research:

1. the interaction between water demand and supply can no longer sufficiently be understood at river basin level
2. local disturbances of the water system are increasingly to be understood through analysis of global markets for agricultural products
3. Impacts on water resources from consumption of goods are cross borders

Globalisation

Global trade in goods and services
brings along global trade in 'virtual water'

Virtual water content

Definition: Virtual water is the water 'embodied' in a product, not in real sense, but in virtual sense. It refers to the water needed for the production of the product.

Approaches in estimation

1. Using the real volume of water consumed in the process at production site
2. Using the '*would have required*' volume of water (if feasible to produce) at consumption site.

Virtual water content

Virtual water content of some products

1 kg grain	1-2 m ³ water
1 kg cheese	5 m ³ water
1 kg beef	16 m ³ water
Five hundred 32-MB chips (2 gram each)	16 m ³ water

Assessing virtual water trade flows

Virtual water content of a crop

Crop water requirement (m^3/ha) / Crop yield (ton/ha)

Virtual water content of a livestock product

1. Virtual water content of the live animal
2. Distribute this volume over the different products from this animal

Virtual water trade flows

Trade volume (ton/yr) \times Virtual water content (m^3/ton)

Basic data

Global trade data

United Nations Statistics Division, New York

Virtual water content

- Crop water requirements (m^3/ha): Empirical equations as per FAO guidelines
- Crop yields (ton/ha): FAOSTAT

International virtual water trade

(1997-2001)

	Volume (billion m ³ /yr)	Percentage (%)
Crops and crop products	987	61
Livestock and livestock products	276	17
Industrial products	362	22
Total	1625	100

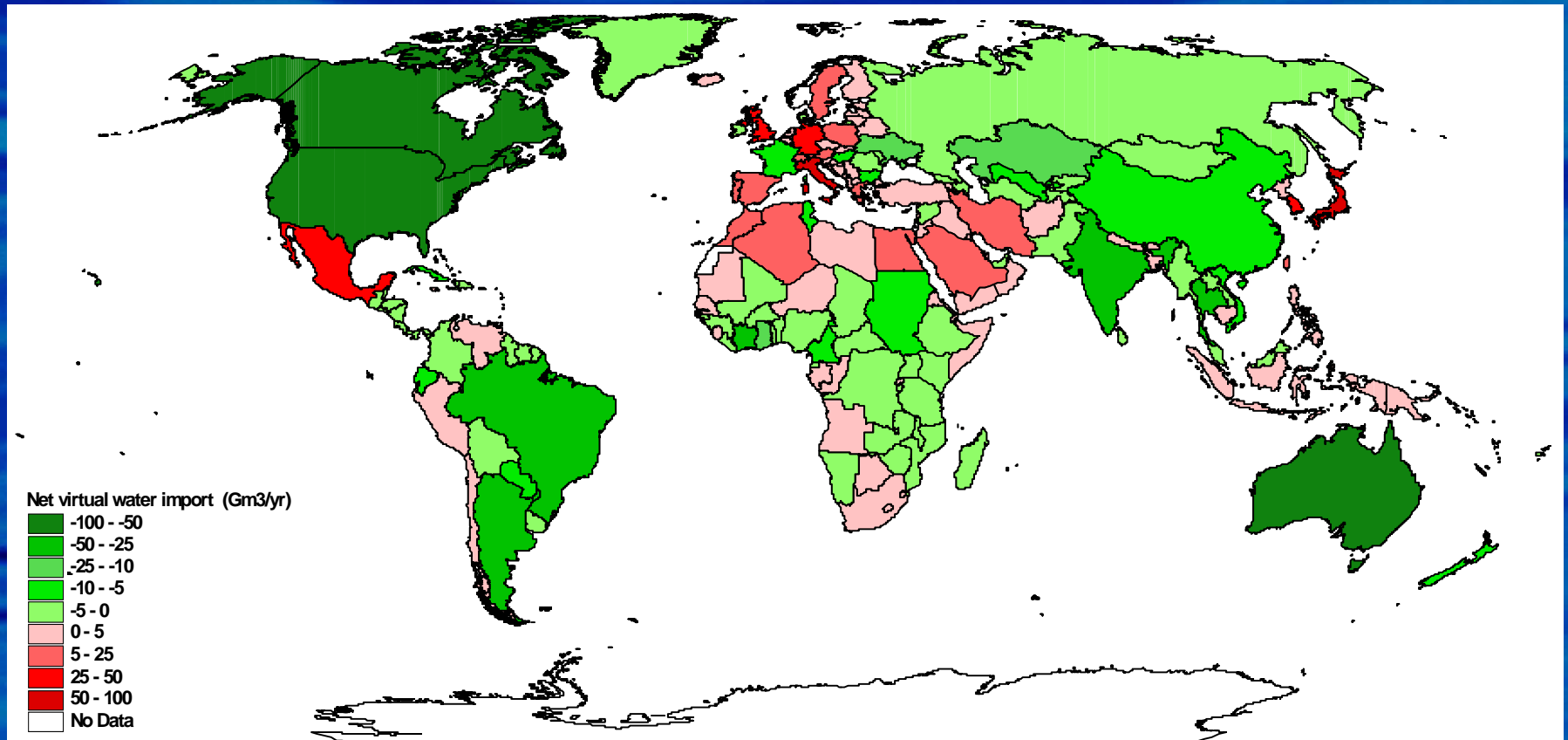
= 16% of global water use!

National virtual water trade balances

(1997-2001)

1. How much water goes into the country in the form of imported products?
2. How much water leaves the country in the form of exported products?

National virtual water trade balances (1997-2001)

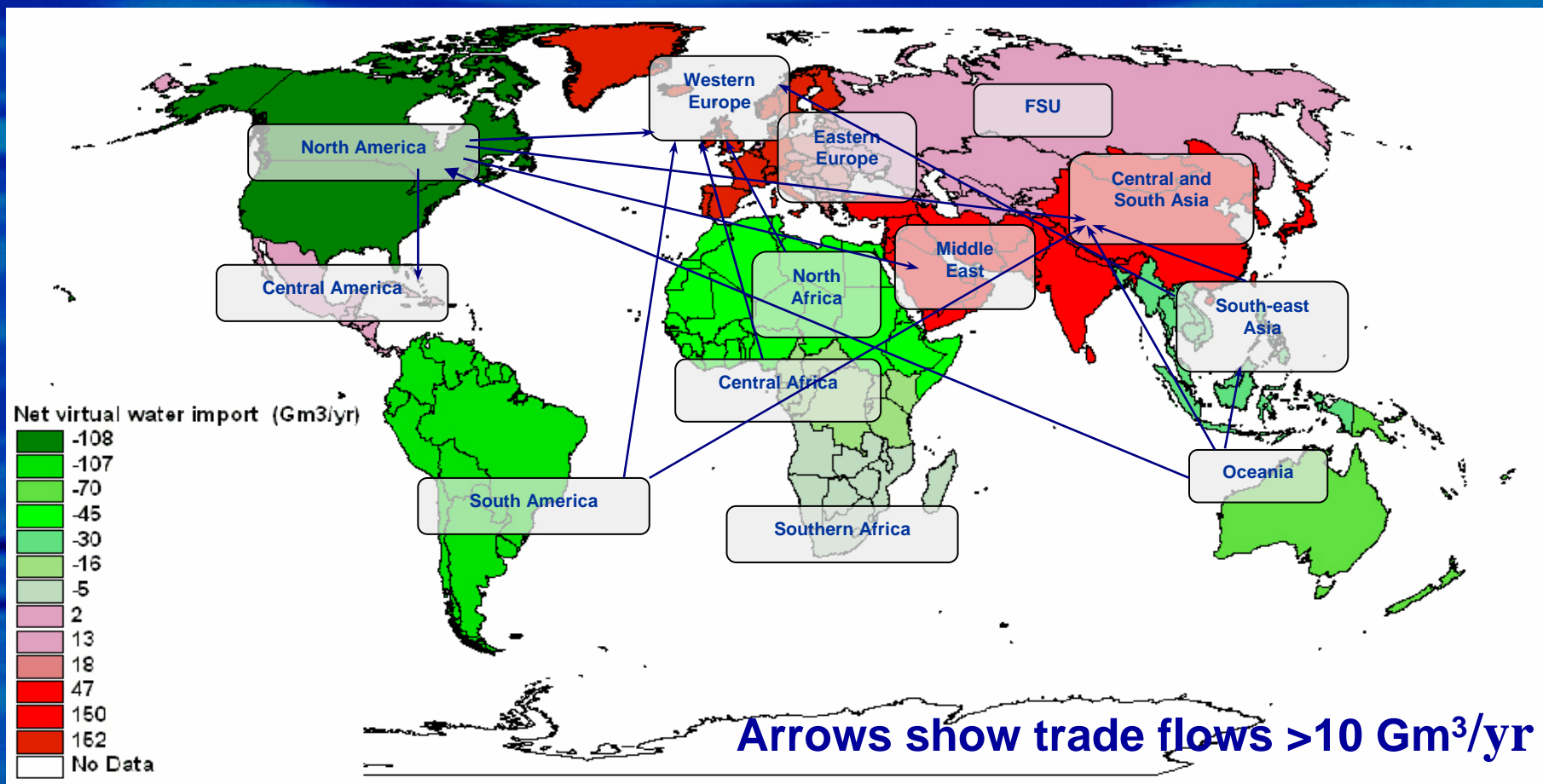


National virtual water trade balances

(1997-2001)

Top-5 exporter	(Gm ³ /yr)	Top-5 importer	(Gm ³ /yr)
Australia	64	Japan	92
Canada	60	Italy	51
USA	53	UK	47
Argentina	45	Germany	35
Brazil	45	South Korea	32

Regional virtual water trade balances (1997-2001)



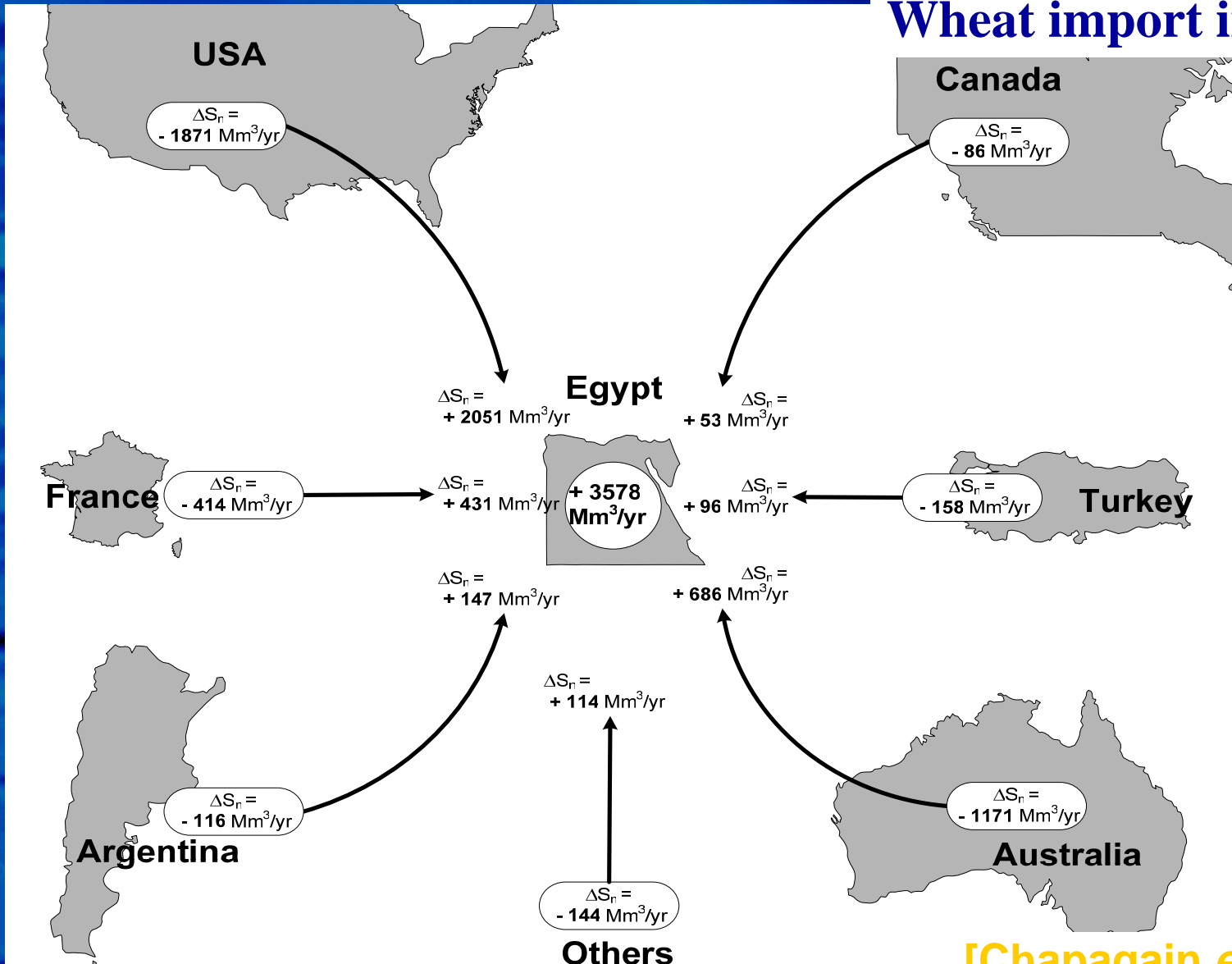
Arrows show trade flows >10 Gm³/yr

Insights gained

1. National water saving
2. Global water saving
3. Alternative to inter-basin water transfers
4. Storage across time
5. Water footprint: as an indicator of water use
6. Local consumption, global impact

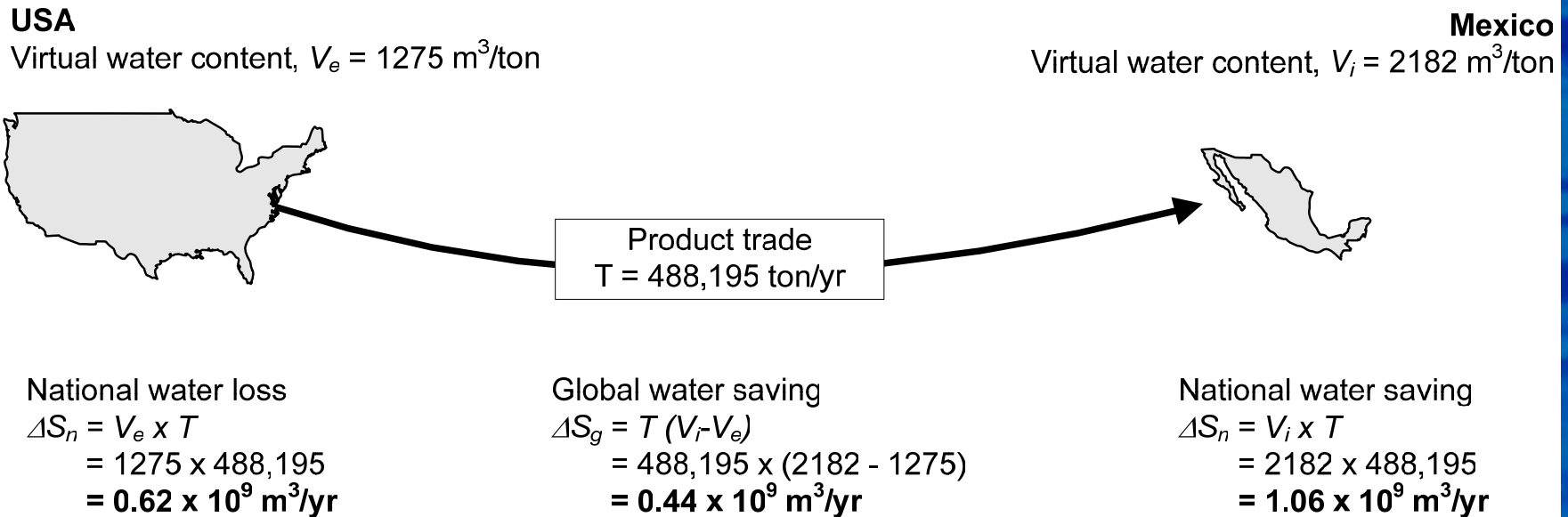
National water saving

Wheat import in Egypt



Global water saving

Rice import in Mexico from USA



Global water saving

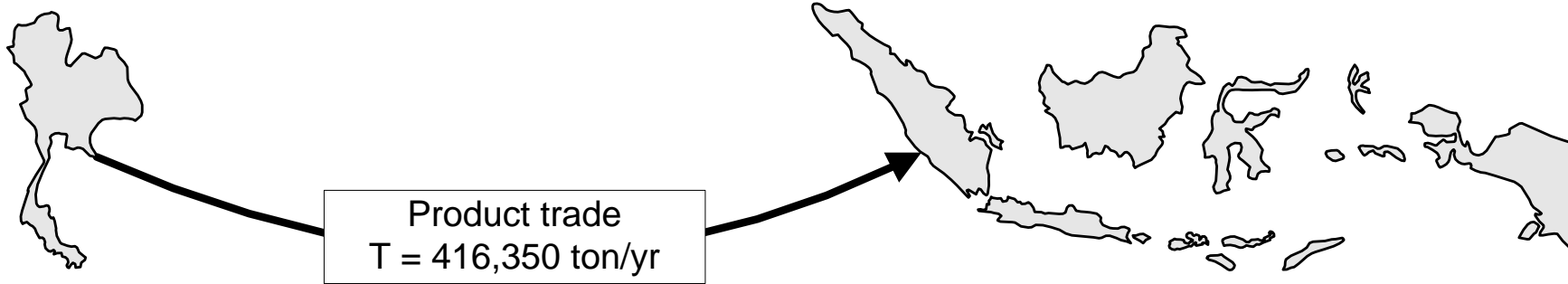
Rice export from Thailand to Indonesia

Thailand

Virtual water content, $V_e = 5455 \text{ m}^3/\text{ton}$

Indonesia

Virtual water content, $V_i = 3103 \text{ m}^3/\text{ton}$



National water loss

$$\begin{aligned}\Delta S_n &= V_e \times T \\ &= 5455 \times 416,350 \\ &= 2.27 \times 10^9 \text{ m}^3/\text{yr}\end{aligned}$$

Global water saving

$$\begin{aligned}\Delta S_g &= T (V_i - V_e) \\ &= 416,350 \times (3103 - 5455) \\ &= -0.98 \times 10^9 \text{ m}^3/\text{yr}\end{aligned}$$

National water saving

$$\begin{aligned}\Delta S_n &= V_i \times T \\ &= 3103 \times 416,350 \\ &= 1.29 \times 10^9 \text{ m}^3/\text{yr}\end{aligned}$$

Global water saving

Global water saving with the international trade of agricultural products (period 1997-2001)

= 352 Gm³/yr

Alternative to real interbasin water transfers

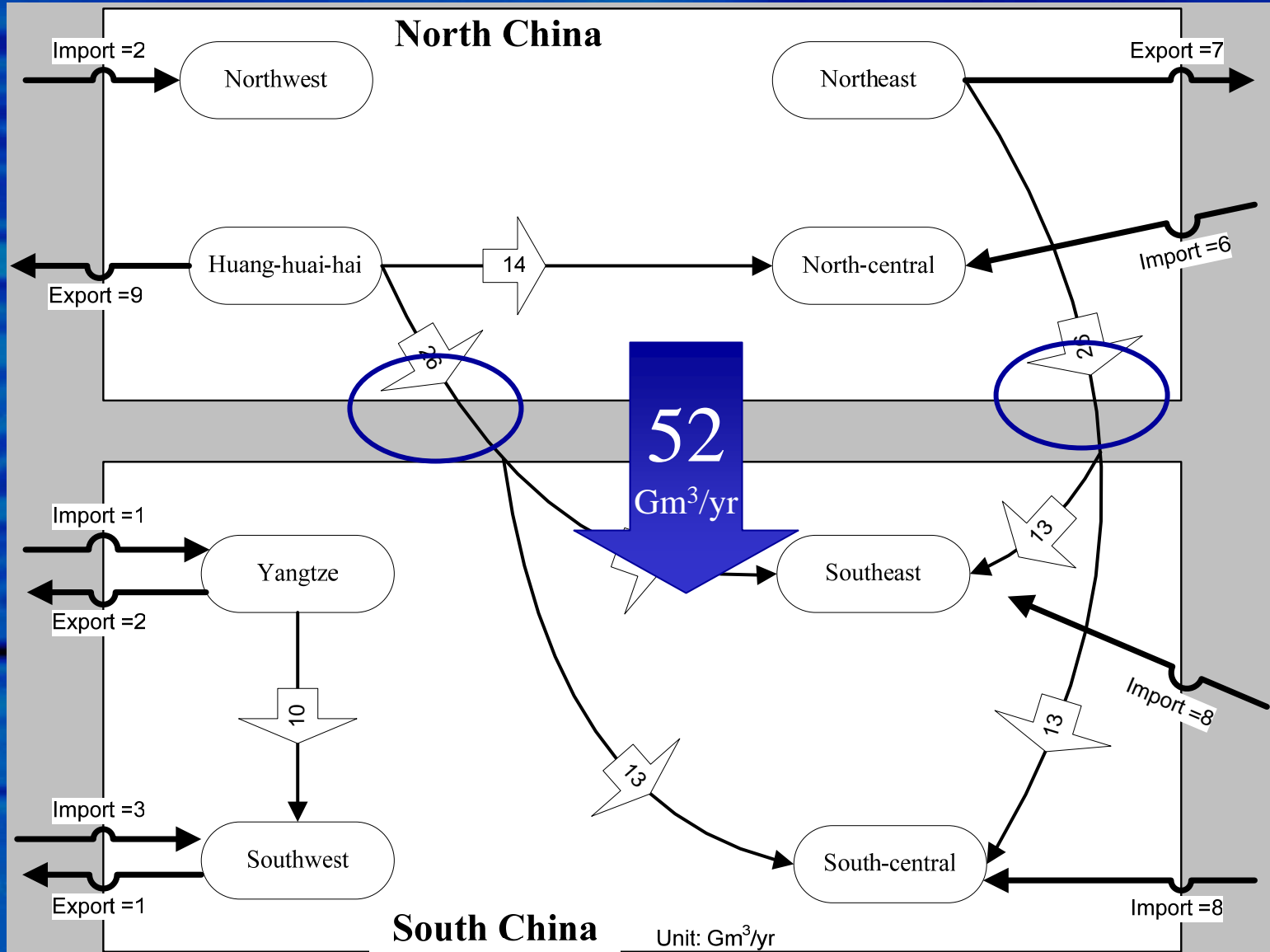
Proposed large inter-basin water transfers:

- China
- India
- South Africa
- Spain

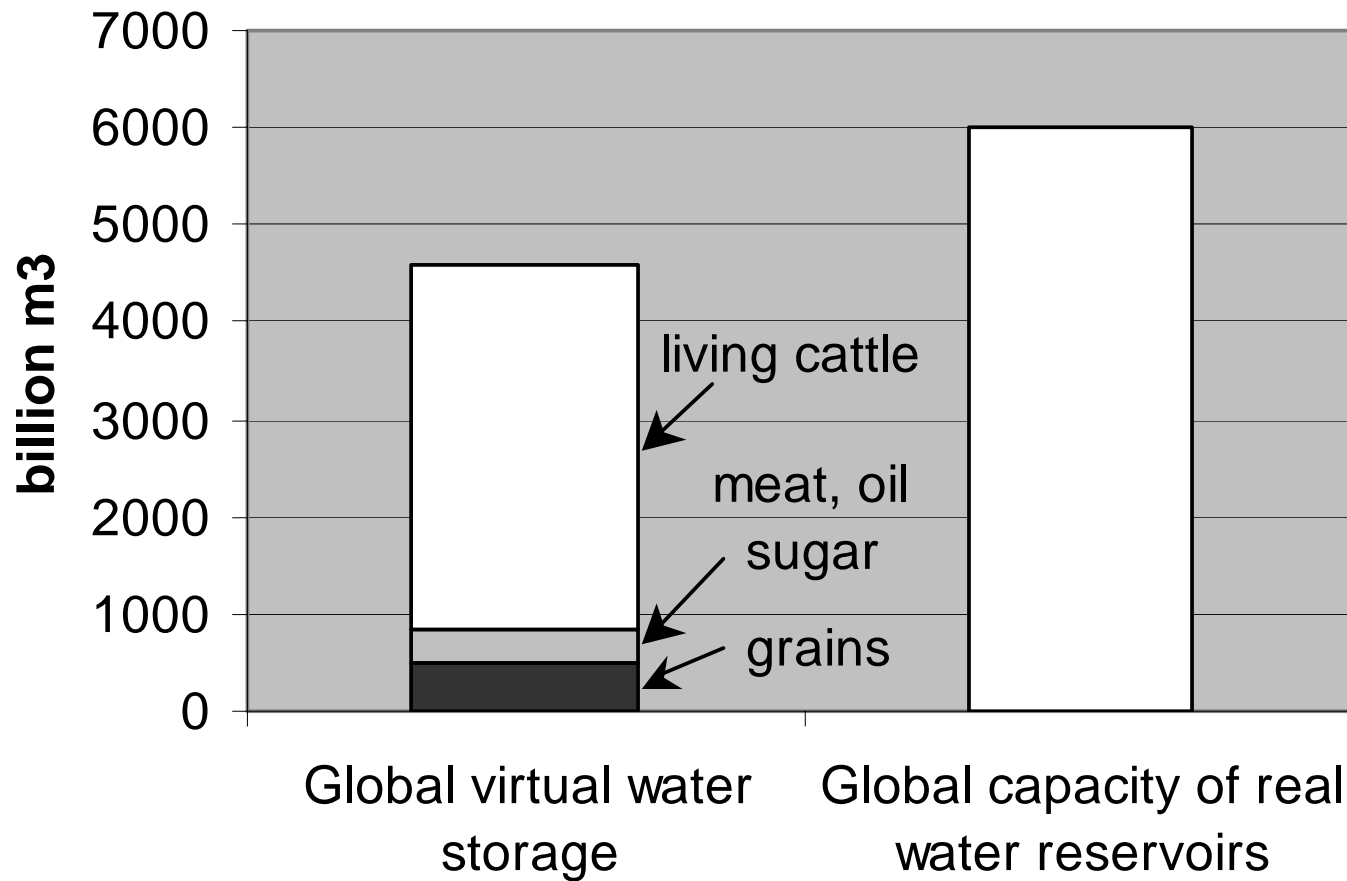
Alternative:

- Trade of water intensive products from water-rich to water-poor regions

Alternative to real interbasin water transfers



Storage over time

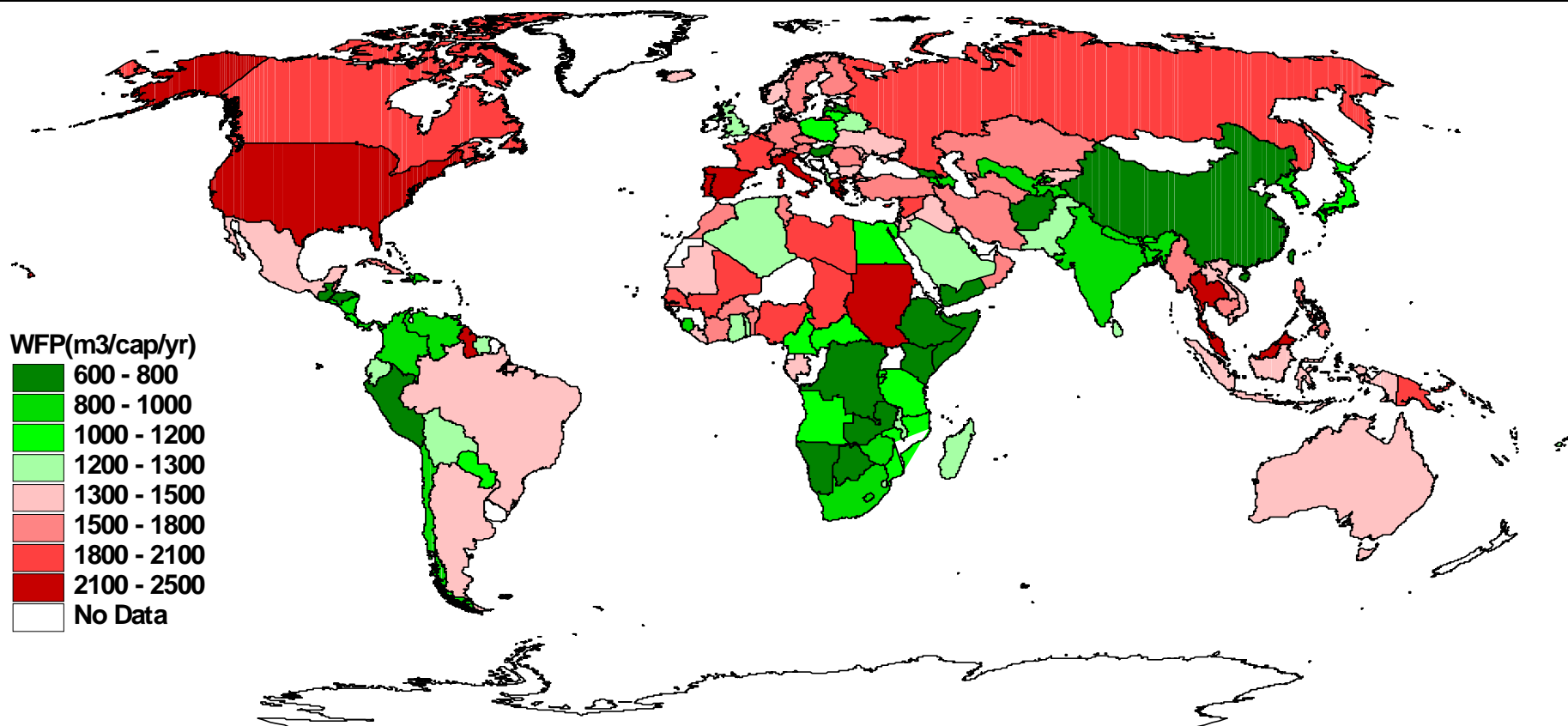


Water footprint

An indicator of impact on water resources

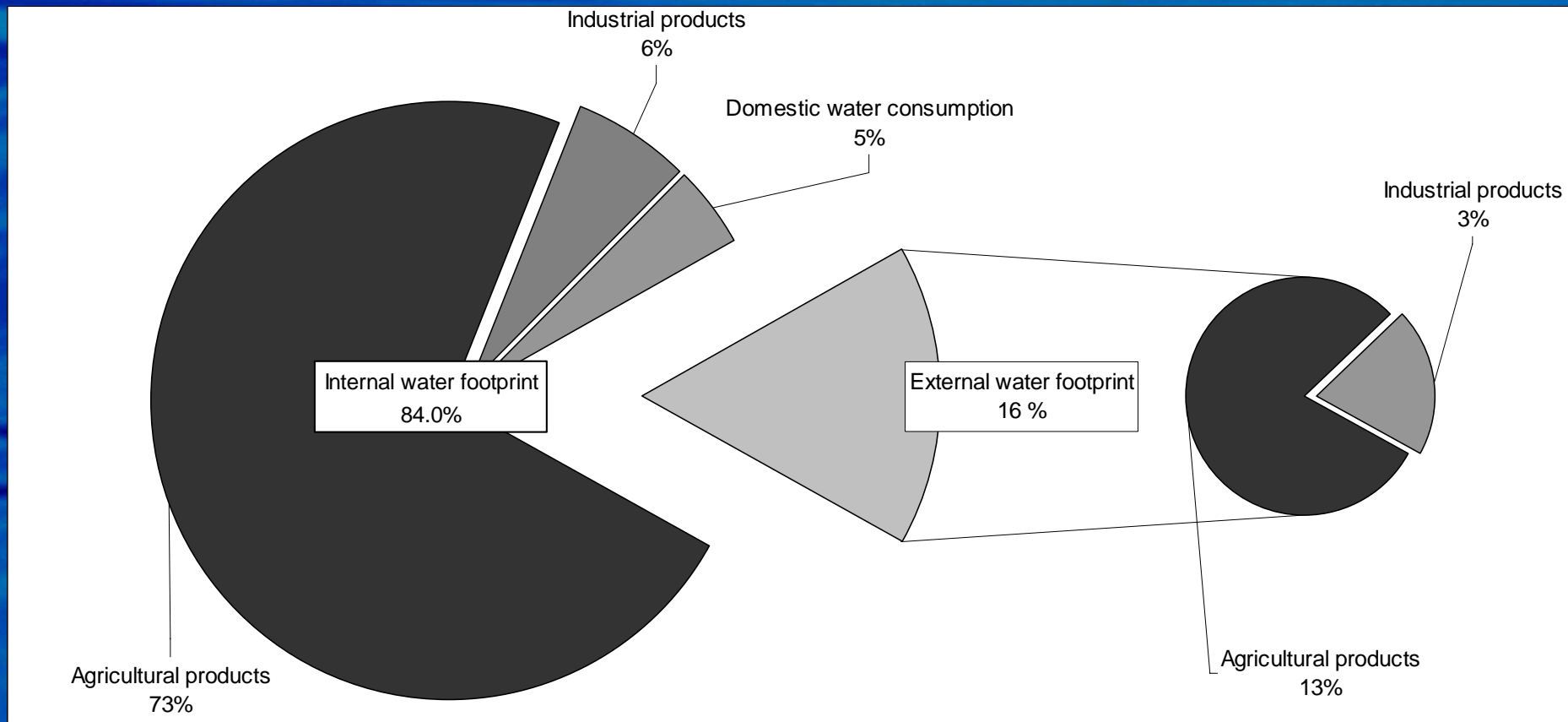
Water footprint

Average national water footprint per capita



Water footprint

Global water footprint - contribution by consumption categories

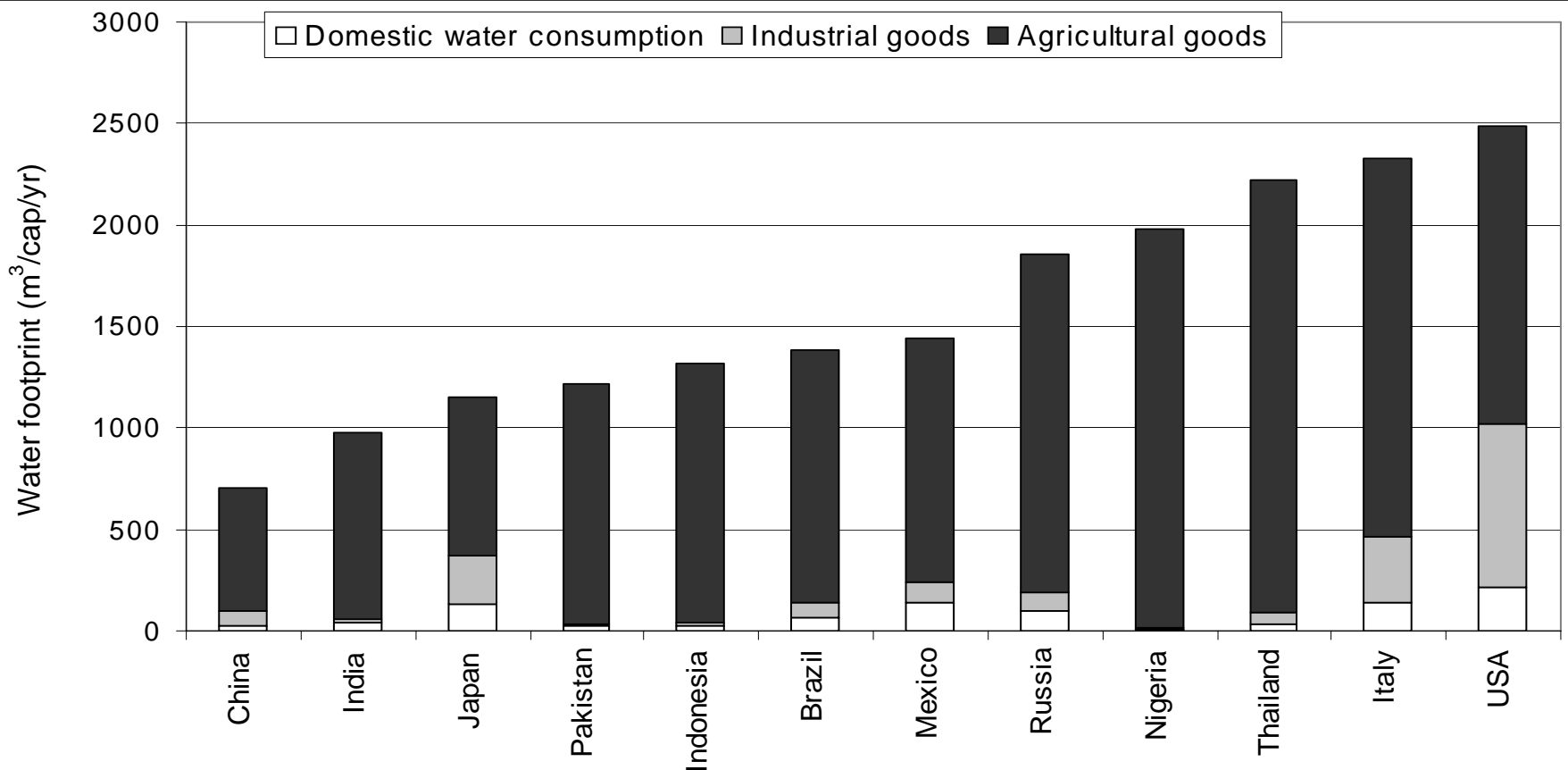


Global water footprint = 7450 Gm³/yr

[Chapagain & Hoekstra, 2004]

Water footprint

Some selected countries - contribution by consumption categories

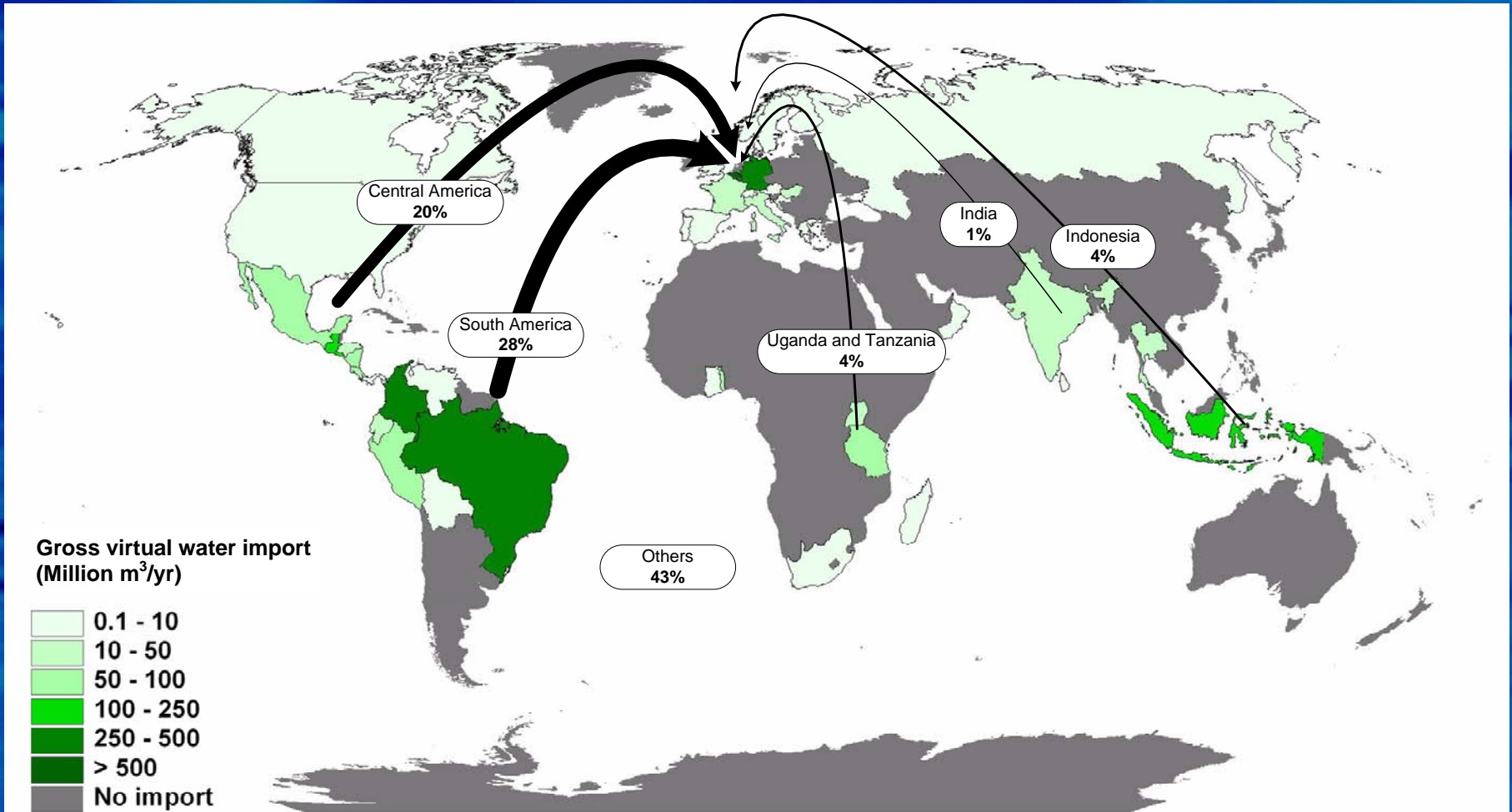


Global water footprint = 1240 m³/cap/yr

[Chapagain & Hoekstra, 2004]

Local consumption, global impact

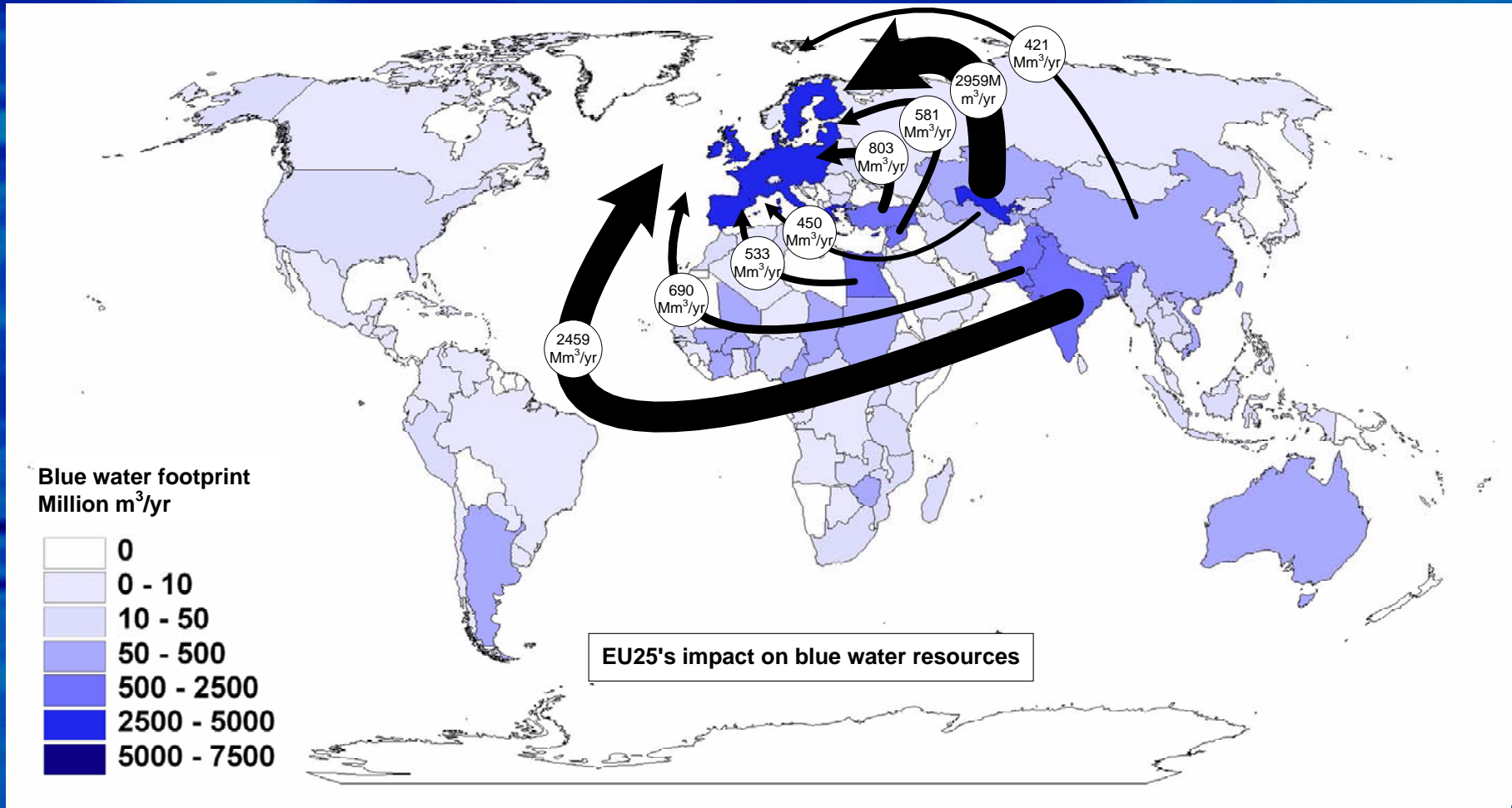
– An example from Dutch drinking tea and coffee



Dutch water footprint_(Coffee Tea) = 2.7 Gm³/yr [Chapagain & Hoekstra, 2004]

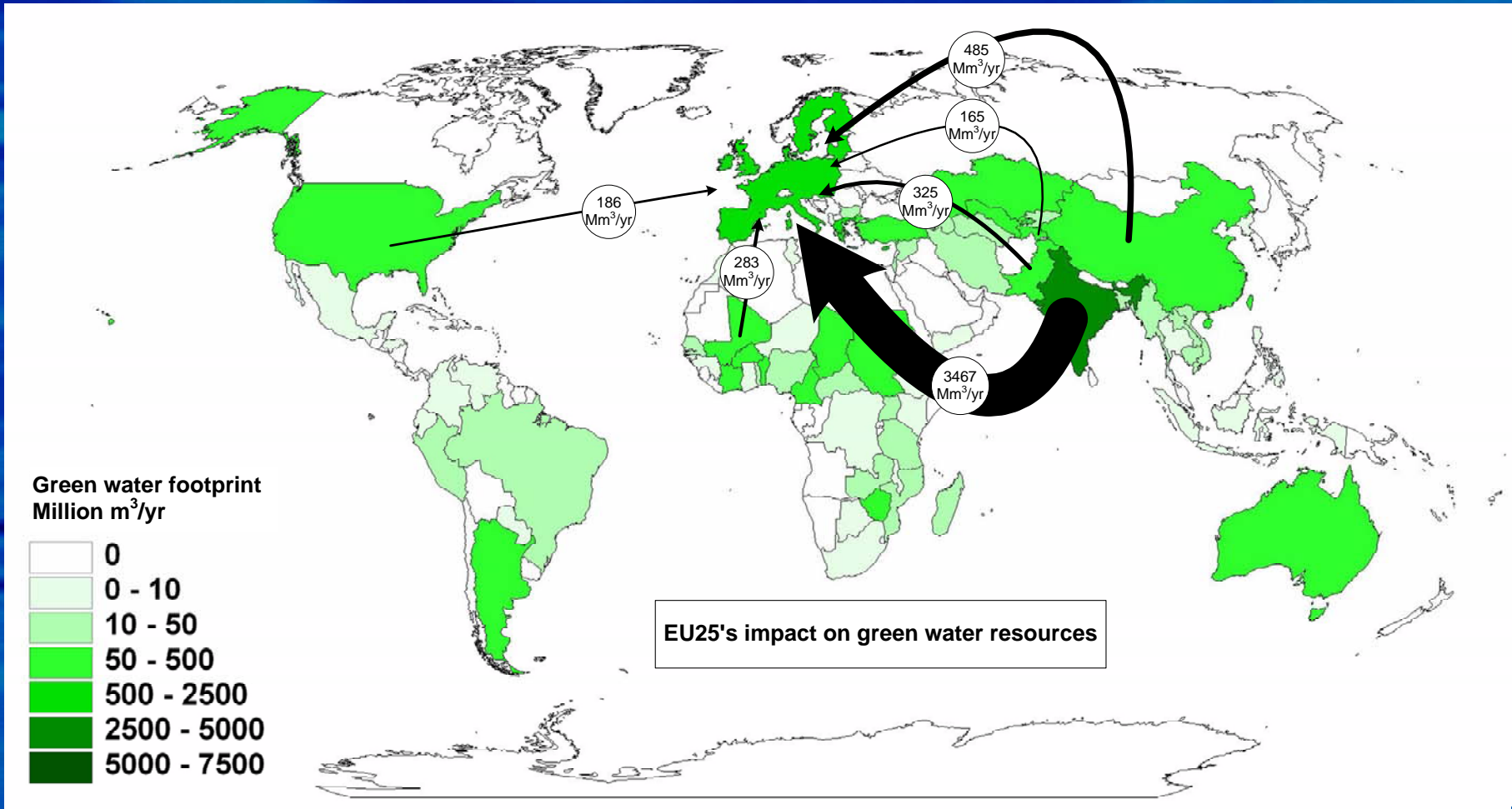
Local consumption, global impact

– An example from cotton consumption in EU 25



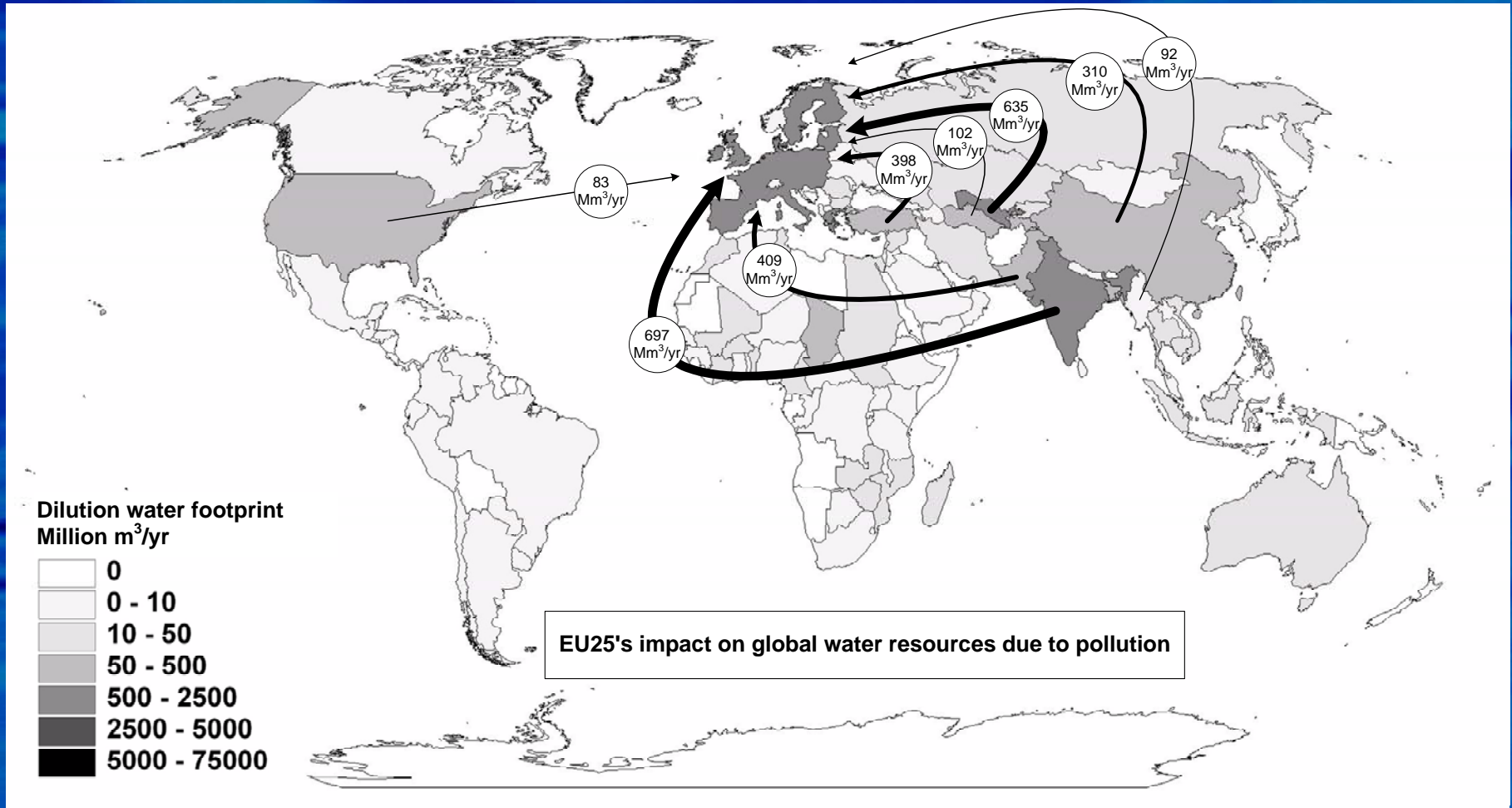
Local consumption, global impact

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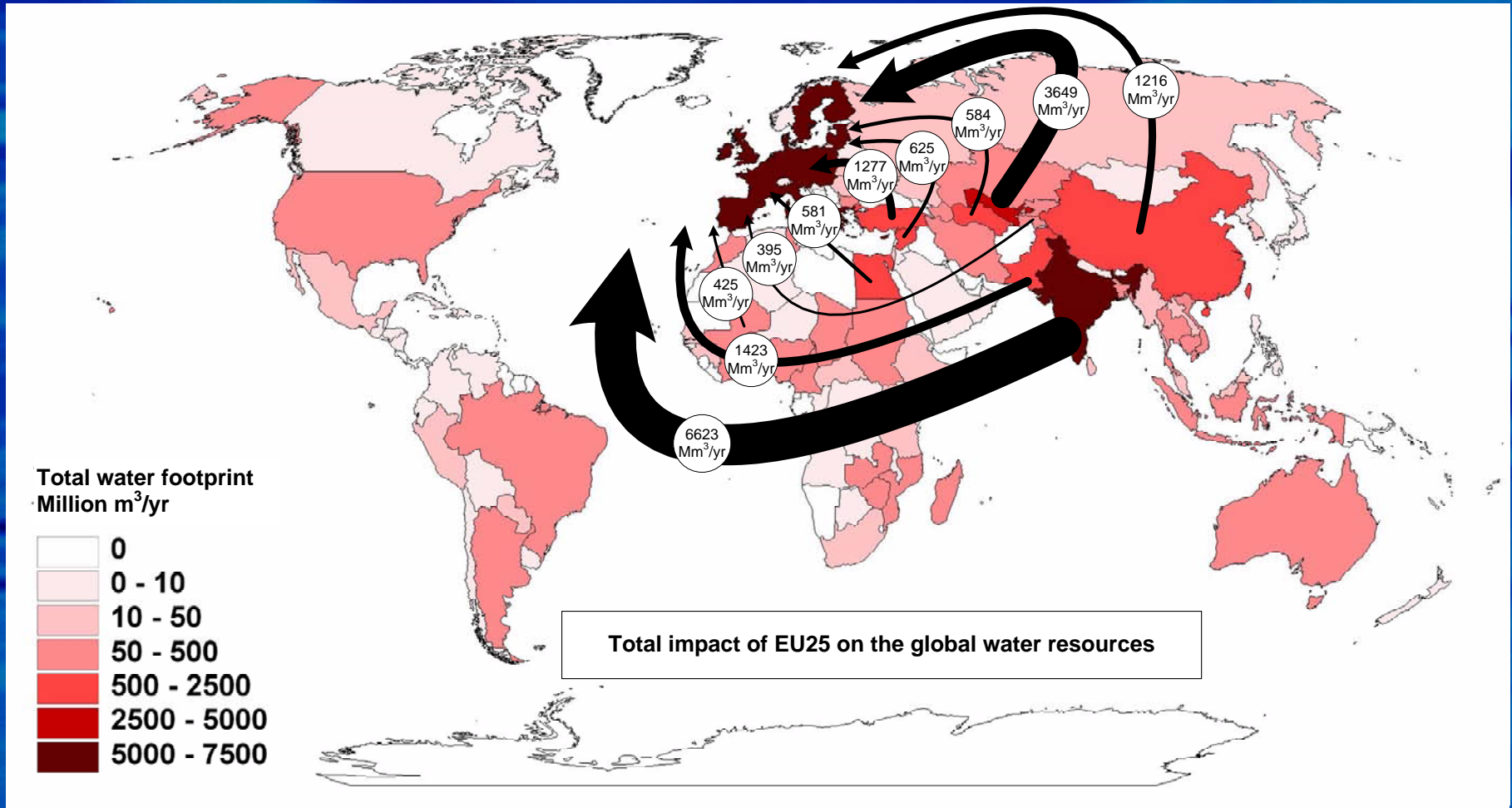
Local consumption, global impact

– An example from cotton consumption in EU 25



Local consumption, global impact

– An example from cotton consumption in EU 25



Conclusion

- **15-20% of the global water use is not used for domestic consumption but for export (in virtual form).**
- **It is very relevant to carry out virtual water analysis in any national or regional water policy study.**
- **Local consumption affects global water system: vis-a-vis, detailed analysis of water footprint is worth investigation for sustainable use of water**

Thank you