# Understanding the economics of water use, allocation and trade under a changing climate

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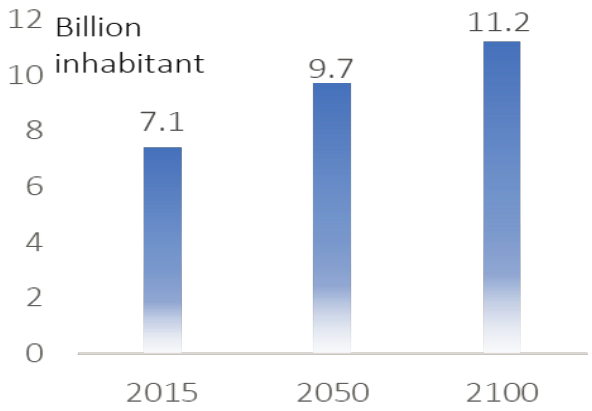
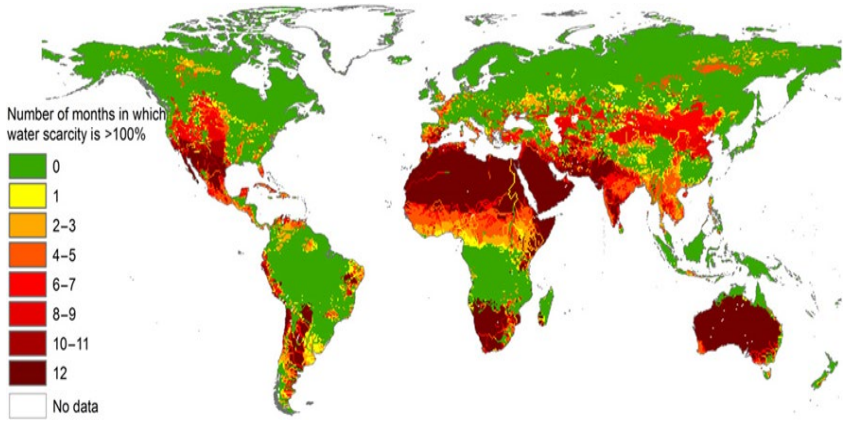
# Introduction

Population **growth**




Source: Medium scenario United Nation (2015)

Water **scarcity**

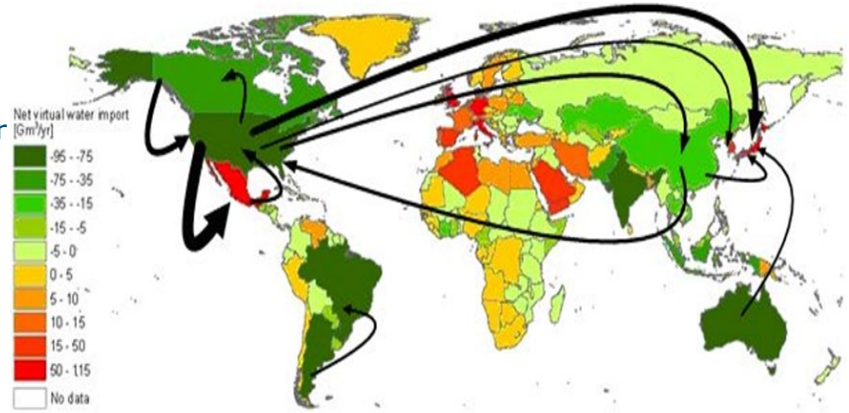



Source: Mekonnen and Hoekstra (2016)

Climate **change**

Source: www.asyousow.org

Virtual water import: **A solution?**




Source: Mekonnen and Hoekstra (2011)

# Presentation objective

- Understanding water allocation in crop production: water footprint and economic water productivity
- Virtual water trade: potential in relieving pressure on local water availability and its driving forces
- Projection of net virtual water import in 2050
- Conclusion & future research

# The water footprint (WF) concept

- WF looks at both **direct** and **indirect** water use of a consumer or producer.
- Water volumes **consumed** (evaporated or otherwise not returned) or **polluted** per unit of time.
- **Geographically** and **temporally** explicit indicator
- A WF can be calculated for a process, a product, a consumer, group of consumers (e.g. municipality, province, state or nation) or a producer (e.g. a public organization, private enterprise).

Source: Hoekstra et al. (2011) *The Water Footprint Assessment Manual*, Earthscan, London, UK

# The water footprint (WF) of a cow

200 gram of boneless meat = **3100 liters of water**

1%

**Water (direct WF)**

- 24000 liters for drinking
- 7000 liters for servicing

99%

**Food (indirect WF)**

- 1300 kg of grain (wheat, oats, barley, dry peas, soybeans, etc)
- 7200 Kg of roughages (pastures, dry hay, silage, etc)

Source: Hoekstra & Chapagain (2008) *Globalization of water*, Blackwell, Oxford, UK

# The water footprint (WF) colors

Green water footprint

Volume of **rainwater** consumed

Blue water footprint

Volume of surface or groundwater **consumed**

Grey water footprint

Volume of surface or groundwater **polluted**

Source: Hoekstra et al. (2011) *The Water Footprint Assessment Manual*, Earthscan, London, UK

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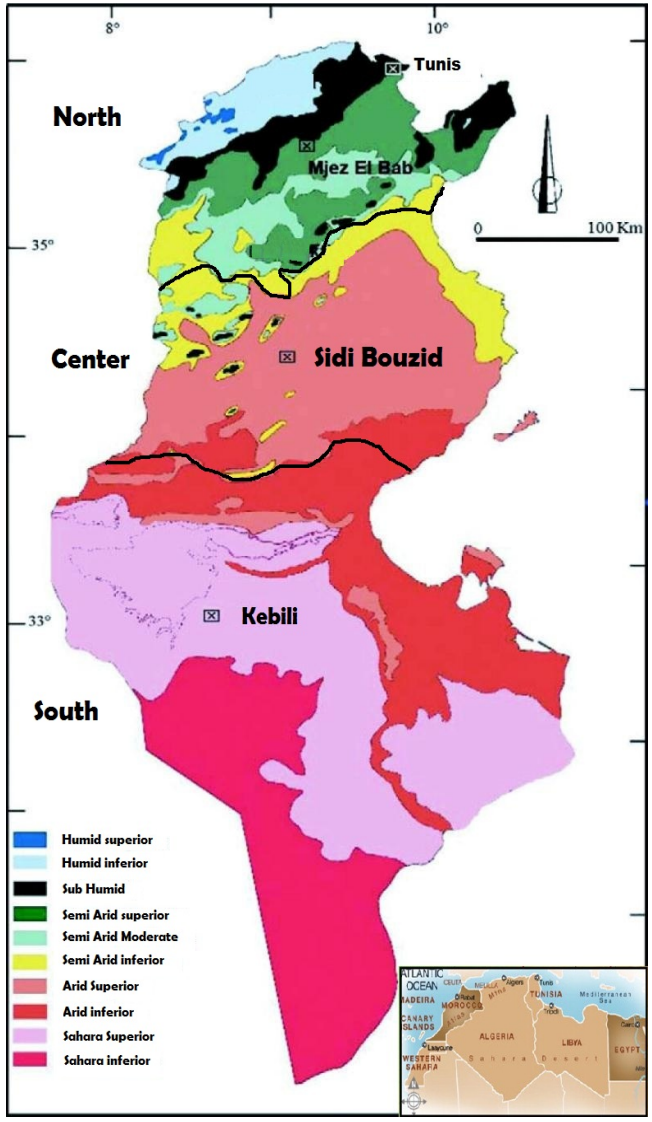
# Economic water productivity (EWP)

- The **economic value** derived per unit of water used **($ per drop)**
- Economic water productivity **(US$/m$^3$)** is calculated by multiplying physical water productivity **(kg/m$^3$)** by crop value **(US$/kg)**
- **Easier** to compare productivity between different crops
- **Blue EWP** may be a relevant variable for production decisions

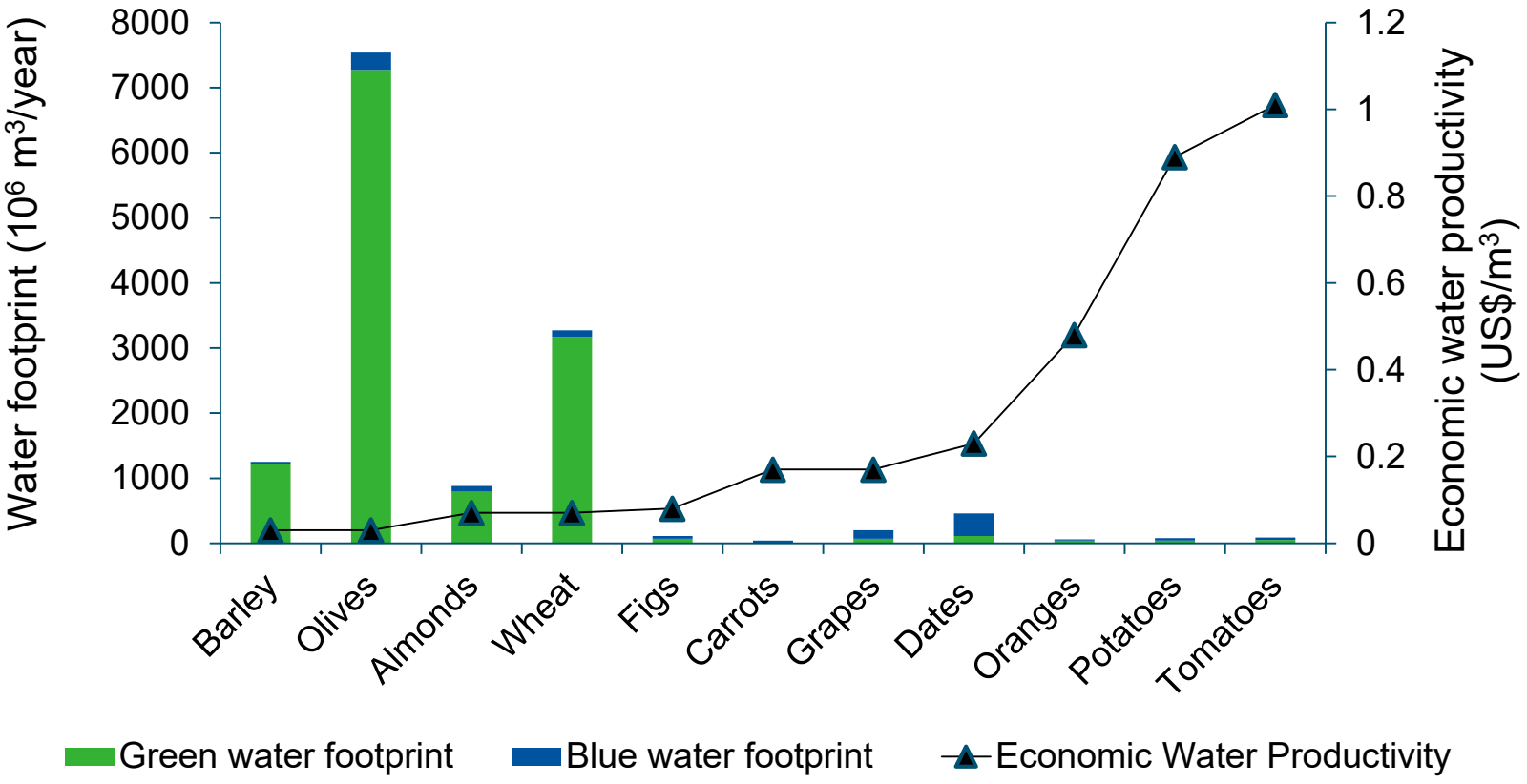
# Case study: Tunisia

- Limited water resources : **403.6 m³**/capita /year (2017)
- Spatial and temporal variability of water resources
- **7 %** of agricultural land under irrigation ⇨ **35%** of the total production
- Annual rainfall: from **100 mm** in the extreme south to over **1200 mm** in the extreme north



# Water allocation for main crops in Tunisia

Total blue and green water footprint and economic water productivity of main crops in Tunisia



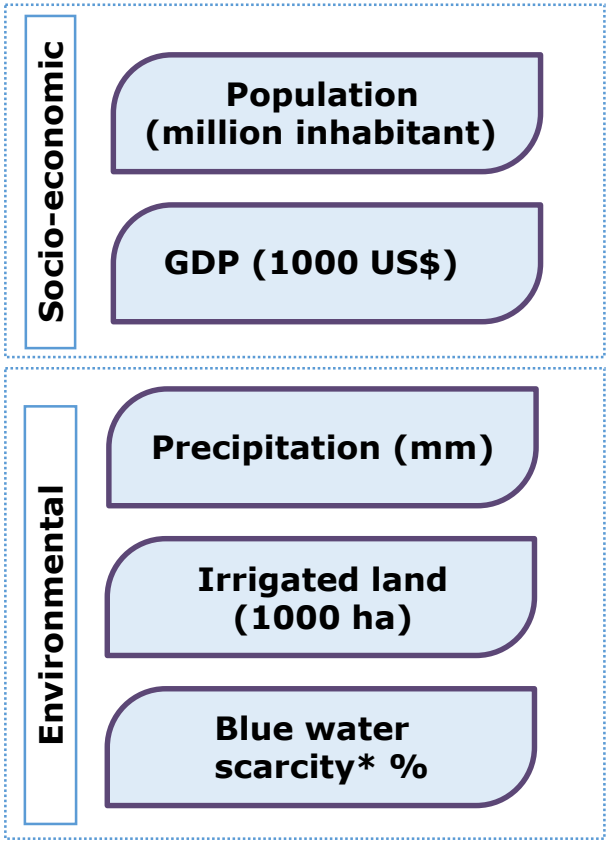

Source: Chouchane et al. (2015) *The Water Footprint of Tunisia from an economic perspective, Ecological Indicators*

# Virtual water trade

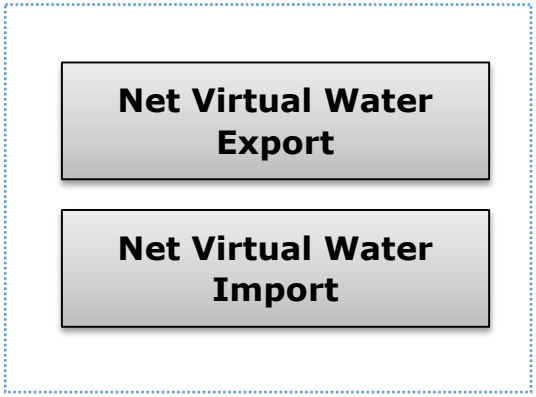
- "Virtual Water" refers to the water virtually embedded in traded products
- Water scarce countries can save water by importing water-intensive products instead of producing them locally
- Compensating for the gap between local demand and supply of water-intensive commodities

# Virtual water driving factors

- Regression analysis




**Independent Variables**




**Dependent Variables**

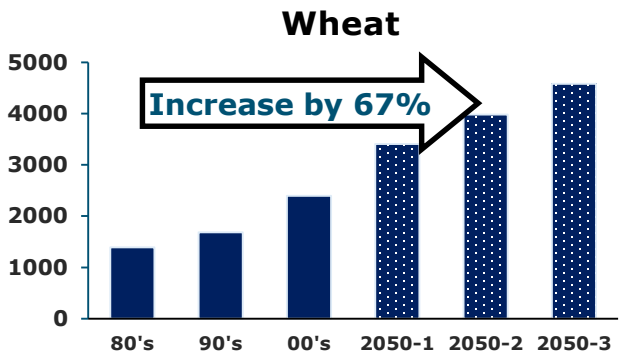
* Blue water scarcity = blue water footprint / surface + ground water availability

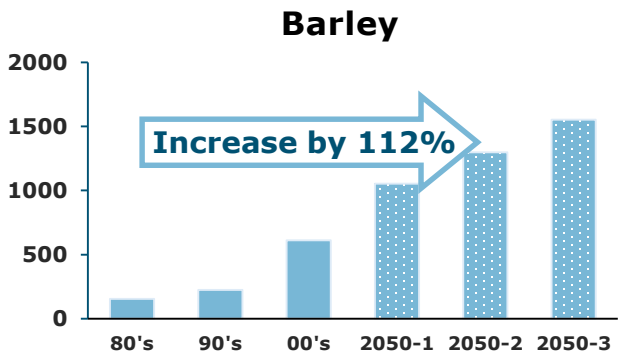
Source: Chouchane et al. (2018) *Virtual water trade patterns in relation to environmental and socioeconomic factors: A case study for Tunisia, Science of The Total Environment*

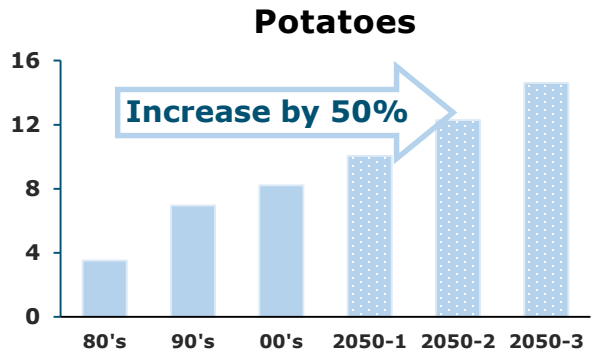
# Virtual water driving factors / results

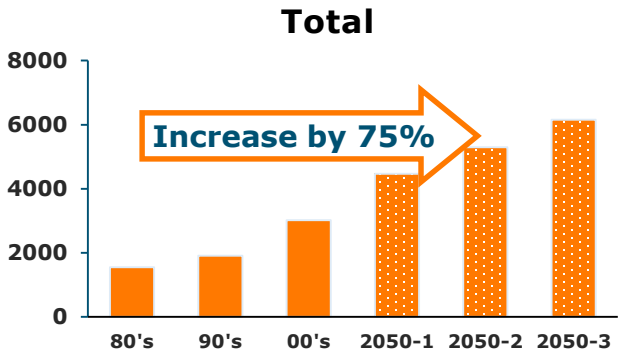
- **Precipitation** and **population** explain net virtual water **import.**
- **GDP** and **irrigated land** explain net virtual water **export.**
- **Blue water scarcity** did not appear as a significant factor in explaining net virtual water import of the selected crops in Tunisia.

# Population and climate change scenarios




- 2050-1: combine the median of 16 climate scenario and the UN low population scenario
- 2050-2: combine the median of 16 climate scenario and the UN medium population scenario
- 2050-3: combine the median of 16 climate scenario and the UN high population scenario
- Increase between 00's and 2050-2

Source climate scenarios: https://crudata.uea.ac.uk/~timm/climate/ateam/TYN_CY_3_0.html
Source population growth scenarios: https://population.un.org/wpp/

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# Concluding remarks

- Water footprint and economic water productivity help understand water allocation efficiency.
- Better prepare for future challenges such as population growth and climate change
- Virtual water can help countries, if used smartly, to save water and mitigate future challenges impacts
- It is important to project future demand and prepare mitigation measures

# Future research

- Extended research on impact of climate change hazards on production (assessing production loss)
- Mitigation measures (irrigation system, crop varieties, diet change, management practices...) and their cost and benefit in crop production
- Add more countries from the Mediterranean and crops in the analysis to have a broader picture of climate change impacts

**“Climate change is an economic, public health, and environmental issue that we have a moral responsibility to address.”**

**– Brad Schneider**

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