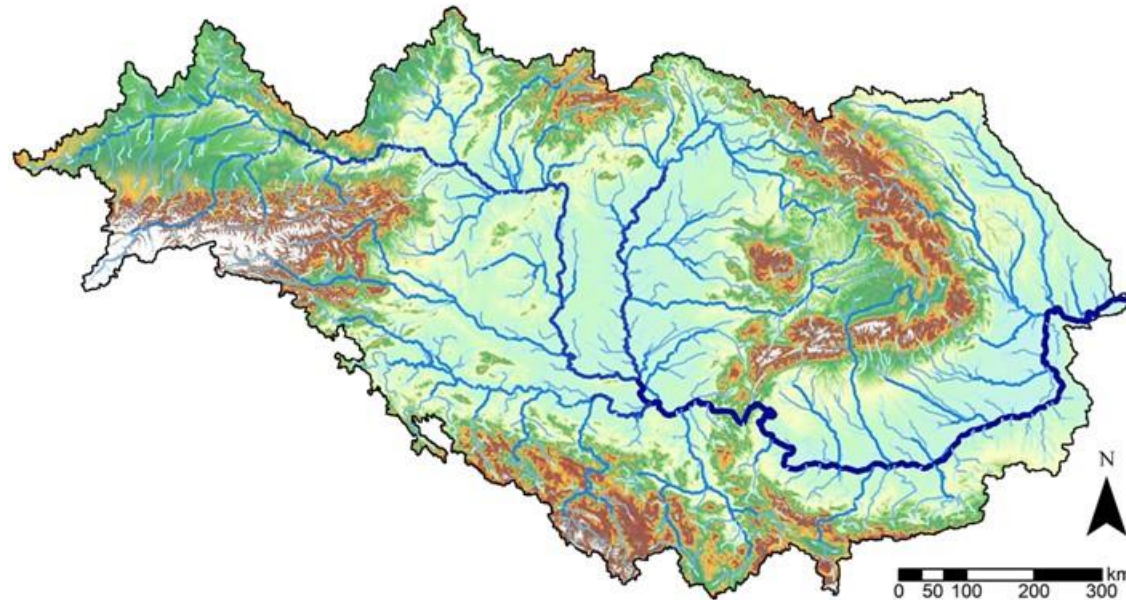


The Danube River Basin – Water-Food-Energy Assessment using PROMET

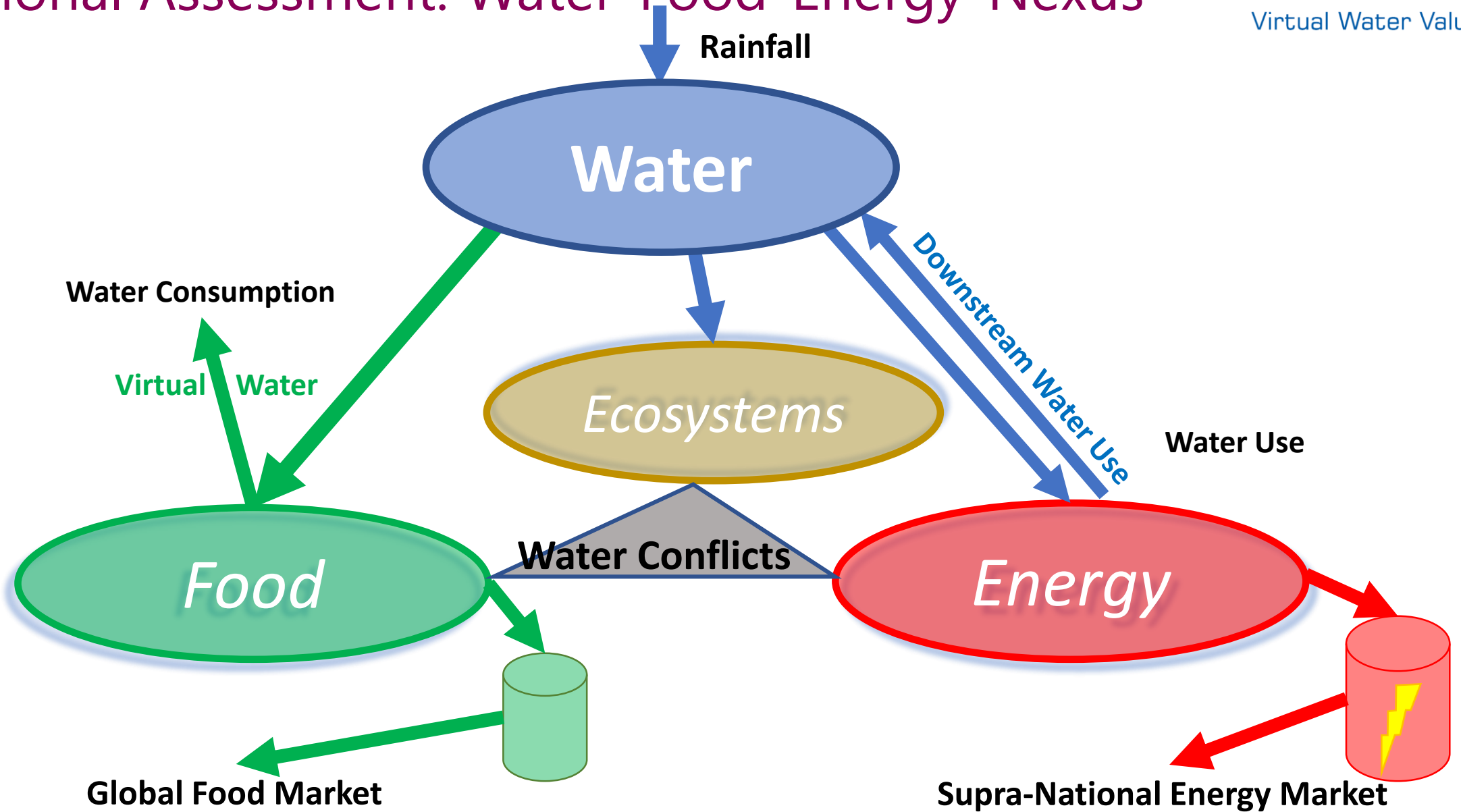


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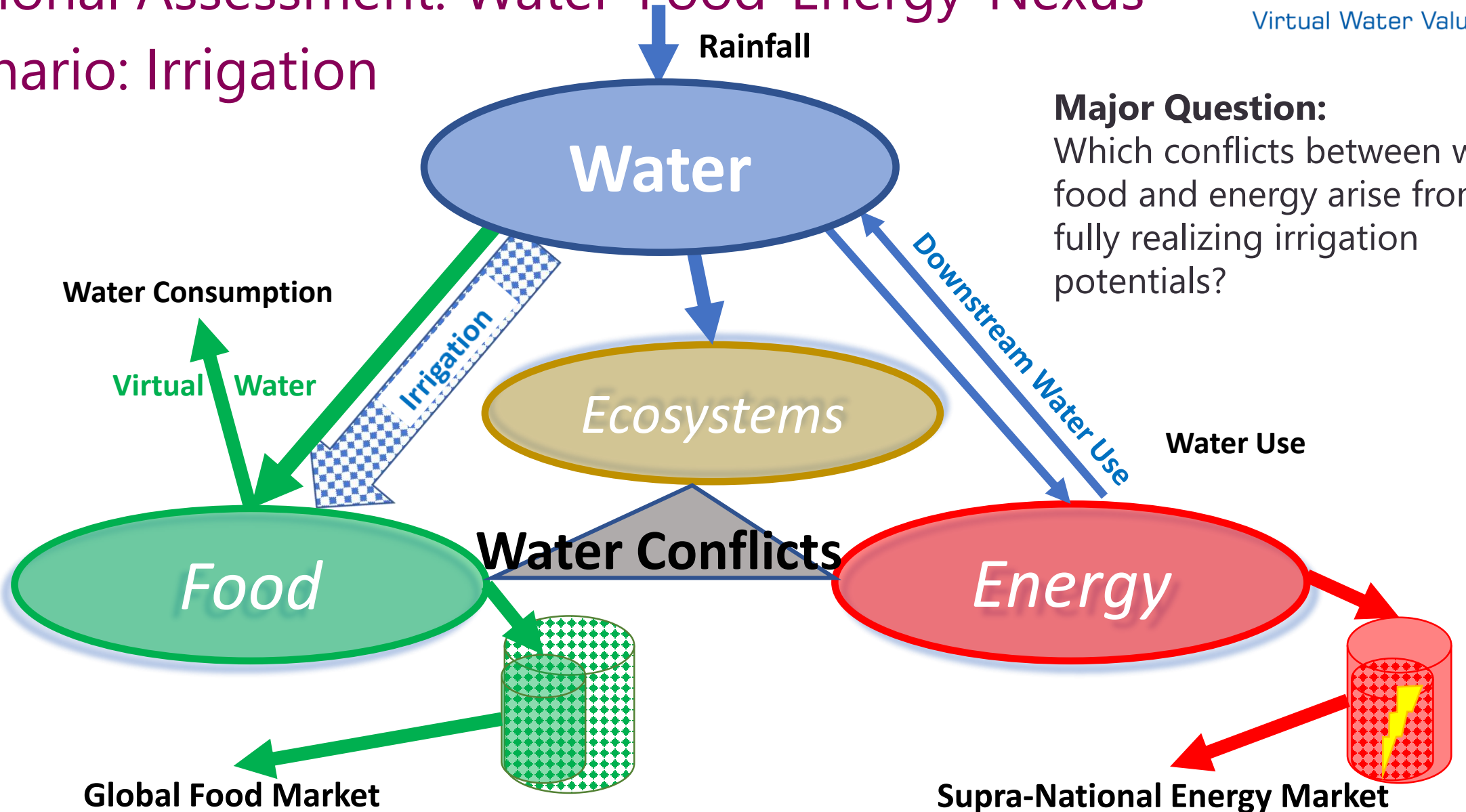
viwa.geographie-muenchen.de/viwa-marketplace/

Regional Assessment: Water-Food-Energy-Nexus

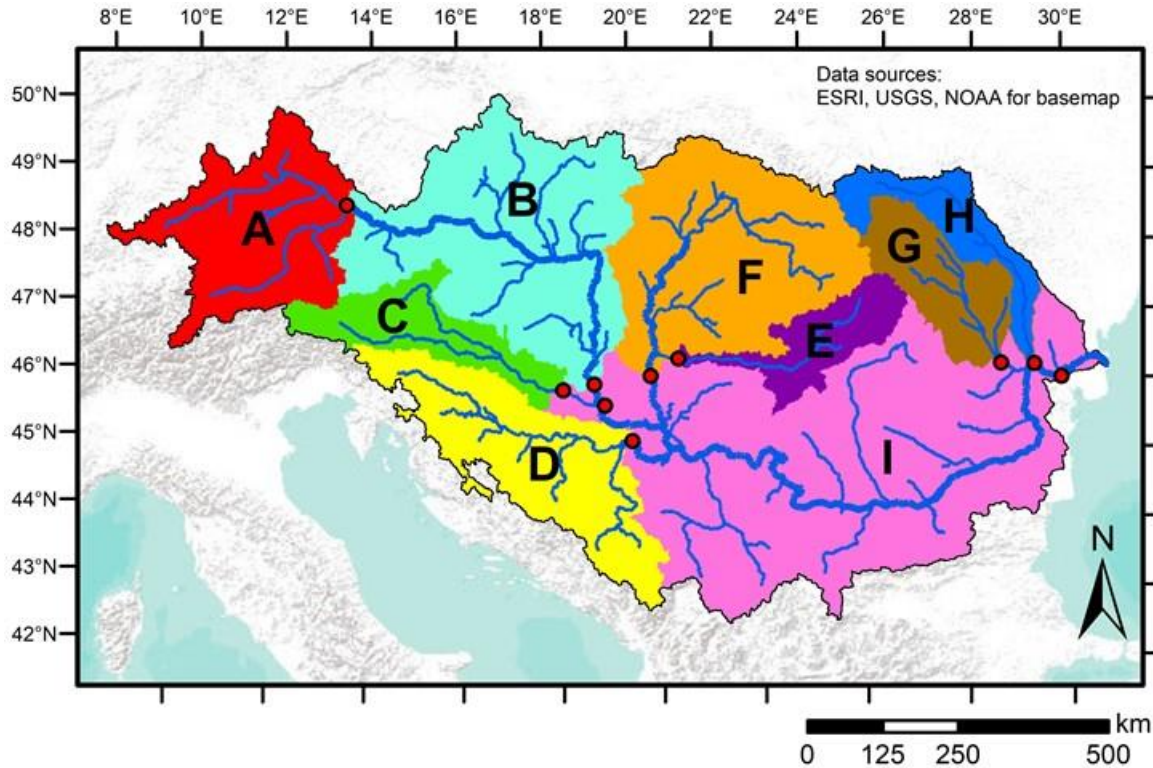


Regional Assessment: Water-Food-Energy-Nexus

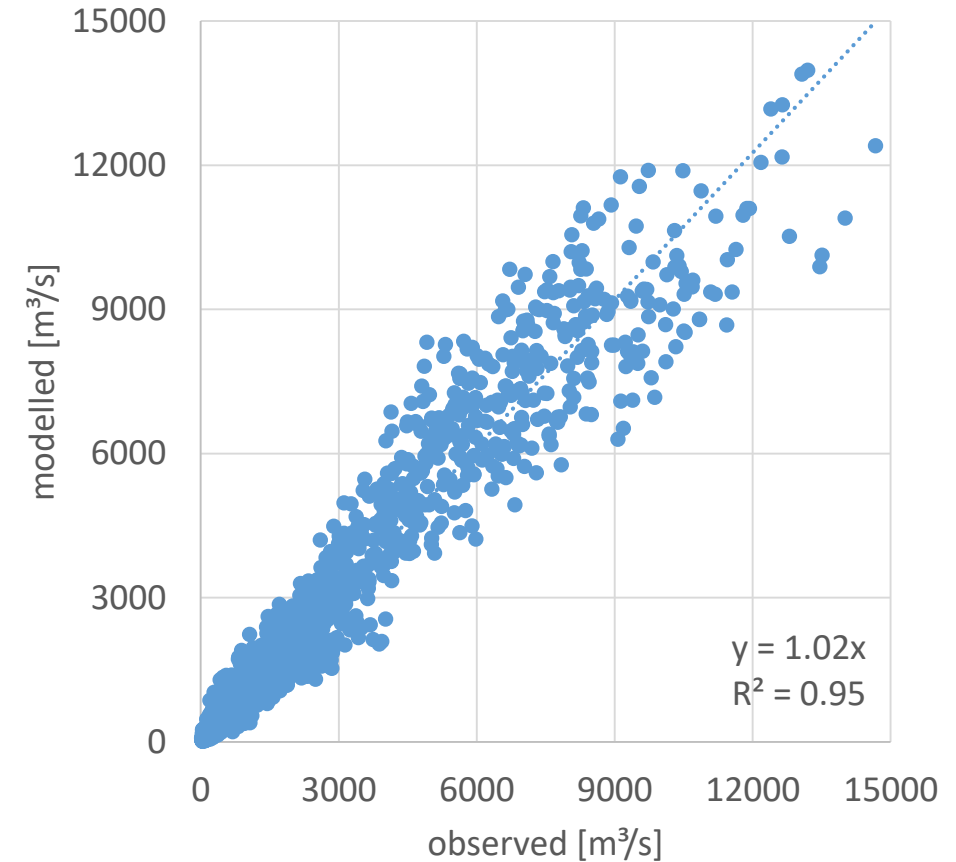
Scenario: Irrigation



Water in the Nexus:



Monthly discharge Danube (+SWS) 1980-2018



Approach:

- No calibration with measured data, closed water-, energy- and carbon-balance

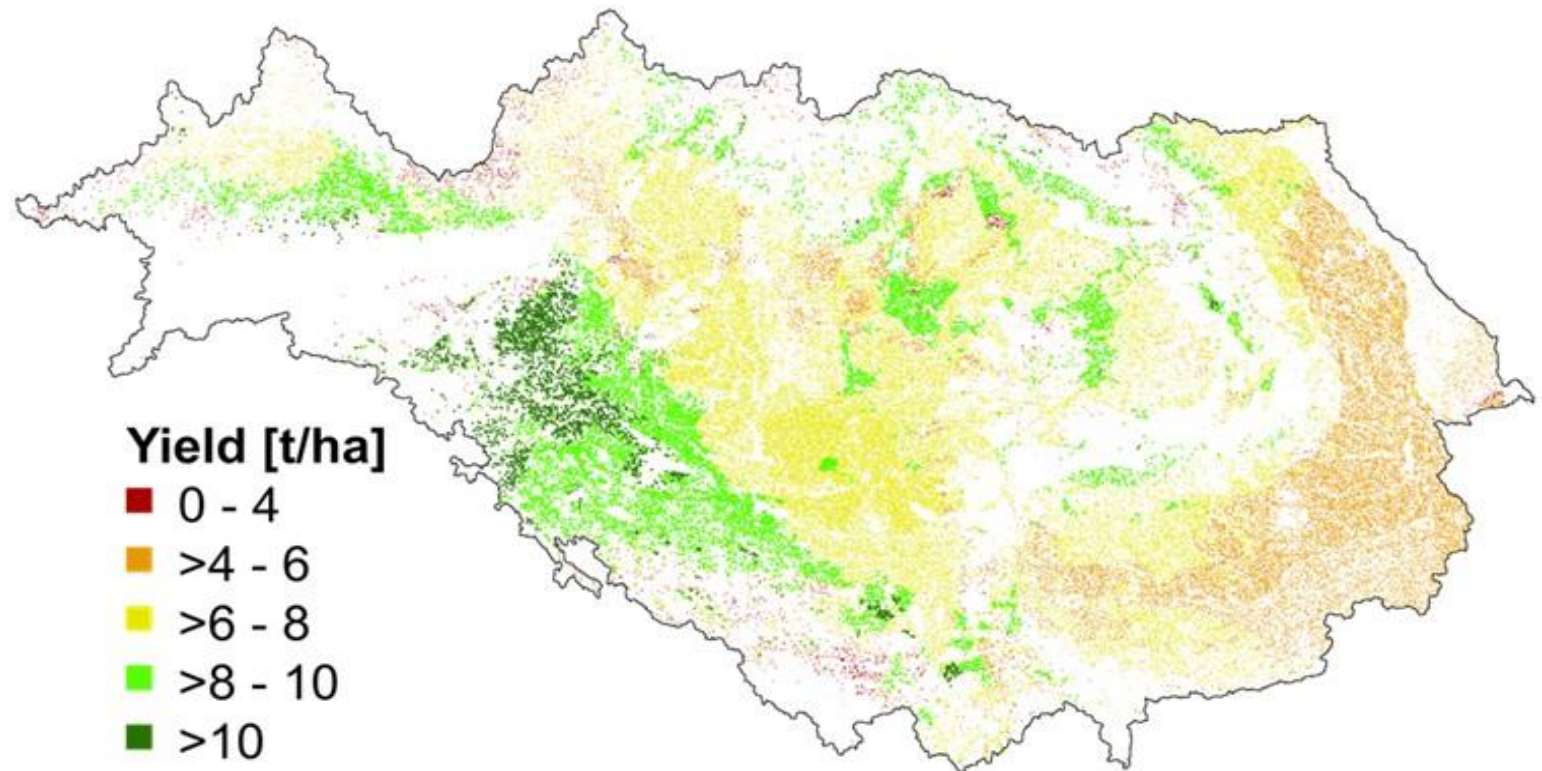
Food in the Nexus: Taking maize as an example – *actual yield*

Mean actual yield (2015-2018)

Rainfed,
standard fertilization,
No pests

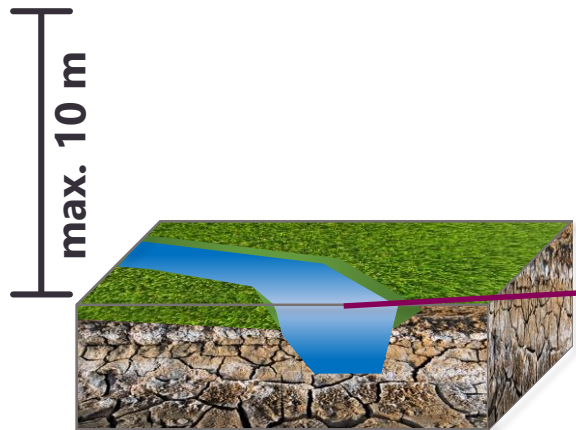
Modelled Maize Yield: 6.9 t/ha
EUROSTAT (Danube Countries): 6.8 t/ha

Total Production: 40.2 Mio t

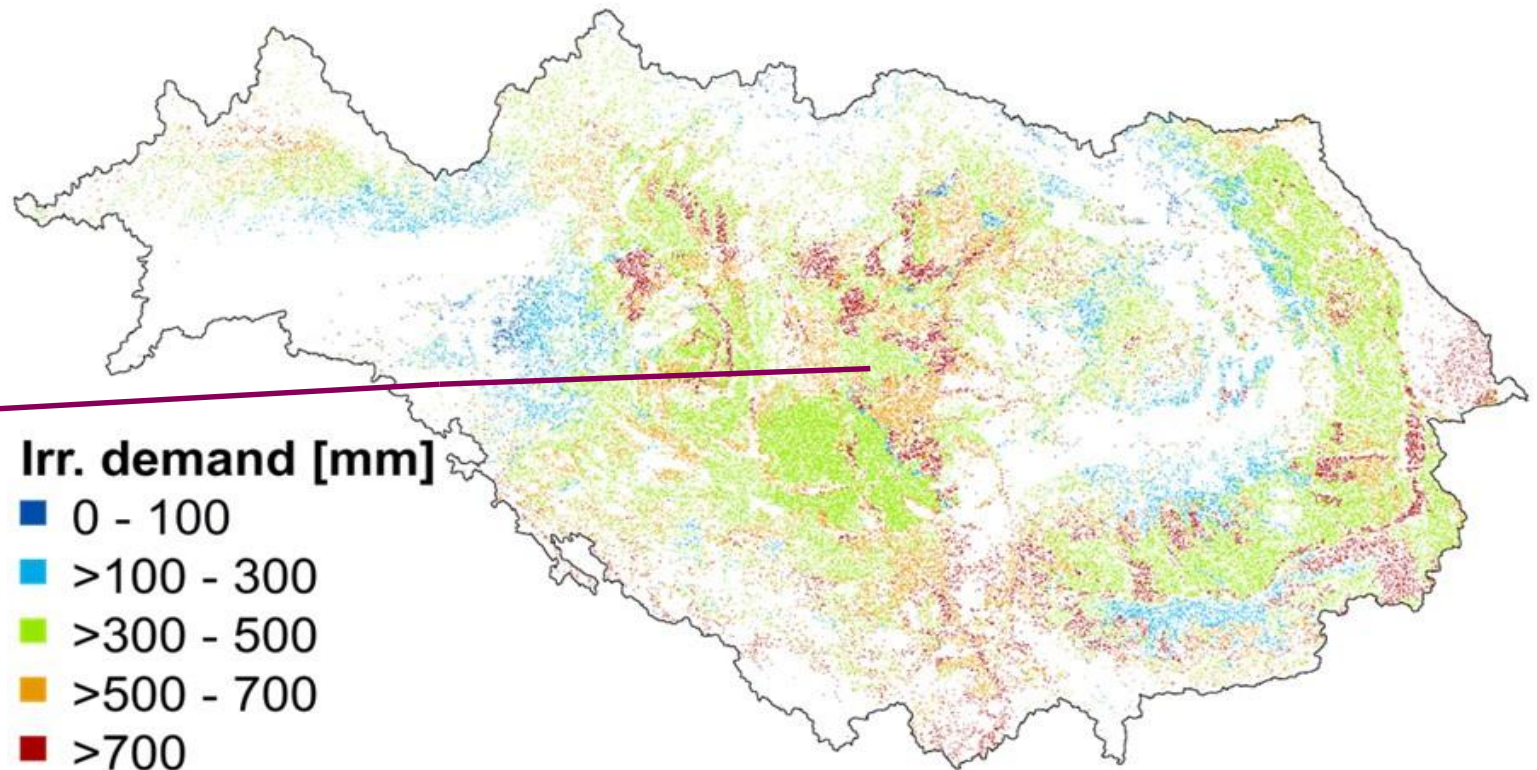


What happens, if large-scale irrigation of maize is introduced?

Mean irrigation demand:
~500 mm/season



Mean Irrigation Water Demand per Season (2015-2018)



Surface water?

Extract irrigation water from closest extraction point in the river network

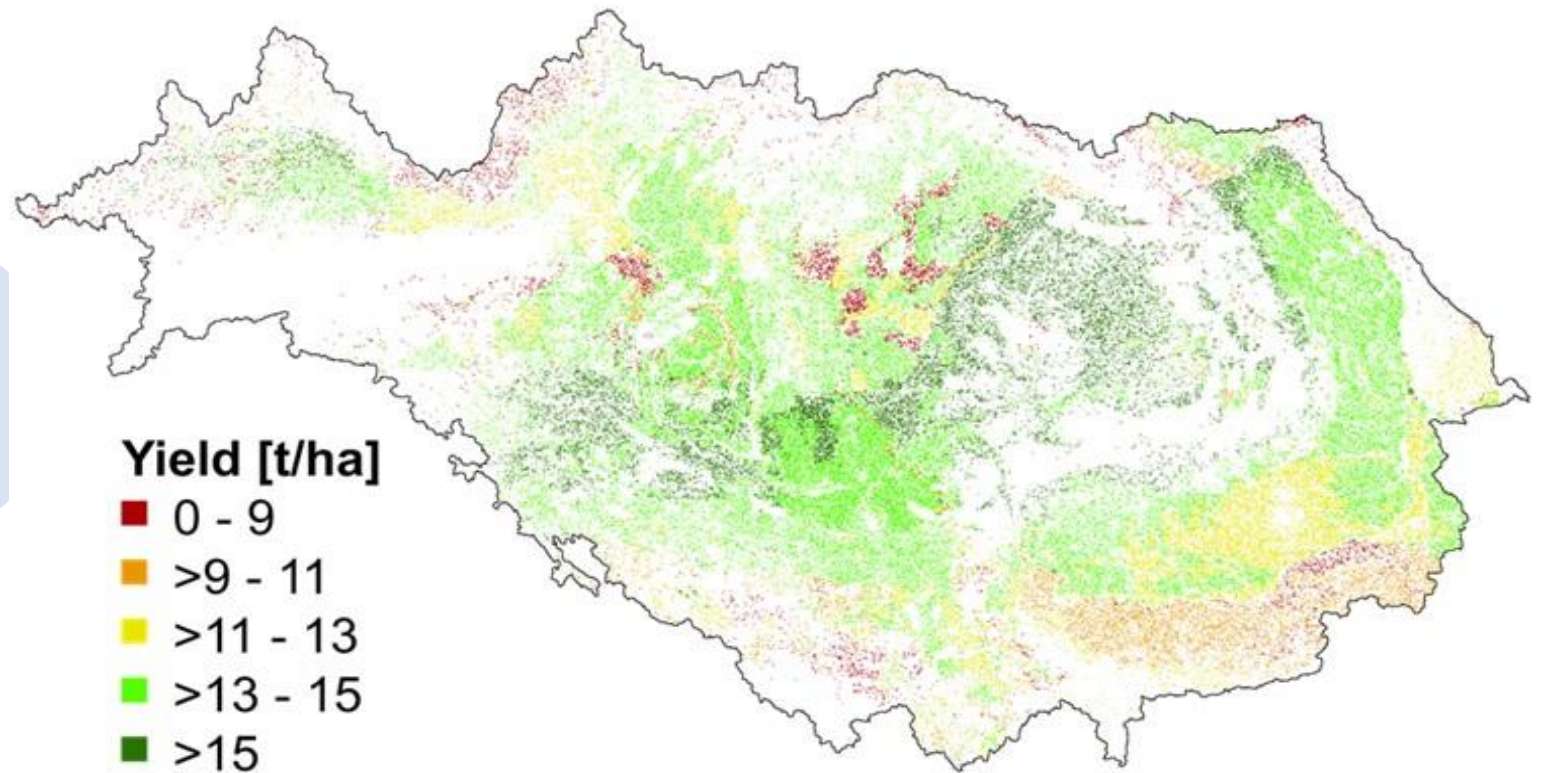
Food in the Nexus: Taking **maize** as an example – *irrigated yield*

Full irrigation,
Full fertilization,
No pests

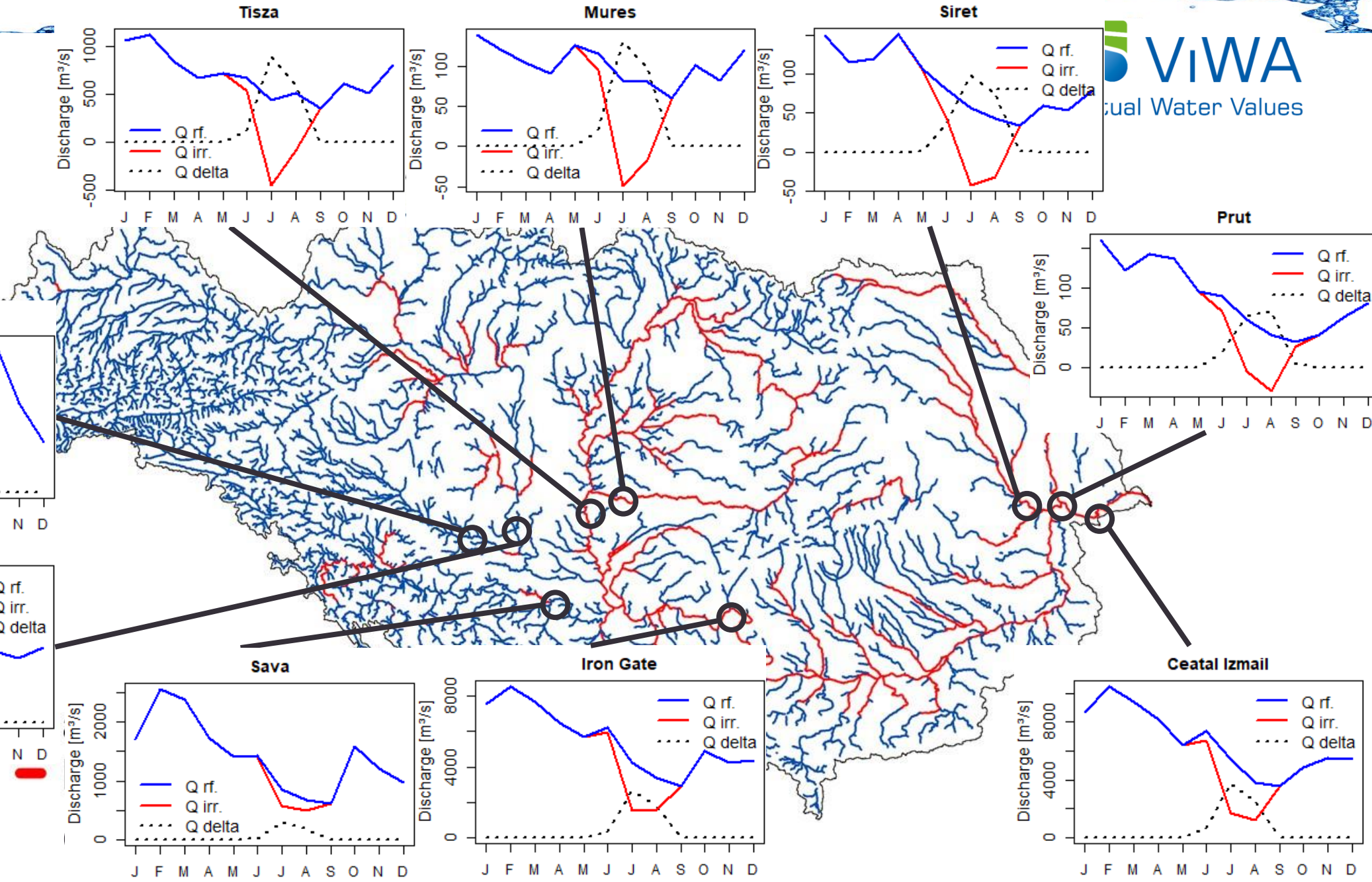
Mean irrigated yield (2015-2018)

Modelled Maize Yield: **13.4 t/ha vs. 6.9 t/ha**
Total Production: 77.8 Mio t vs. 40.2 Mio t

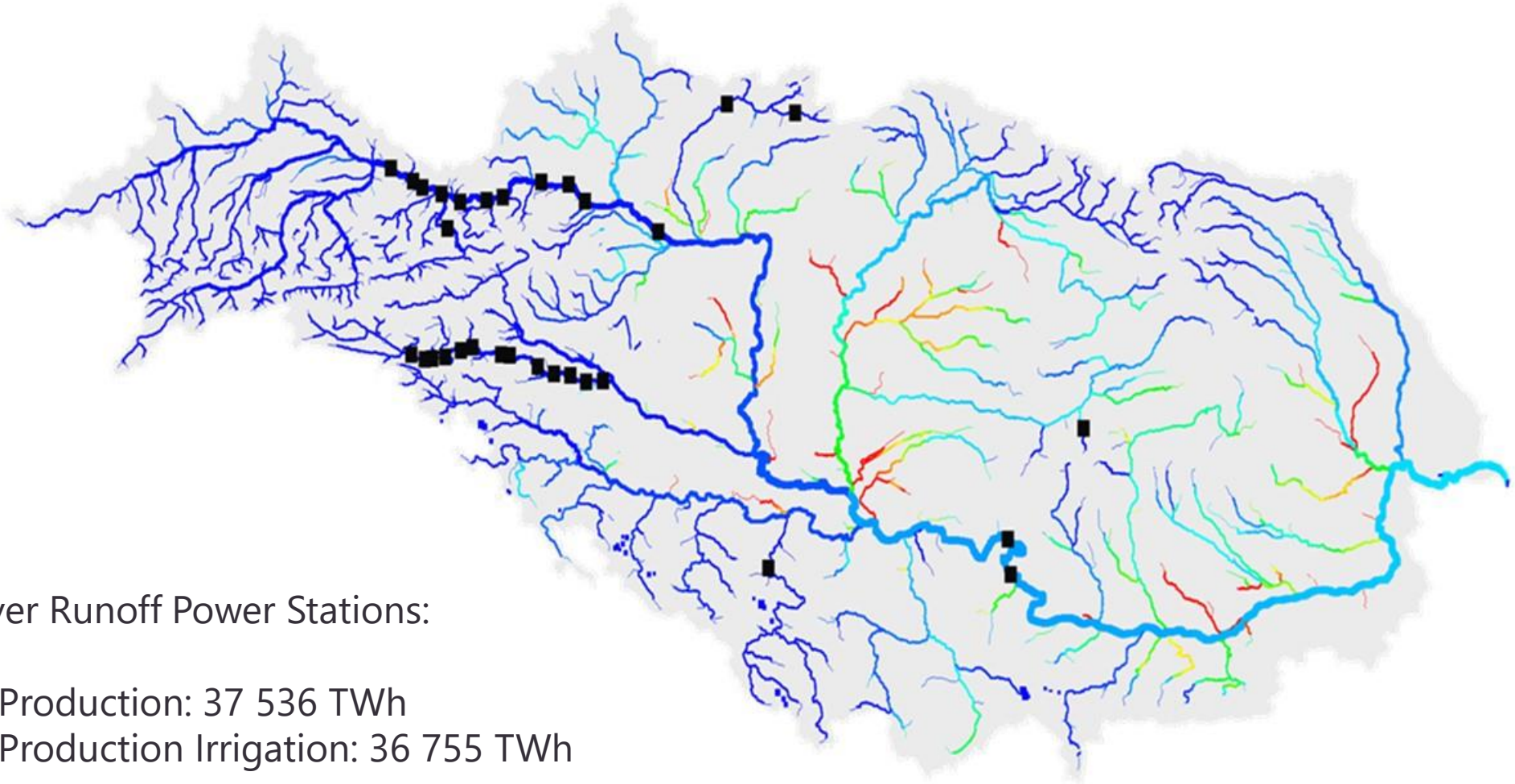
Total Irrigation Water Consumption: **29 Gm³**



Scenario: Impact on runoff



Energy in the Nexus: Impact of Scenario on Hydropower



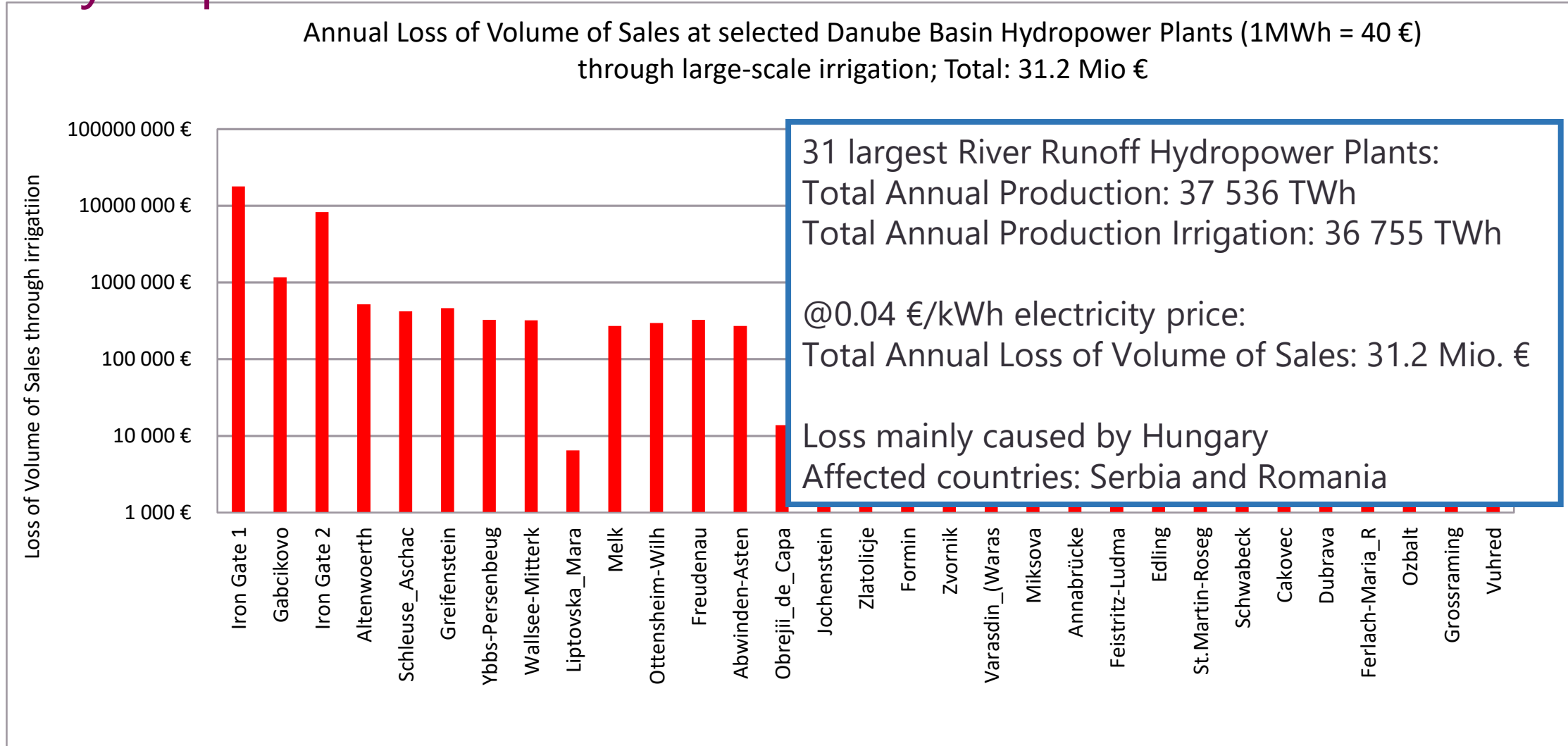
31 largest River Runoff Power Stations:

Total Annual Production: 37 536 TWh

Total Annual Production Irrigation: 36 755 TWh

Energy in the Nexus: Impact of Scenario on Hydropower

Annual Loss of Volume of Sales at selected Danube Basin Hydropower Plants (1MWh = 40 €) through large-scale irrigation; Total: 31.2 Mio €



Synthesis: Impact of large-scale irrigation on Danube

Integrated assessment:

1) Water:

- Irrigation water withdrawal: ~29 billion m³/a, mostly in Hungary, Serbia and Romania
- **Severe ecological consequences:** discharge in July/August falls below min. ecological flow requirements (\triangleq 60% of monthly MQ = hard sustainability criterion) in most rivers in Hungary, Serbia and Romania

2) Food:

- Maize production roughly doubled from ~40 to ~78 Mio. t/a
→ increase in volume of sales of ~6 Billion €/a (@ 160 €/t maize)

3) Energy:

- Hydropower production is reduced from 37.5 to 36.7 PWh/a
- → reduction in volume of sales of ~30 Mio €/a (@ 0.04€/kWh)