Solar energy for irrigation: mitigation and adaptation option for the Mediterranean

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Thanks to: Sinan Shi, Werner von Bloh, Fabian Boyard, Alberte Bondeau, Wolfgang Cramer

OT-MED LABEX

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Research questions & integration in OT-Med

1. Irrigation water requirements in the Mediterranean
2. Potential savings through more efficient irrigation systems
3. Can photovoltaics provide the energy needed for future irrigation? And if yes, using how much area?

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OT-MED objectives:

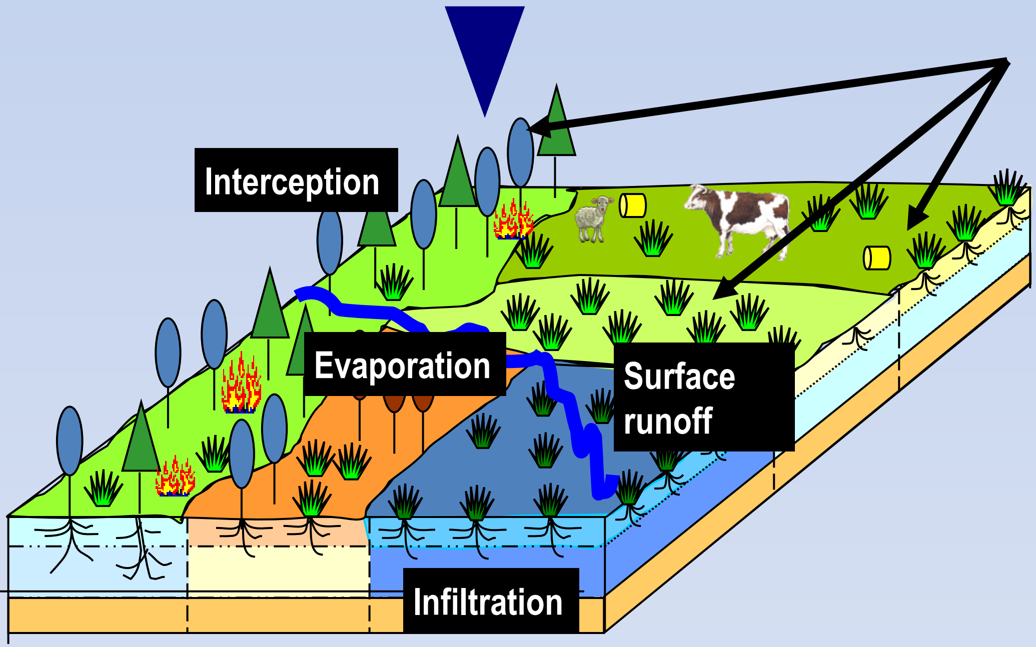
- Interdisciplinary research human – environment interactions
- Innovative strategies to help decision-makers in elaborating public policies and enterprises in treating environmental questions

TWP2 objective:

- Sensitivity of the Mediterranean's anthropogenic ecosystems to projected climate changes

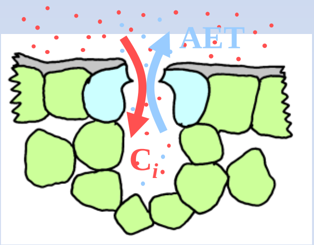
Modelling tool: LPJmL

Climate, CO_2 concentration, soil structure, land use



Irrigated and rainfed agriculture, grasslands, natural vegetation

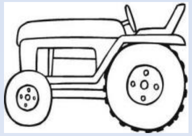
C, H_2O exchange



Photosynthesis
⇔
Water availability

Phenology

Management



Production

- River discharge (Gerten et al., 2004; Biemans et al. , 2009)
- Irrigation water requirements (Rost et al., 2008)
- Water consumption of crops (Fader et al., 2010)

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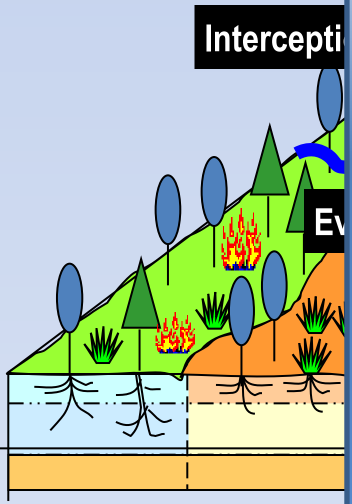

A process-based vegetation, agro-ecosystem and hydrology model

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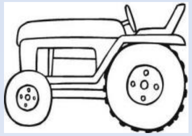
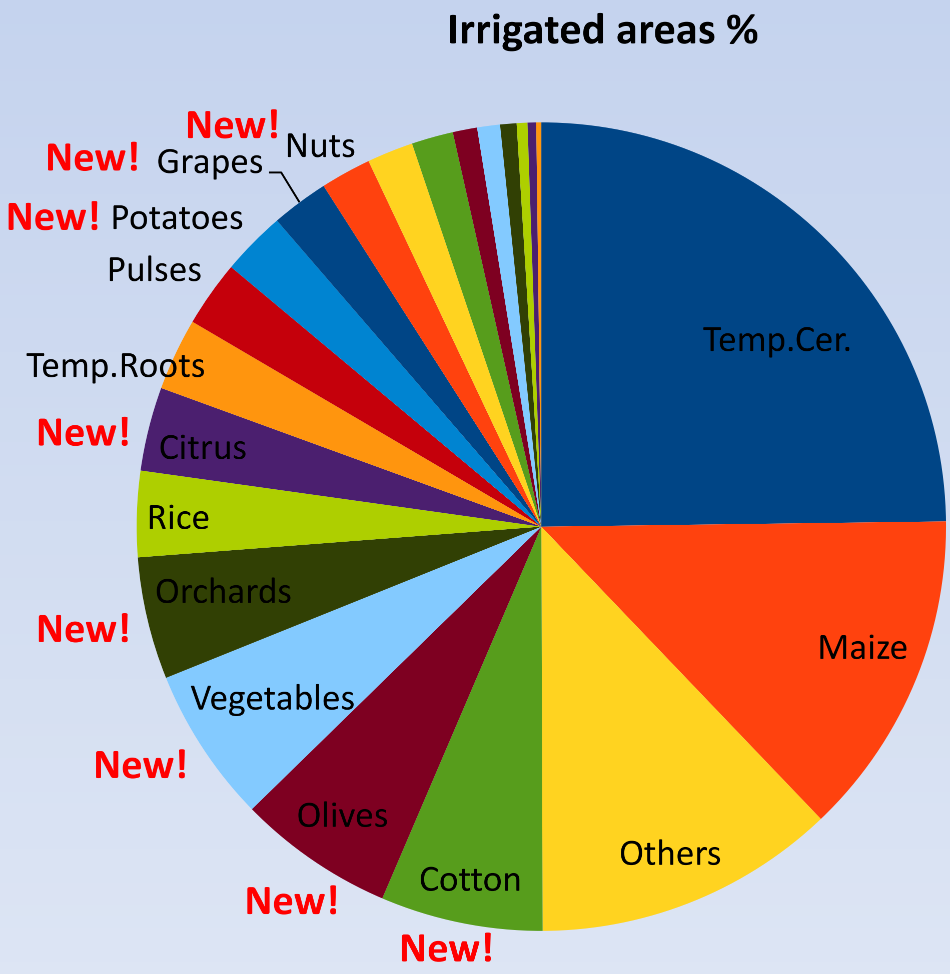
Rost et al., 2008)

- Water consumption of crops (Fader et al., 2010)

Phenology



Model development: 10 Med. cultivars included



Agricultural trees: for adult trees a plant-specific portion of the biomass increment of the tree is harvested every year.

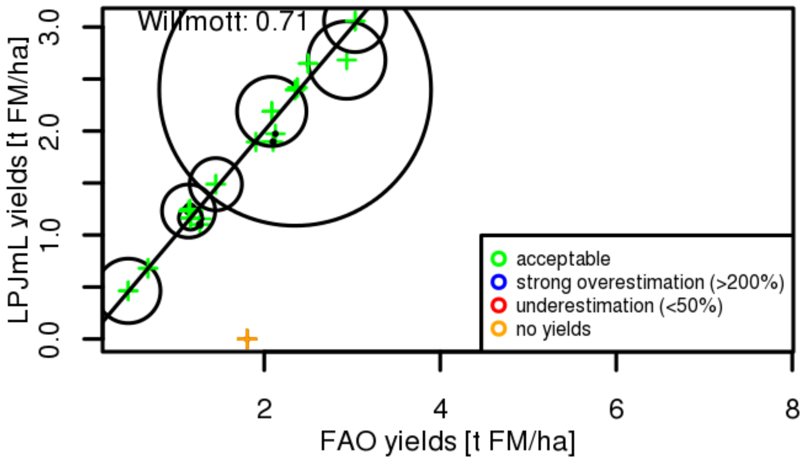
- **Deciduous:** fruits grow in the second half of the active phase of the year
- **Evergreen:** fruits grow in days where temperature is above the tree-specific base temperature.

Potatoes (annual crop): Phenology modelled after the heat unit theory. Spring and winter varieties.

Vegetables and fodder grass: parameterised as C3 grass (allows multiple harvests).

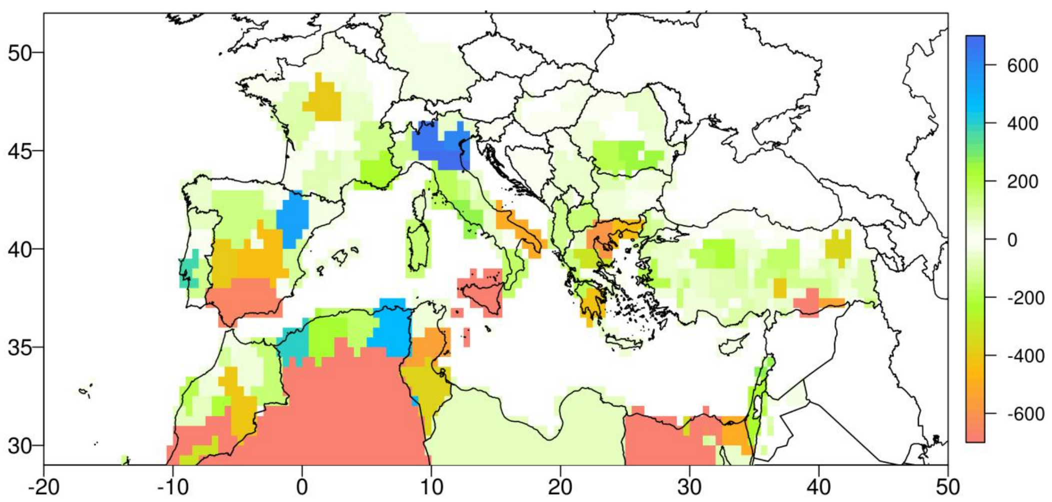
Model calibration & validation

Olives



Agricultural management calibrated for best possible match with FAO yield data.

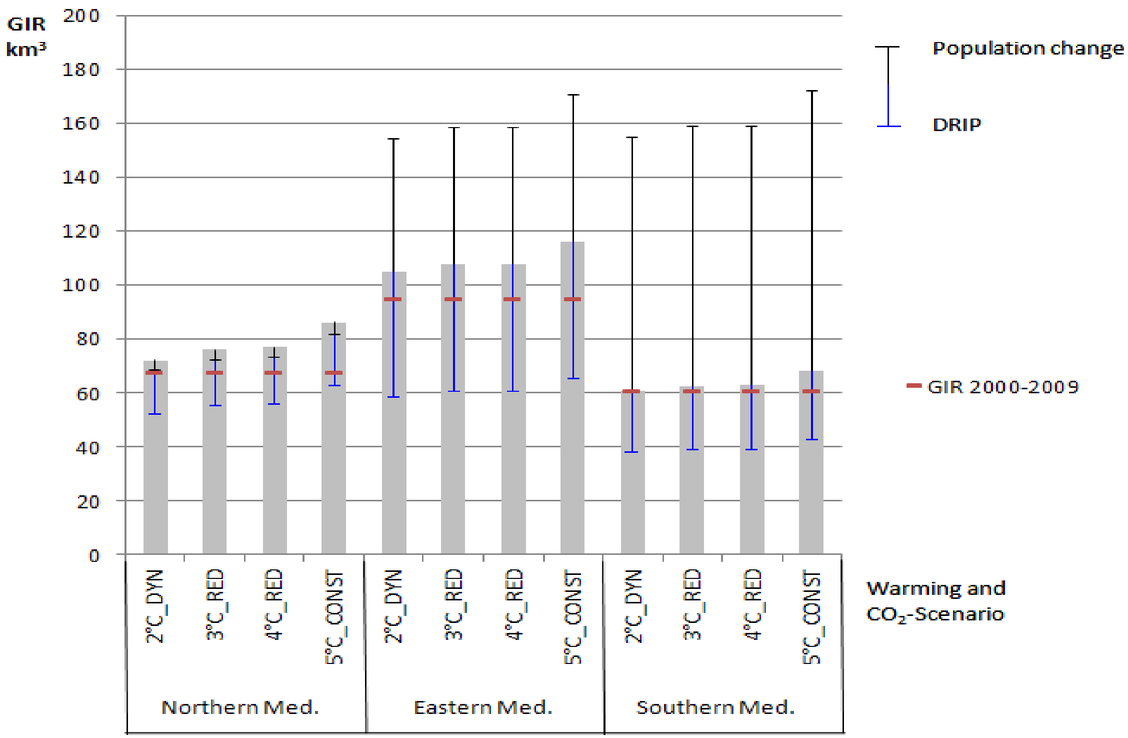
New algorithm developed



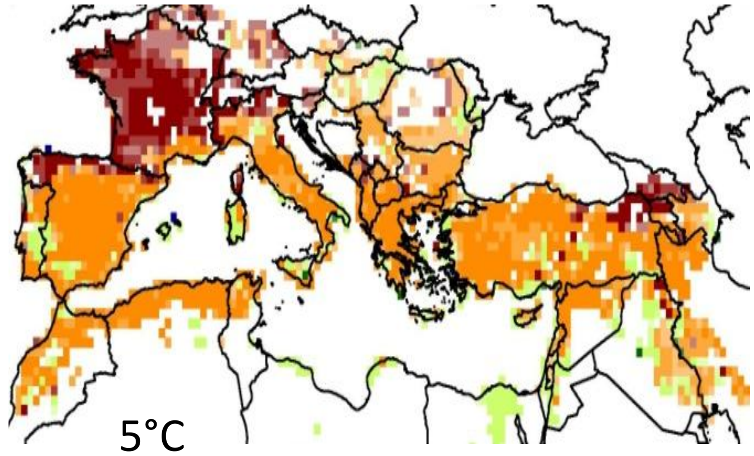
Testing irrigation water consumption with the GCWM (Siebert et al., 2010)

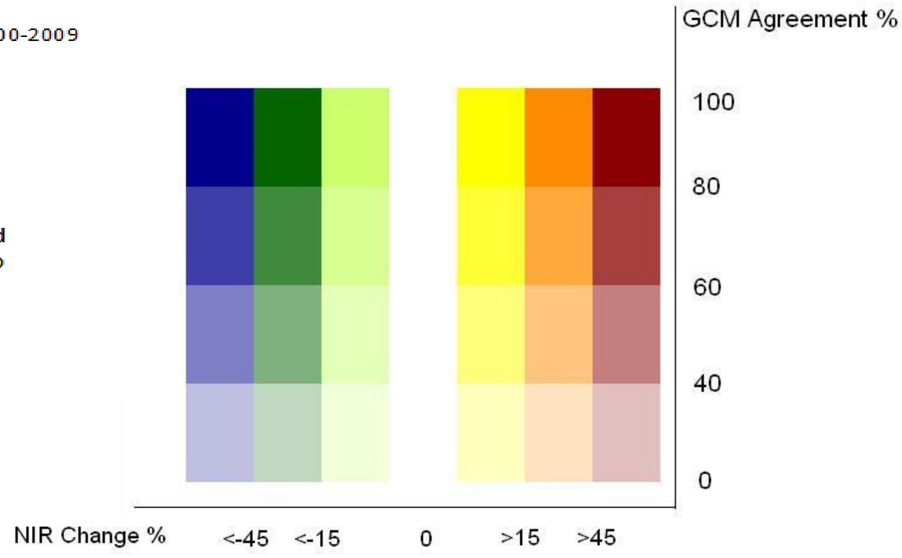
New testing routine developed

Climate change will increase irrigation requirements



2080-2090





Can we drive irrigation with photovoltaics?

3 ha grapes farm, Sprinkler, 34% increase in NIR (5°C warming 2080), Marseille
~200 m^3 d^{-1} for 3 ha
4 pumps working 5 h d^{-1}

Energy needed in 2000: ~84 MJ d^{-1}
Energy needed in 2080: ~112 MJ d^{-1}
Photovoltaic area needed in 2080 46 m^2

3 ha maize farm, Drip, 25% increase in NIR (5°C warming 2080), Marseille
~90 m^3 d^{-1} for 3 ha
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Energy needed in 2000: ~42 MJ d^{-1}
Energy needed in 2080: ~50 MJ d^{-1}
Photovoltaic area needed in 2080 21 m^2

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Thank you for your attention!