Climate change, variability and rice production in Italy

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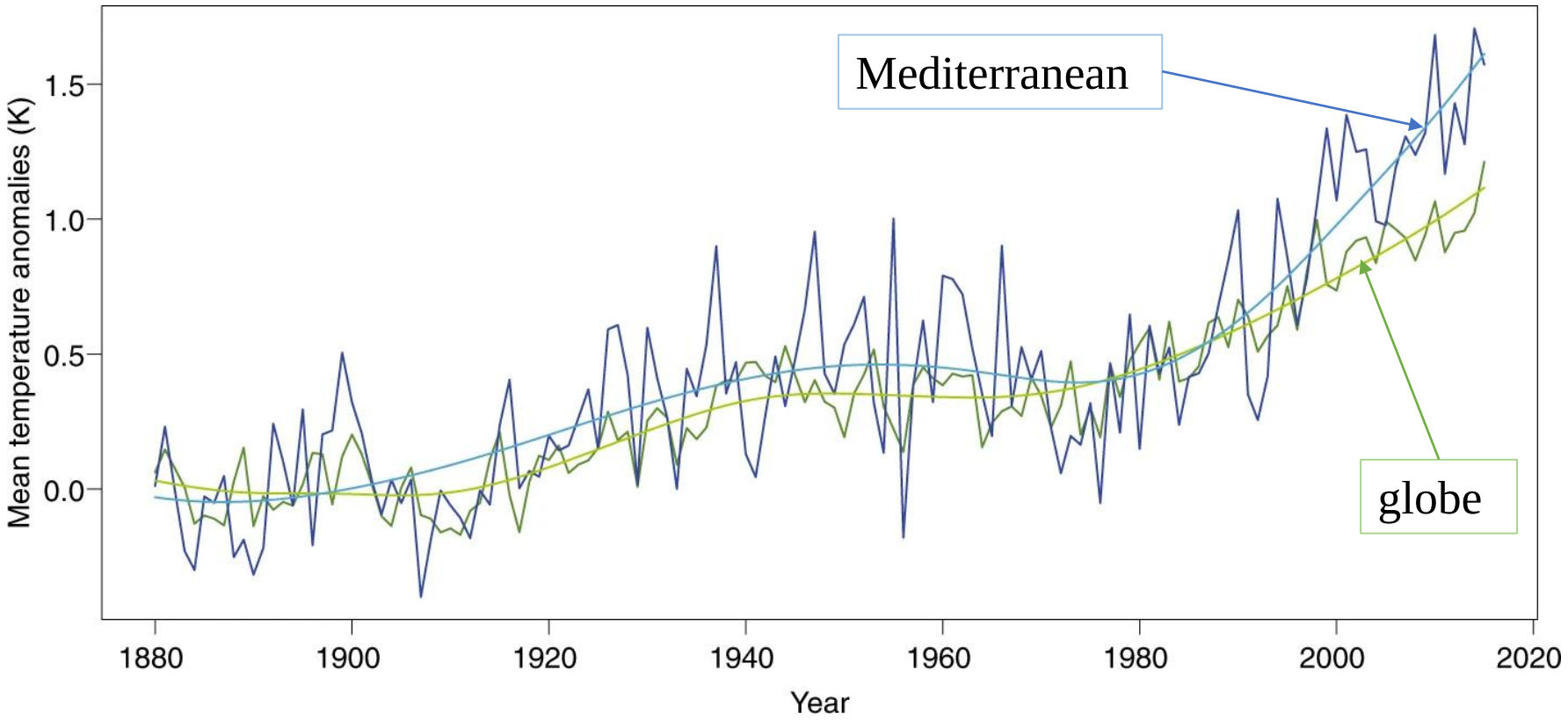
Past and Current Climate



Temperature anomalies (w.r.t. 1880-1899): Mediterranean region and the globe

Source: Cramer et al., Nature Climate Change 8, 2018

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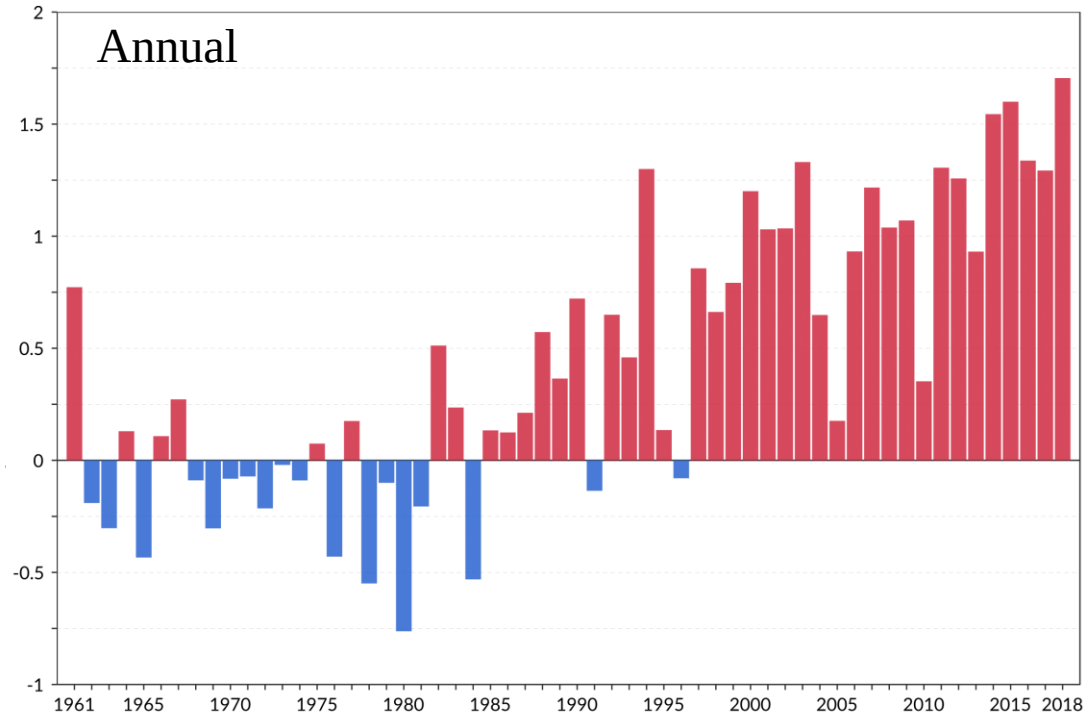
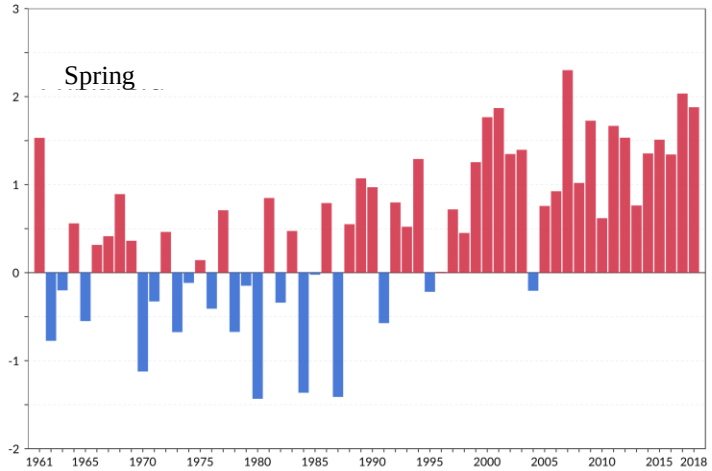
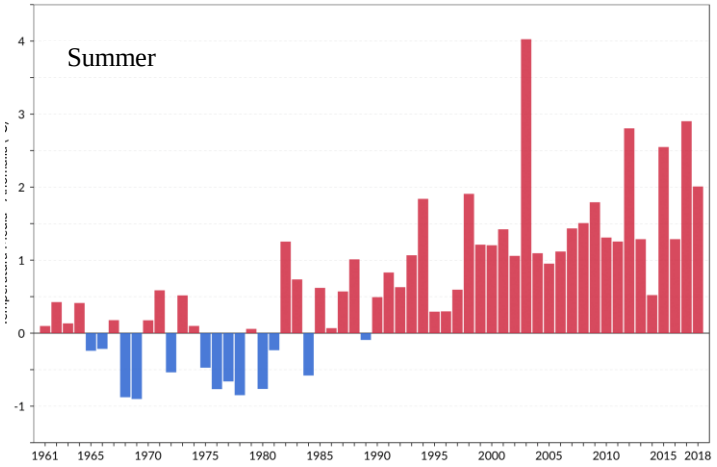
Past and Current Climate

Annual and Seasonal Mean Temperature Anomalies (w.r.t. 1961-90) in Italy







Source: Desiato et al., Ispra Report 88, 2019

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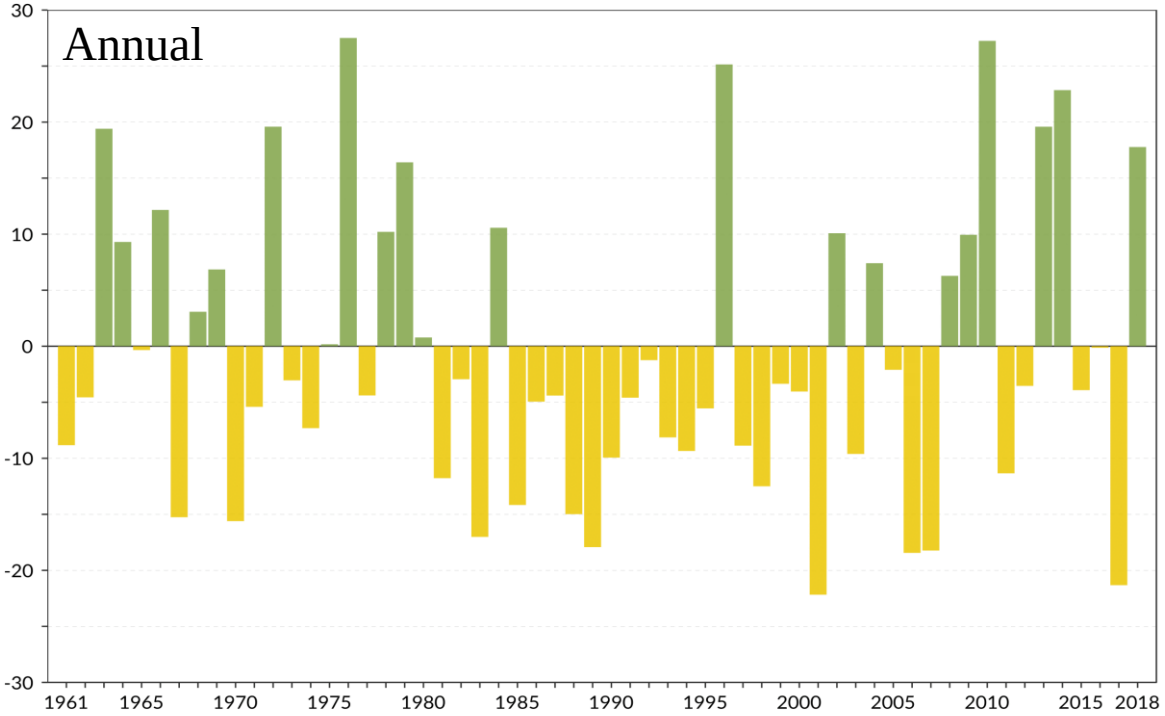
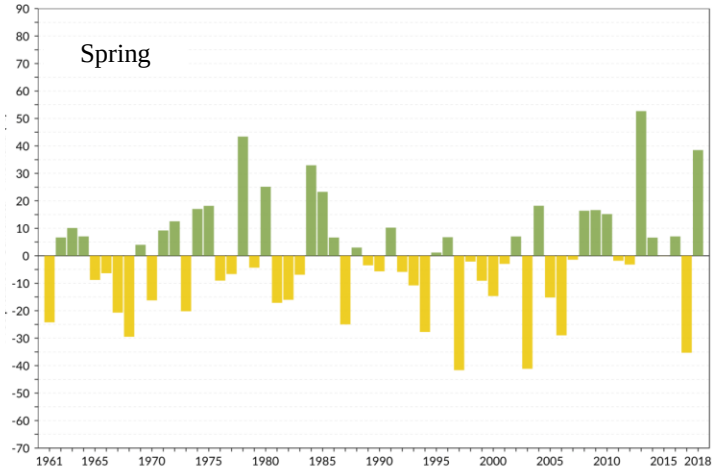
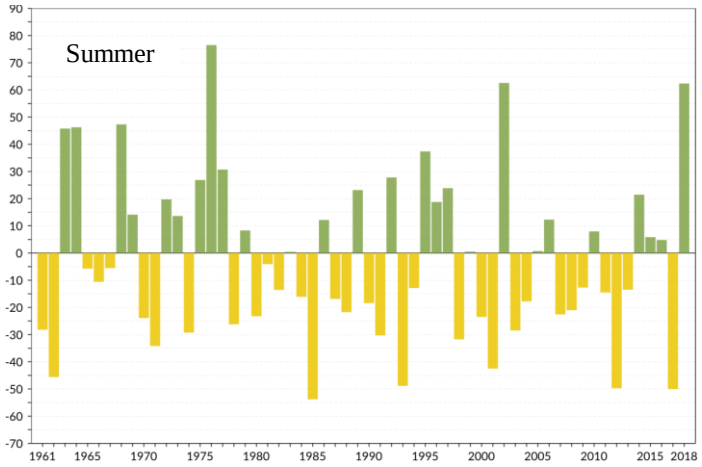
Past and Current Climate

Annual and Seasonal Precipitation Anomalies (w.r.t. 1961-90) in Italy







Source: Desiato et al., Ispra Report 88, 2019

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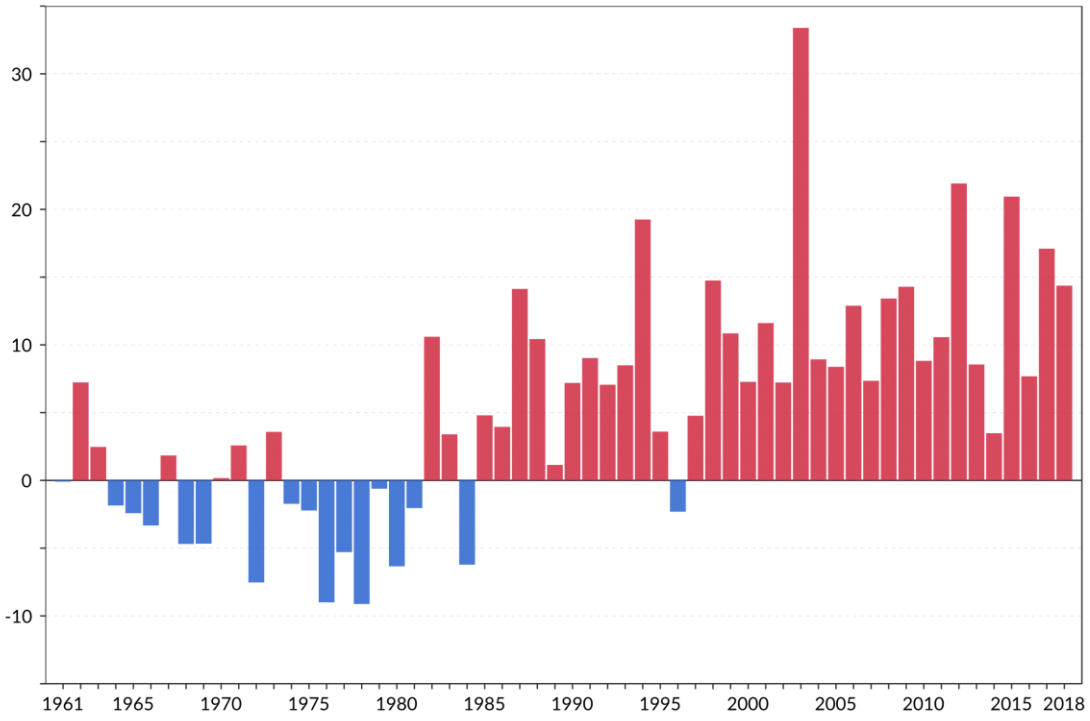
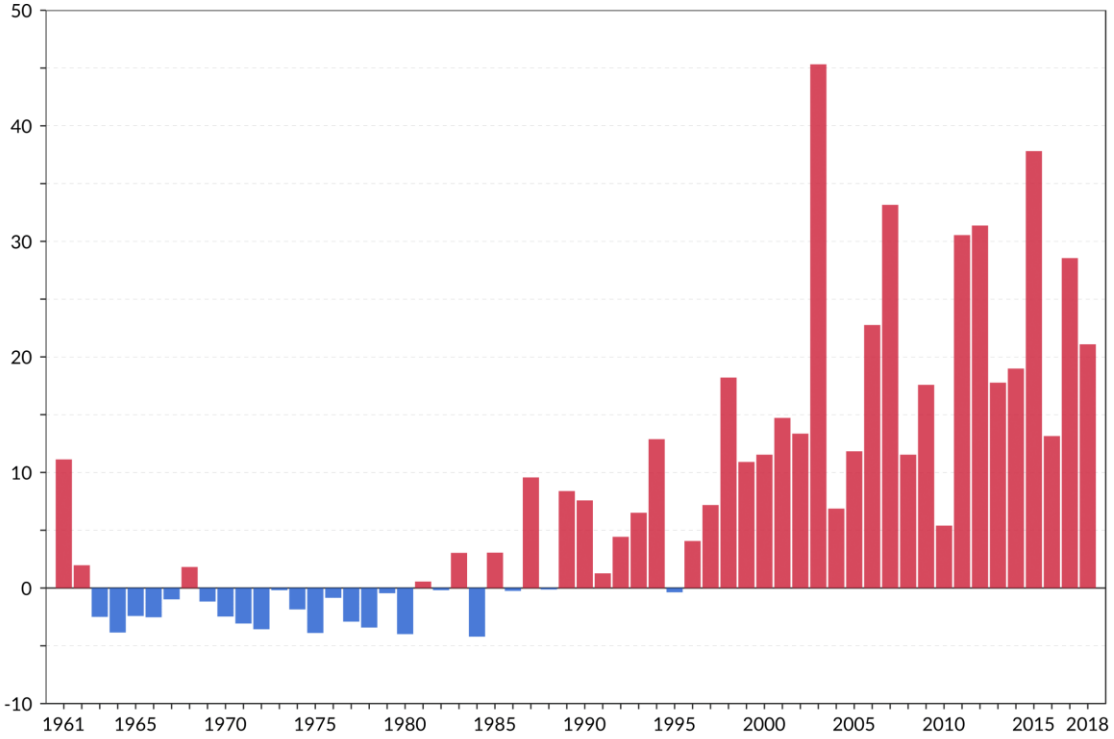
Tropical nights



Warm spell duration



High nighttime temperatures and heat stress during daytime affect rice productivity

Source: Desiato et al., Ispra Report 88, 2019

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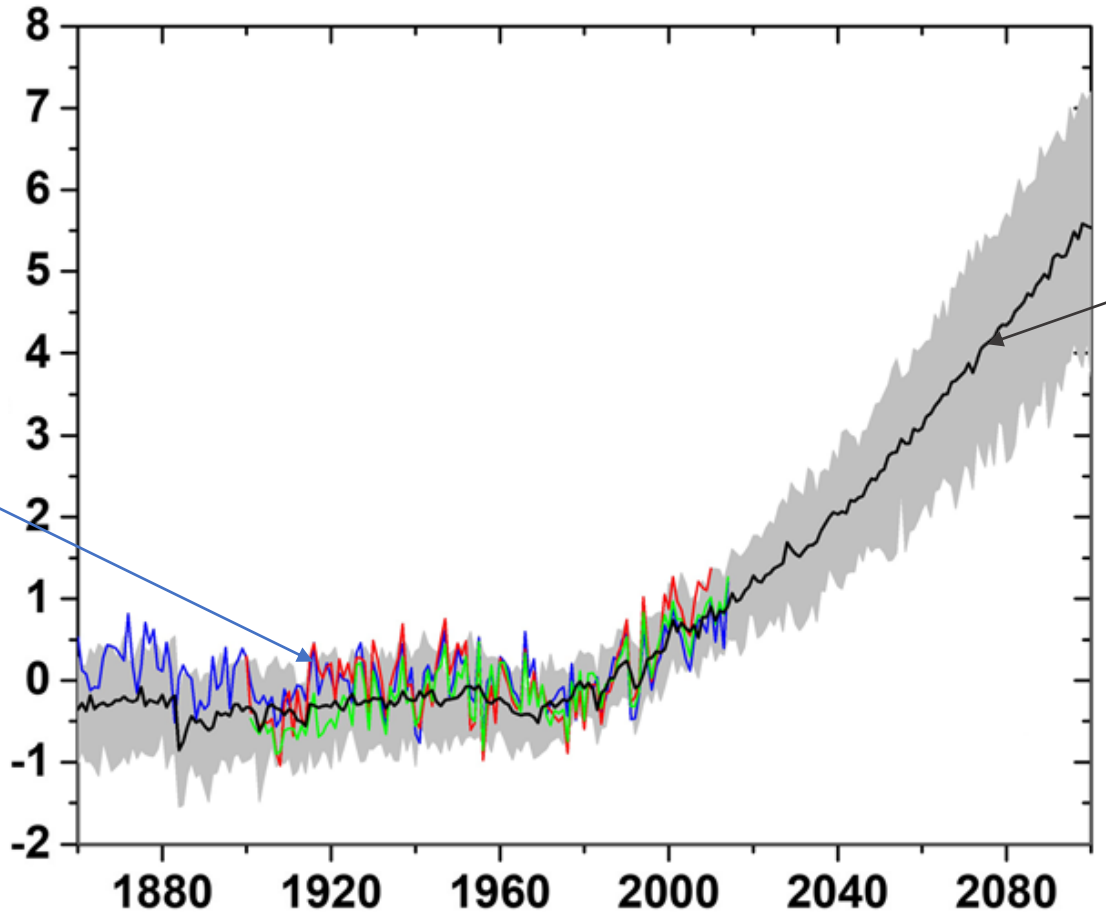
Climate projections - temperature

Mean annual temperature anomalies in the Mediterranean region (only land)



Different *observational* datasets

Projections under the high-emission scenario RCP8.5

Source: Lionello and Scarascia, Reg. Env. Change 18, 2018

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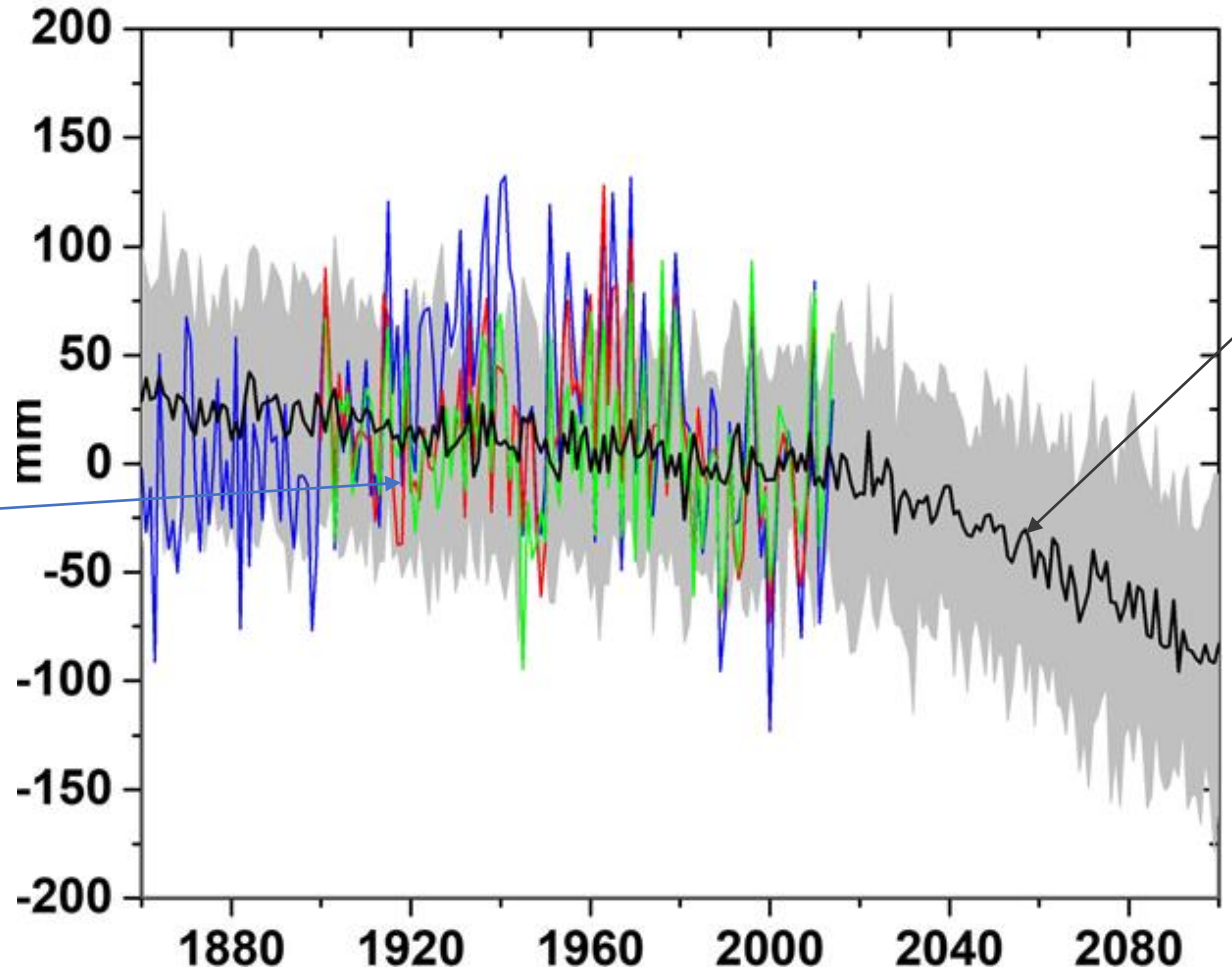
Climate projections - precipitation

Total annual precipitation anomalies in the Mediterranean region (only land)



Different *observational* datasets

Projections under the high-emission scenario RCP8.5

Source: Lionello and Scarascia, Reg. Env. Change 18, 2018

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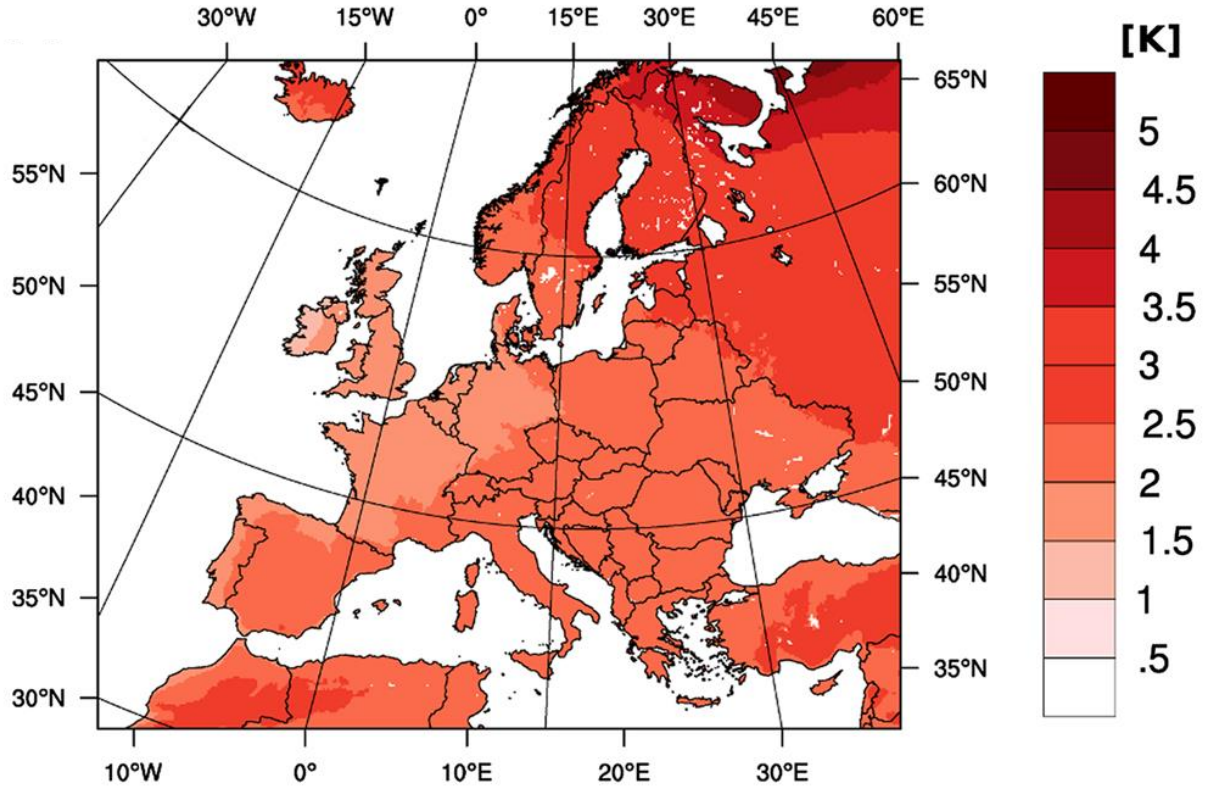
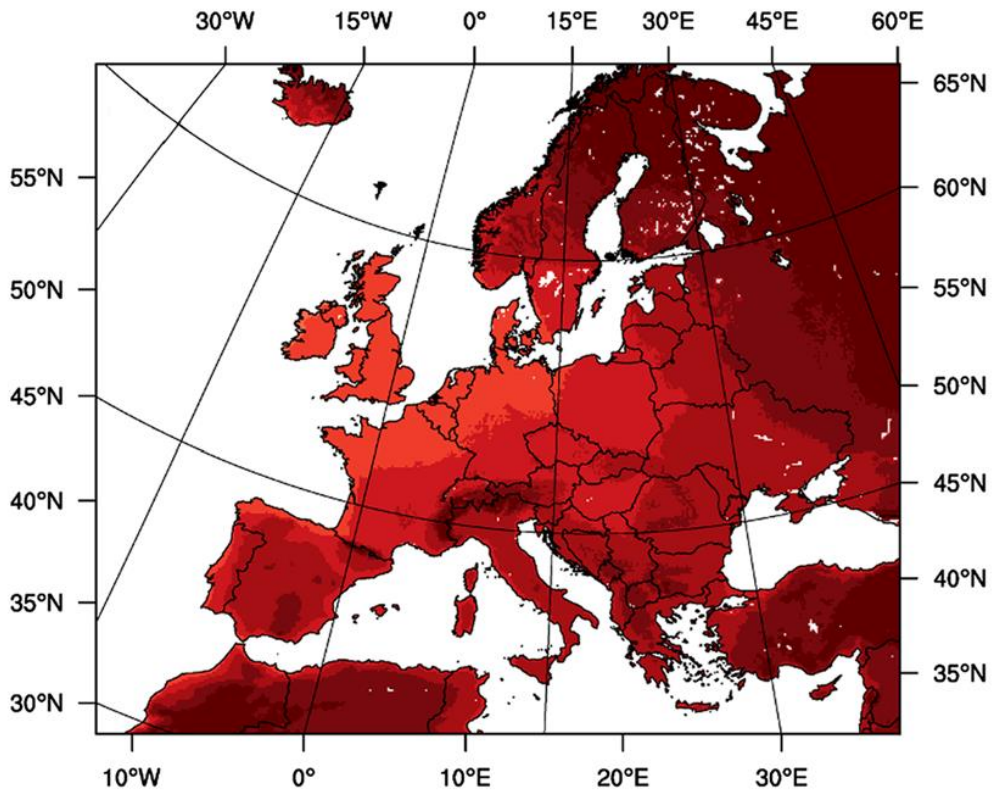
Climate projections - temperature

Projected changes (2071-2100) of mean annual temperature

mid-range mitigation scenario RCP4.5



high-end emission scenario RCP8.5



Source: Jacob et al., Reg. Env. Change 14, 2014

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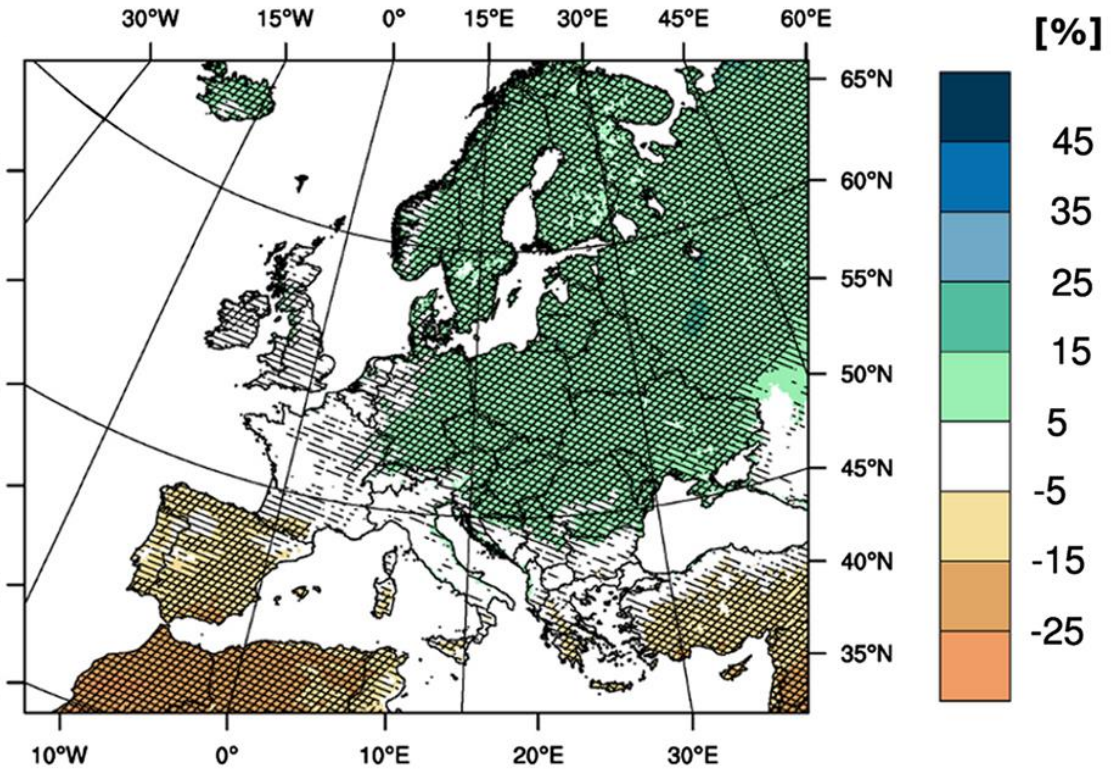
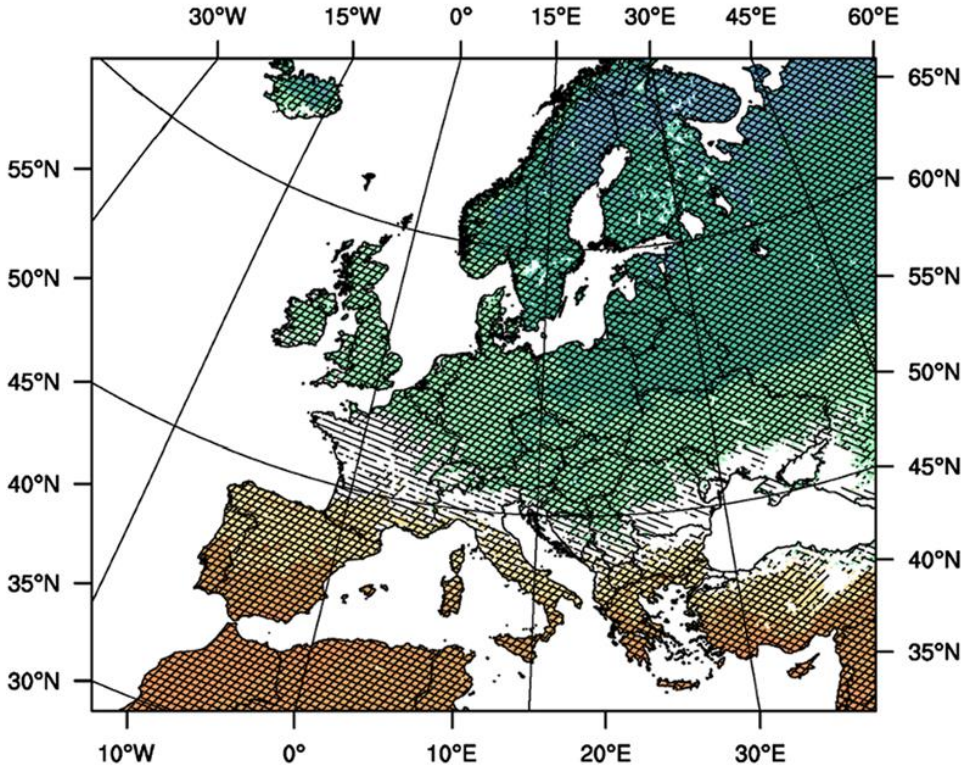
Climate projections - precipitation

Projected changes (2071-2100) of total annual precipitation

mid-range mitigation scenario RCP4.5



high-end emission scenario RCP8.5



Source: Jacob et al., Reg. Env. Change 14, 2014

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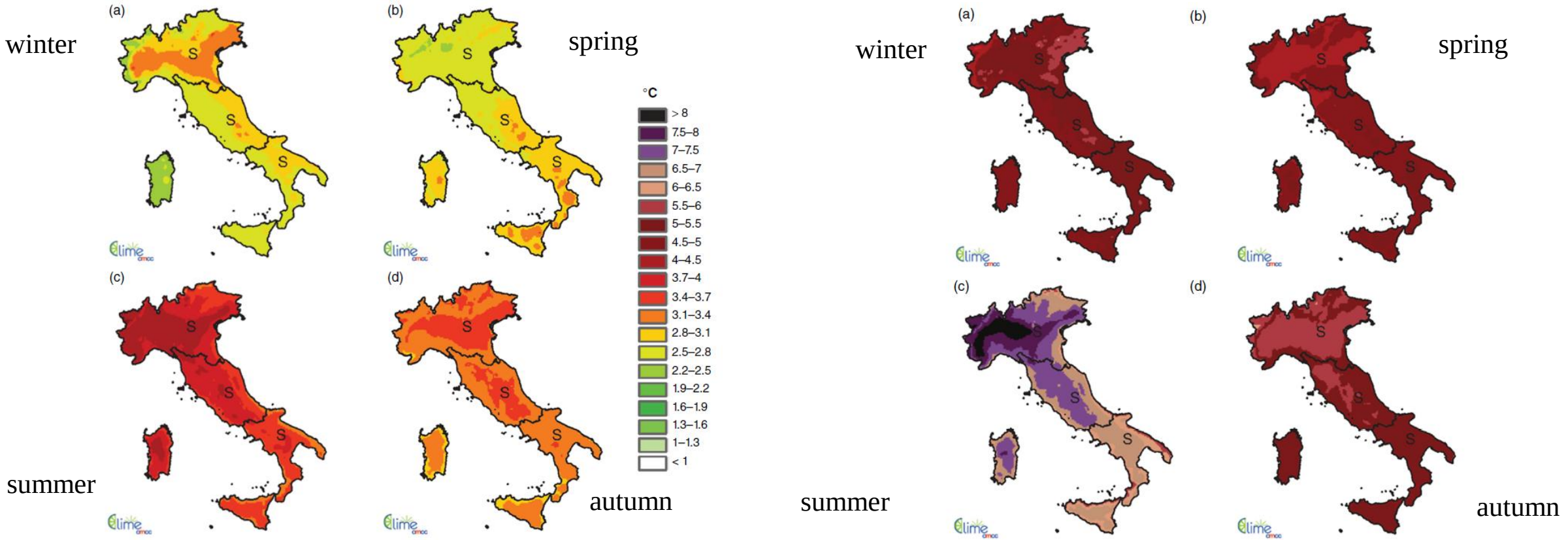
Climate projections

mid-range mitigation scenario RCP4.5

high-end emission scenario RCP8.5



Projected changes (2071-2100) mean seasonal temperature

Source: Bucchignani et al., Int. J. Climatol. 36, 2016

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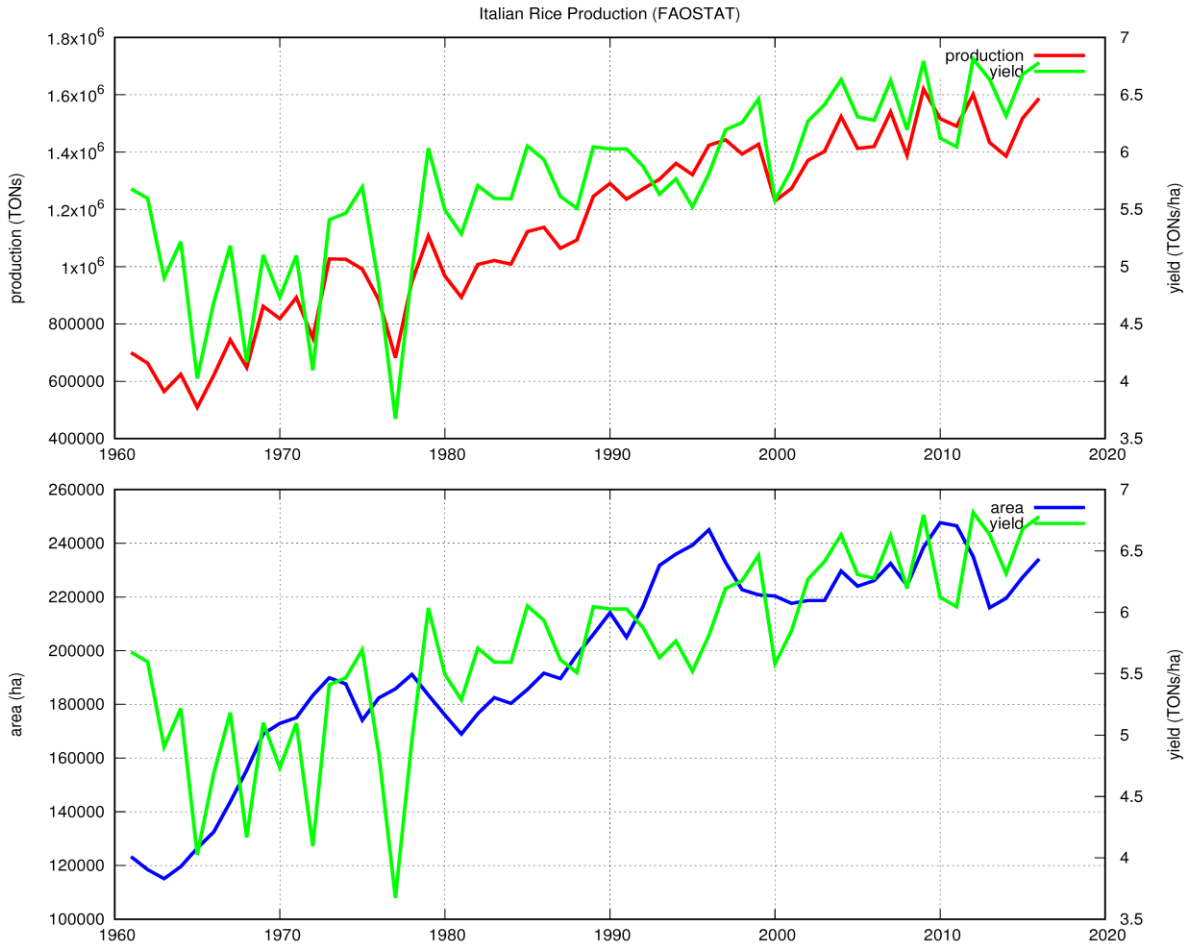
Rice production in Italy

Italian rice production, yield and harvested area from 1961

Italy is the top European rice producer



Source: Zampieri et al., Land Degrad. Develop. 30, 2019

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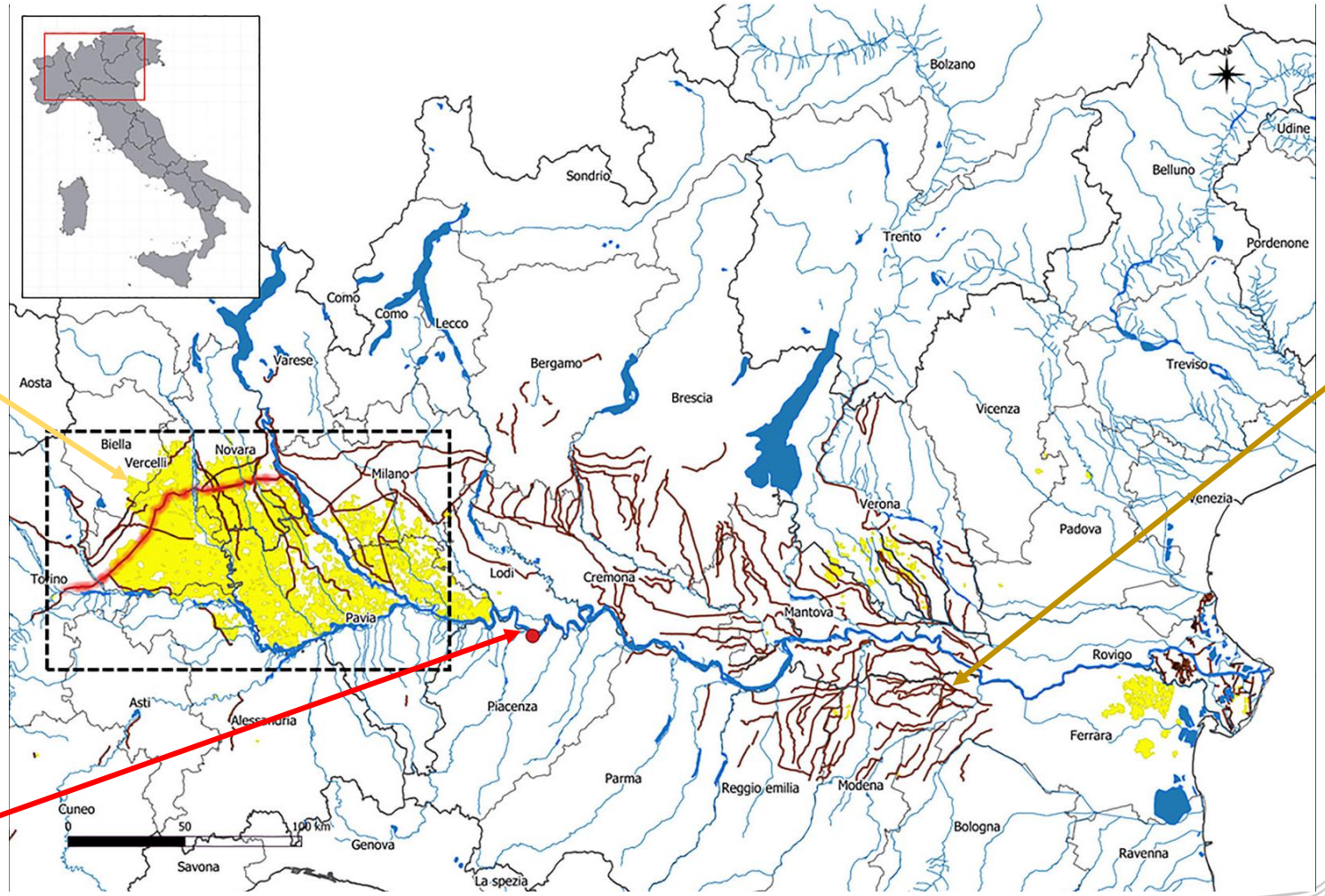
Rice production in Italy

Main rice production area

Po river discharge monitoring station



Artificial channels

Source: Zampieri et al., Land Degrad. Develop. 30, 2019

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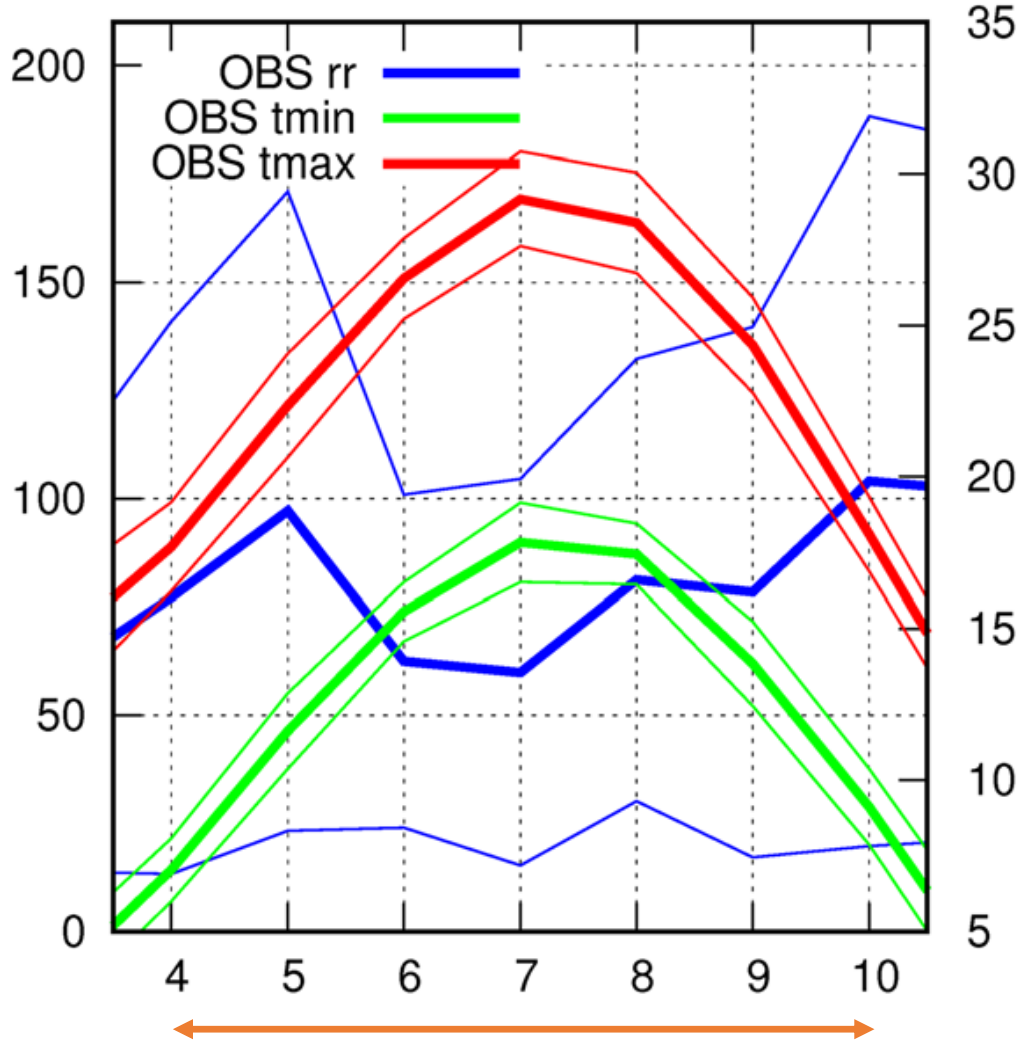
Rice production in Italy – Climate

Mean climate in the analysed rice producing area



Source: Zampieri et al., Land Degrad. Develop. 30, 2019

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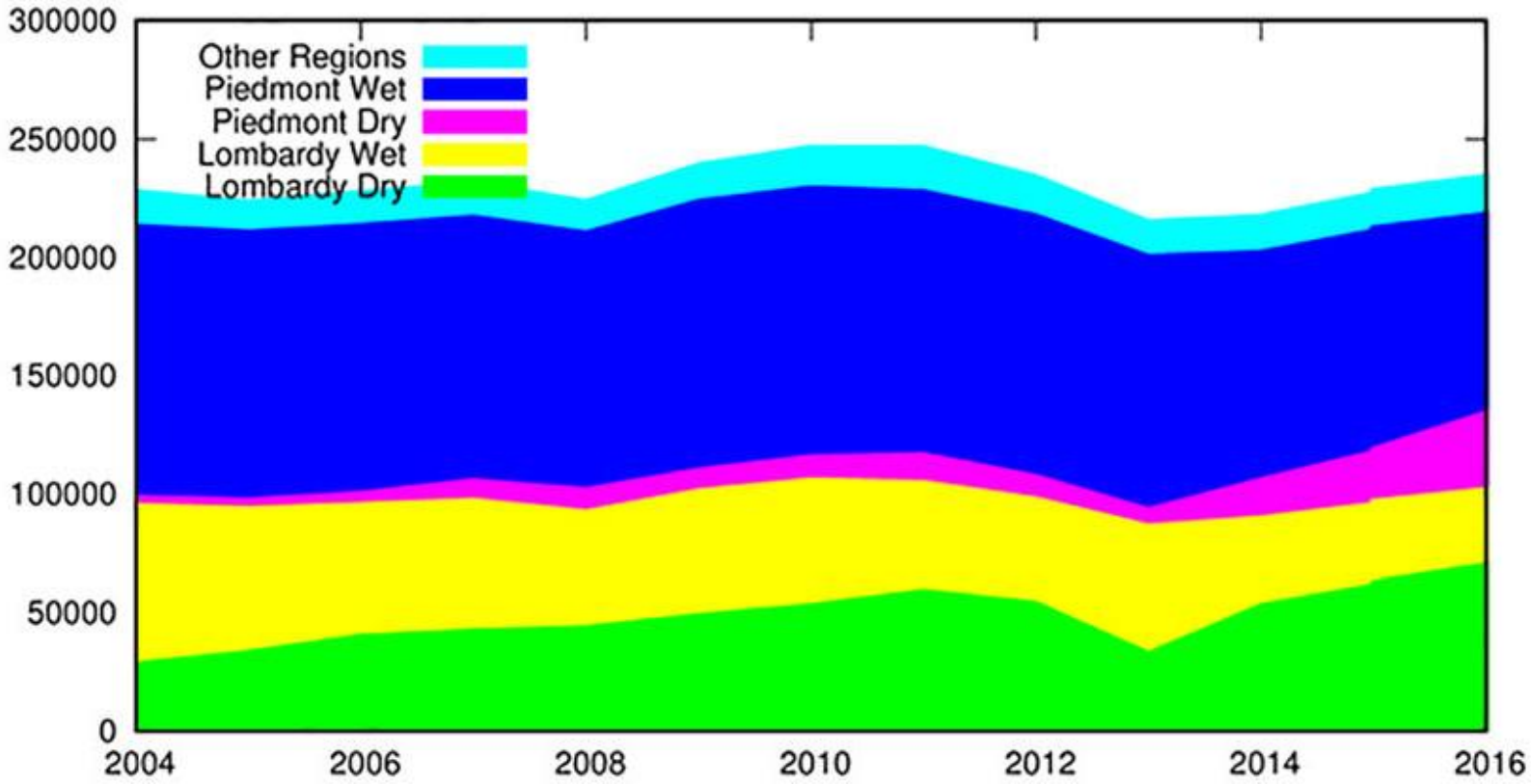
Rice production in Italy

Two main agro-management practices: dry and wet seeding

In 2016, 44% of the national rice paddy fields were dry-seeded

Harvested areas



Source: Zampieri et al., Land Degrad. Develop. 30, 2019

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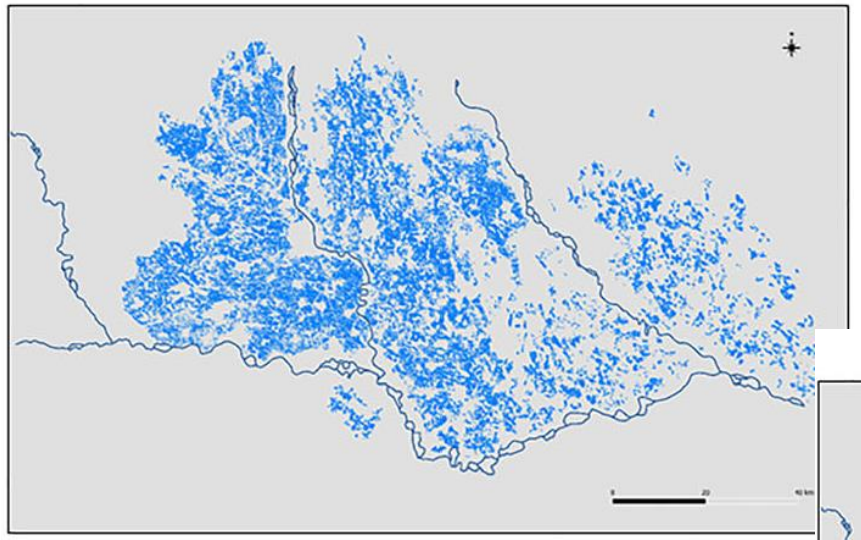
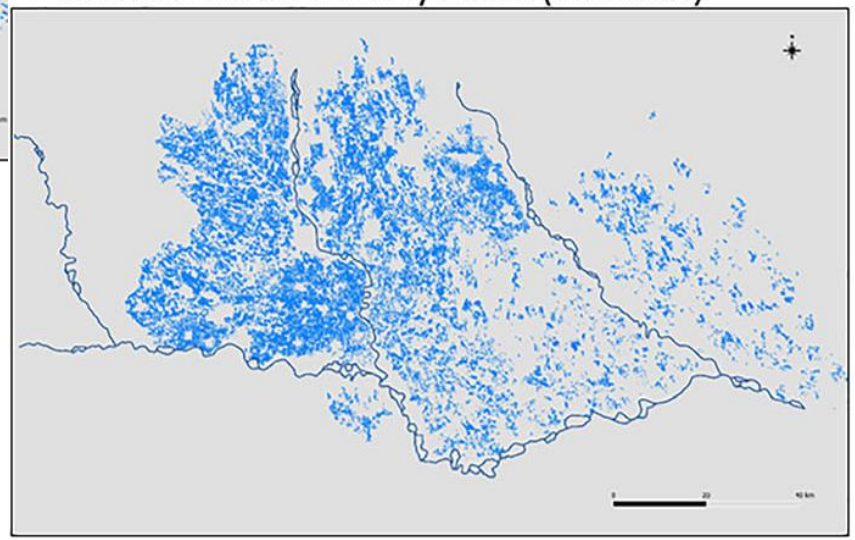
Rice production in Italy

Rice flooded fields. Three snapshots to highlight the evolution of dry seeding

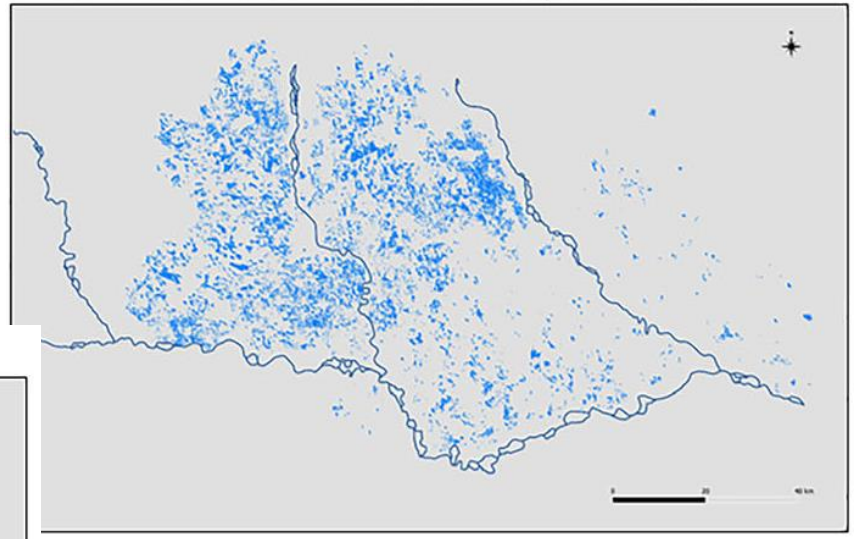
surface water in May 1987 (Landsat)



surface water in May 2000 (Landsat)



surface water in May 2016 (Landsat)



Source: Zampieri et al., Land Degrad. Develop. 30, 2019

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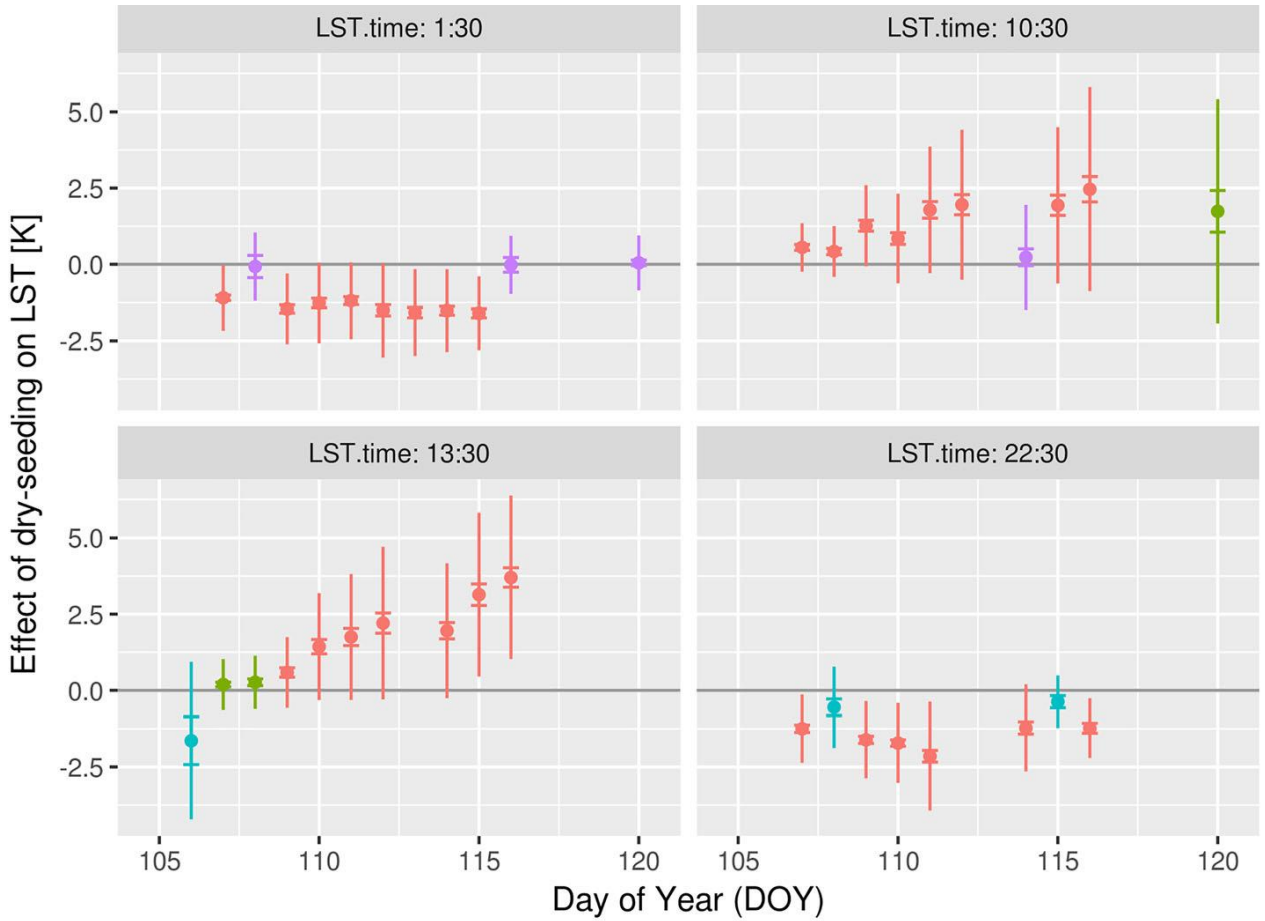
Rice management and effects on climate



Effect on land surface temperatures of dry seeding (2018) compared to wet seeding, as estimated from satellite data.

Source: Zampieri et al., Land Degrad. Develop. 30, 2019

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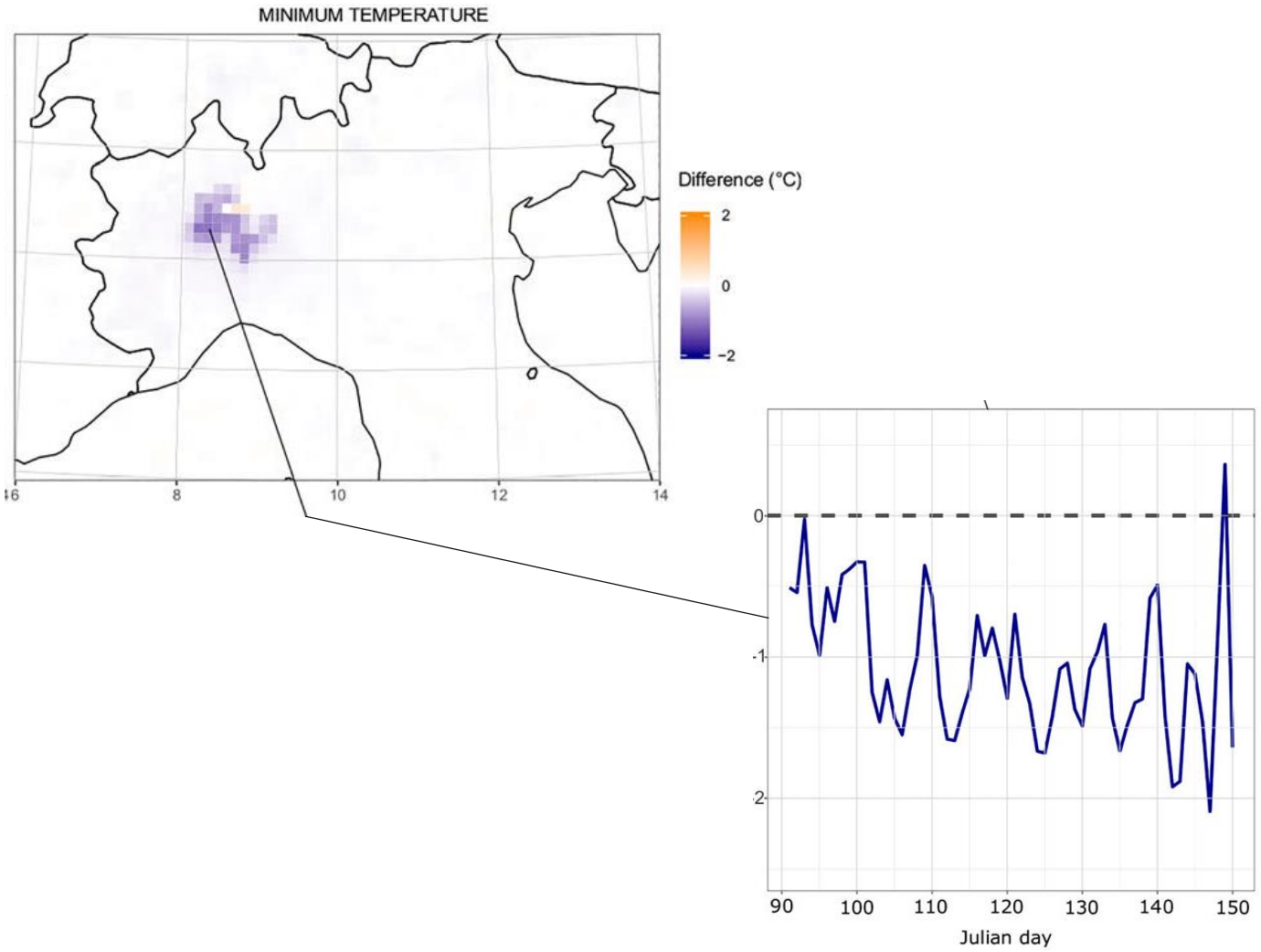
Rice management and effects on climate



Effect on surface temperatures of dry seeding compared to wet seeding as estimated from regional climate model simulations. April-May 2003.

Source: Zampieri et al., Land Degrad. Develop. 30, 2019

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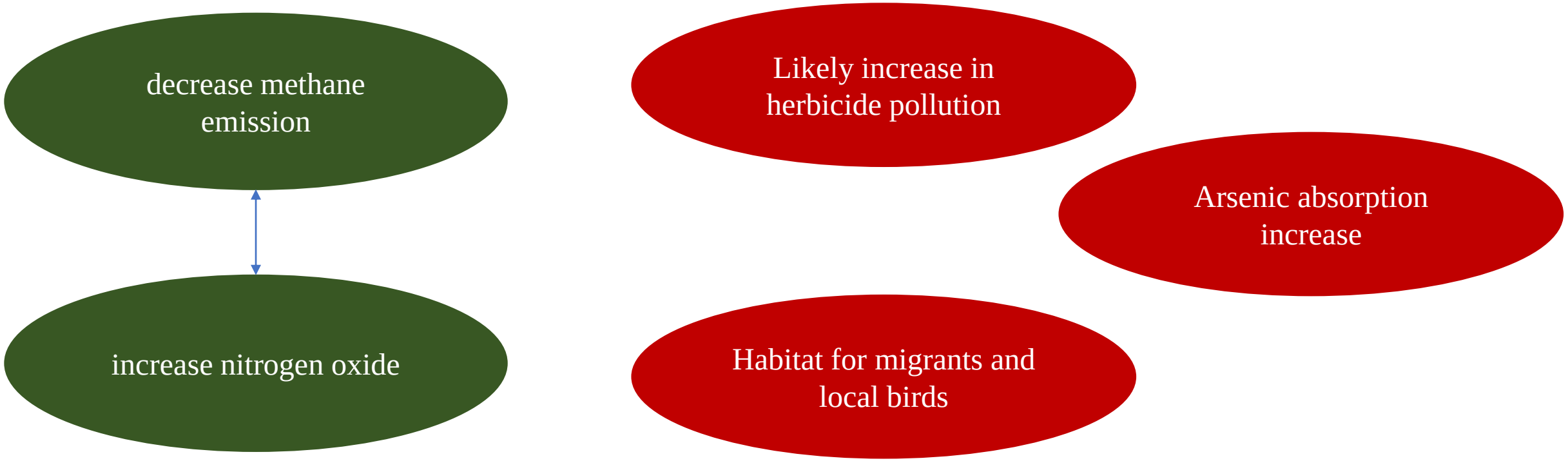
Rice management and effects on the environment

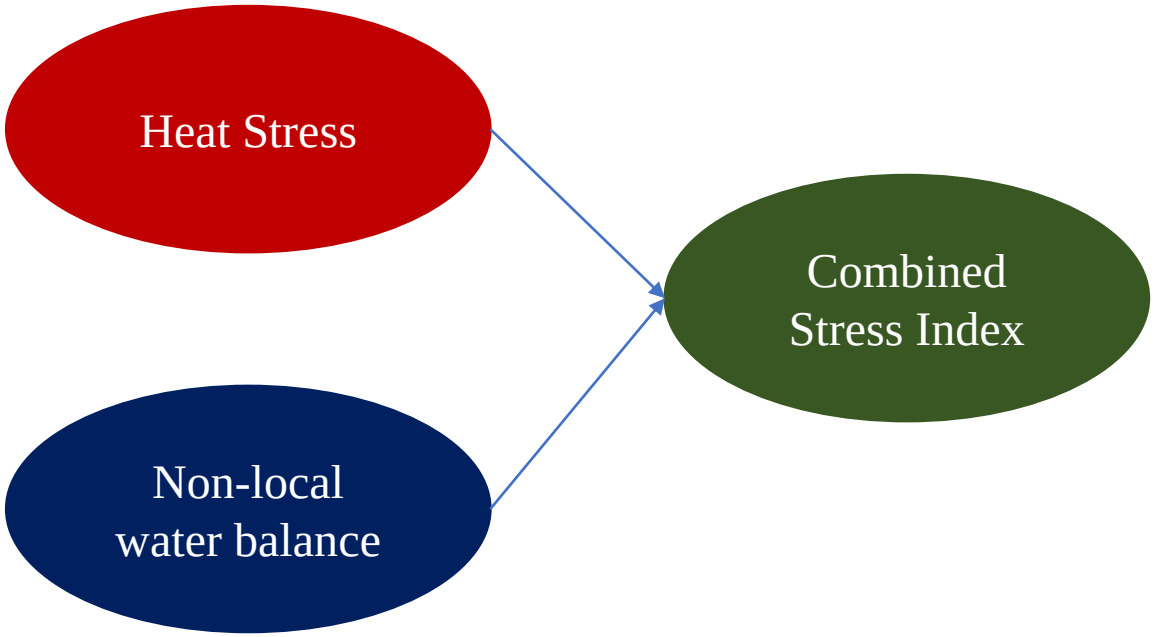
Dry seeding vs wet seeding



Source: Zampieri et al., Land Degrad. Develop. 30, 2019; Tenni et al., Agr. and Food Chem. 65, 2017; Imperio et al., 2017; Peyron et al., Agr. Ecos. Env. 232, 2016; Miniotti et al., Agr. Ecos. Env. 222, 2016

Rice production and climate

Climate impacts on rice production



~32% explained variability of global rice production

~80% explained variability of Italian rice production before 1995

Source: Zampieri et al., Land Degrad. Develop. 30, 2019

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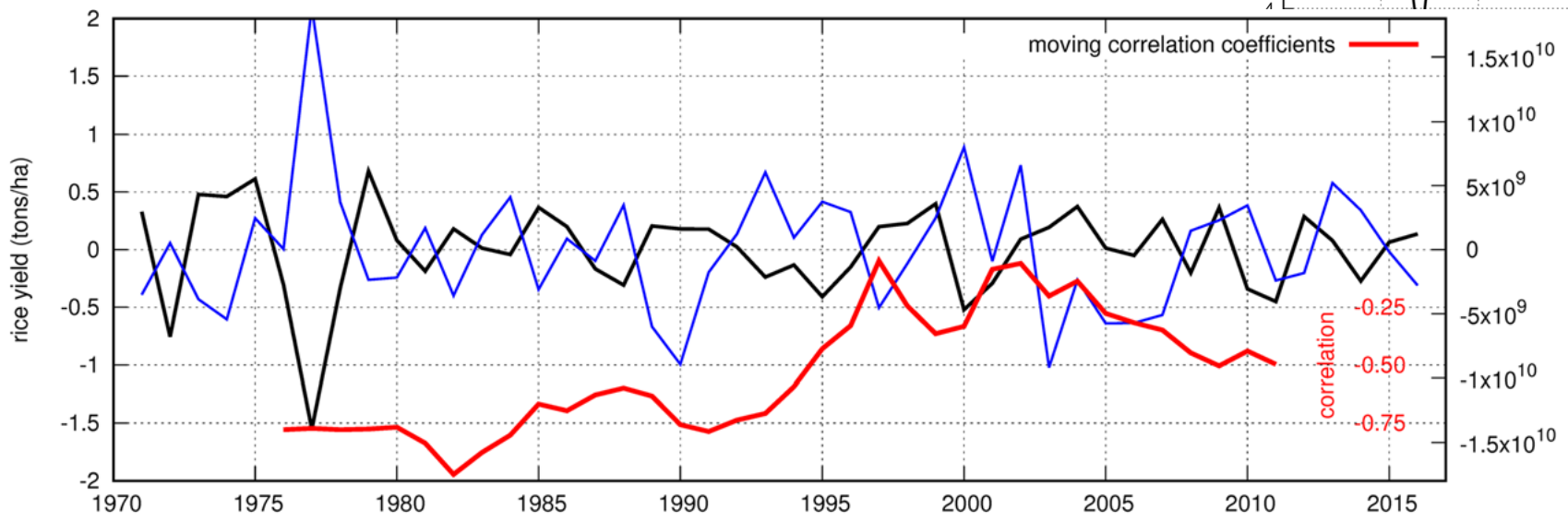
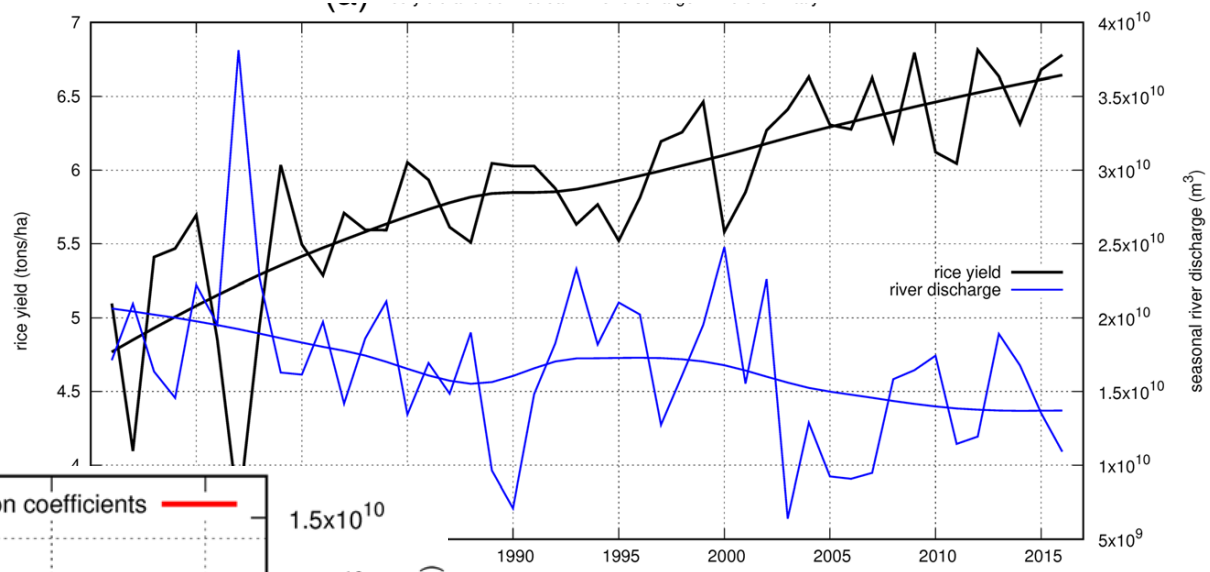
Rice production and climate

No freshwater-limited but sensitive to cold and wet seasons

anti-correlated rice yield and Po rive discharge





Sharp change in the rice *climate sensitivity* in mid-'90s

Source: Zampieri et al., Land Degrad. Develop. 30, 2019

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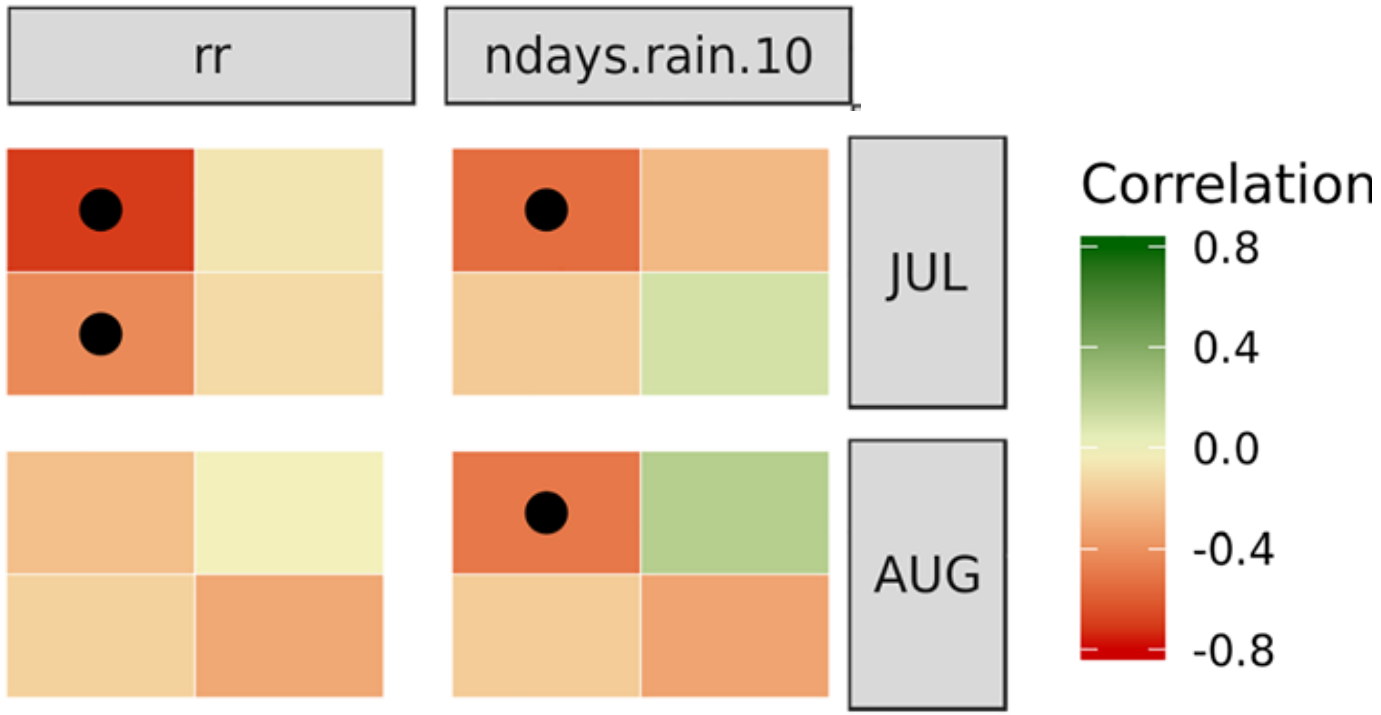
Rice production and climate



Changes in the rice *climate sensitivity*.
1995-2016 vs 1975-1994

Source: Zampieri et al., Land Degrad. Develop. 30, 2019

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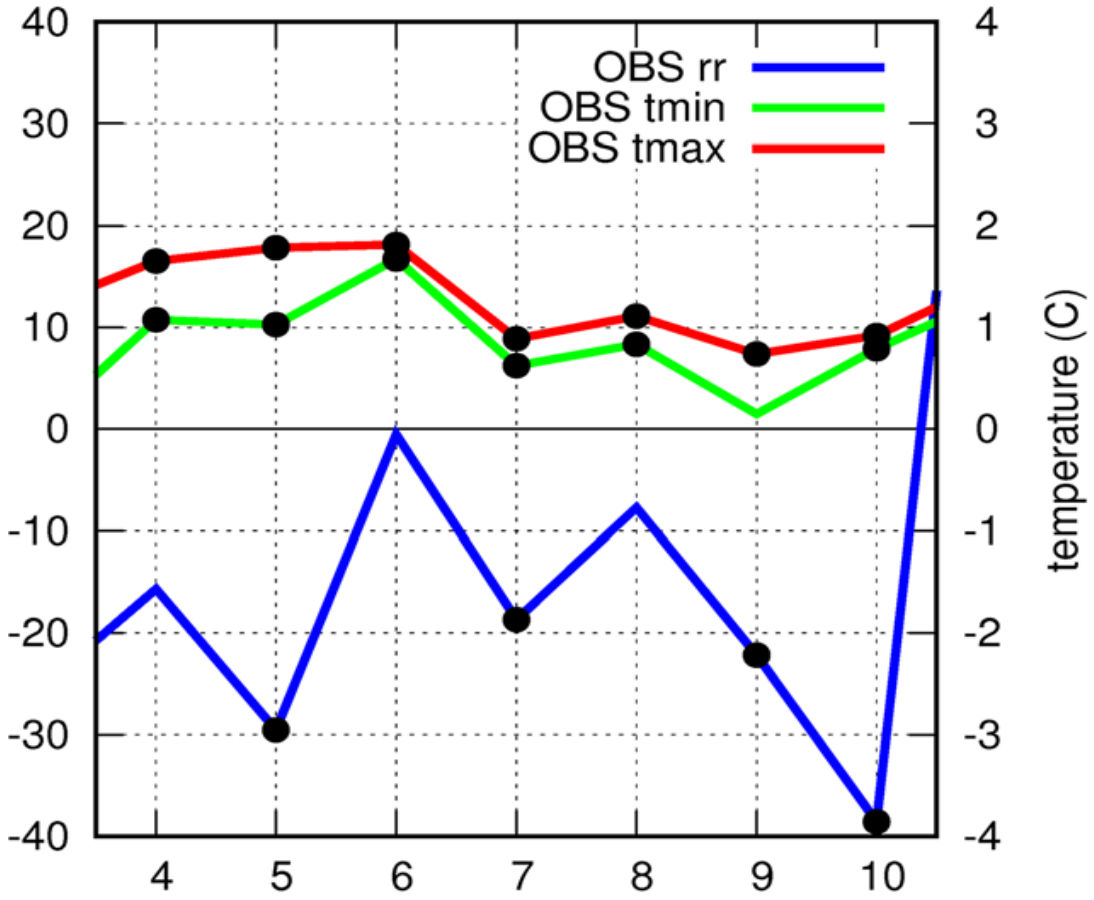
Rice production and climate



Observed changes in mean temperature and total precipitation. 1995-2016 vs 1975-1994

Source: Zampieri et al., Land Degrad. Develop. 30, 2019

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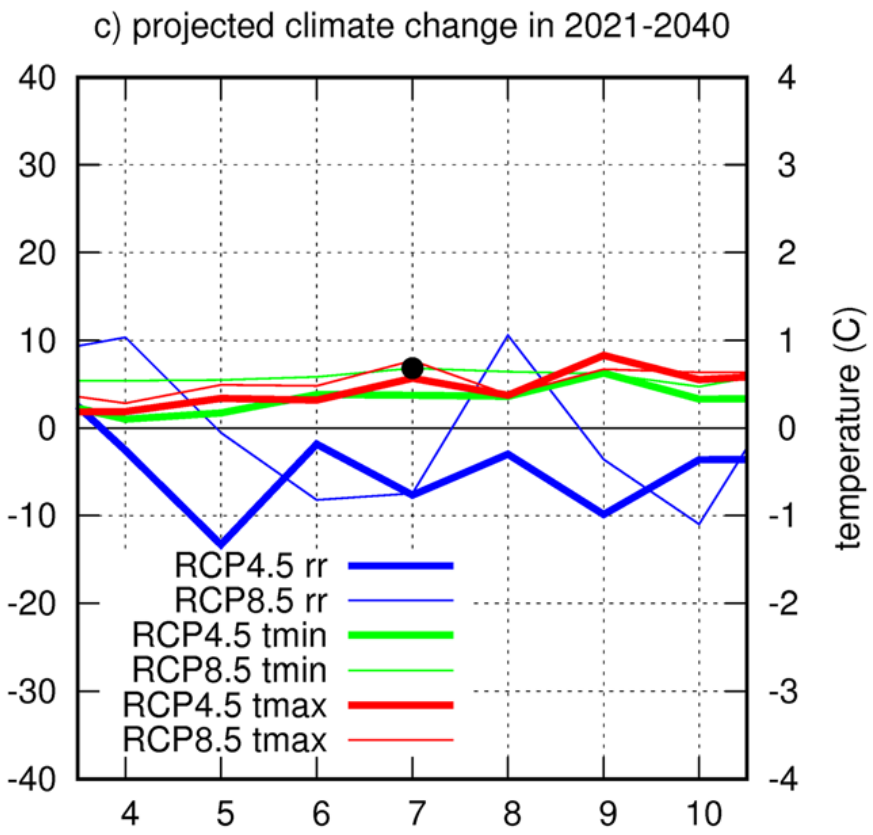
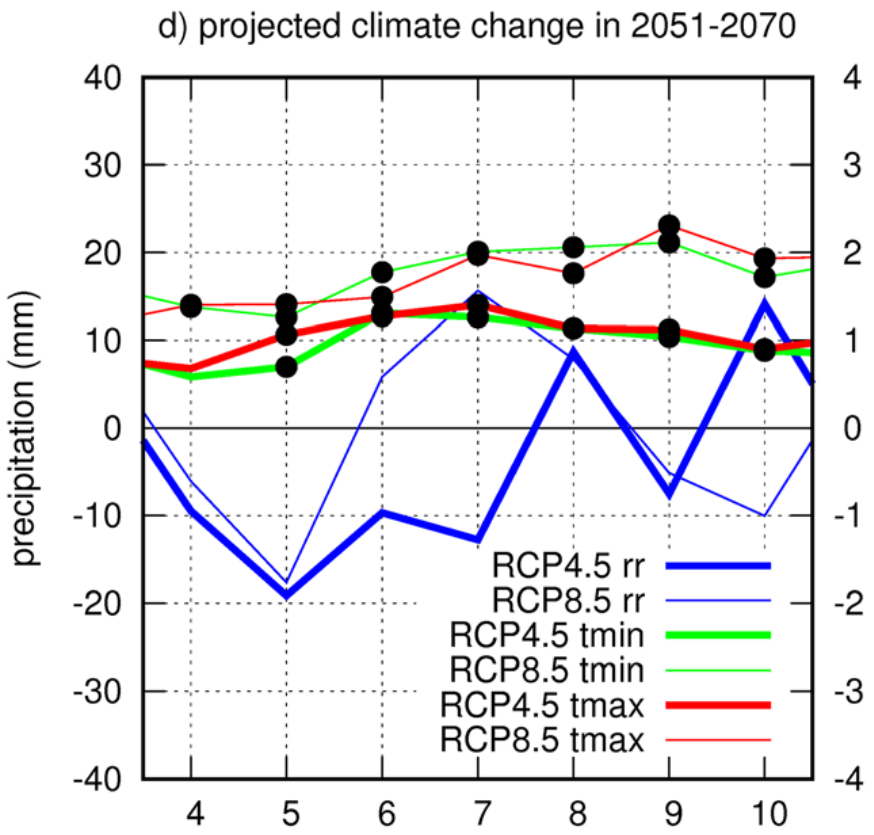
Climate projections in rice producing areas

Significant warming of the region





Source: Zampieri et al., Land Degrad. Develop. 30, 2019

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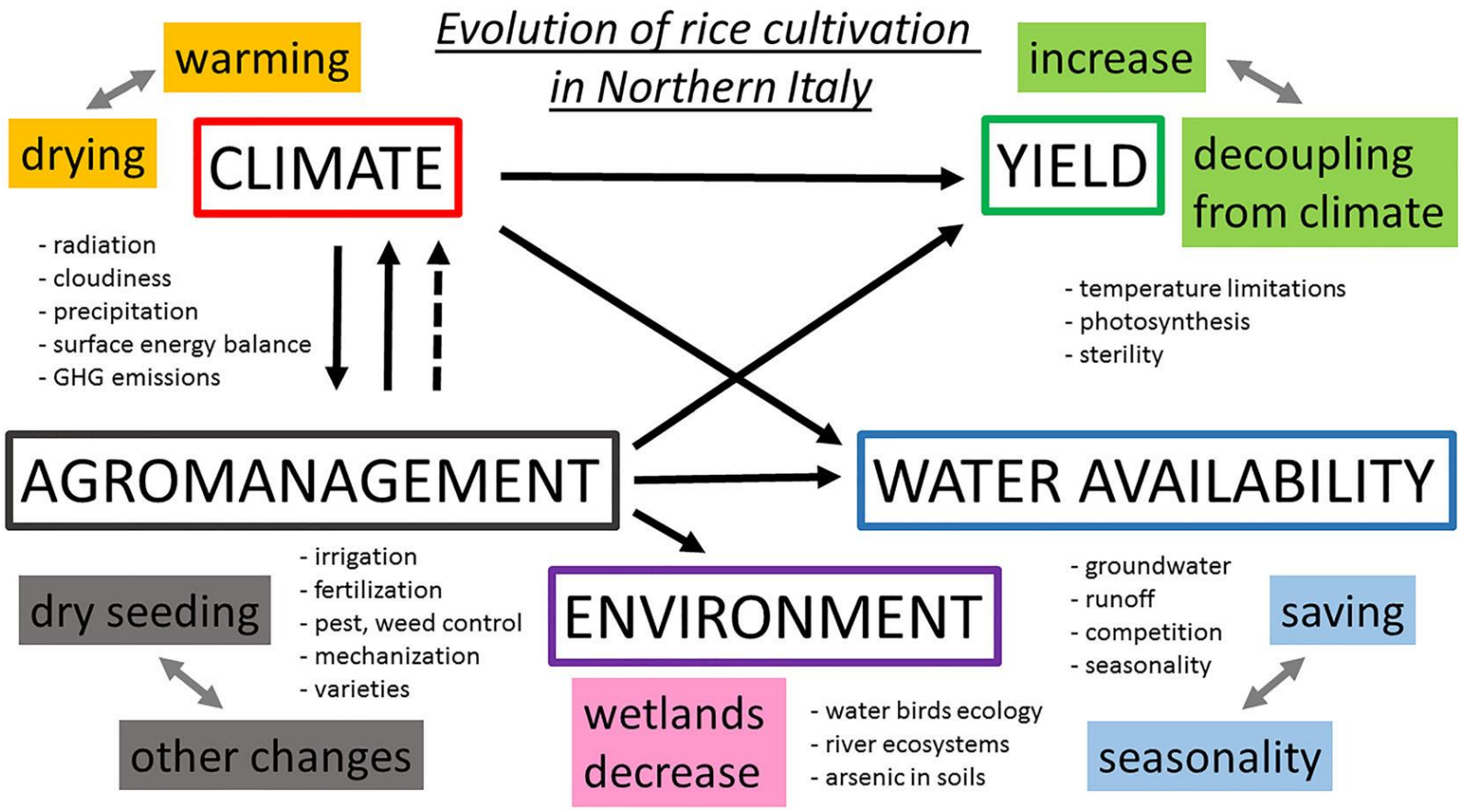
Conclusions



Source: Zampieri et al., Land Degrad. Develop. 30, 2019

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Conclusions

- Decreasing rice climate sensitivity after mid-’90s
- More favourable climate conditions after 1994 with mild minimum temperatures in spring and *sunny* conditions
- Dry seeding was favoured by climate shift in mid-’90s
- Changes in agro-management practices had an impact on surface climate of the region but at the same time were possible due to climate variability and changes
- Dry seeding led to net reduction of GHG emissions
- Dry seeding may increase env pollution (e.g. nitrate water contamination) and pose a threat for natural habitat
- Dry seeding saves 20% of water at the beginning of the growing season, but leads to higher water requirement in June where competition from other sectors and crops is higher
- With respect to water management, dry seeding seems to have already reached its max potential

Challenges

- Projected warming conditions with more frequent and intense warm temperature extremes (daytime and nighttime)
- No significant mean changes in seasonal precipitation, but increase of both drought and heavy precipitation events
- Agro-management strategies should take into account future changes and climate variability to keep an optimal balance w.r.t. water needs
- Water availability (linked to changes in the Alps) and competition from other crops and other sectors
- Complex feedback of different practices on climate must be investigated and considered
- Modelling and data efforts are needed: high resolution regional climate model simulations with dynamic land/crop models

Thanks

Any questions?

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