Irrigation modernization

Modelling the effects on groundwater recharge

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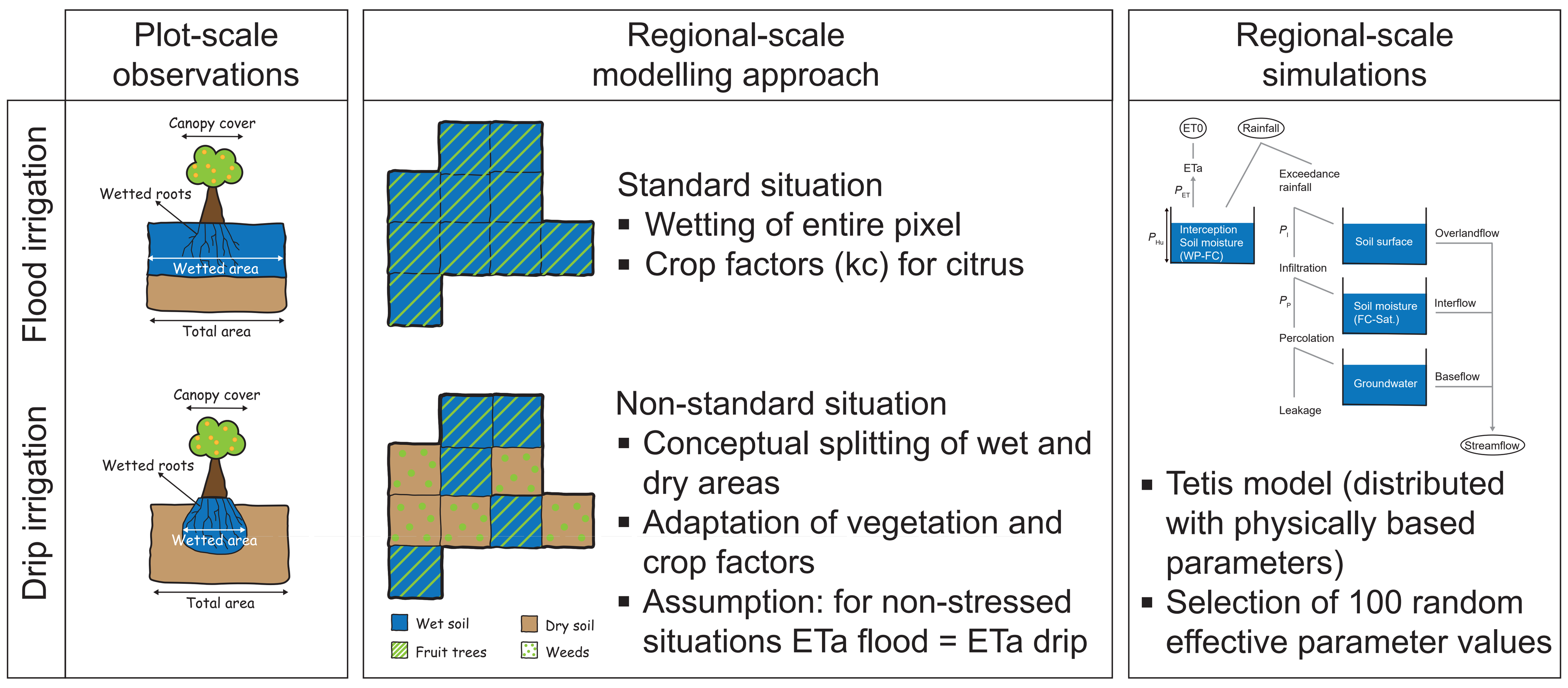
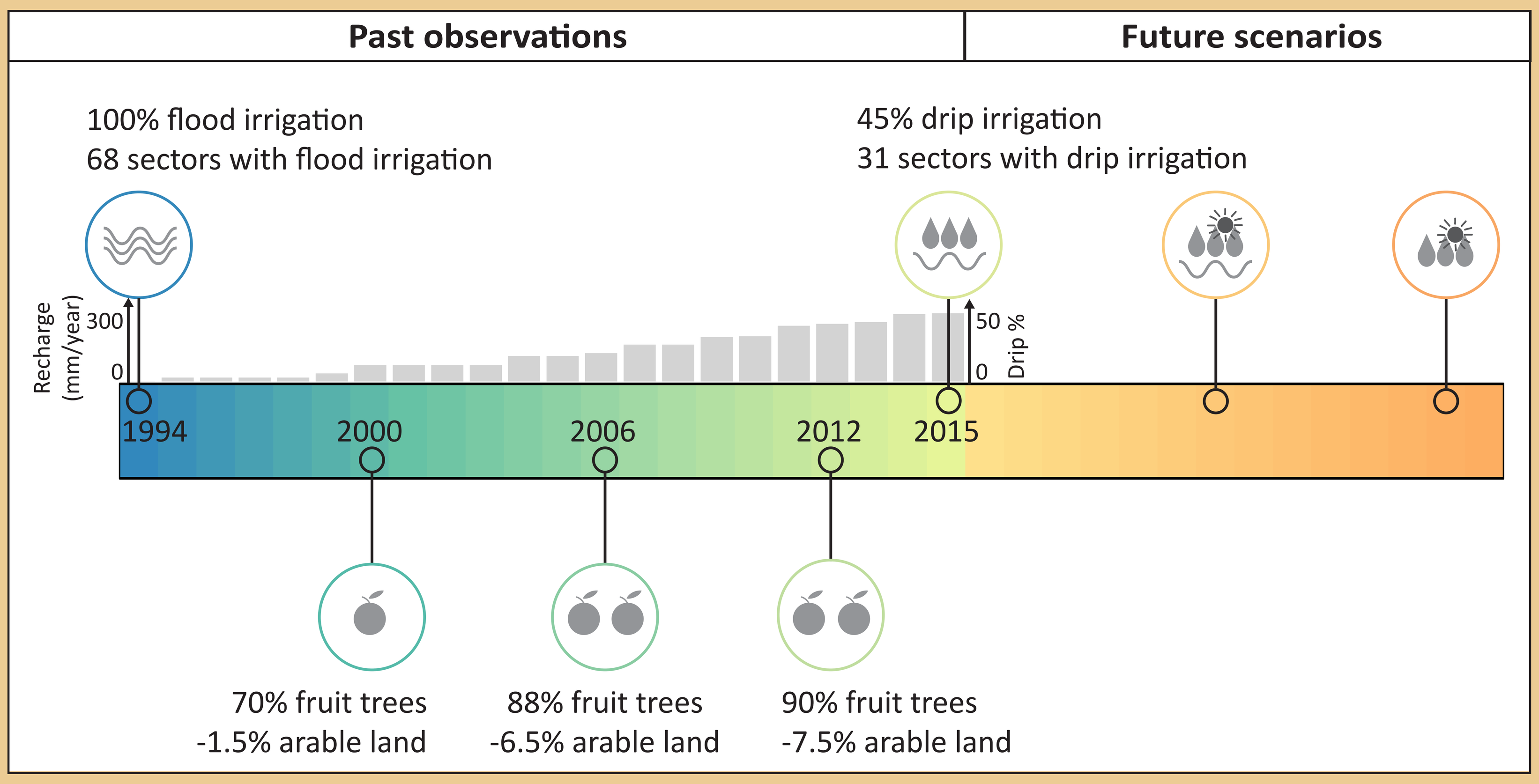
On the difference between flood and drip irrigation



A constantly changing agricultural landscape



- The region of Valencia (Spain) is one of the major citrus producers in Europe.
- The high citrus productivity in the prevailing semi-arid conditions can only be sustained by irrigation with a considerable volume of freshwater.
- In the last decades national and regional governments have promoted the installation of pressurized drip irrigation systems to replace traditional flood irrigation schemes.

➔ How is irrigation modernization influencing the regional hydrological cycle?

Multi-scale and multi-variable evaluation

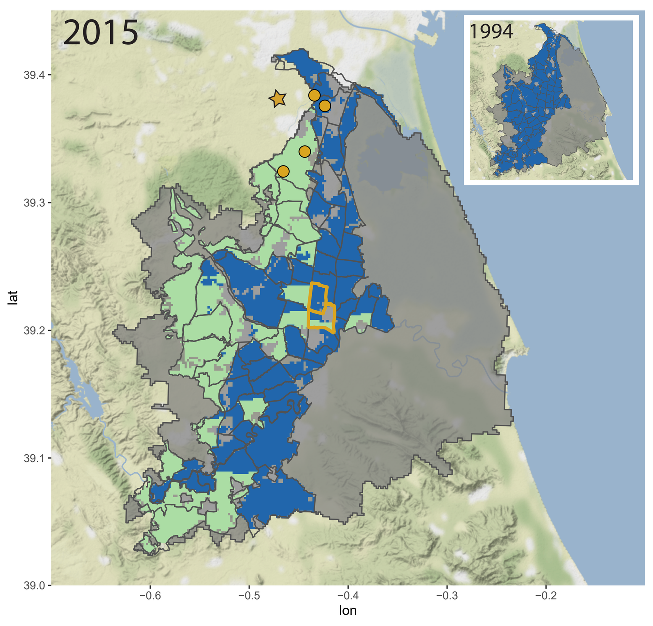


Fig. 40% of the study area (913 km^2) are irrigated by surface water using drip (green) or flood (blue) irrigation technologies.

Fig. Evaluation framework

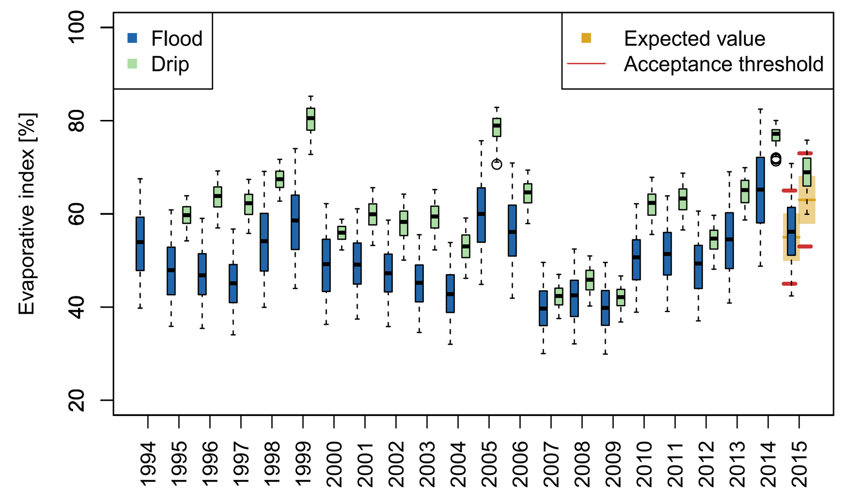
Increasing level of detail

Annual water balance
- Evaporative index: ETa/(P+I)
- Acceptance criteria: +/- 20%
- Irrigation information: drip vs. flood

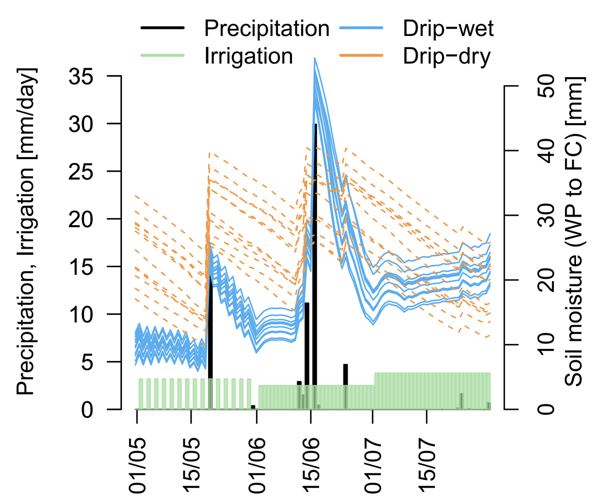
Seasonal groundwater dynamics
- Groundwater table
- Acceptance criteria:
  (a) Spearman rank correlation >= 0.3
  (b) Amplitude ratio +/- 25%

Daily soil moisture dynamics
- Acceptance criteria: realistic soil moisture response to irrigation and precipitation
- Irrigation information: drip (ETa vs. E)

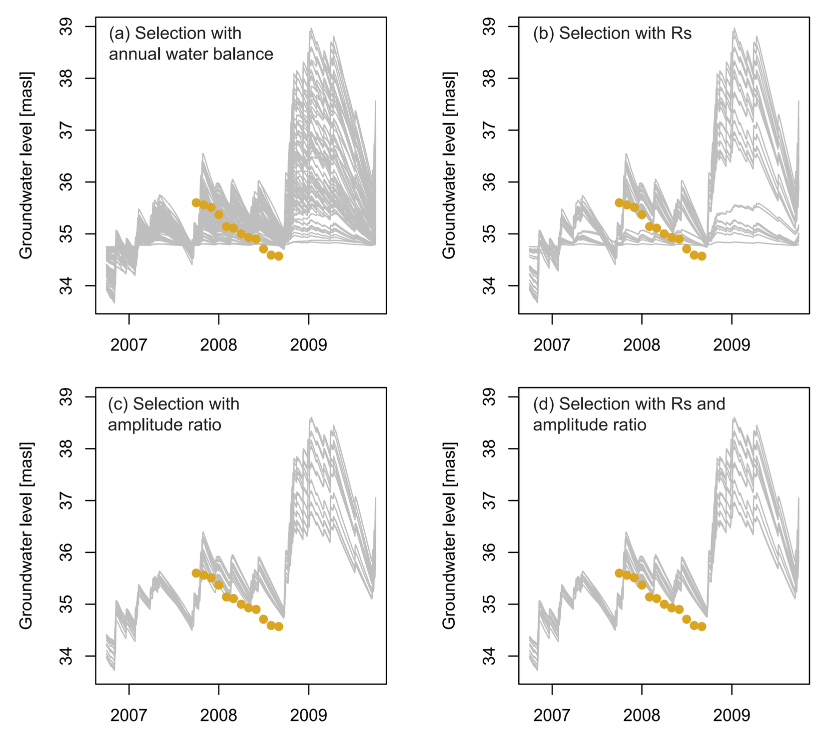
(1) Evaporative index



(3) Soil moisture



(2) Groundwater level



Figs. Of the initially 100 simulations, 75 result in acceptable estimates of the evaporative index (1). The simulations that are acceptable in terms of water balance show considerable differences in groundwater dynamics (2a). Applying the two groundwater criteria (2b and c) reduces the number of acceptable effective parameter values to twelve (2d). These twelve simulations all simulate daily soil moisture dynamics in a realistic way (3).

Groundwater recharge in irrigation modernization

How variable is recharge in a mediterranean climate?

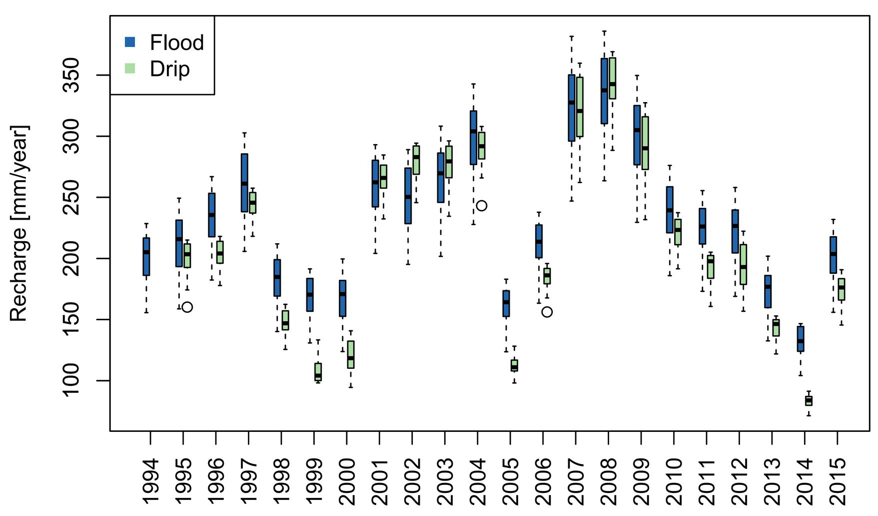


Fig. While the variability in annual recharge is strongly linked to annual rainfall (Rs = 0.89), it is not significantly correlated with the fraction of drip-irrigated area.

What makes rechage in drip and flood irrigation different?

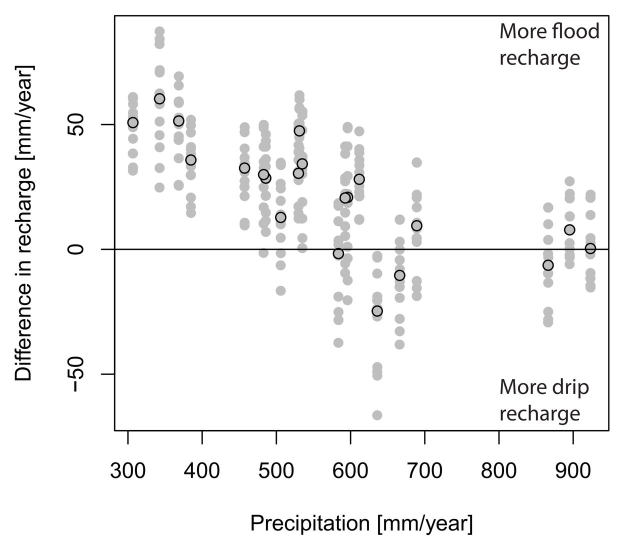


Fig. Recharge is clearly higher in flood irrigation than in drip irrigation in dry years. However, wet years can lead to higher recharge in drip irrigation than in flood irrigation.

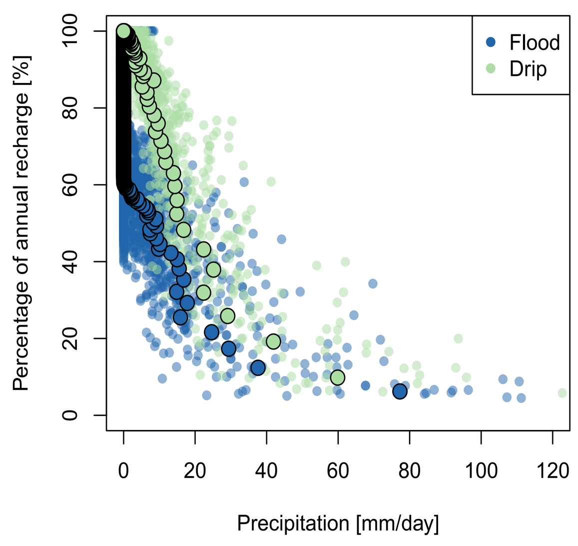


Fig. The majority of recharge can be produced by a few precipitation events. Additionally, recharge is also produced at non-rainy days following a flood irrigation event.

Conclusion

- The proposed method to model flood and drip irrigation at regional scale seems to provide realistic simulations for multiple variables at multiple process, spatial, and temporal scales.
- Simulated annual groundwater recharge is highly variable between years for both flood and drip irrigation.
- Annual groundwater recharge is a function of irrigation type and annual precipitation, whereby precipitation dominates the annual recharge volumes.
- At event scale, recharge in drip irrigated areas tends to have a stronger response to rainfall than recharge in flood irrigated areas.

Image from www.acequiarj.es

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