ASCROM : A crop model designed to simulate agricultural water constraints in semi-arid areas from plot to territory

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Background

In semi-arid regions of South India, agriculture is facing a major crisis, due to overexploitation of groundwater resources. The development of irrigation since the 90's led to a fast decline in groundwater levels and a decrease of pump yields and this situation is likely to worsen due to climate change effects in these regions (Sekhar et al. 2016). To explore adaptation strategies to cope with these constraints, we implemented an Integrated Assessment Modeling approach using the Berambadi watershed (84 km^2, tropical sub-humid climate, Sekhar et al. 2016) as a case study. Workshops with stakeholders allowed us to identify the main solutions namely: water conservation (i.e. harvesting runoff in farm ponds for irrigation and/or groundwater recharge) and water use efficiency increase (i.e. drip irrigation, smart sensors for improved irrigation scheduling).

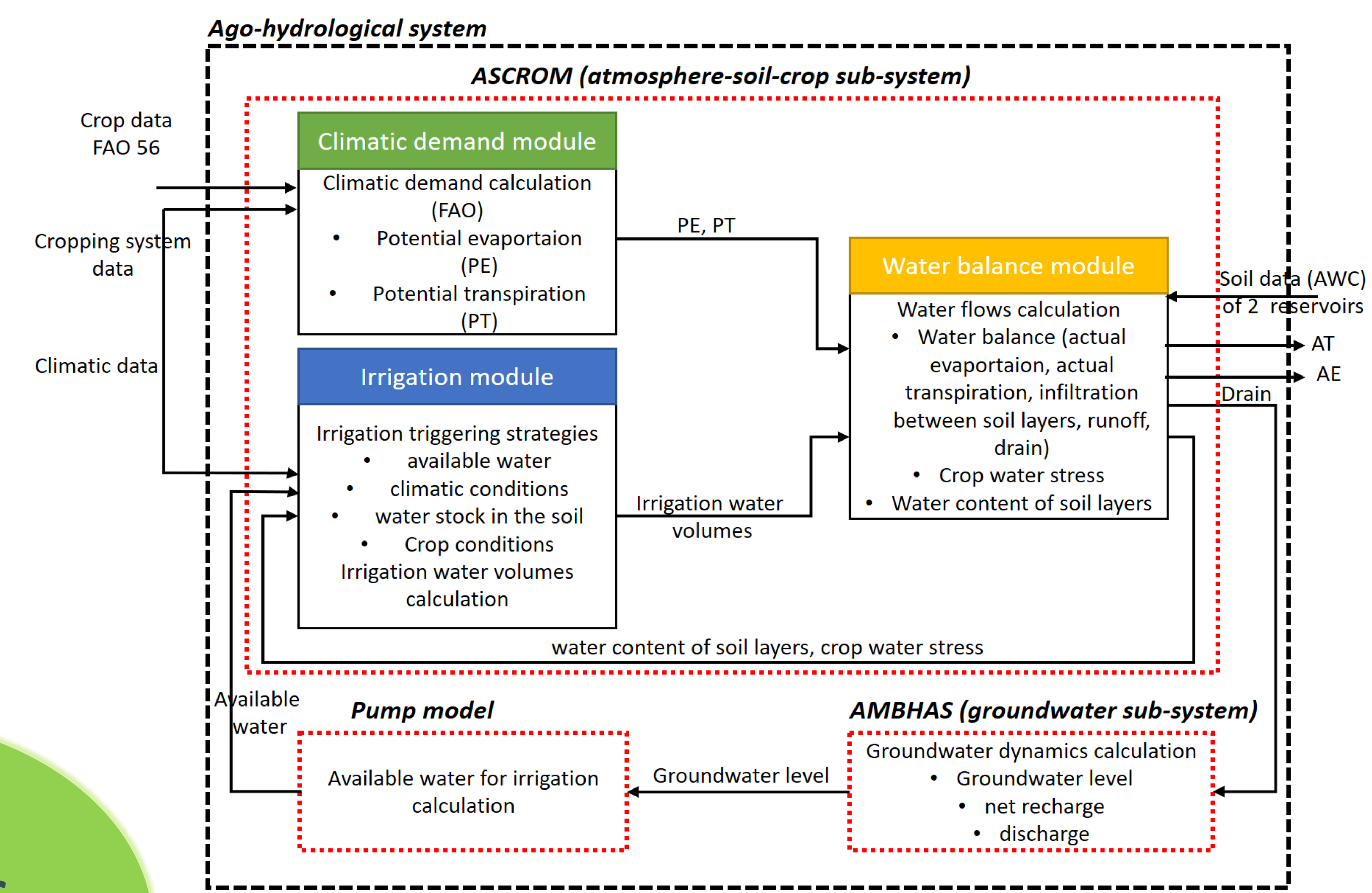
Aim

To meet the expectations of local stakeholders and to assess the impacts of the scenarios at different level (plot, farm, territory), we developed ASCROM (atmosphere soil crop model) which is based on a parsimonious representation of the agro-hydrological system but still accounts for its functional complexity.

ASCROM's functioning

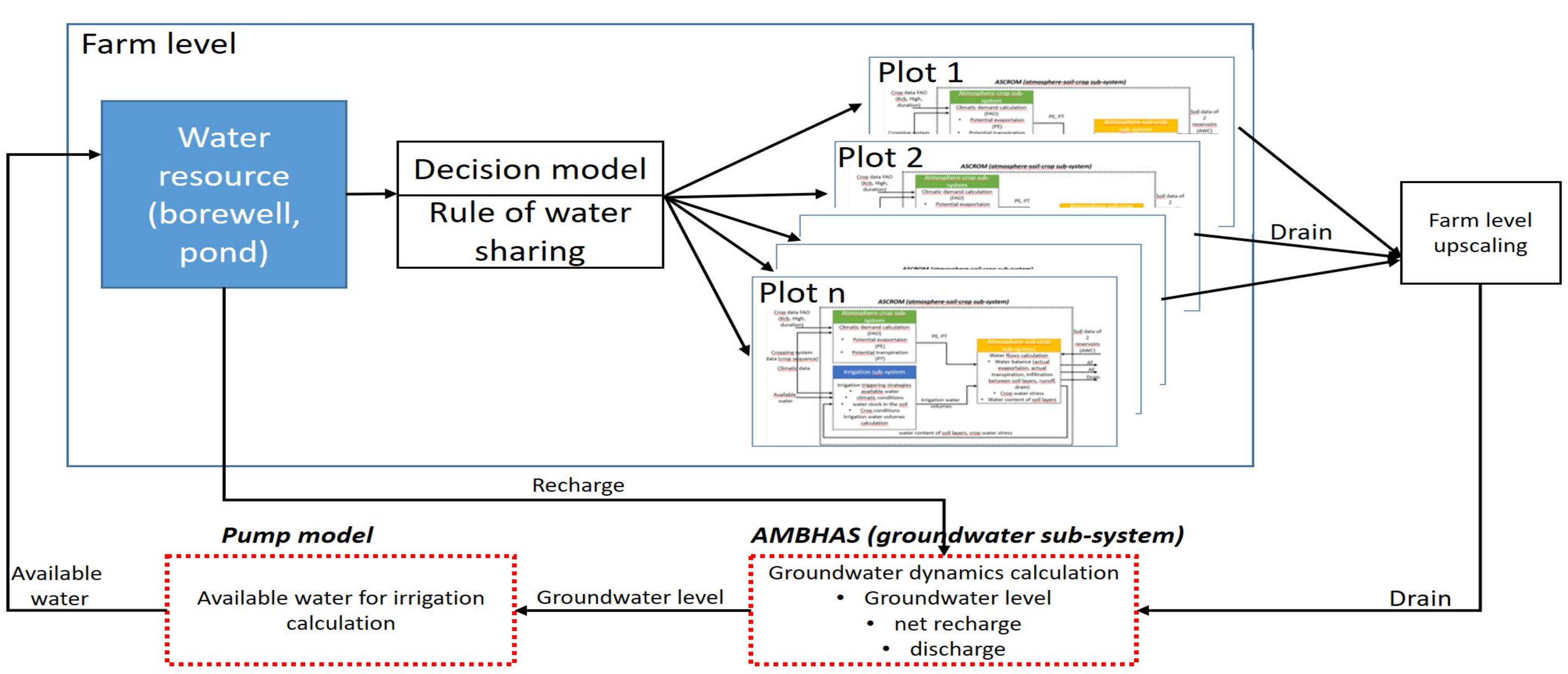
At plot level

ASCROM is based on three modules which are coupled dynamically: i) the climatic demand of cropping systems is computed using the dual crop coefficient equation of FAO (Allen et al., 1998) to simulate transpiration and evaporation fluxes, ii) the irrigation module represents different irrigation technics (drip, sprinkler, furrow) and strategies and iii) the water balance module simulates the daily water flows between the atmosphere, the soil (represented by 2 layers) and the crop. In order to represent the interactions and feedbacks governing the ago-hydrological system, ASCROM is itself coupled with AMBHAS, the groundwater model (Tomer, 2012) via a pump model. The coupling of modules and models has been realized thanks to the RECORD platform (Bergez et al., 2013).



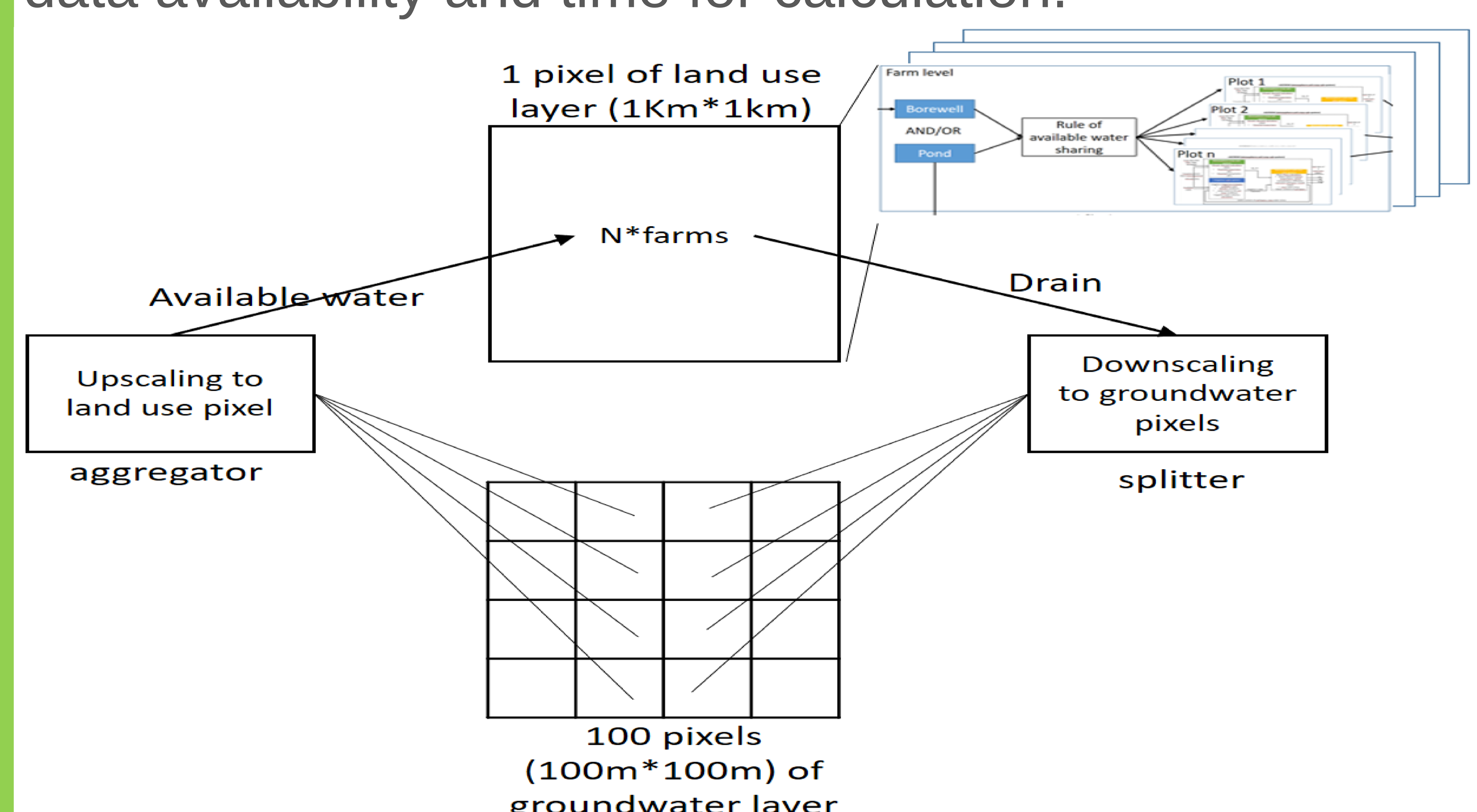
Integration at farm level

The farm is composed of one or more irrigation sources (pond, borewells) and a number of plots, each managed by an ASCROM model. The rules for sharing water between plots are handled by a decision model that provides irrigation volume as input for every ASCROM.



Integration at territory level

The transition to the territory level is made through the superposition of the two layers land use and groundwater. The dimensions of layer's grid is based on a trade-off between the biophysical process precision, data availability and time for calculation.



Conclusions

ASCROM, while parsimoniously representing the system, allowed to simulate complex interactions and feedbacks. Embedded within an integrated model allowing to consider a variety of spatial scales, it is a useful tool for engaging with a large variety of stakeholders.

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ACKNOWLEDGMENT

This work is funded by the ANR, project ATCHA, ANR-16-CE03-0006.