AGRICULTURE VICTORIA

Overcoming the challenges in hydrological modelling of irrigated catchments in SE Australia

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and Resources

Introduction

- Irrigated agriculture in Victoria, Australia covers 3% in area and accounts for 79% of consumptive water use.

- Significant investment has been directed to modernise irrigation infrastructure both at farm and regional levels.

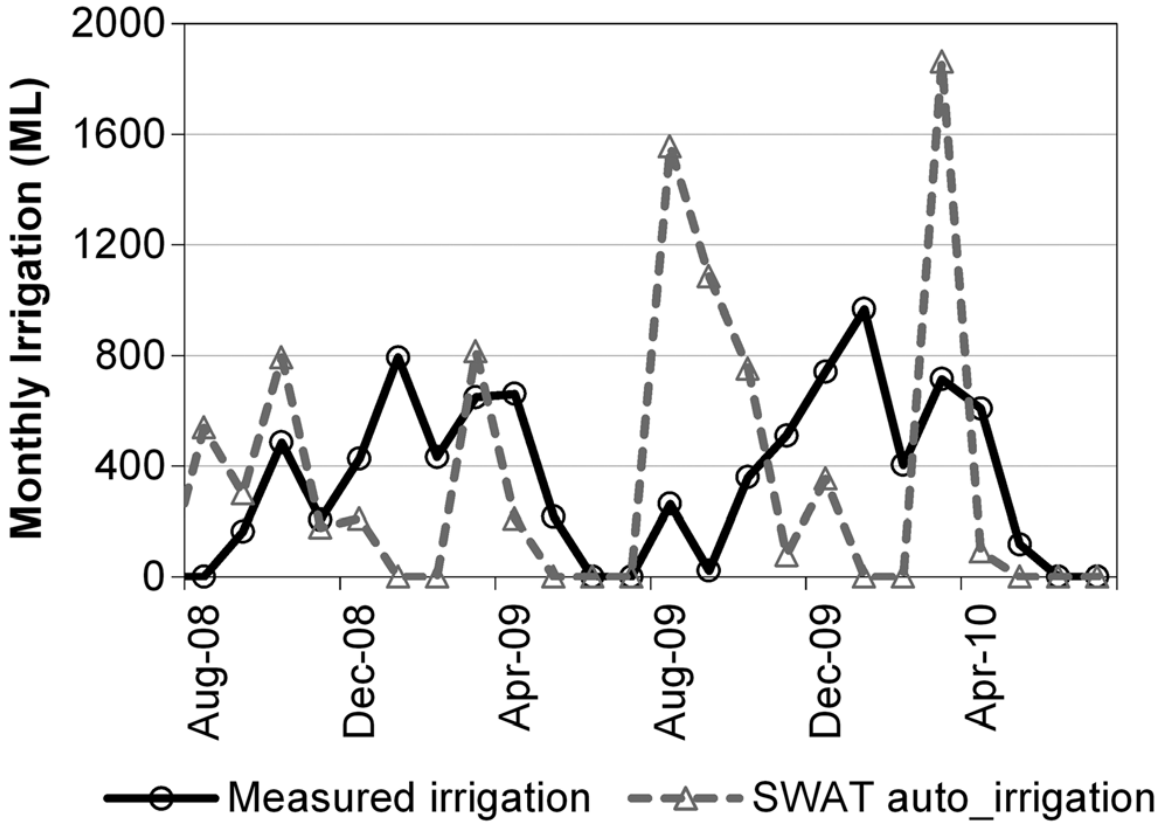
- Effectiveness and efficiency of the improved infrastructure are mostly assessed at catchment scales.

Introduction cont'd

- Irrigated catchments pose challenges in hydrological modelling due to the varied nature of irrigation systems, exacerbated by the on-farm re-use dams used to capture and recycle irrigation runoff in SE Australia.

- With the modernization of irrigation systems in Victoria, spatial-temporal irrigation data is increasingly becoming available and can be integrated in hydrological models.

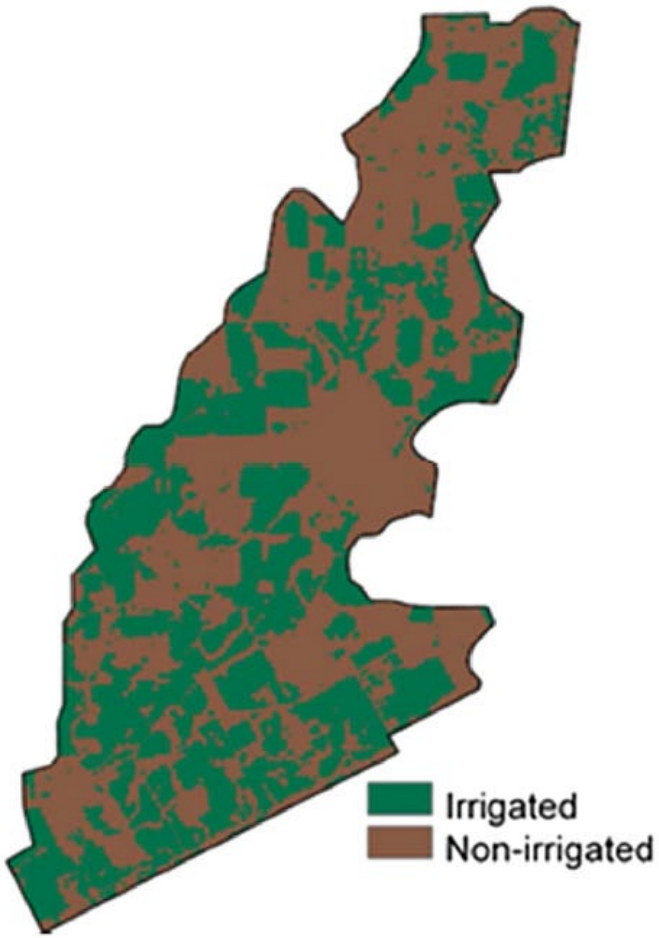
- The challenge is to find suitable models that can capture these complexities.



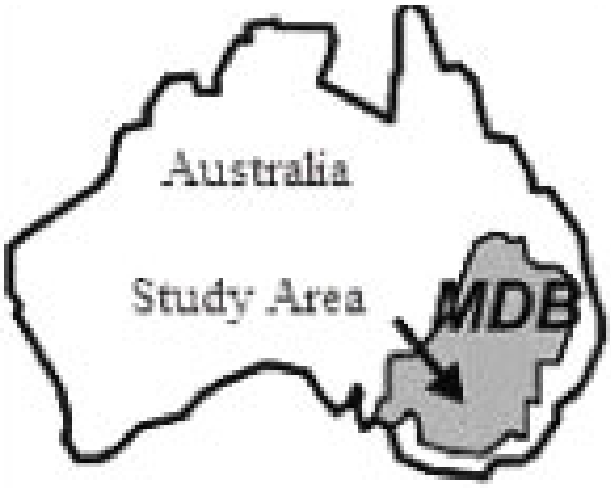
Githui, F. Thayalakumaran, T., Selle, B. Estimating irrigation inputs for distributed hydrological modelling: A case study from an irrigated catchment in southeast Australia. **Hydrol. Process**. **2016**

Case studies

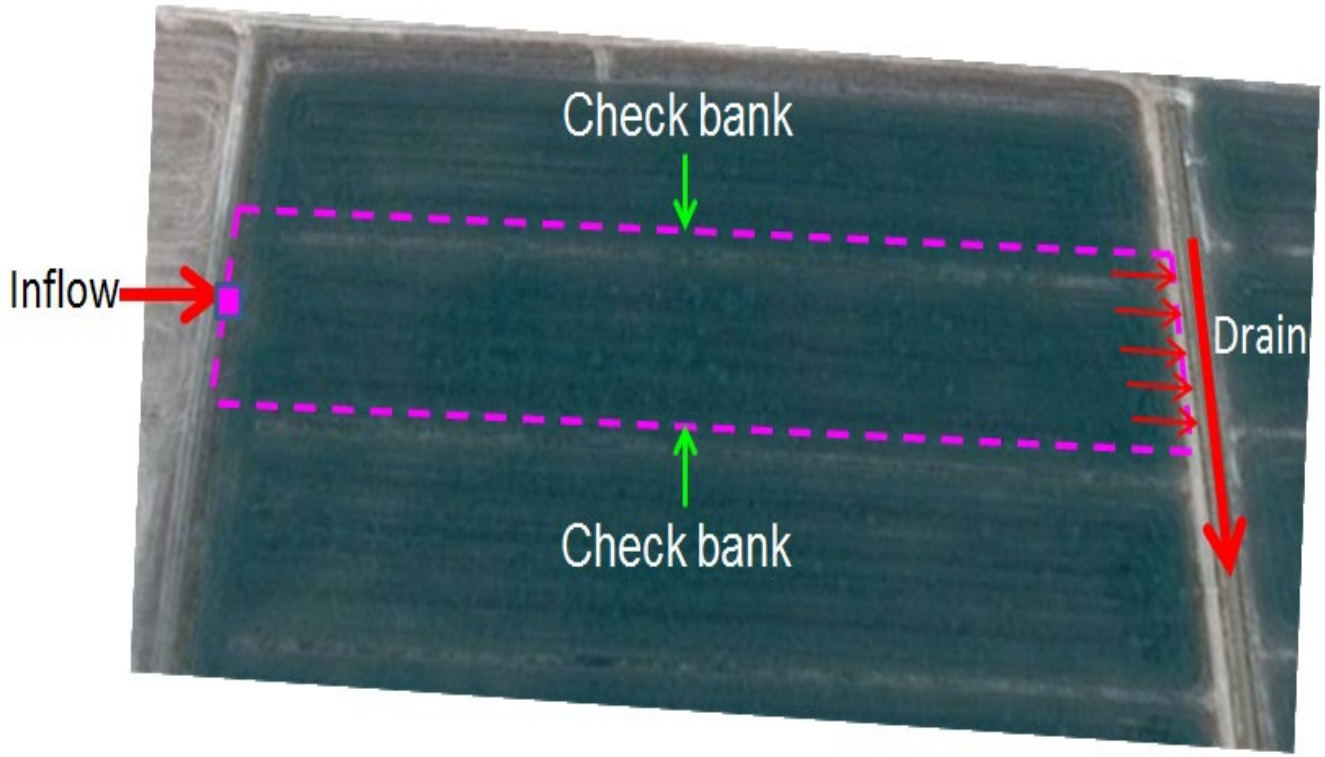
Case 1: Estimating irrigation inputs for use with SWAT



- South east Victoria, Australia
- 3012 ha
- ~45 % irrigated
- Border check irrigation



Border-check irrigation



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Case 1: Estimating irrigation inputs for use with SWAT

DATA

Land use/cover
Irrigated area/season

Irrigation application rates (ML/ha)

Measured daily irrigation water

Measured annual irrigation water

cont'd
Case 1: Estimating irrigation inputs for use with SWAT

METHOD

1. Calculate the volume of total daily irrigation water used for the whole catchment using all data sources.

2. Distribute volume from (1) to irrigated HRUs in the catchment according to land use and season (irrigation amounts and frequency for each HRU).

cont'd
Case 1: Estimating irrigation inputs for use with SWAT

METHOD

3. Scenario 1: IrrVar - variable rates of irrigation application

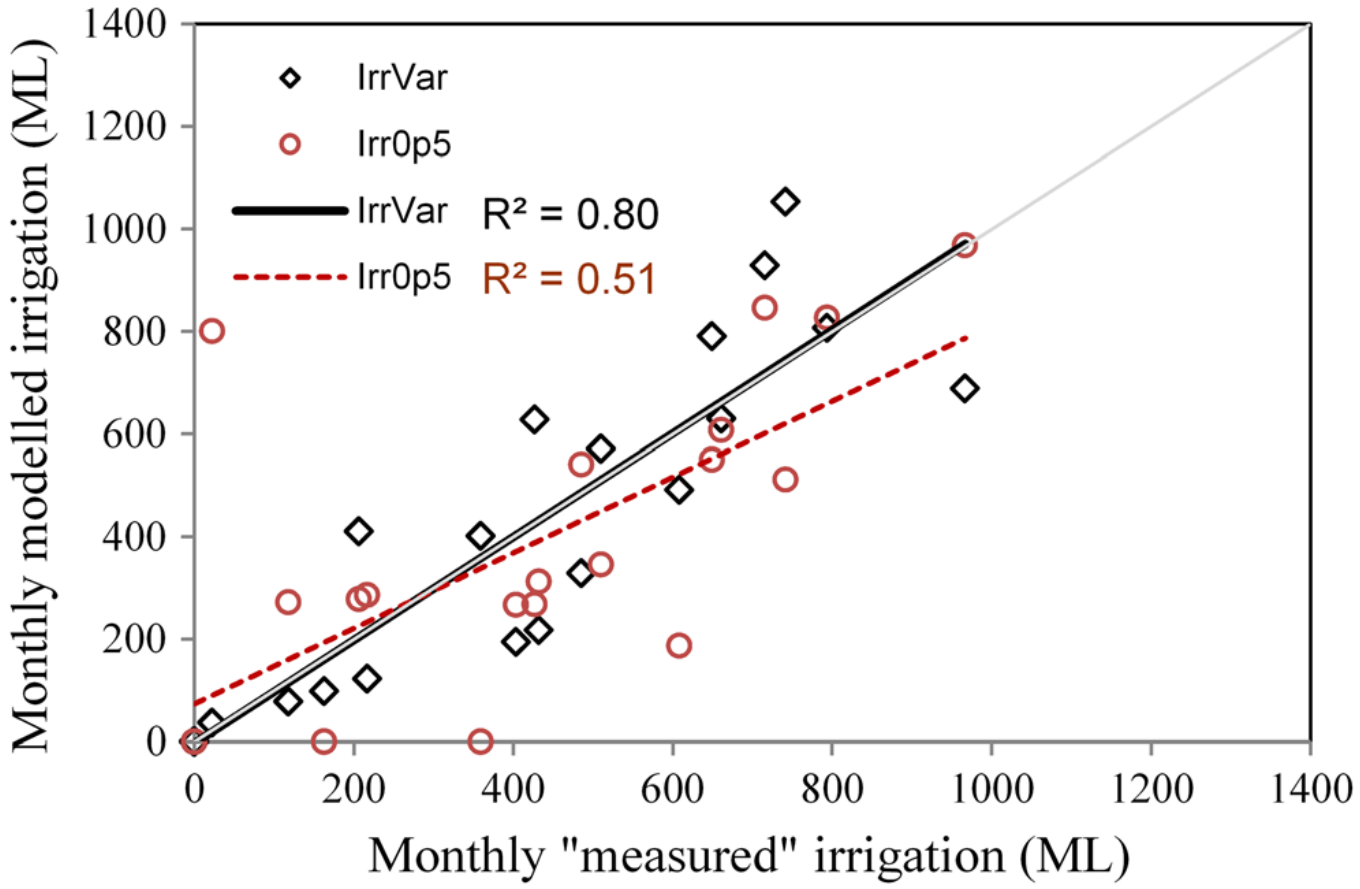
4. Scenario 2: Irr0p5 - fixed irrigation rate of 0.5 ML/ha

5. Calibration against irrigation measured data before input to SWAT

6. Write SWAT management files (*.mgt).

cont'd
Case 1: Estimating irrigation inputs for use with SWAT

Results



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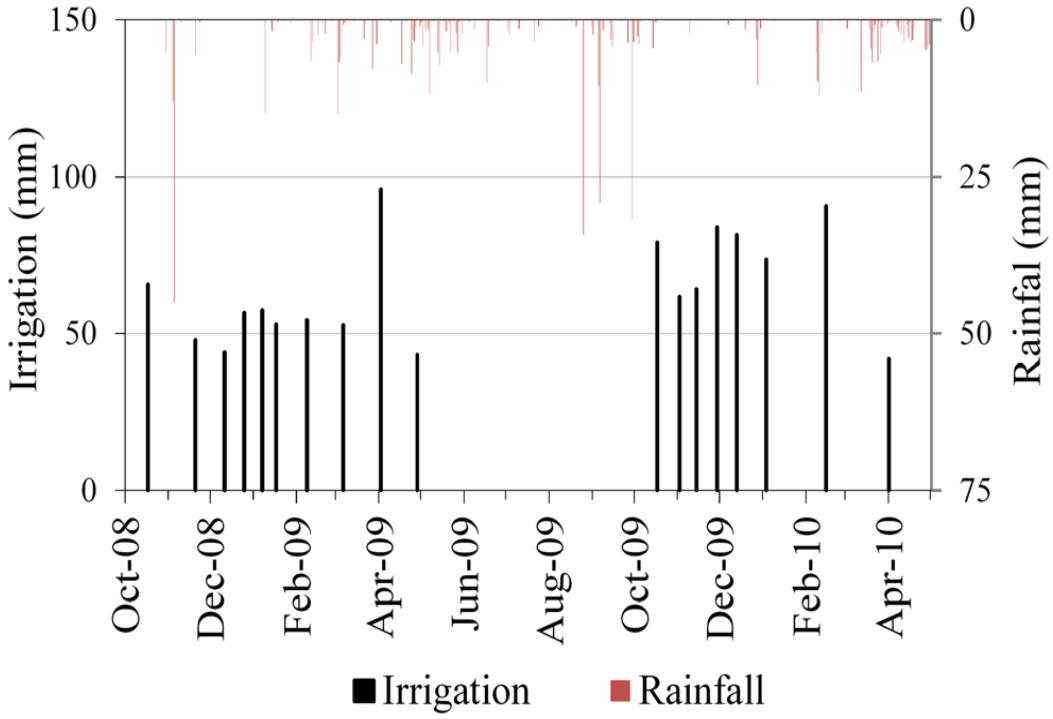
Case 1: Estimating irrigation inputs for use with SWAT



Results

(i) irrigation intervals in summer (~10 days) were shorter compared with intervals both at the beginning of the season in spring and at the end of the irrigation season in autumn

(ii) due to rainfall, irrigation intervals between February and April 2010 were longer than during the same period in 2009

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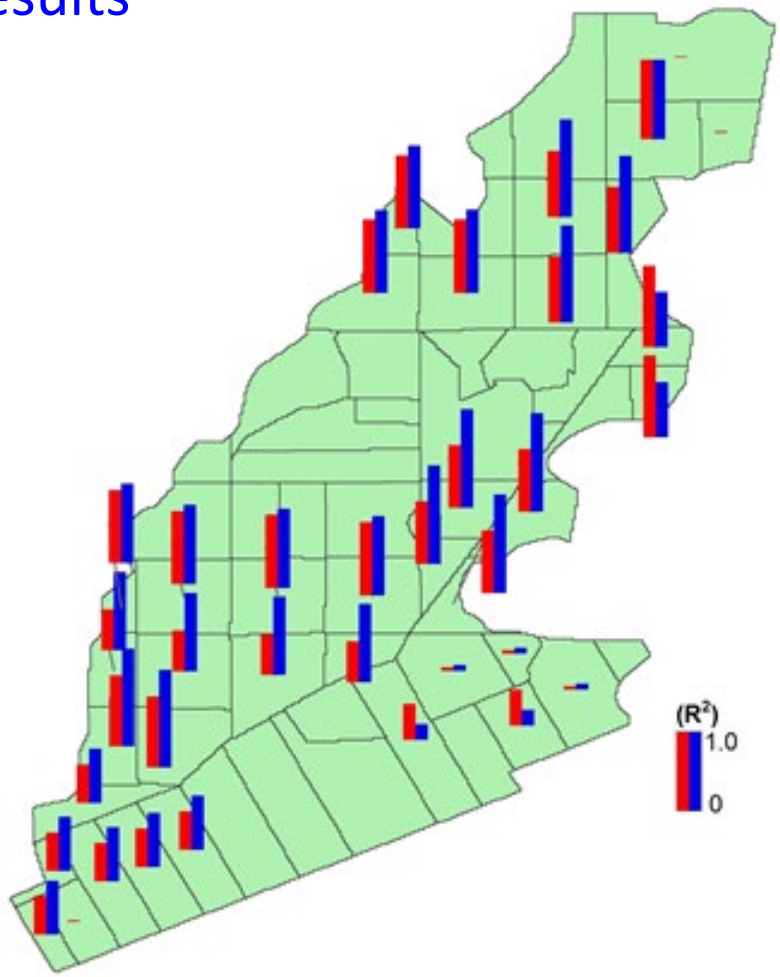
Case 1: Estimating irrigation inputs for use with SWAT

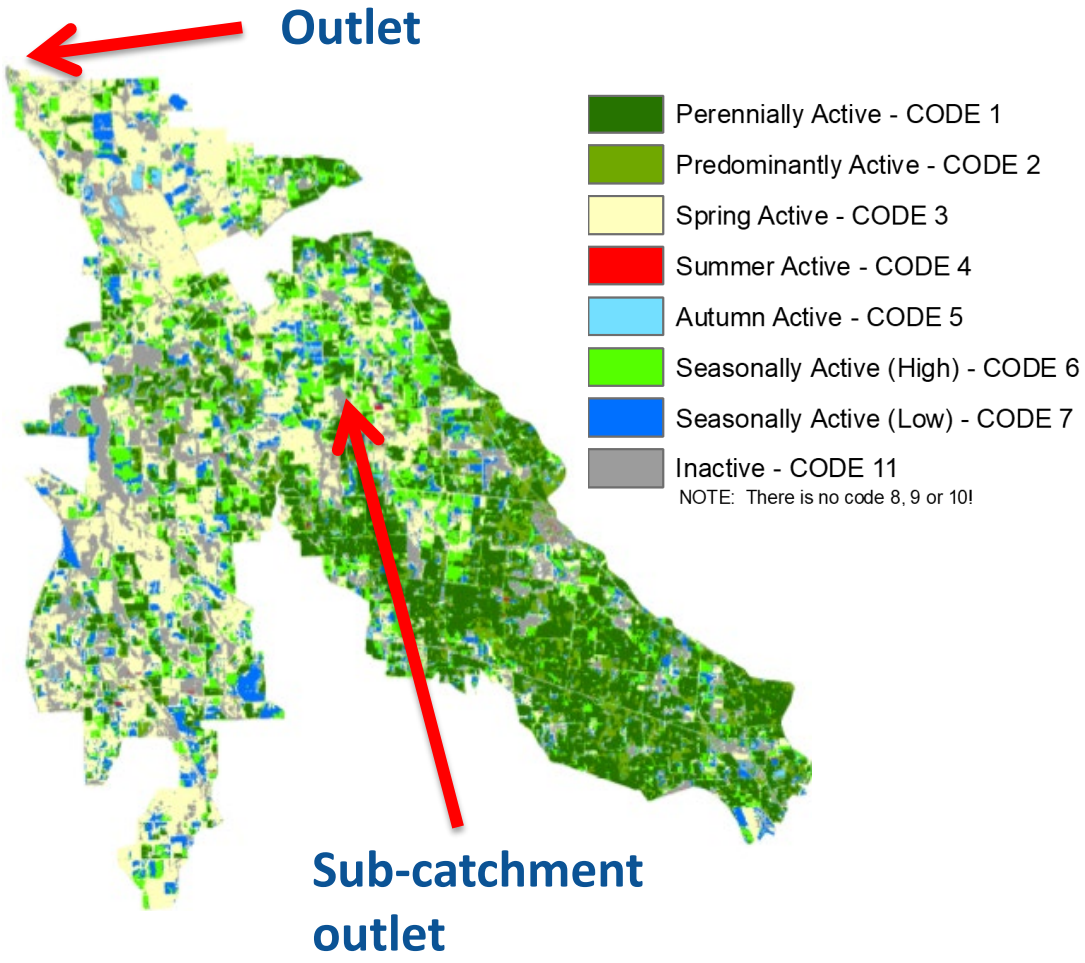
Results



NSE values for streamflow

	IrrVar	Irr0p5
Daily flow	0.72	0.37
Monthly flow	0.91	0.74

Case studies
Case 2: Estimating irrigation inputs for use with SWAT



- Northern Victoria, Australia
- 60,000 ha
- ~60 % irrigated
- Border check irrigation

cont'd
Case 2: Estimating irrigation inputs for use with SWAT

METHOD

1. Similar to **Case 1** method except:
   i. A fixed irrigation rate of 0.5 ML/ha was used (Irr0p5, **Case 1**)

   ii. The order of HRUs was randomized (unlike 'timing' of irrigation in **Case 1**)

   iii. Calibration of SWAT using multiple irrigation schedule replicates

2. Uncertainty in irrigation inputs and its impact on streamflow simulation

David McInerney, Mark Thyer, Dmitri Kavetski, Faith Githui, Thabo Thayalakumaran, Min Liu and George Kuczera (2018).The importance of spatio-temporal variability in irrigation inputs for hydrological modelling of irrigated catchments.
Water Resources Research, 2018

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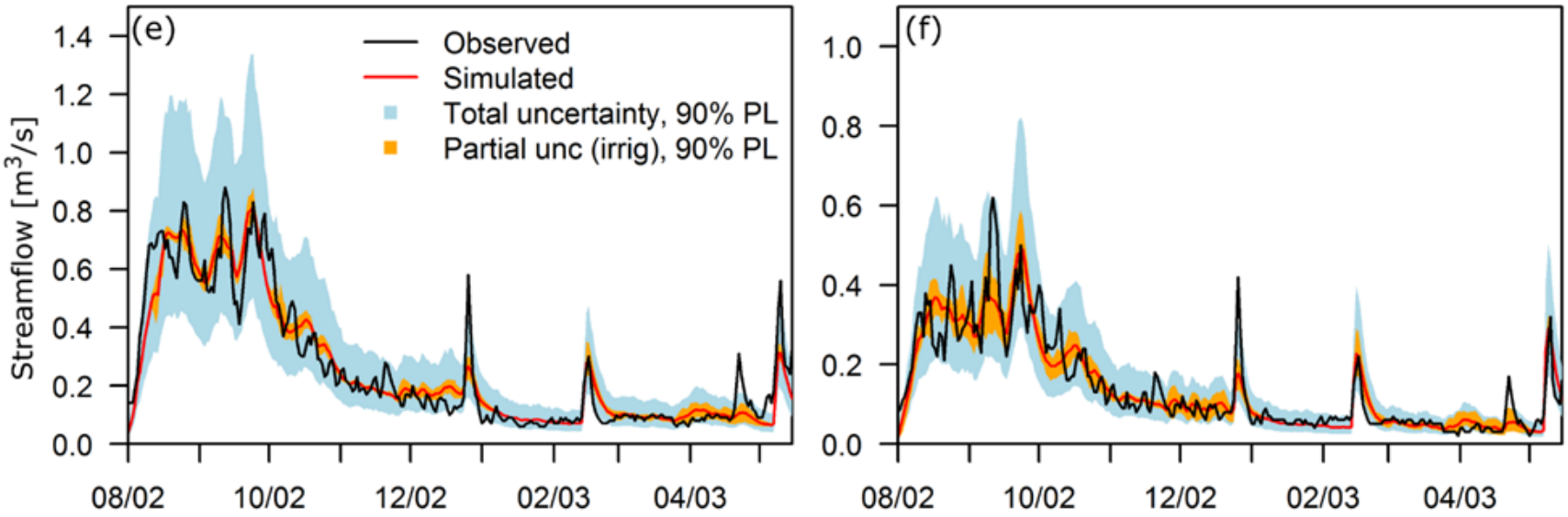
Case 2: Estimating irrigation inputs for use with SWAT

Results

Catchment outlet

Sub-catchment outlet



Sub-catchment scale, irrigation schedule uncertainty - 40% of total simulation uncertainty in the streamflow.

At the larger catchment scale, - 20%.

Findings

- Incorporating variable irrigation application rates as is practiced by farmers improved water balance estimates simulated by SWAT (streamflow and ET).

- Spatio-temporal variability in irrigation inputs on simulations of major hydrological processes is important

- Uncertainty in irrigation inputs can contribute substantially to total uncertainty in the hydrological simulations.

Current / Future work

- Development of a method for applying the spatial-temporal data in SWAT without aggregating at catchment level.

- Adapting/modifying SWAT to include on-farm reuse dams and their operation so that their impact on water demand and environment can be assessed.

Current / Future work cont'd

Re-use dam

Drain