

Impacts of irrigation on groundwater recharge, mixing and quality: Sandy aquifer of the Limagne Bourbonnaise (central France)

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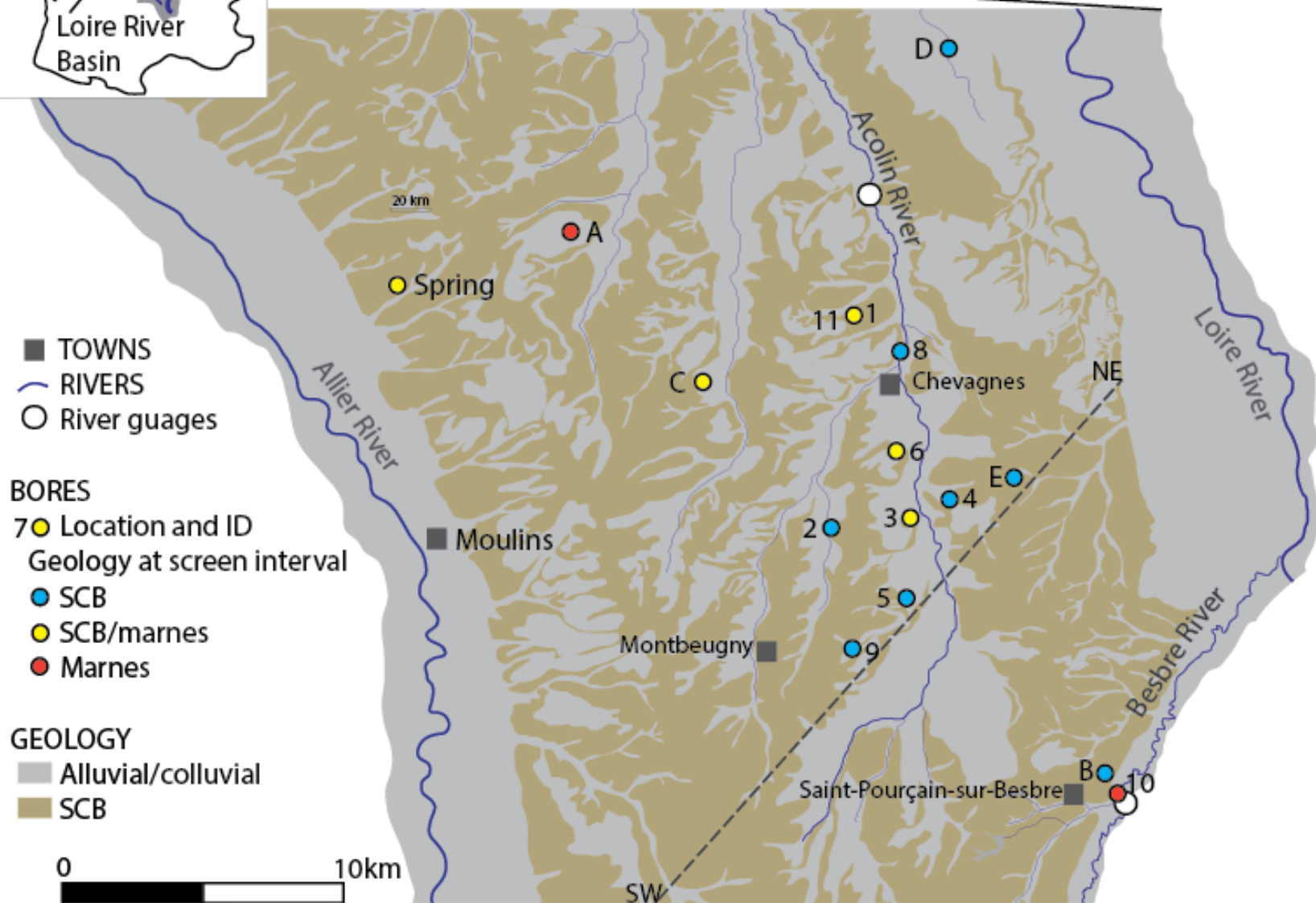
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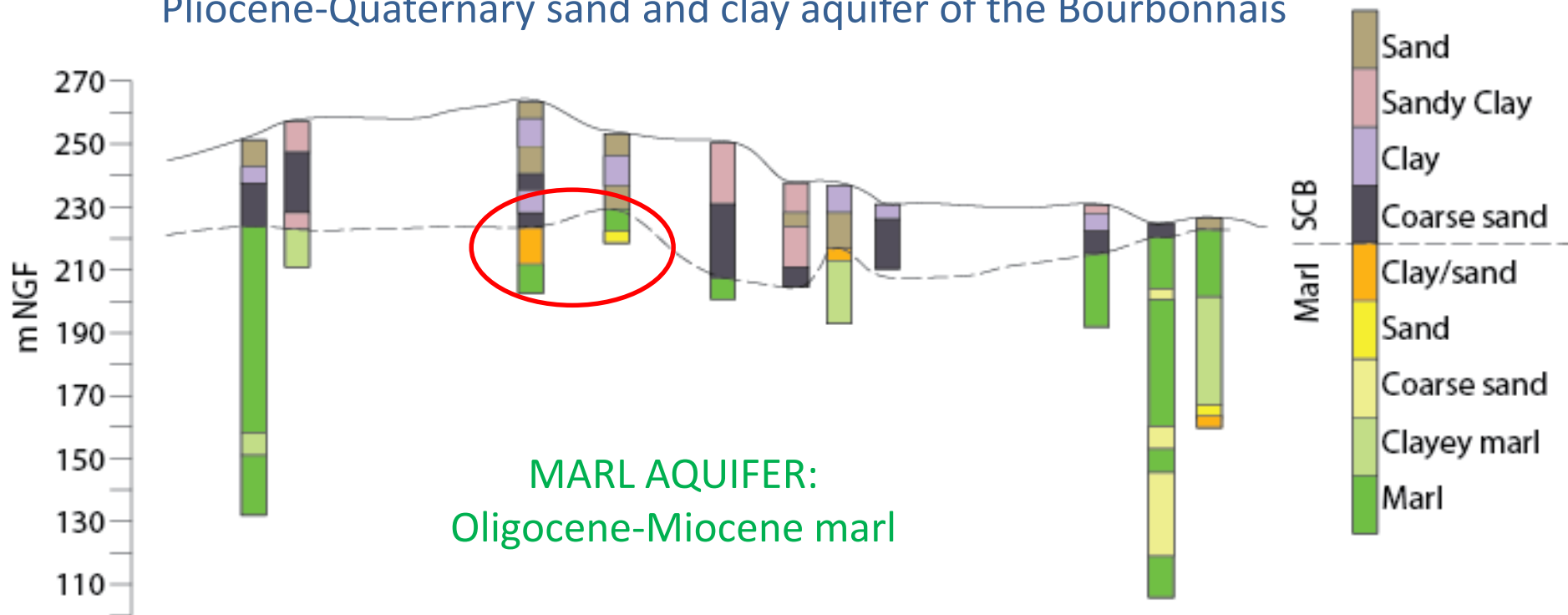


SURFICIAL GEOLOGY



CROSS SECTION OF LITHOLOGY

SCB AQUIFER:
Pliocene-Quaternary sand and clay aquifer of the Bourbonnais

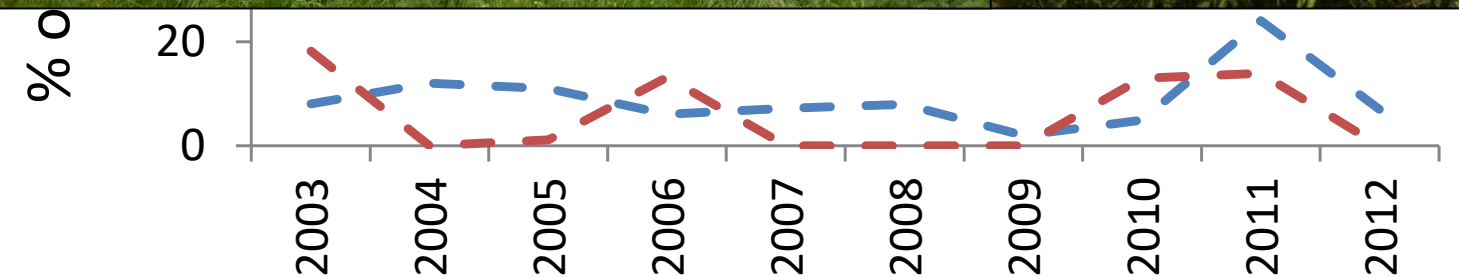


LAND USE

- a) increase in surface area irrigated
- b) Irrigation for corn

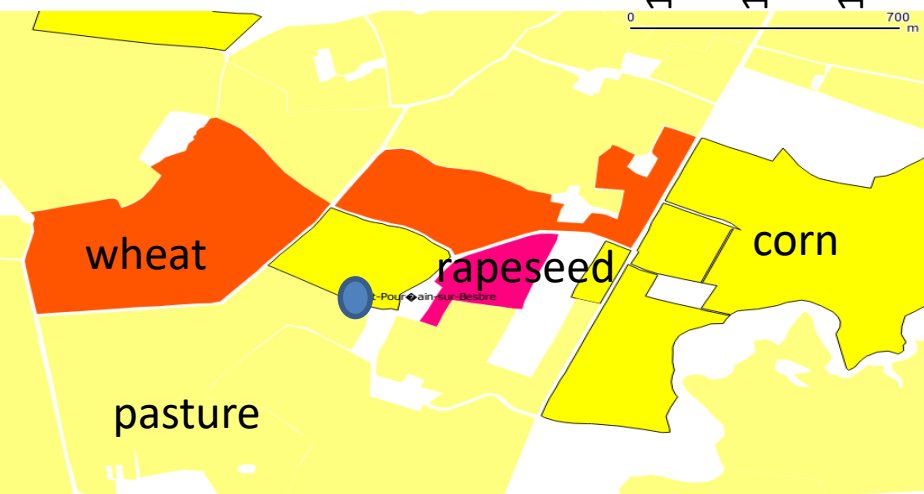
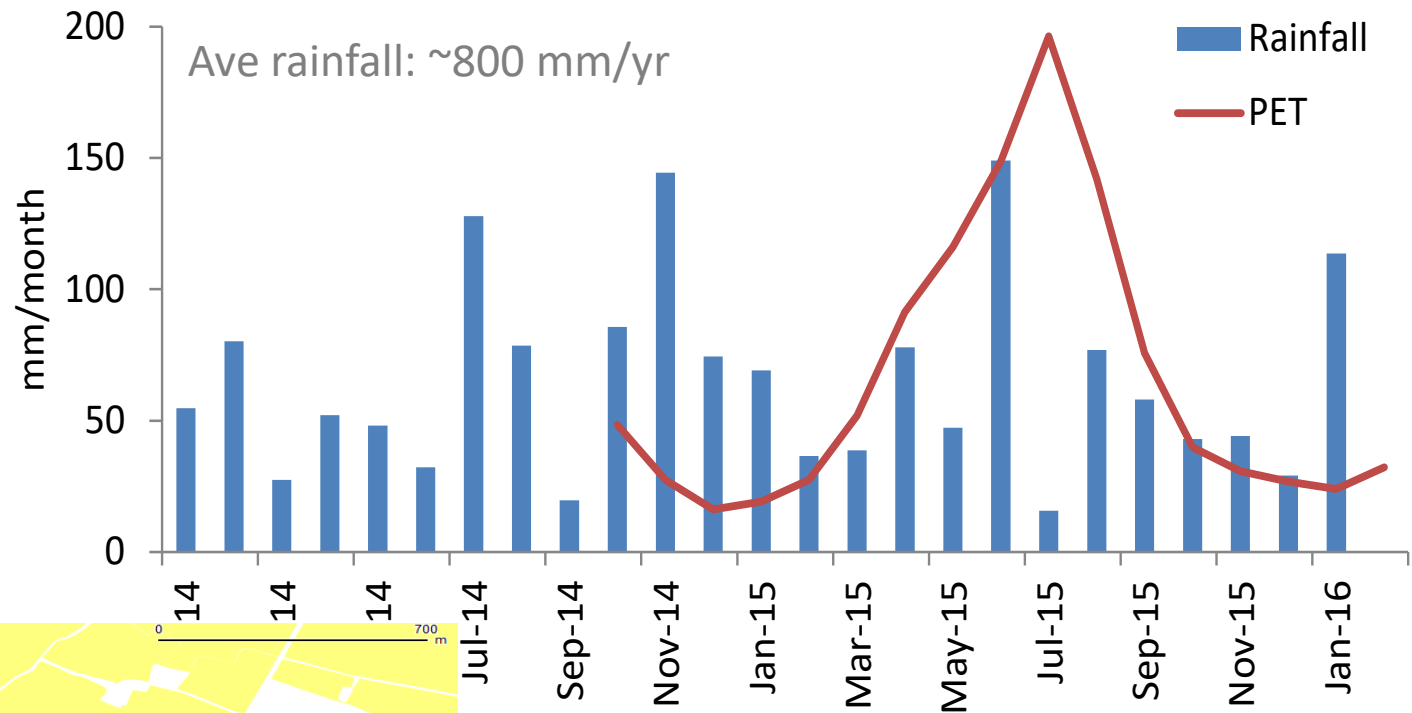


Decrease in pasture, increase in corn and cereals

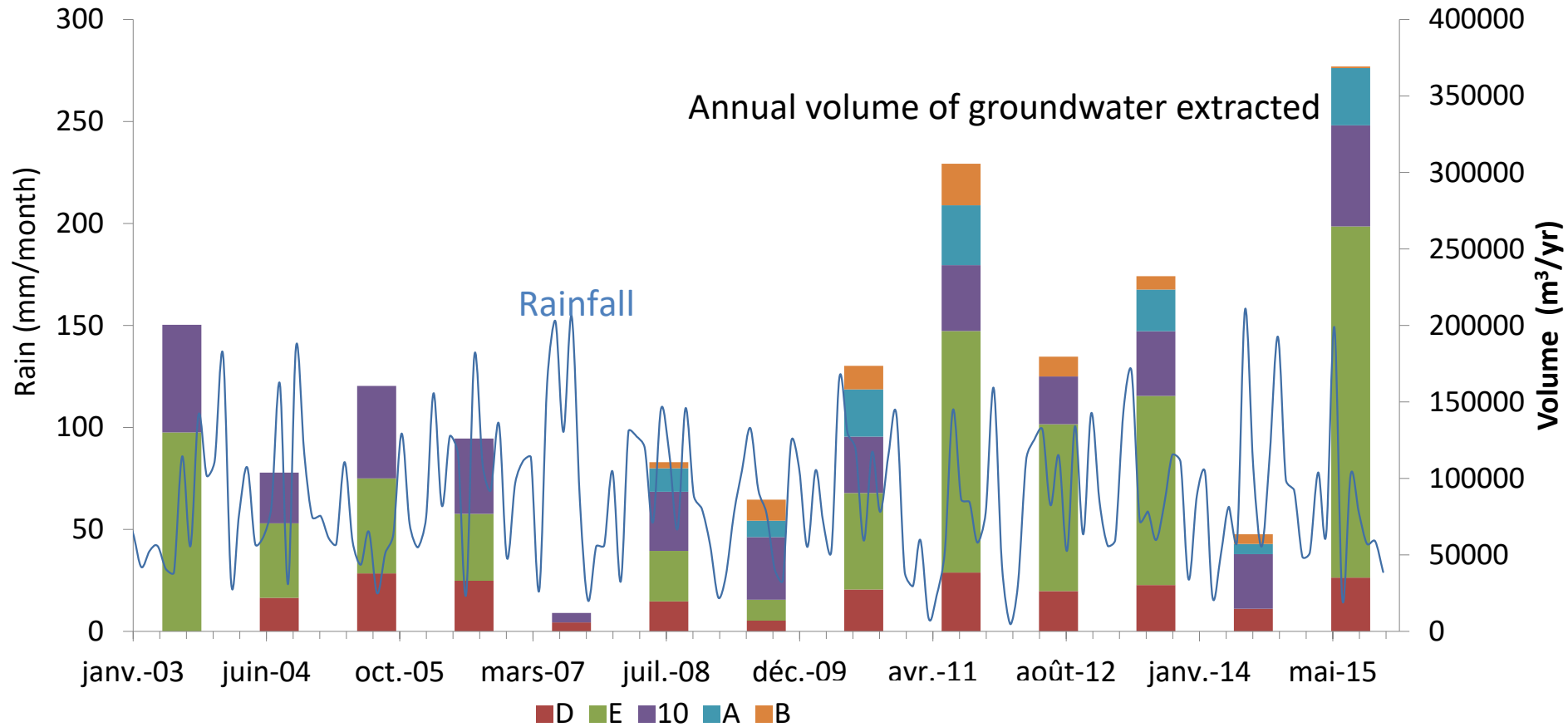


Groundwater used for irrigation

Surface water = less reliable resources in summer



Groundwater volumes extracted

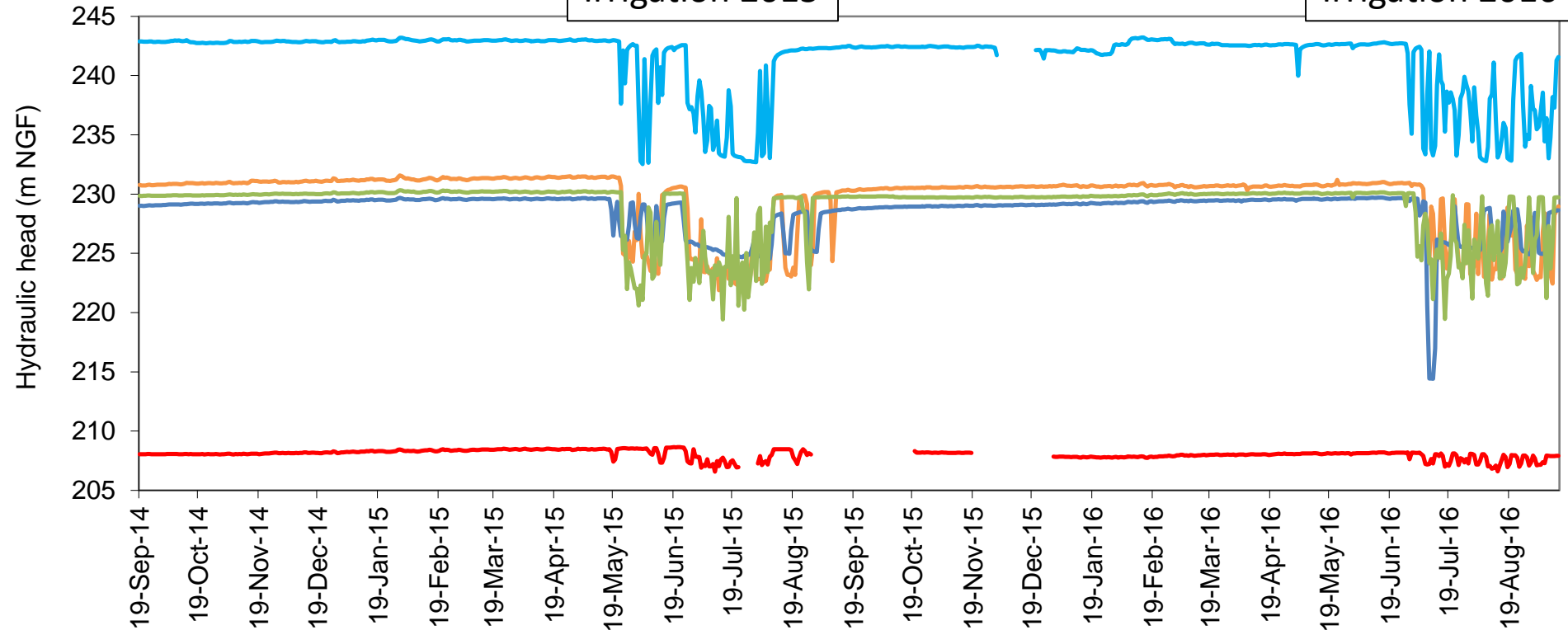


Groundwater used for irrigation

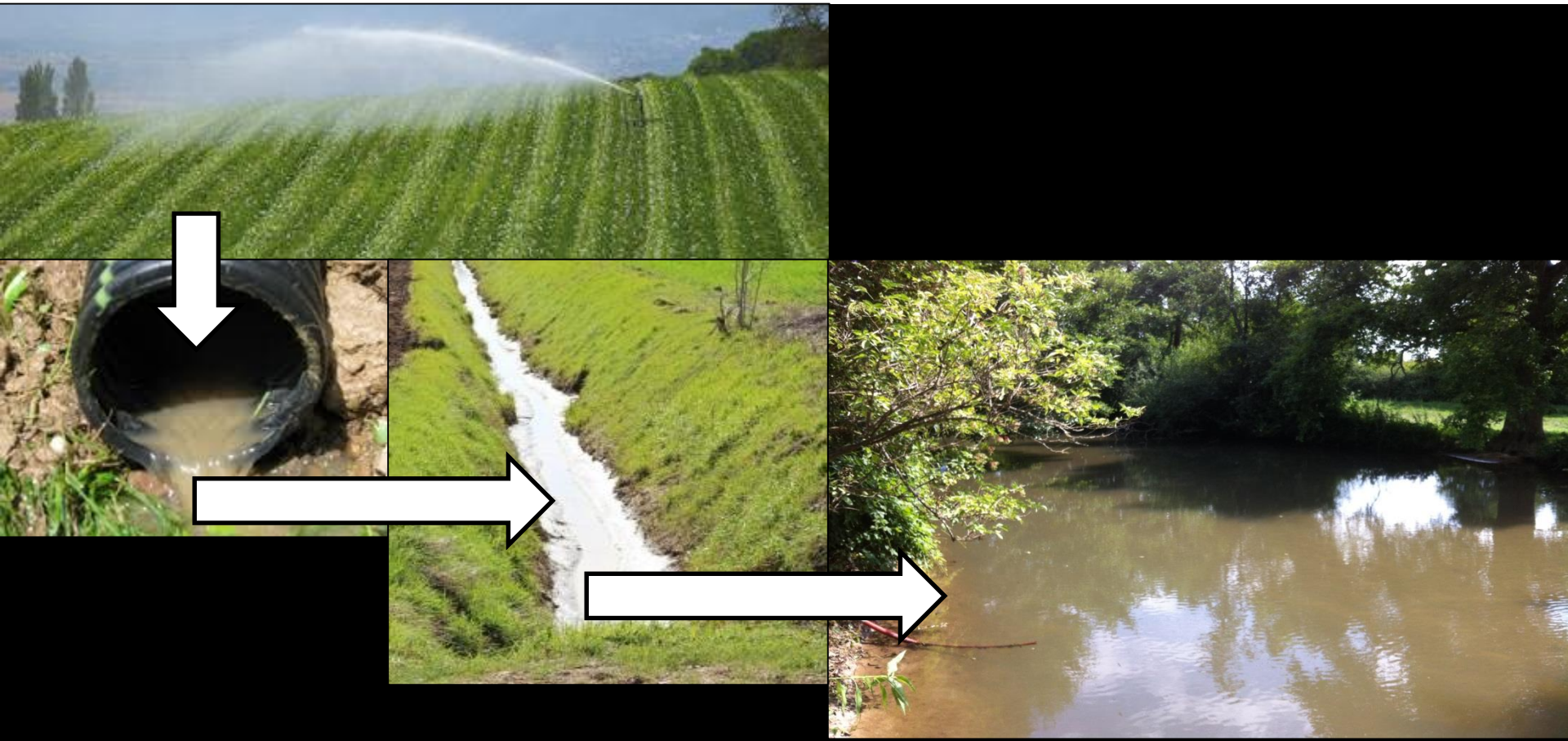


Irrigation 2015

Irrigation 2016

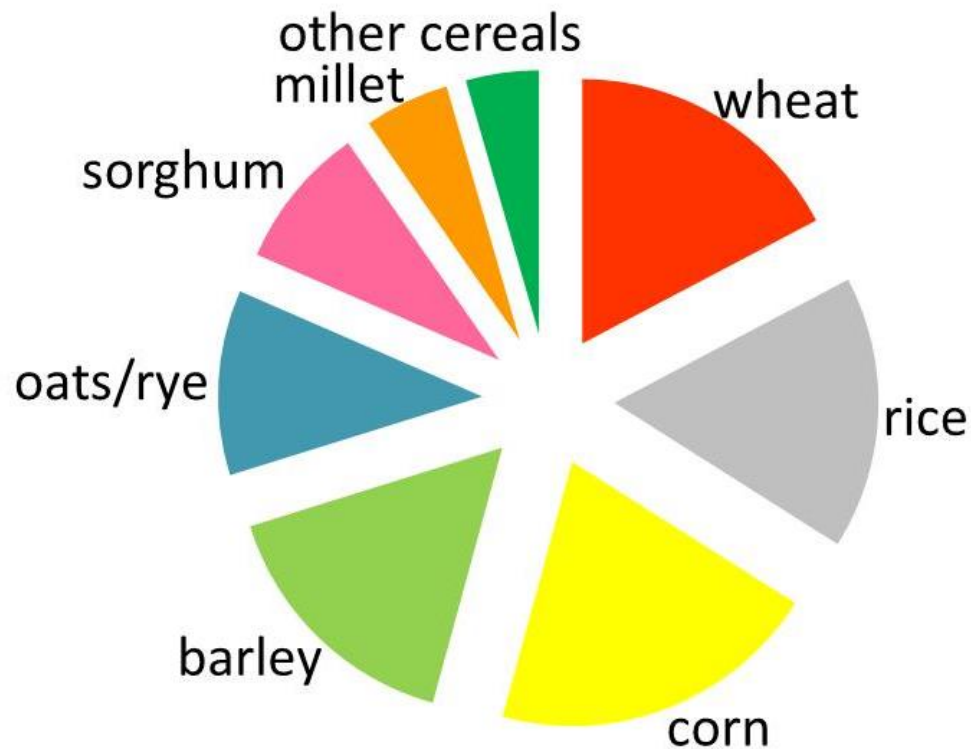


Sub-surface drainage



Increased fertiliser application

⇒ Corn: high fertiliser application rate (FAO, 2006)



This study, 2016

1. Impacts of irrigated agriculture on groundwater **quantity**
2. Impacts of irrigated agriculture on groundwater **quality**

⇒ Sustainable irrigated agriculture?

⇒ Only 5 bores monitored for hydraulic head (since 2014)

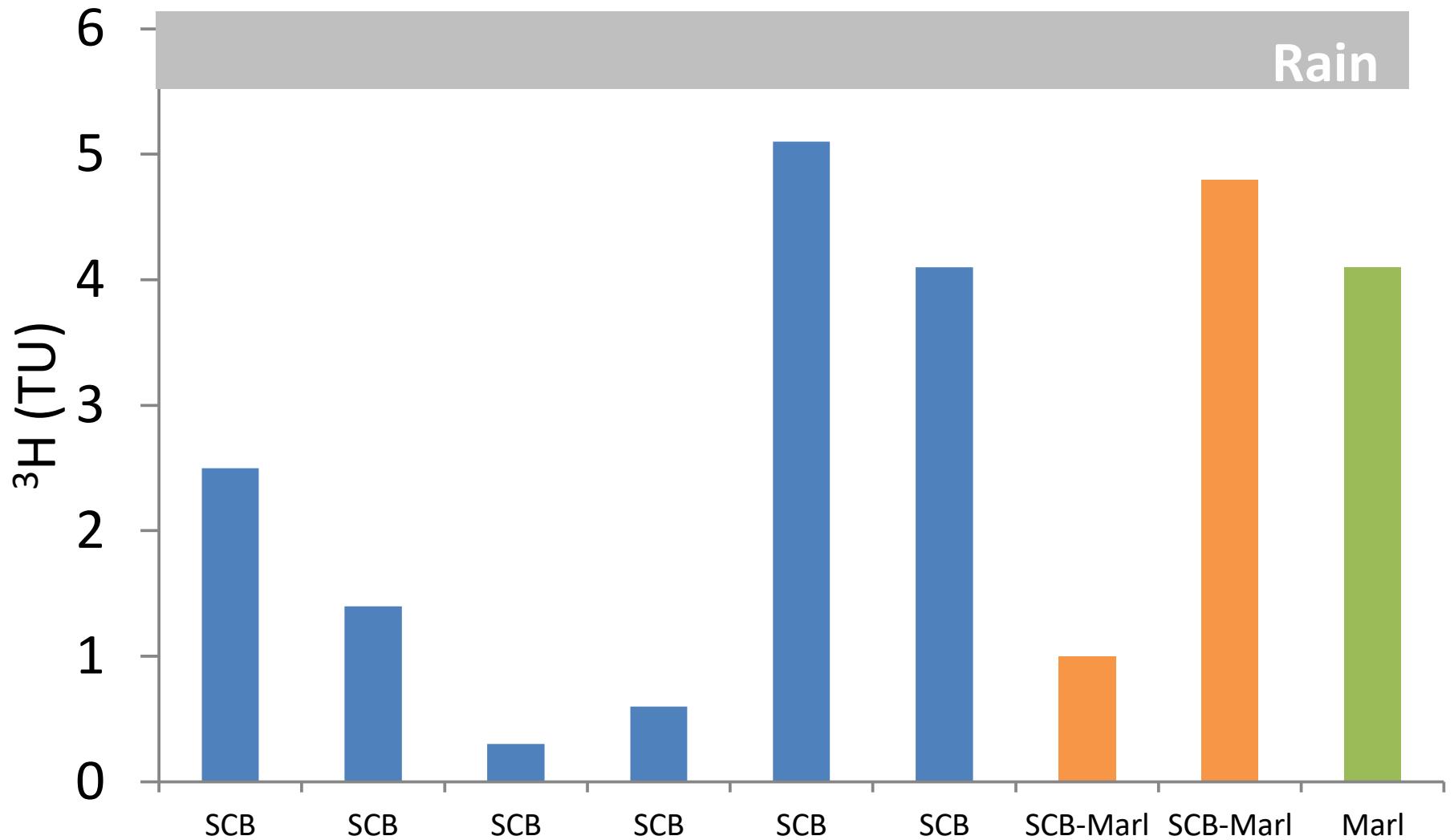
Hydrochemisty

16 bores; before and during irrigation

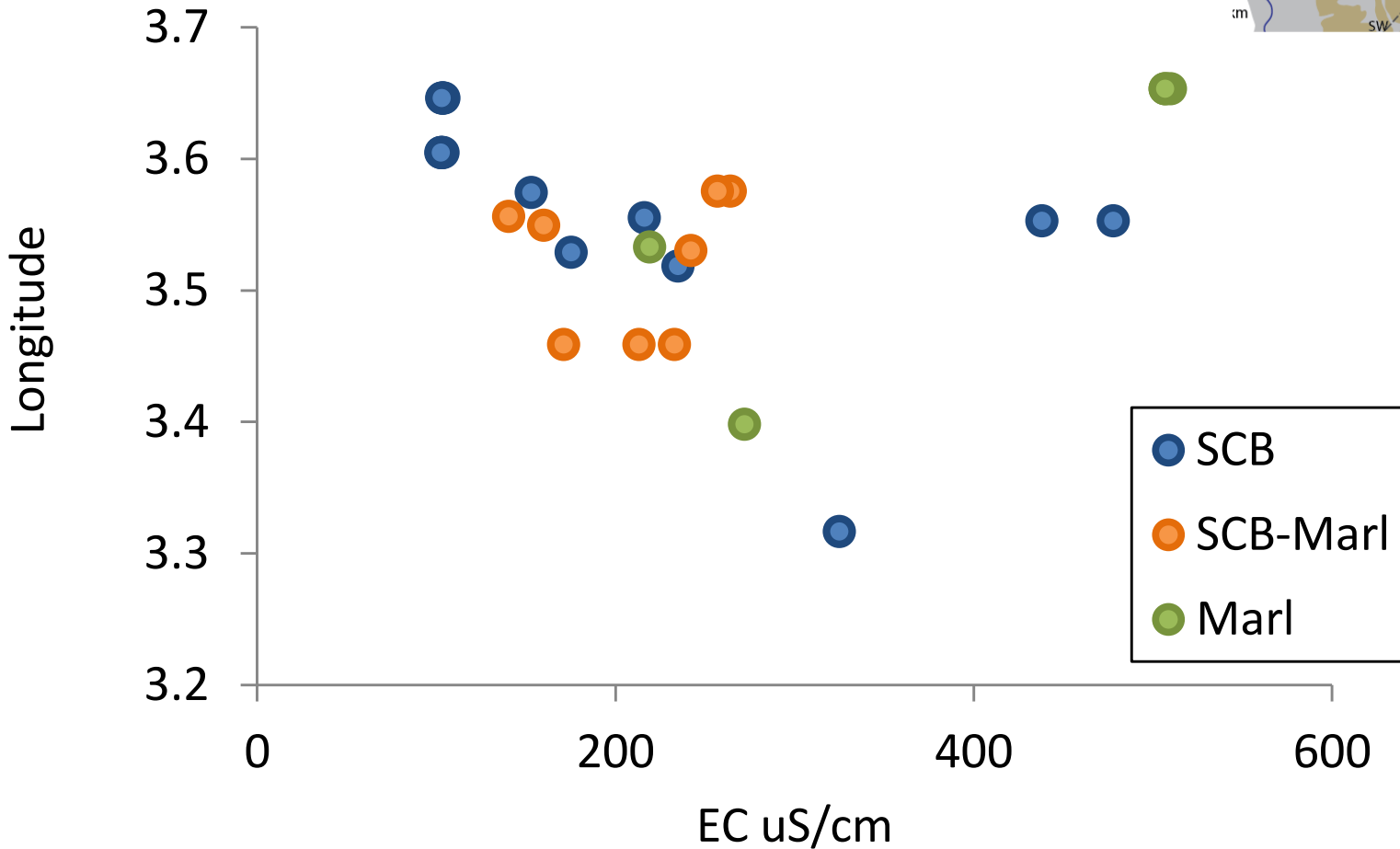
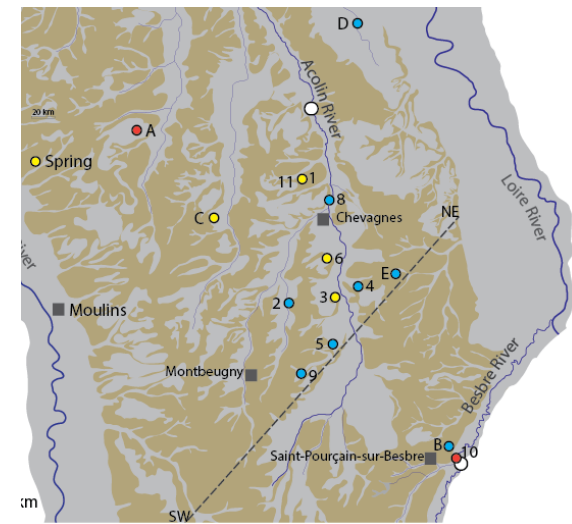
2 rivers, 4 irrigation dams, 3 irrigation drains

Groundwater system

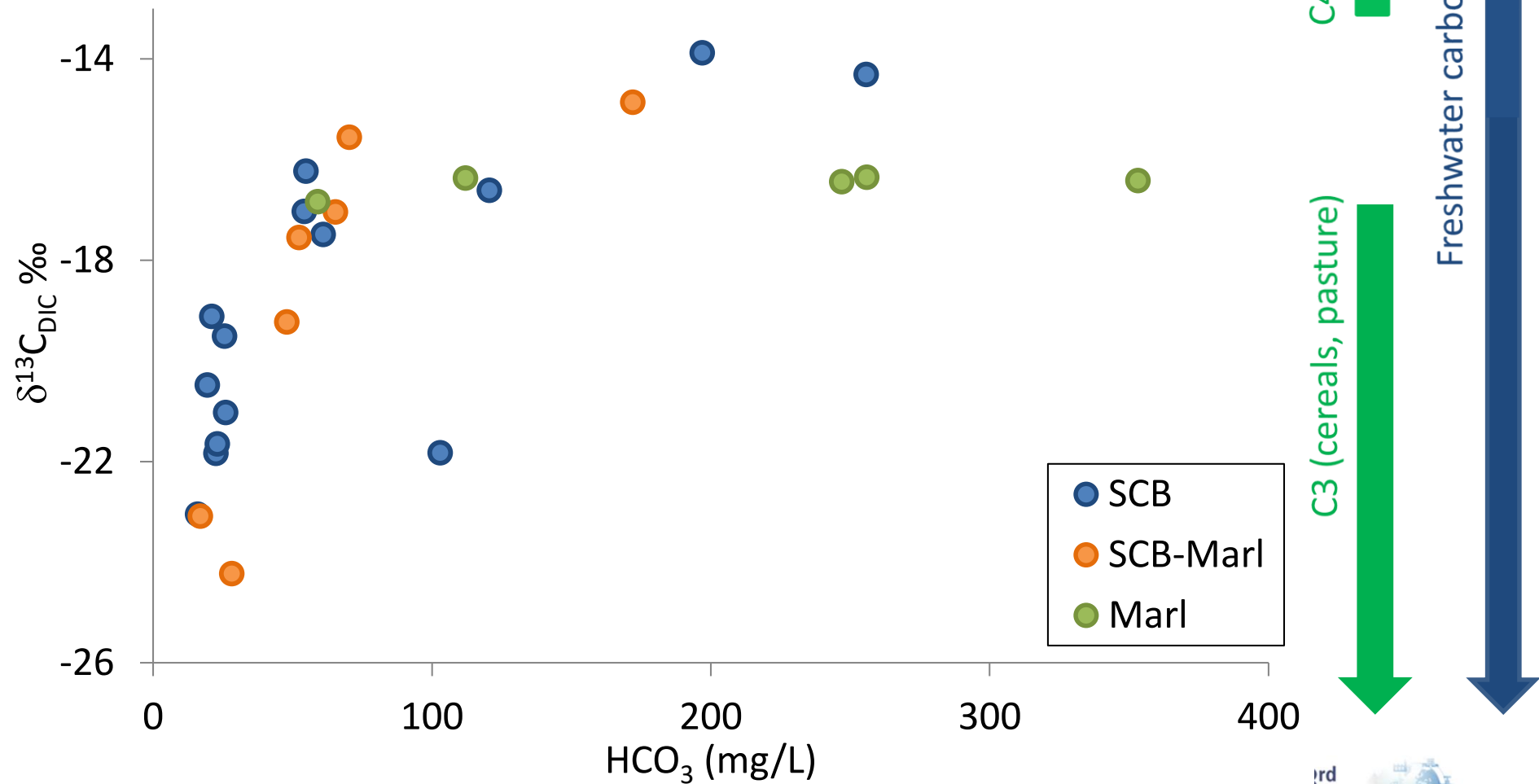
Older and more recent waters



High mixing



^{13}C , DIC – aquifer differences



Impacts of irrigated agriculture

Recharge

WTF – recent winter recharge

Bore	Recharge mm/month
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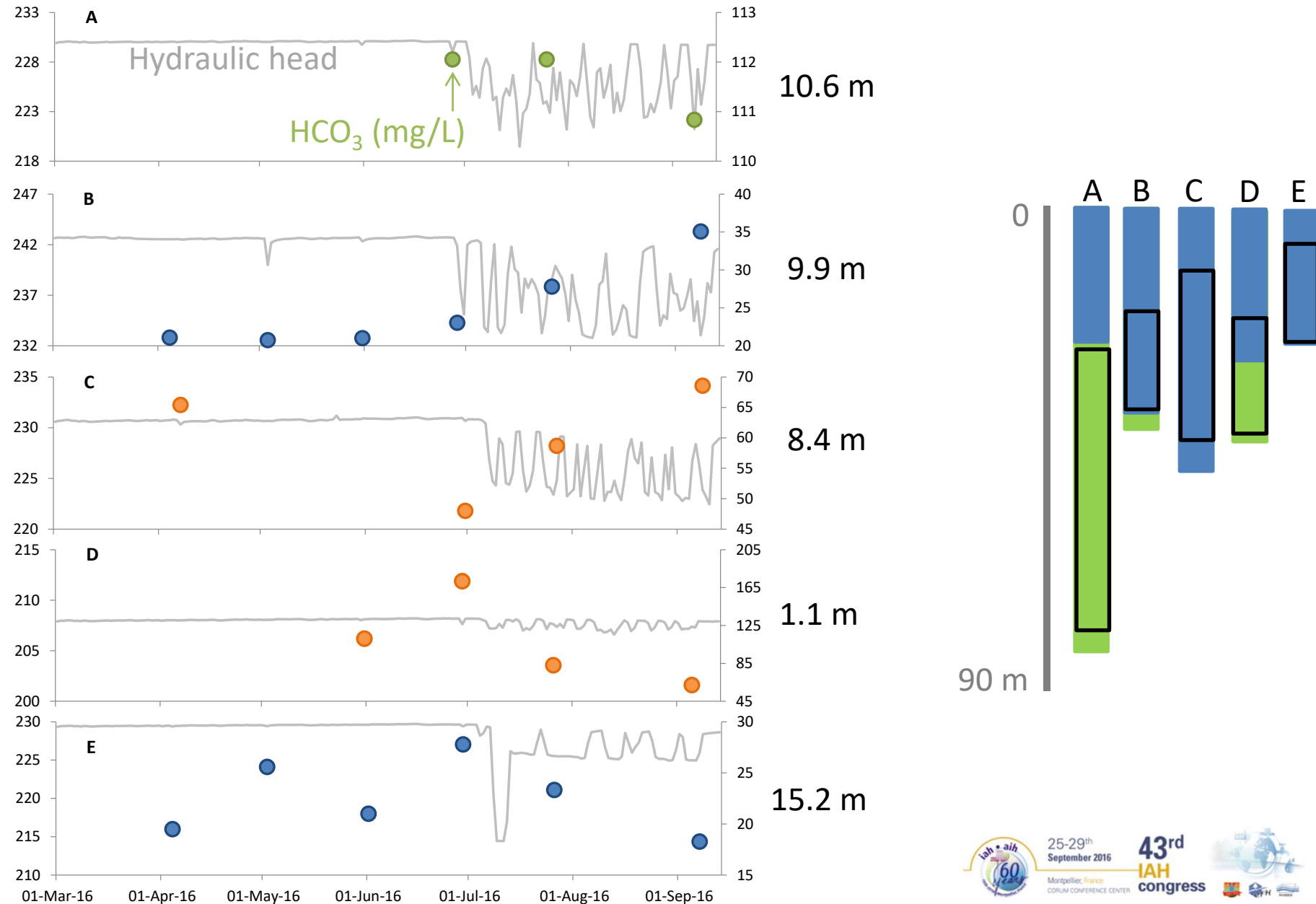
C	6-21
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E	4-20
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Renewal rates – average long term recharge

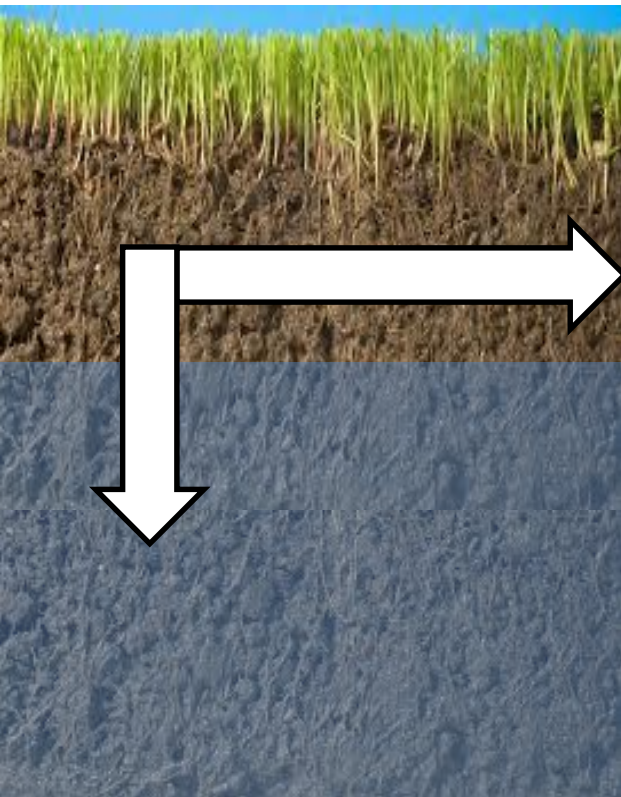
Bore	Renewal rate (mm/year)
C	14-42
E	18-55

HCO₃: pre-irrigation and irrigation



Water quality

NO₃ (mg/L)



DRAIN

GROUNDWATER

Site B

Site C

Site E

9-27

56

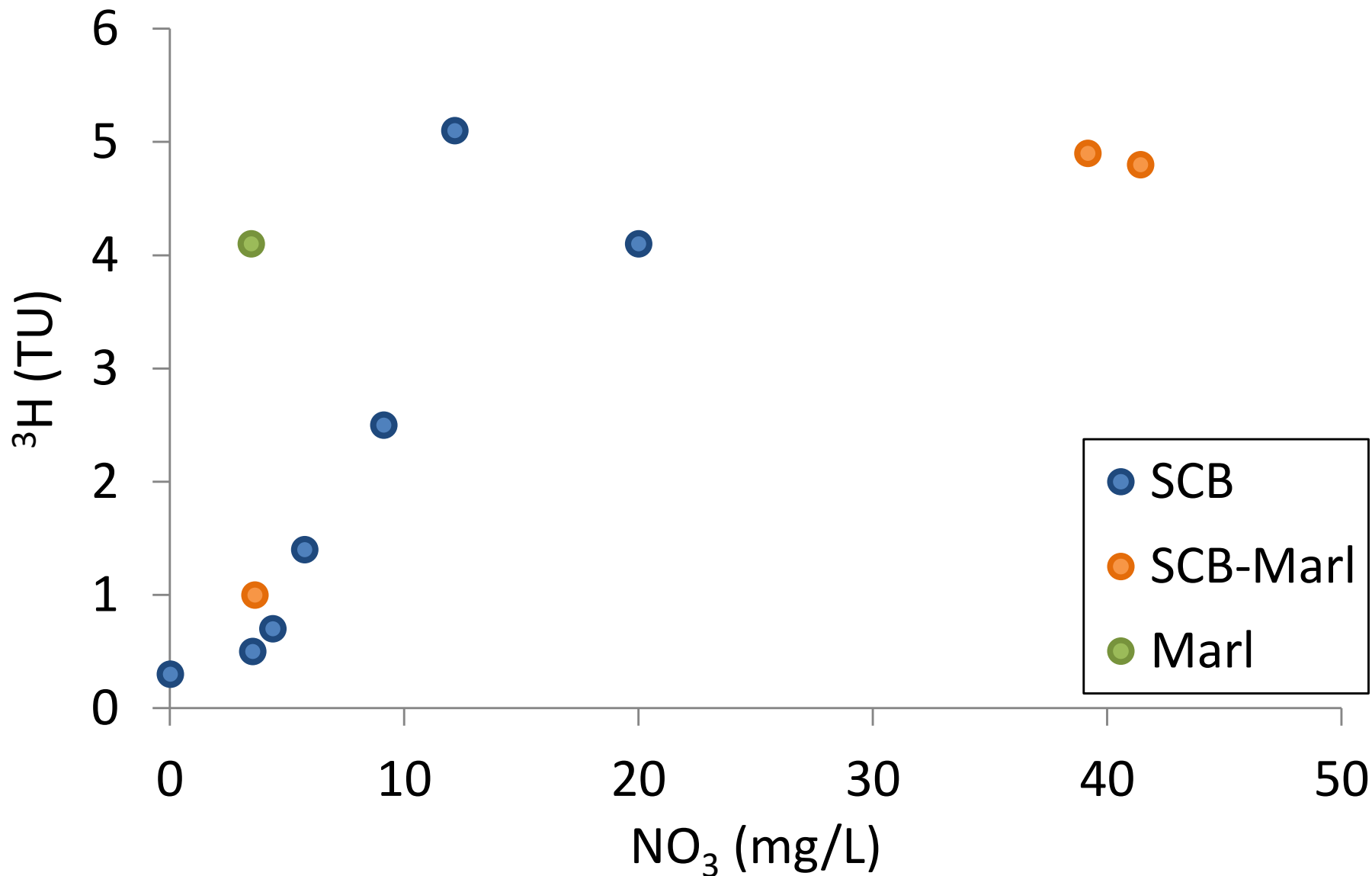
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3-4

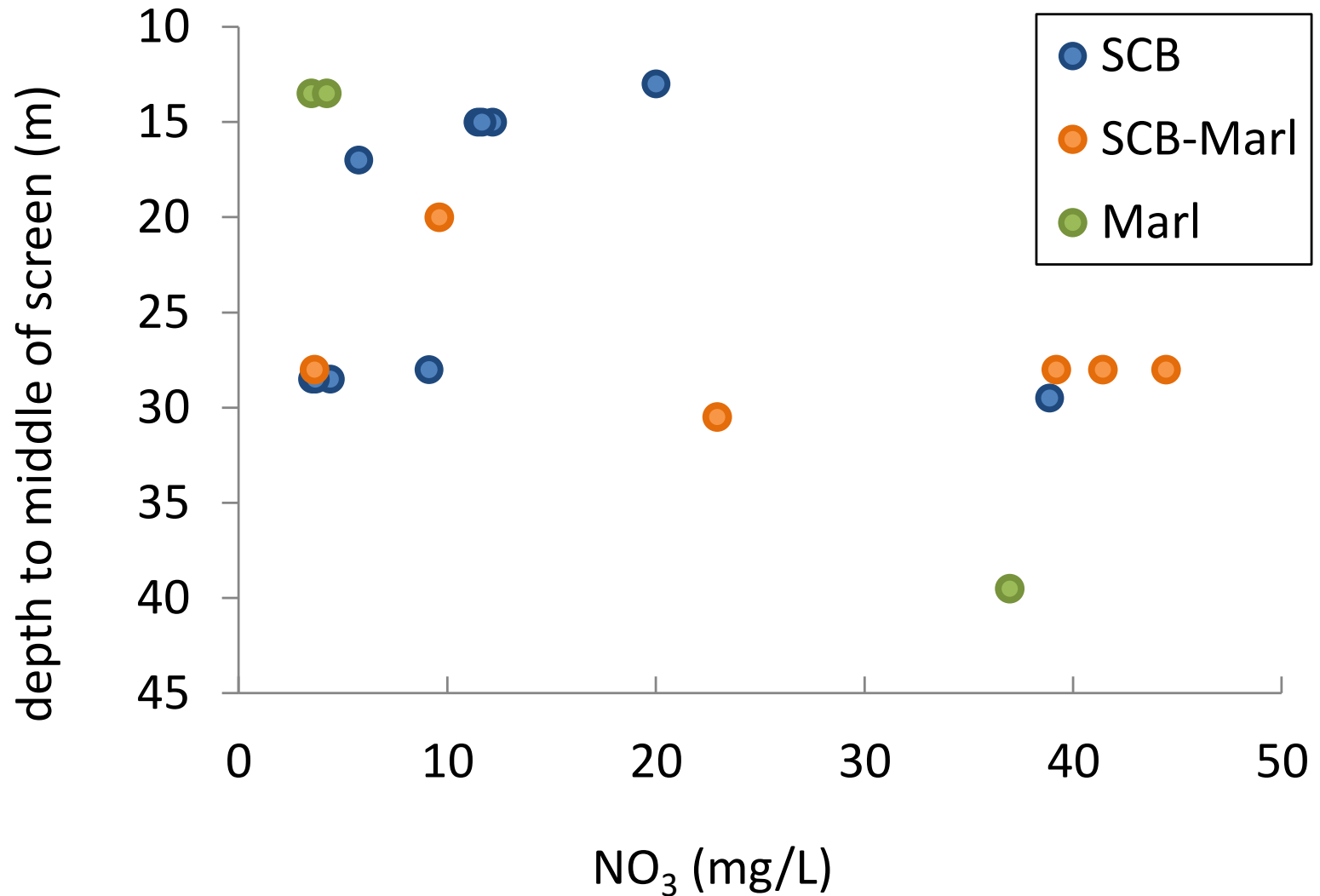
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NO₃ increase in more recent groundwater



NO₃ vertical infiltration



Conclusions

Shallow groundwater system

- Mix of older and younger waters
- High interaction between shallow and deeper aquifer

Sustainability of irrigated agriculture?

- Subsurface drainage system
 - Reduced groundwater recharge
 - High nitrate transfers
- Groundwater pumping
 - Seasonal declines in hydraulic head
 - Vertical mixing induced - spatially heterogeneous
- Fertiliser applications
 - Increased recent nitrate contamination of groundwater



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