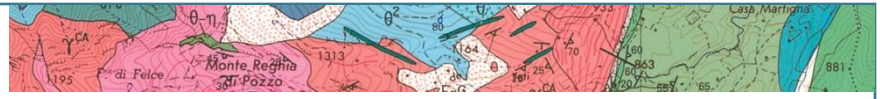

Impact of MAR structures on groundwater quality in south-Indian crystalline aquifers: Case study of the Tumulur tank, Maheshwaram watershed

Alazard M, Boisson A, Maréchal J.C, Dewandel B, Perrin J, Pettenati, Picot Colbeaux, G, Ahmed S, and Klopmann W.

Conférence Internationale Aquifères de socle : le point sur les concepts et les applications opérationnelles – La-Roche-sur-Yon 2015

SAPHPANI

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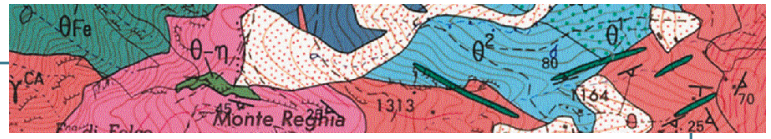


Context: Managed Aquifer Recharge

SAPHPANI

- **MAR structures = enhancement of groundwater availability**

India: ½ million of structures → Impact on recharge (CGWB, 2007)

- **Several studies focusing on the impact on groundwater quantity**

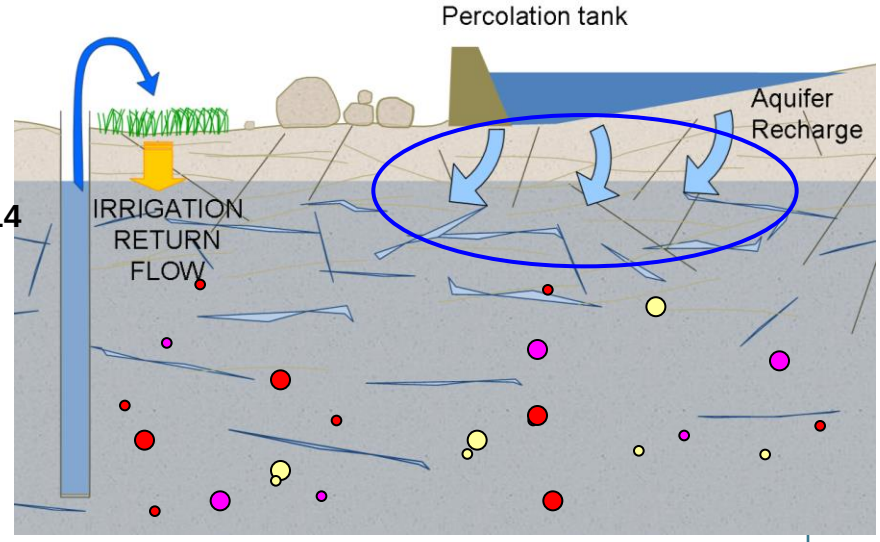
e.g. Massuel et al., 2014, Perrin et al., 2011, Boisson et al., 2014

- **.....A few dealing with groundwater quality**

e.g. Pettenati et al., 2013, 2014

- Geogenic pollutants
- Human activities pollution

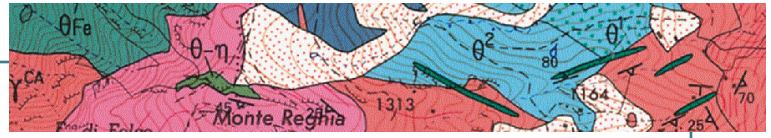
(enhanced by Irrigation return flow...)



MAR → Dilution from fresh surface water → **Groundwater quality is expected to be improved**

→ **Efficiency of the system?**
On quantity?
On quality

→ **Limited data on recharge dynamics**



Study site: The Tumulur tank

<u>A typical percolation tank</u>

South India - Maheshwaram Watershed:

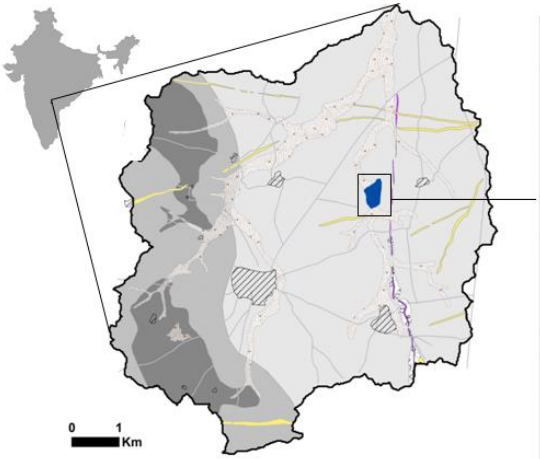
-Fractured granite bedrock, (typical alteration profile)

-Semi arid climate (highly variable monsoon events)

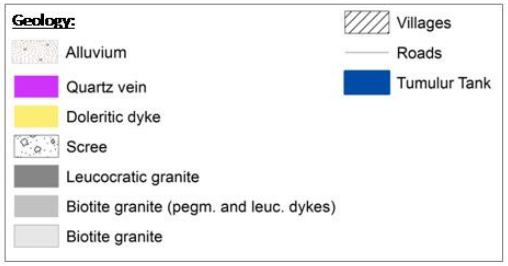
-Paddy field cultures (IRF)
-Geogenic fluoride

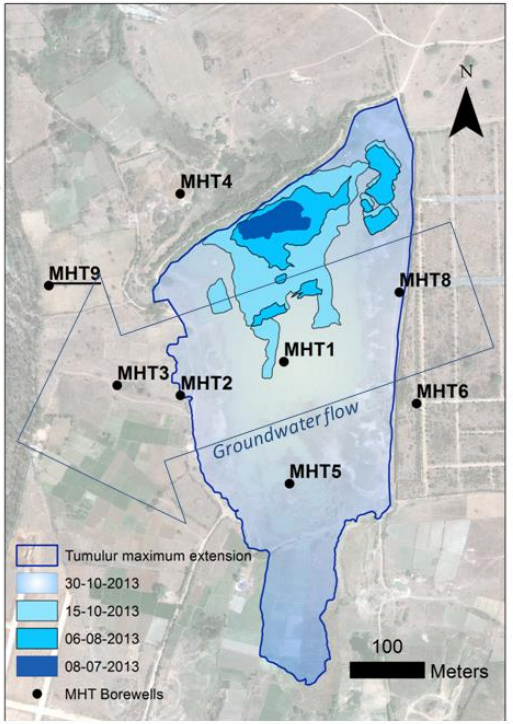
<u>Strong temporal Monitoring</u>

- Tank extension evolution
- Several chemical sampling over the year (1 campaign/month)
- Time series : piezometry & Electrical conductivity (15min time step)



Maheshwaram watershed





Tumulur study site

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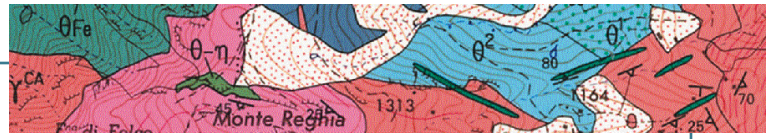
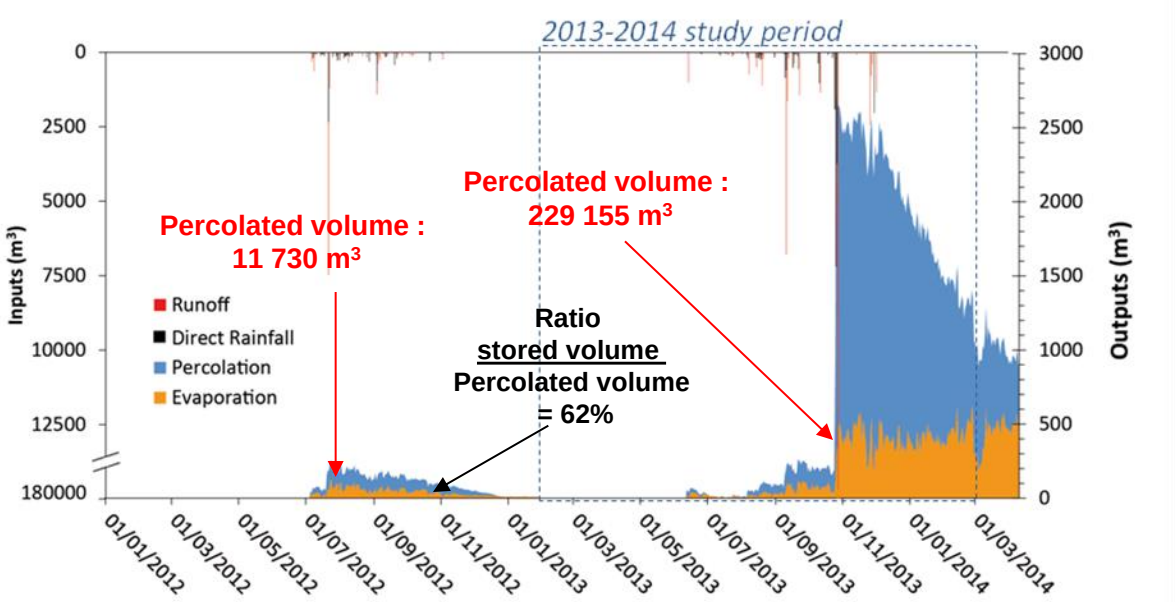


Study site: The Tumulur tank

Tanks water budget



Boisson et al., 2014

Water budget of Tumulur tank	2012 Monsoon	%	2013 Monsoon	%
Evaporation	7 280	38	75 970	25
Percolation	11 730	62	229 155	75
Total m³	19 010	100	305 125	100

2-3 raining events contribute to more than 90% of the two years inputs
Local effect in case of average monsoon

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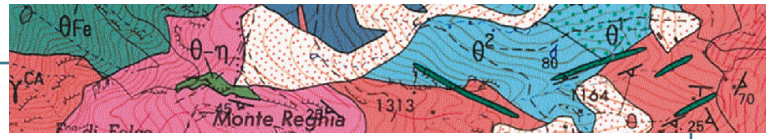
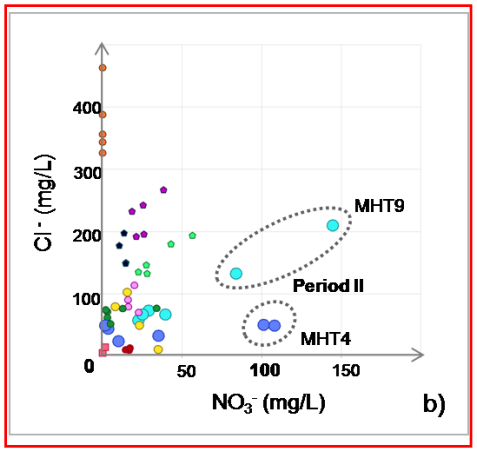
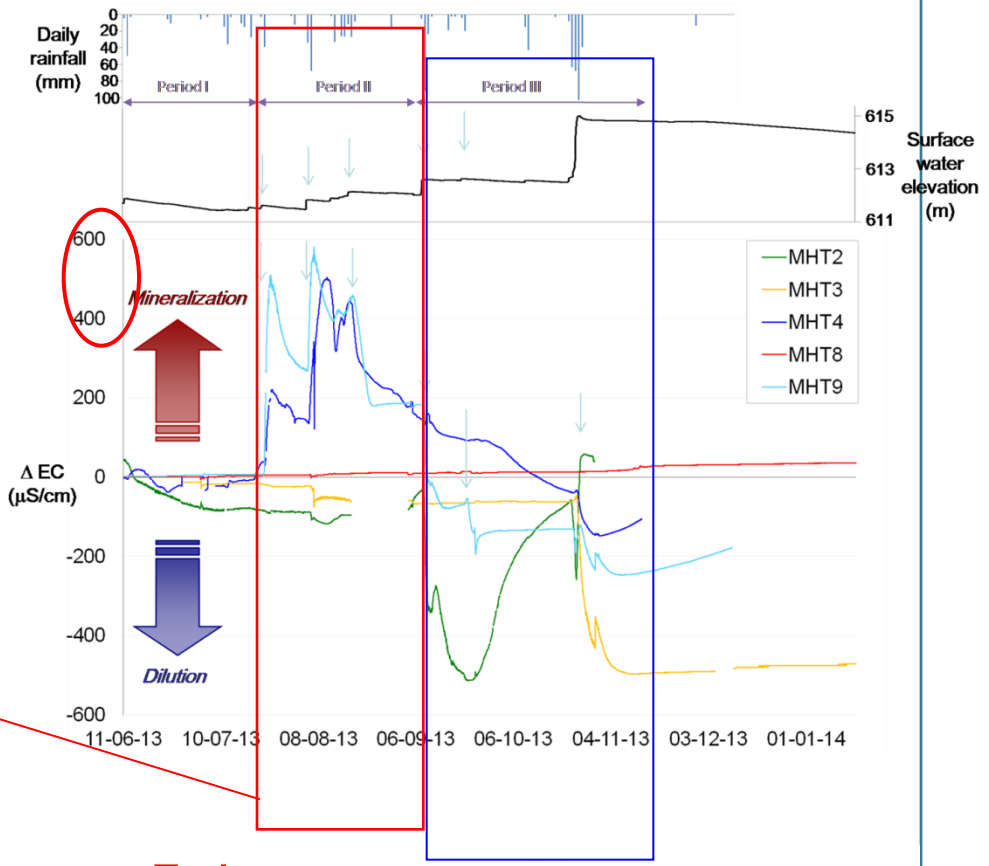


Temporal variability of the recharge impact

- ≠ monsoon events → variable impacts

- Variation of electrical conductivity > ±500µS/cm

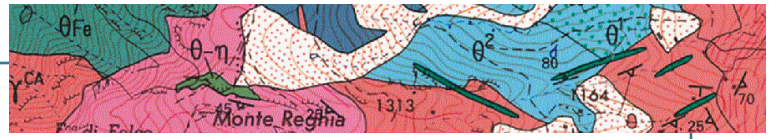




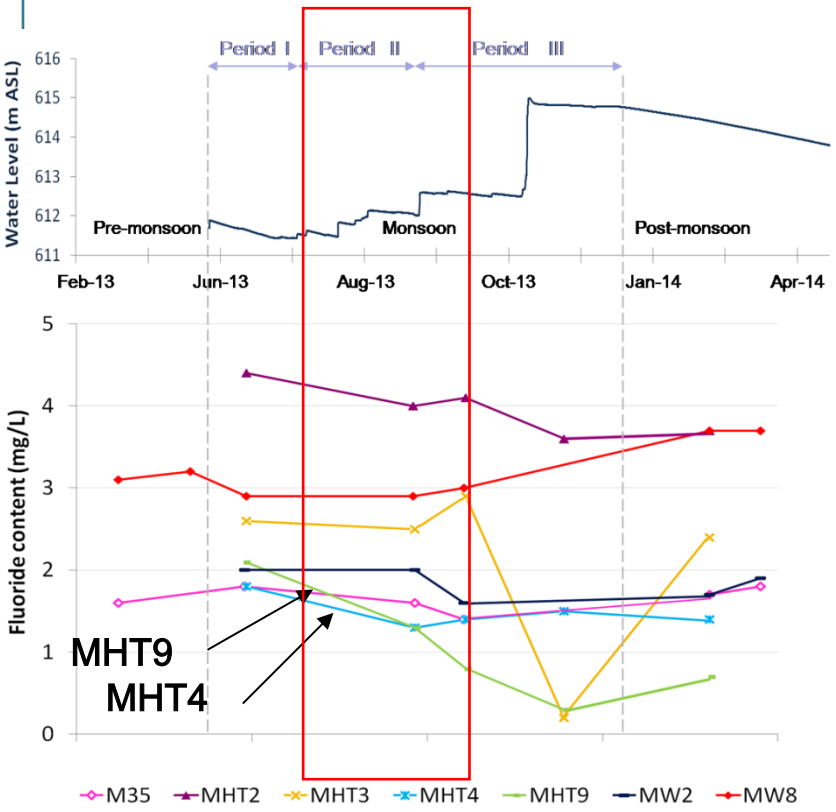
→ Mineralization associated with degradation of groundwater quality (e.g. Nitrates)

Early monsoon stages

Late monsoon stages: Very high water level



Recharge = No impact on geogenic contaminent contents



Even with extreme monsoon almost no impact on geogenic contaminant concentration

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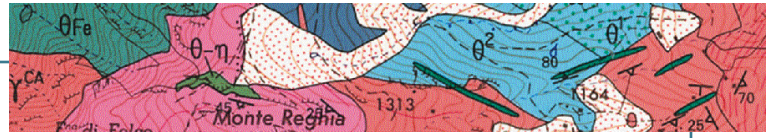
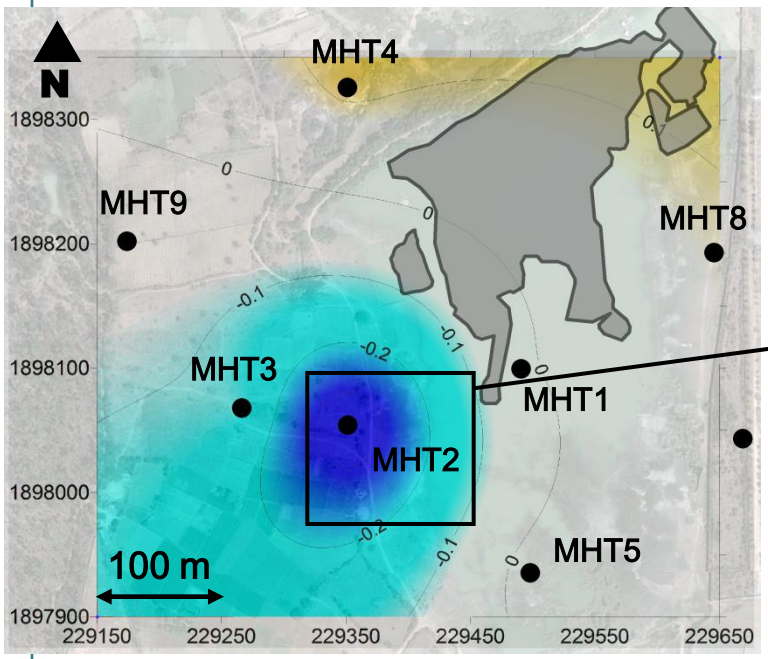
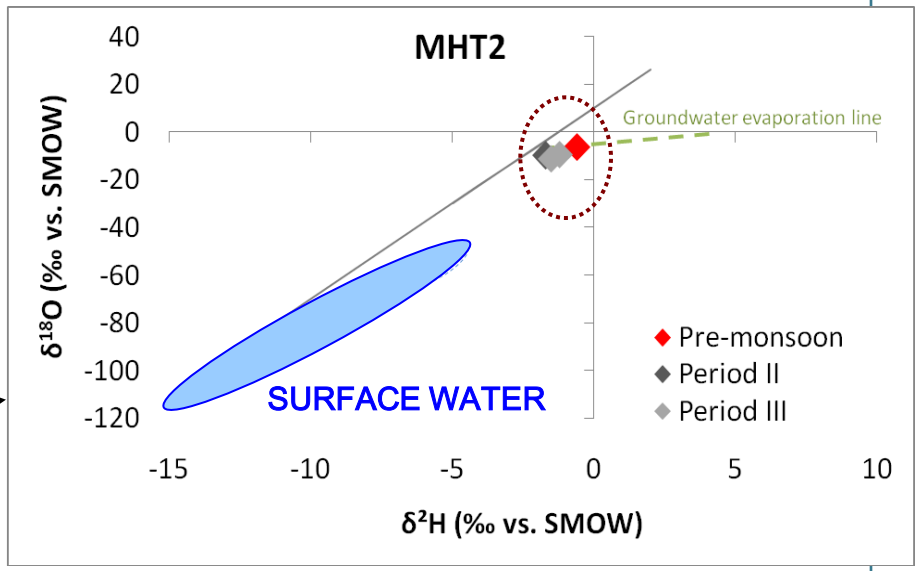


Spatial variability of the recharge impact



Spatial heterogeneity of the « dilution »

(Variation of the EC (Δ EC in %) during the late stage of the monsoon –Period III)



-Strong « dilution » (ΔEC -35%)

-No impact on isotopic signature

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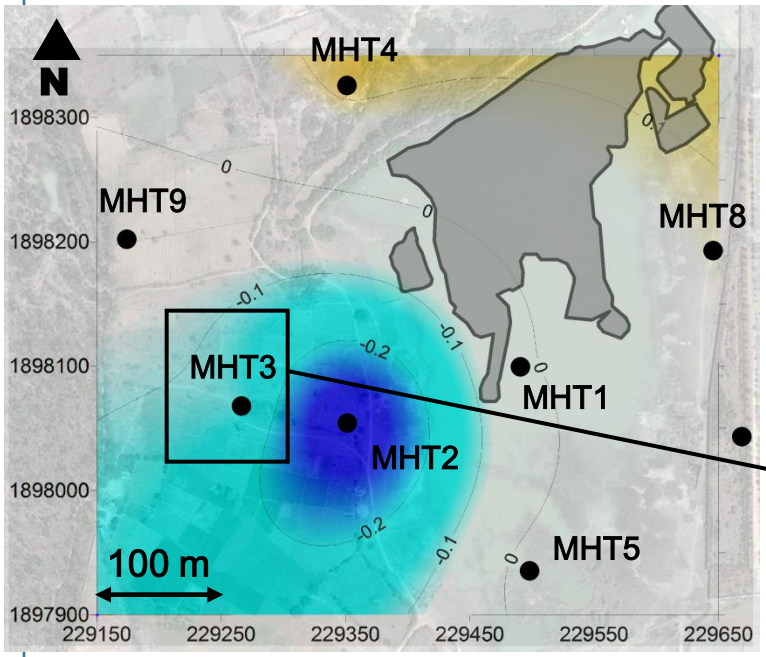
Spatial variability of the recharge impact

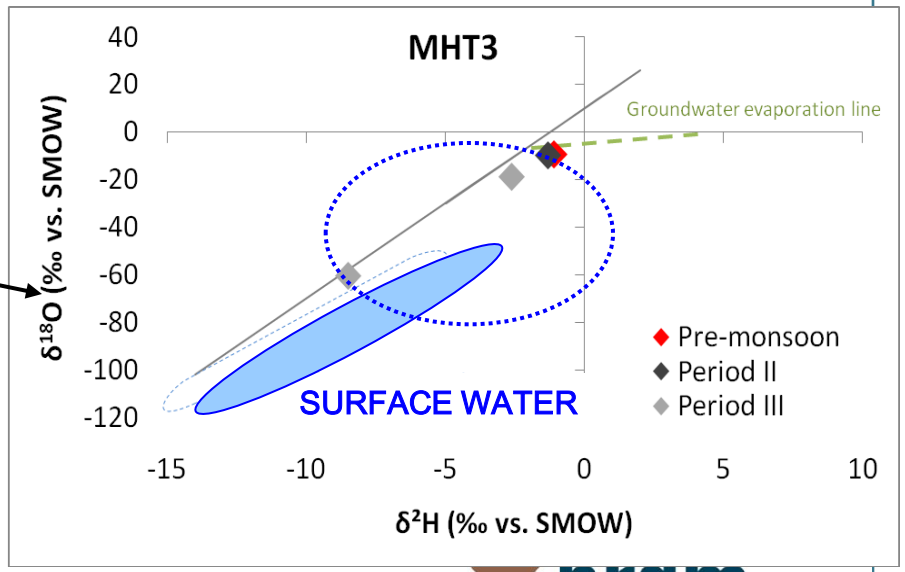


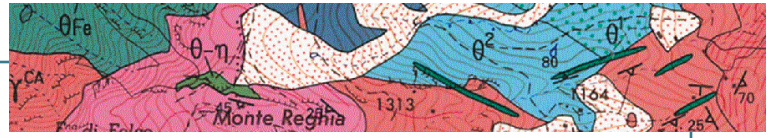
Spatial heterogeneity of the « dilution »

(Variation of the EC (Δ EC in %) during the late stage of the monsoon –Period III)

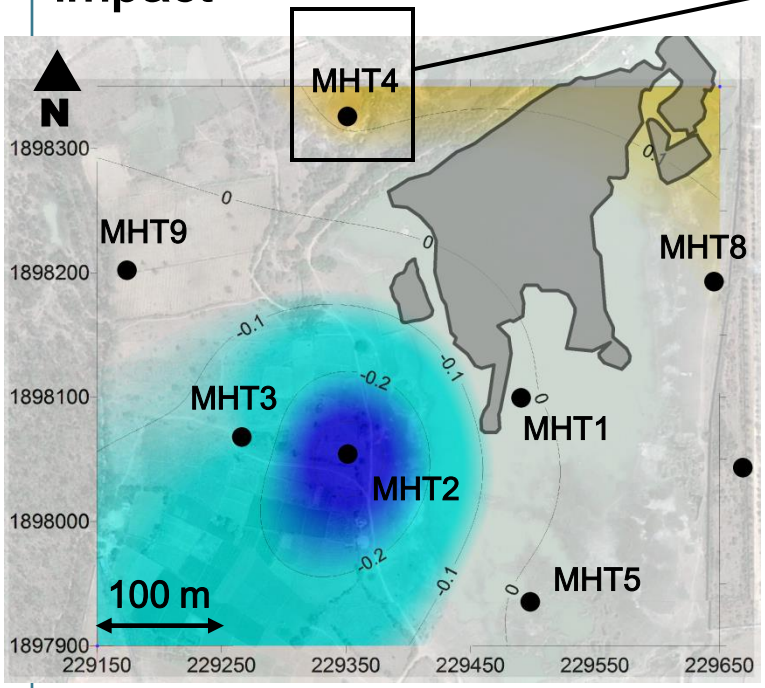
-«Dilution» (ΔEC -15%)

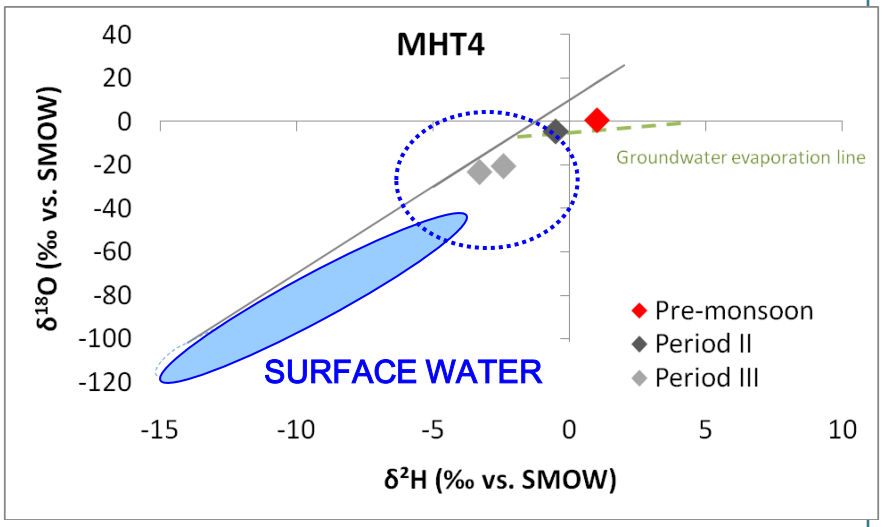
-Strong impact on isotopic signature





Spatial variability of the recharge impact





-Mineralization (ΔEC +12%)

-Strong impact on isotopic signature

Spatial heterogeneity of the « dilution »

(Variation of the EC (Δ EC in %) during the late stage of the monsoon –Period III)

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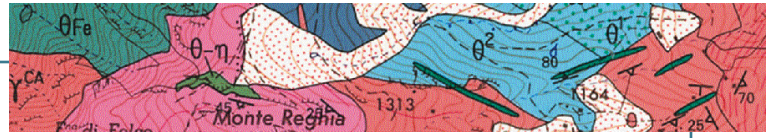
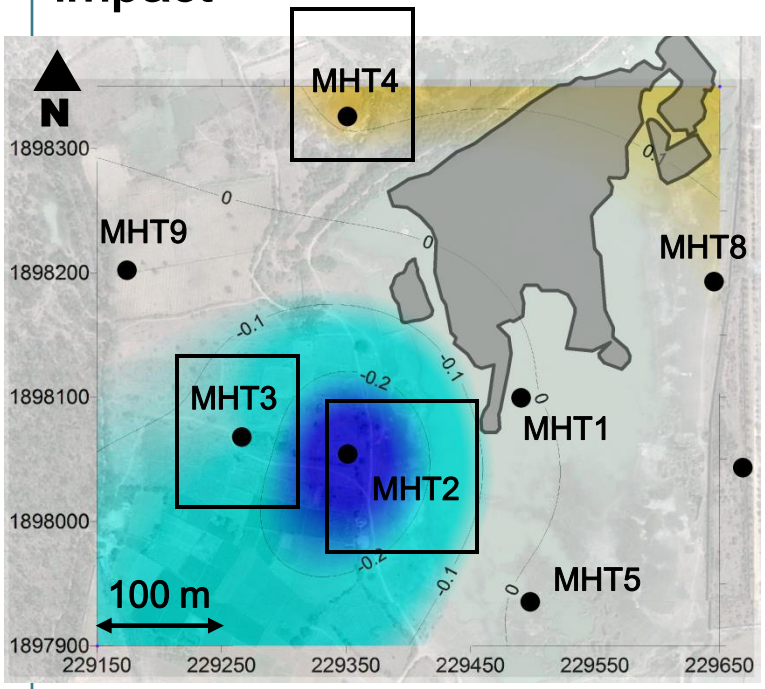
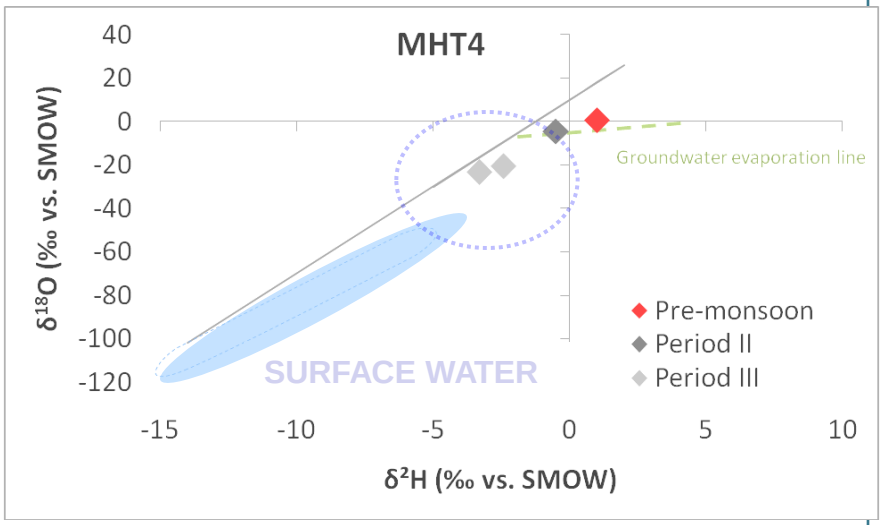


Spatial variability of the recharge impact



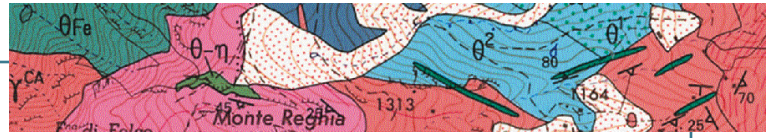
Spatial heterogeneity of the « dilution »
(Variation of the EC (Δ EC in %) during the late stage of the monsoon –Period III)



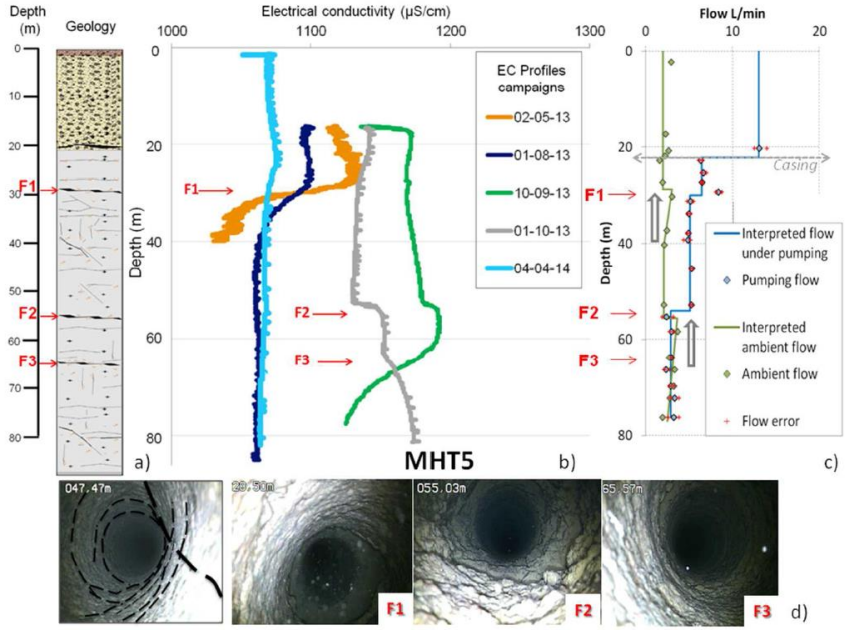
-Mineralization (ΔEC +12%)
-Strong impact on isotopic signature

3 boreholes = 3 contrasted situations

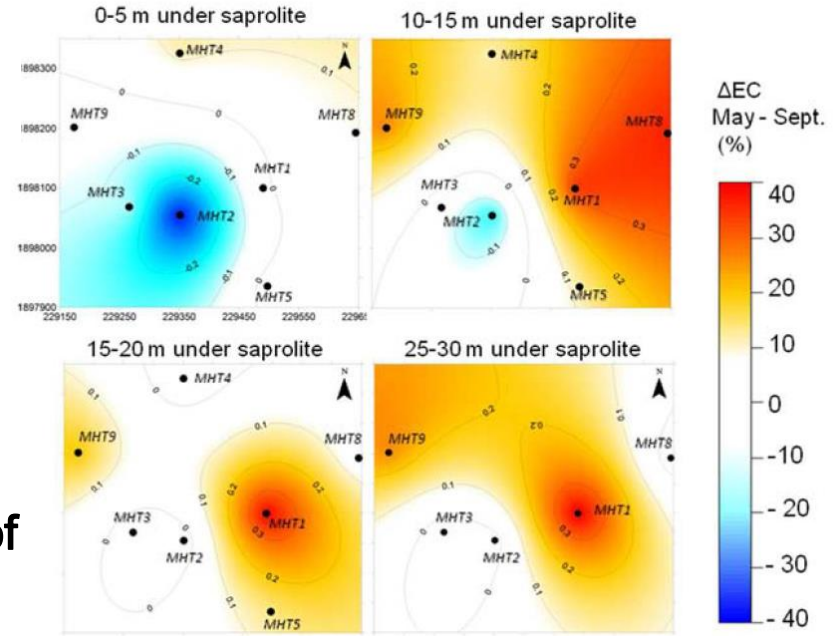
Very contrasted recharge impact = complexity of fluxes / matrice interaction / ...



Vertical variability of the recharge impact



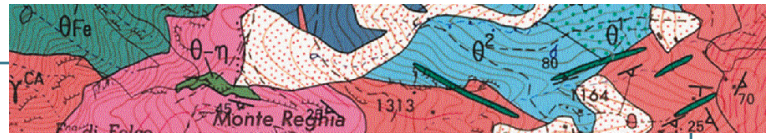
Alazard et al., accepted Hydrogeology journal



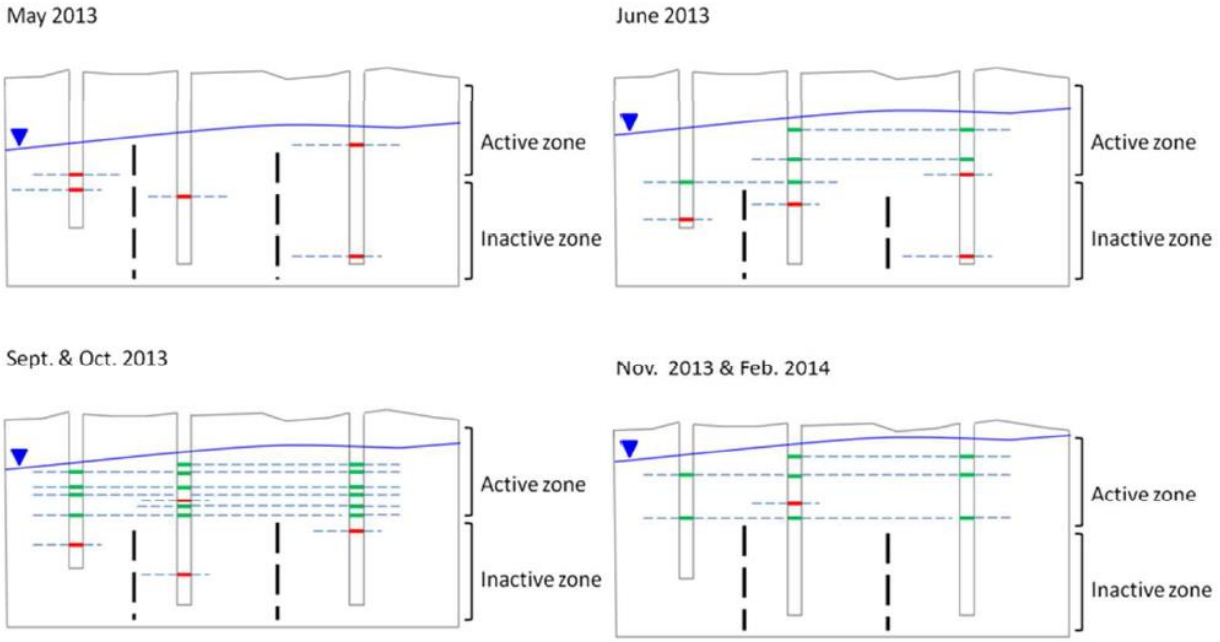
Very low vertical transfert

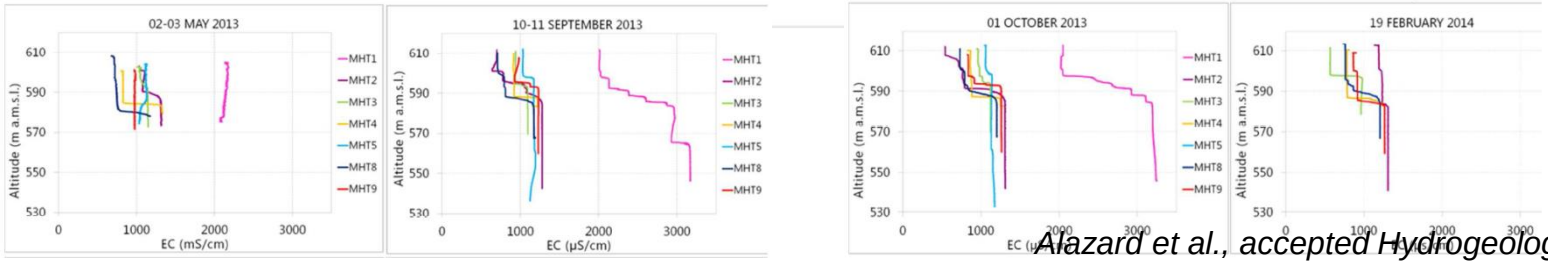
Mineralisation on the deepest part of the aquifer

Alazard et al., accepted Hydrogeology journal

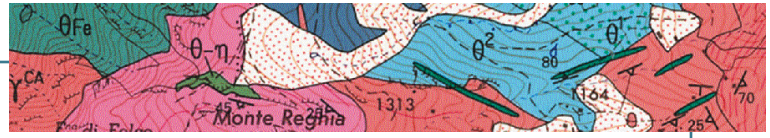


Connectivity evolution



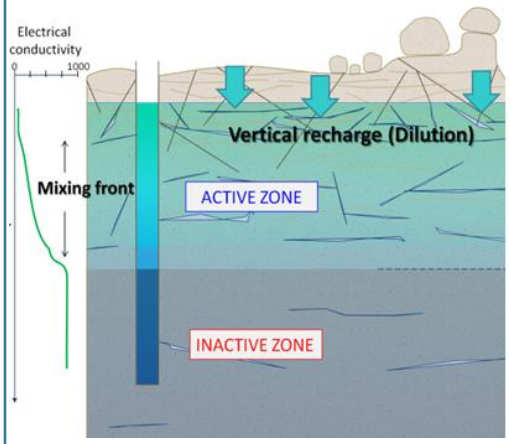


Alazard et al., accepted Hydrogeology journal

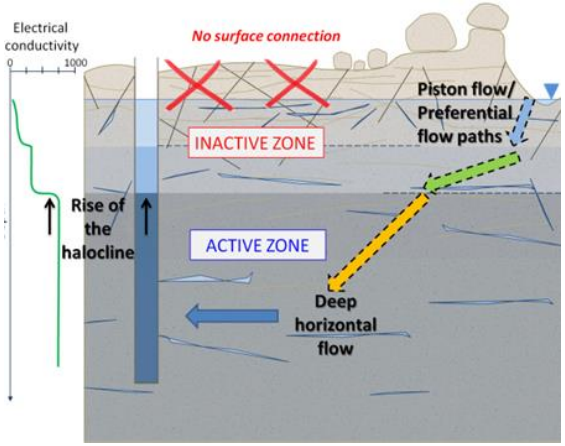


Recharge fluxes complexity

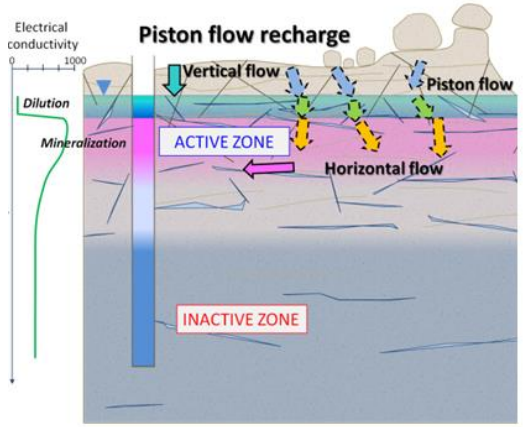
(Modified from Alazard *et al.*, Hydrogeology Journal, *under Review*)



Dilution / vertical recharge



(Deep) preferential flow paths



Piston flow

Coexistence of ≠ recharge fluxes
+
temporal variability

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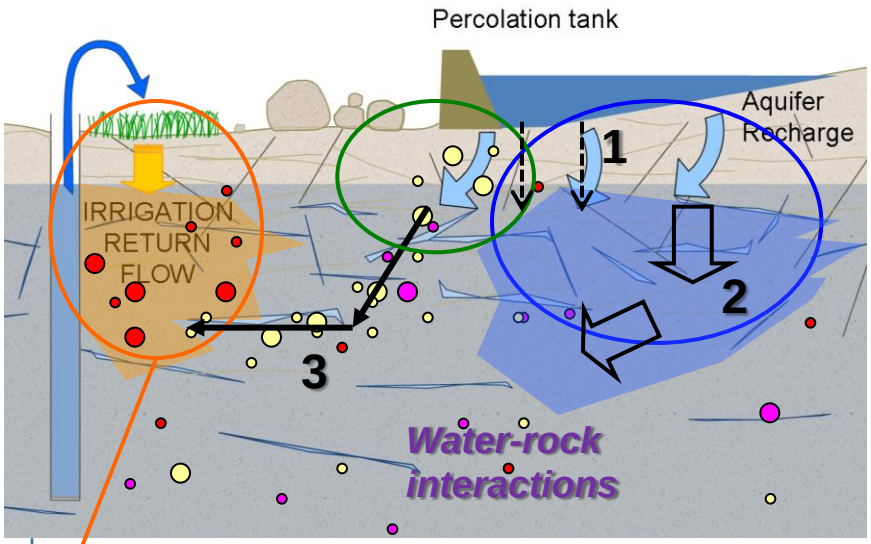
MAR impact is a combination of…



IRF
↑ Cation exchange processes
↑ Geogenic contaminant...

« Chemical processes»	Hydrological processes
-Dilution	- (1) Diffuse/vertical direct recharge
-Salt leaching	- (2) Piston flow
-Cation exchanges processes	- (3) Preferential flow paths
-Water-rock interactions	…
…	

…Variable in time and space

With no real positive impact on groundwater quality

Conclusions

MAR in crystalline rock on water availability

- Limited impact
- Positive only in case of extreme events

In crystalline aquifers, limited impact of MAR structures on GW quality

May decrease GW quality (dependent of the surrounding context.

Question the assessment methodology for groundwater quality in crystalline aquifers

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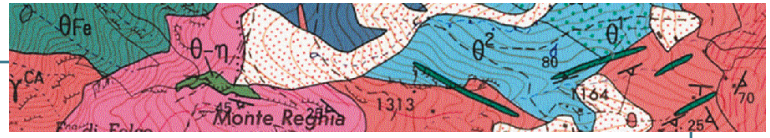

Hydrogeology Journal, *Accepted*

M. Alazard [1,2], A. Boisson[1,3], J-C. Maréchal[2], J. Perrin[3], B. Dewandel[2], T. Schwarz[1], M. Pettenati[3], G. Picot-Colbeaux [3], W. Kloppman[4], S. Ahmed [5]

Recharge dynamics and flow path investigation through borehole logging in fractured crystalline aquifer in a semi-arid climate – Implications on managed aquifer recharge

Procedia Earth and Planetary Science, 2014

Pettenati M.[3], Picot-Colbeaux Géraldine[3], Thiéry Dominique[3], Boisson Alexandre[1,3], *, Alazard Marina[1,2], Perrin Jérome[3], Dewandel Benoît[2], Maréchal Jean-Christophe[2], Ahmed Shakeel[5], Kloppmann Wolfram[4].

Water quality evolution during managed aquifer recharge (MAR) in India crystalline basement aquifers: reactive transport modeling in critical zone

Journal of Hydrology, 2014

Boisson, A[1,3]., Baisset, M[1]., Maréchal, JC[2]., Perrin, J[3]., Villesseche, D[1], Kloppmann, W[4]., Chandra, S[5]., Dewandel, B[2]., Picot-Colbeaux, G[3]., Ahmed, S[5]

Comparison of surface and groundwater balance approaches in the evaluation of managed aquifer recharge structure: Case of a percolation tank in hard rocks aquifer in India

[1] Indo-French Centre for Groundwater Research, Hyderabad, India
[2] BRGM, D3E Unit, Montpellier, France
[3] BRGM, Division, D3E Unit, Orléans, France
[4] BRGM, Division, LAB Unit, Orléans, France
[5] National Geophysics Research Institute, Indo-French Centre for Groundwater Research, Hyderabad, India

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