



<http://www.eranetmed-chaams.org>

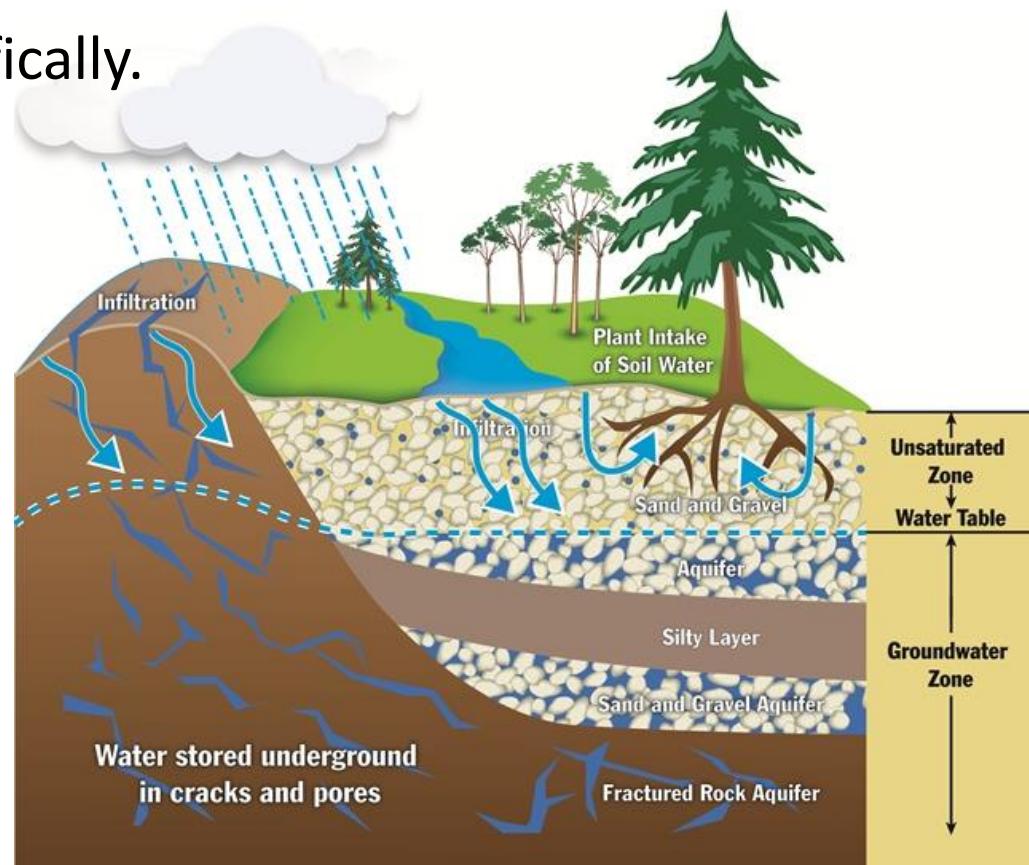
GROUNDWATER RECHARGE INVESTIGATIONS IN THE HAOUZ- TENSIFT BASIN

**Dr Younes Fakir, UCA,
Marrakech**

fakir@uca.ac.ma

Groundwater recharge :

- Process by which groundwater is renewed.
- Essential term of the hydrological balance.
- Management tool
- Very challenging scientifically.

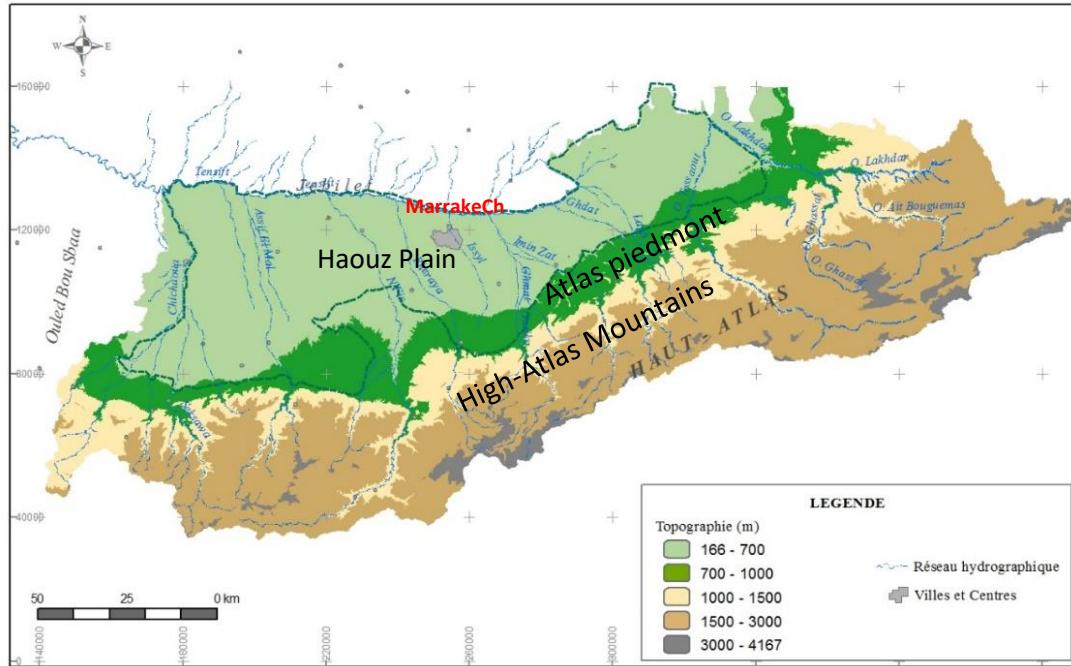


<https://www.americangeosciences.org/geoscience-currents/managed-aquifer-recharge>

In the Tensift basin, the groundwater recharge issue is very challenging:

Different hydrological landscapes:

- Mountains
 - Piedmont
 - Plain

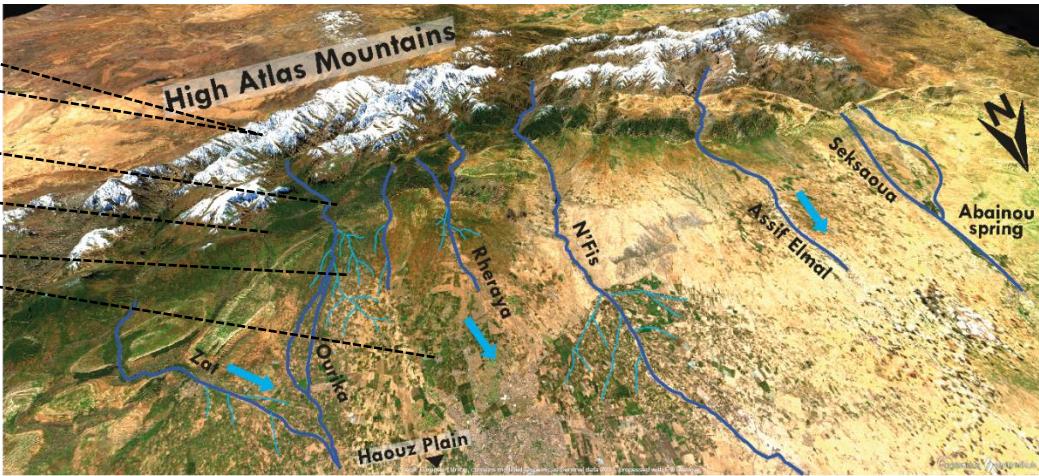


Various potential sources of groundwater recharge:

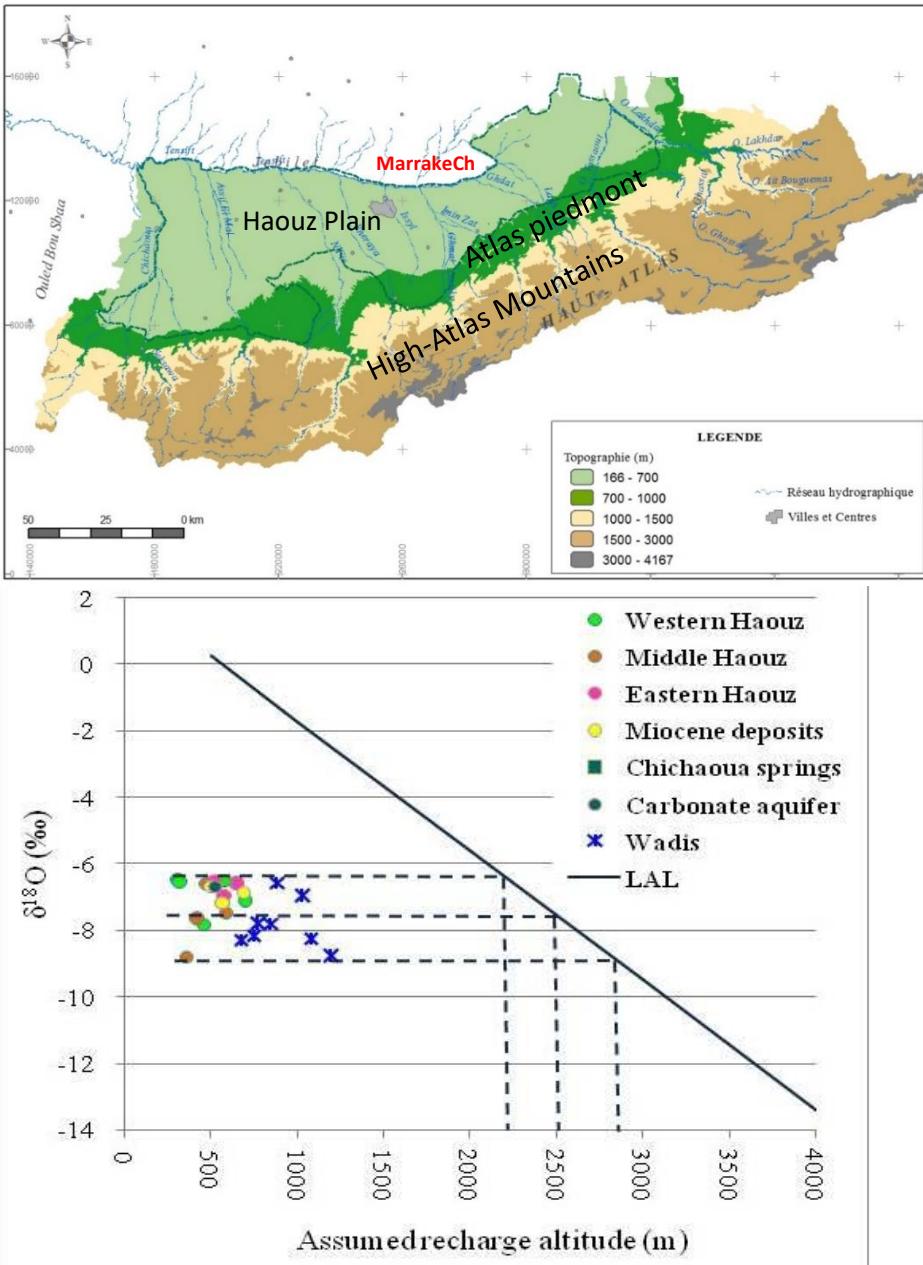
- Rainfall
 - Snow
 - Streamwater
 - Lateral fluxes
 - Irrigation

Two types of study:

- Processes
 - Qualifications



THE HAOUZ PLAIN



STABLE ISOTOPES FOR ASSESSING GW RECHARGE ORIGIN IN THE HAOUZ PLAIN

Direct rainfall infiltration in the plain seems to have a low contribution to the plain aquifer recharge.

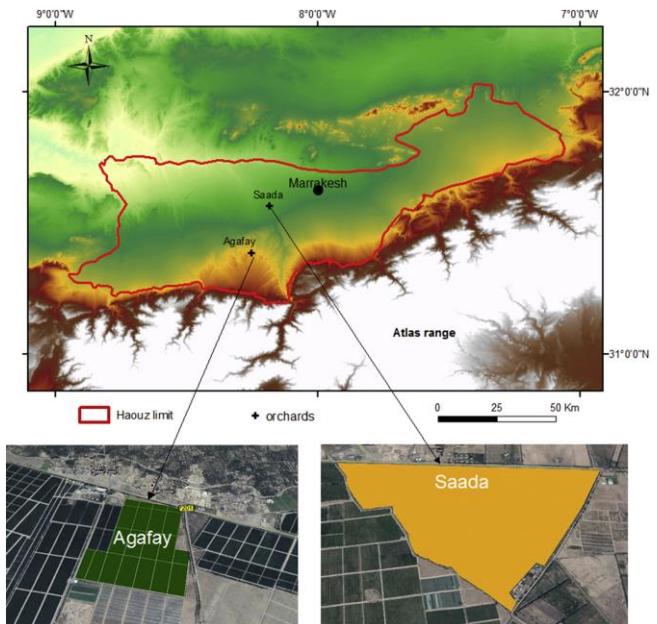
One of the factors could be the arid climate in the plain:

Rainfall (mm) <<< ET (mm)
(200mm) (1600mm)

K. Boukhari, Y. Fakir, T. Y. Stigter, Y. Hajhouji, G. Boulet (2015). Origin of recharge and salinity and their role on management issues of a large alluvial aquifer system in the semi-arid Haouz plain, Morocco. Environmental Earth Sciences, Volume 73, Issue 10 (2015): 6195-6212. DOI [10.1007/s12665-014-3844-y](https://doi.org/10.1007/s12665-014-3844-y)

Assumed recharge altitude with regard to
the local altitudinal line (LAL)

EVALUATION DE LA PERCOLATION PROFONDE DANS LA PLAINE PAR MÉTHODE DE BILAN HYDRIQUE

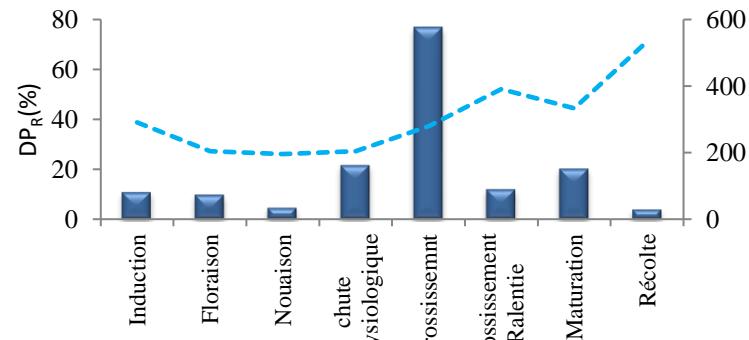


Parcelles en G/G

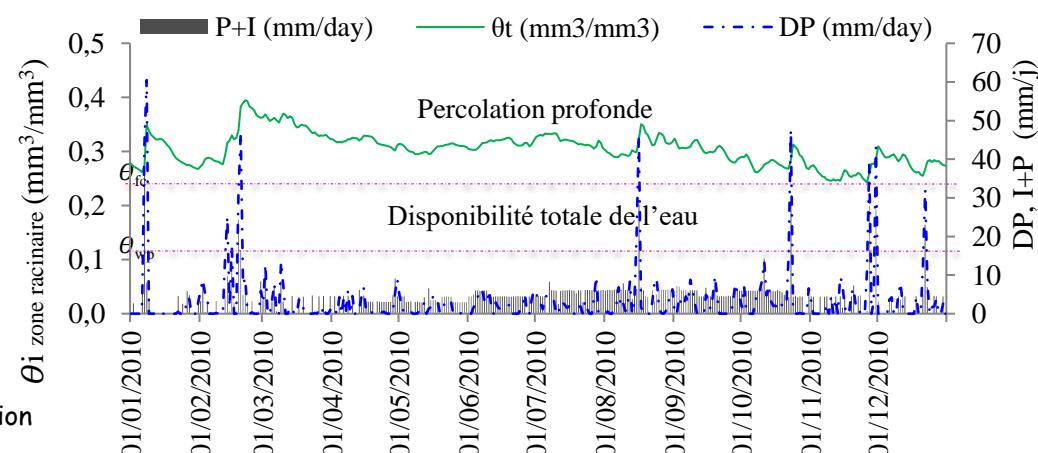
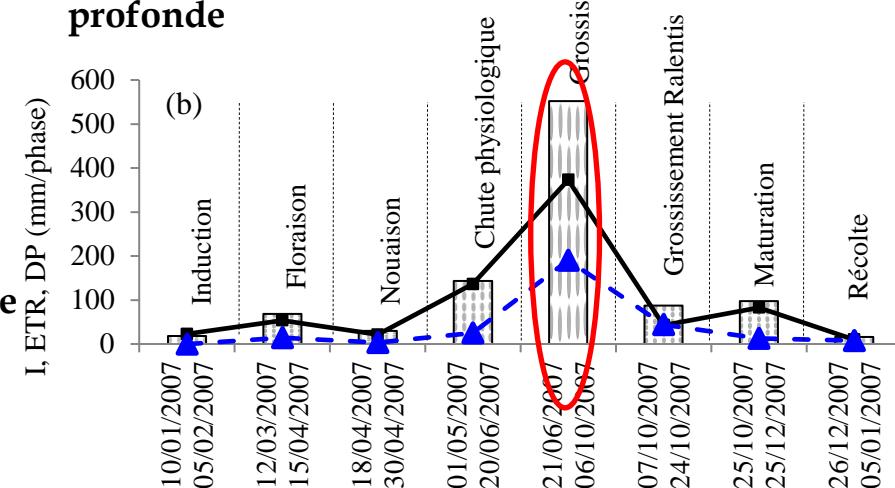
➤ la densité du couvert végétal sur la percolation profonde

Sites	Densité	I+P	ETR	DP (%)
Agafay (G à G)	4*6	1209.9	754.8	49
Saada1 (G à G)	3*5	1206.21	786.29	38.3

■ P+I (2007) - DPR (2007)

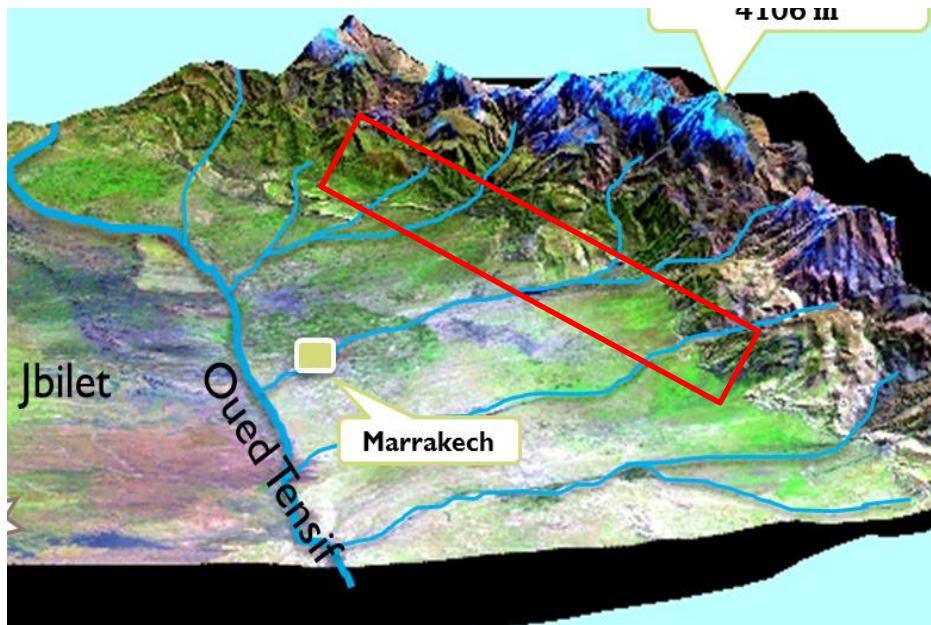


➤ L'impact du cycle végétatif sur la percolation profonde

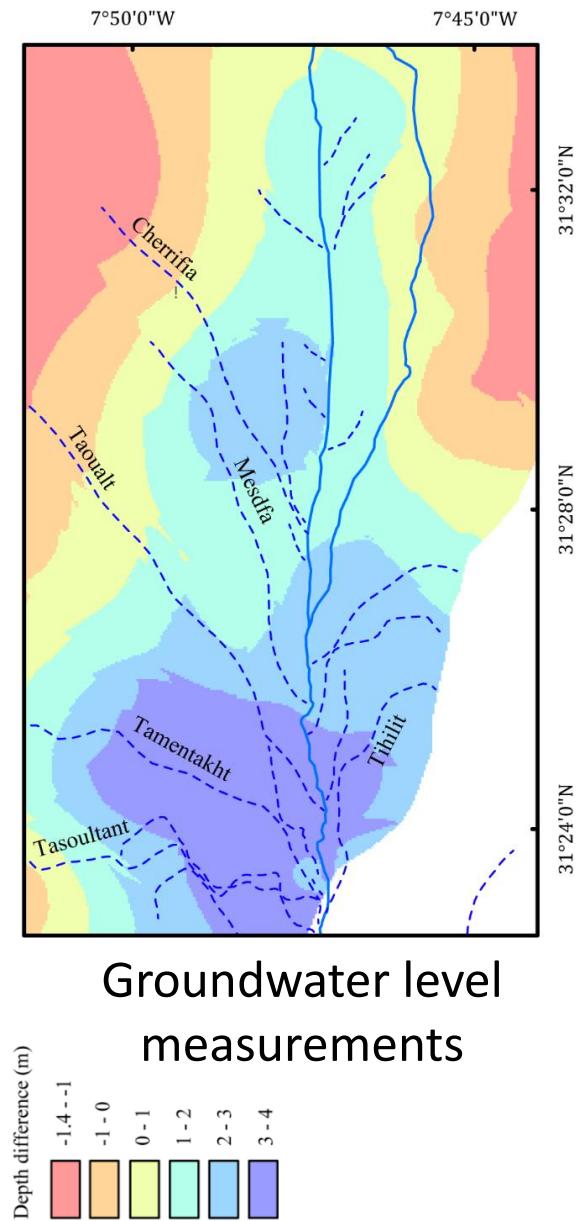
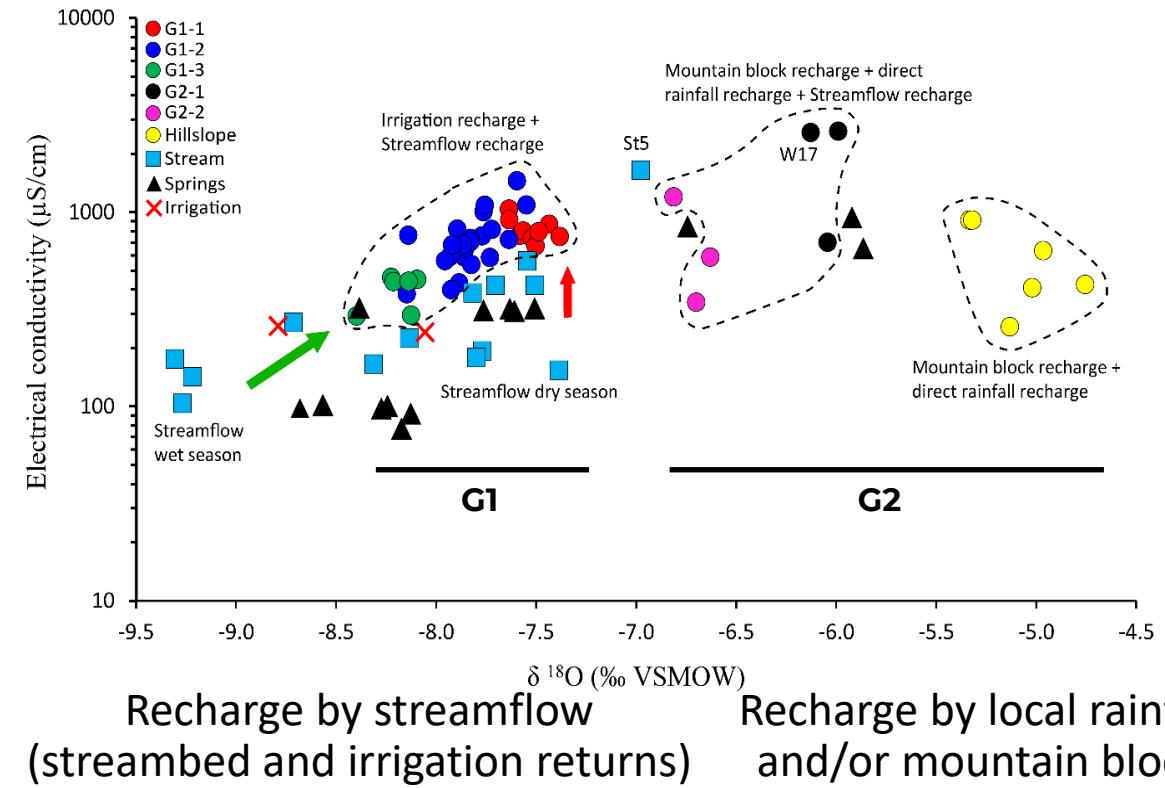


Nassah H. et al. (2018). Evaluation and analysis of deep percolation losses of drip irrigated citrus crops under non-saline and saline conditions in a semi-arid area. Biosystems engineering 165: 10-24.
<https://doi.org/10.1016/j.biosystemseng.2017.10.017>

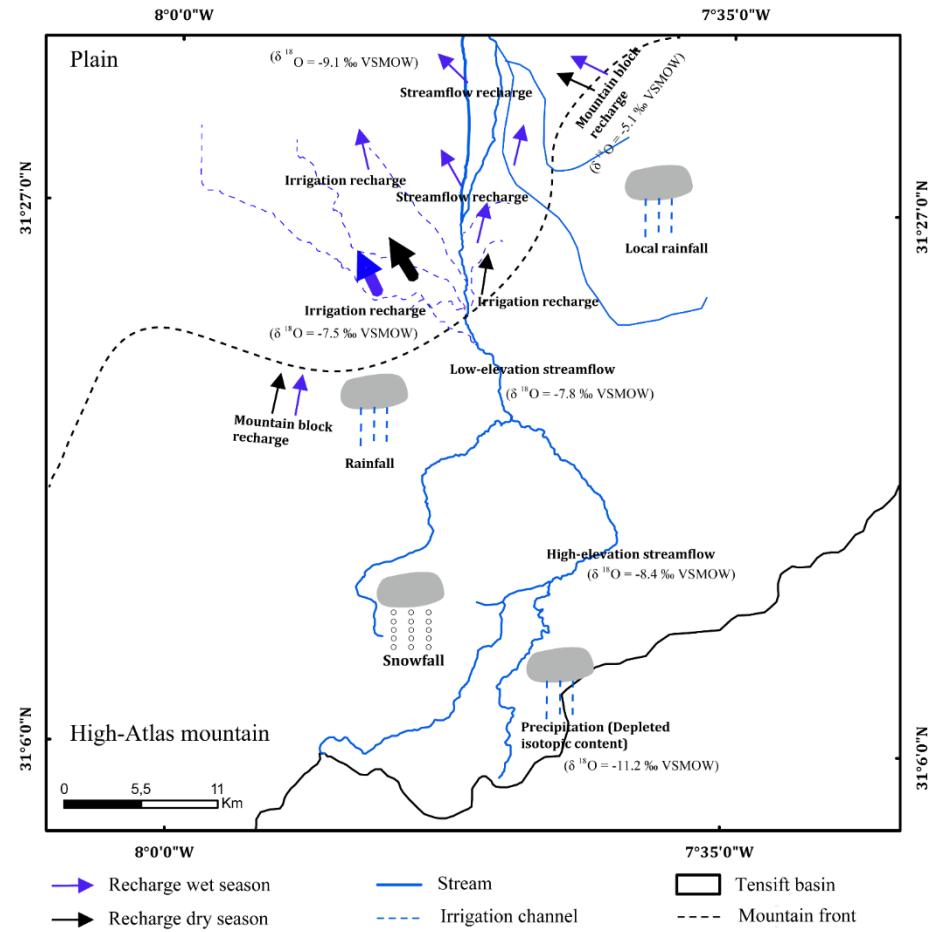
GWR IN THE PIEDMONT



The roles of Wadi in gw
recharge



Conceptual model of recharge in piedmont area



The obvious isotopic contrast in the study area allowed the identification of the recharge sources contributing to groundwater in the mountain front of the High-Atlas :

- Irrigation returns: diverted snowmelt water (winter, spring and early summer) + baseflow (summer and autumn) + flood water.
- In-stream infiltration within the wadi.
- Local precipitation in the foothills / underflow from the mountain.

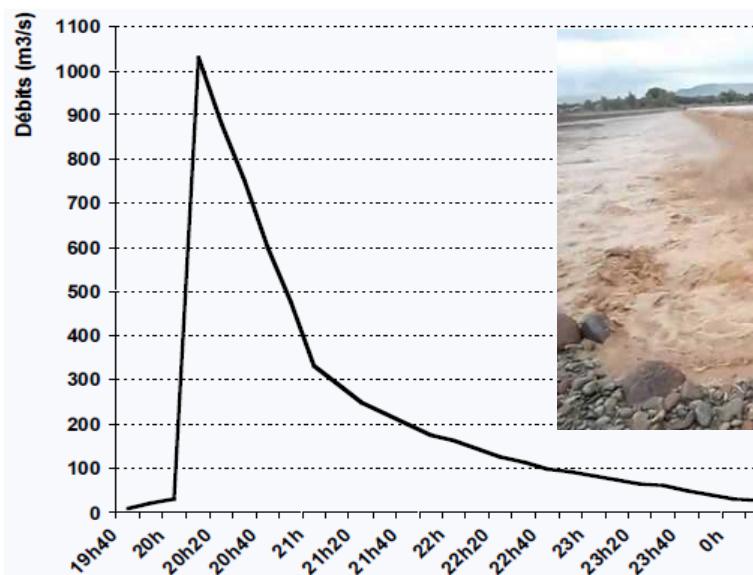
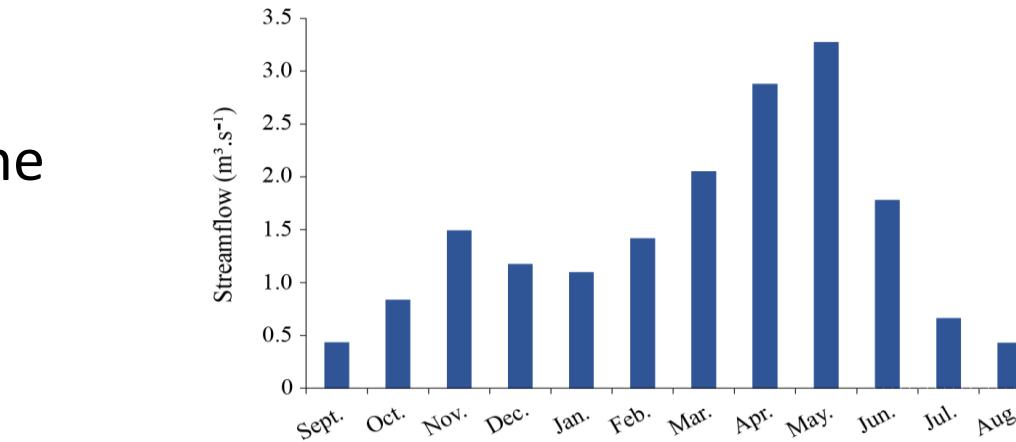
Bouimouass H. et al. (2020) Groundwater recharge sources in semiarid irrigated mountain fronts. Hydrological Processes. 2020; 1-18, <https://doi.org/10.1002/hyp.13685>

HOW AND WHEN DOES THE RECHARGE OCCUR IN STREAMBED?

- Snow hydrological regime
- Flushfloods

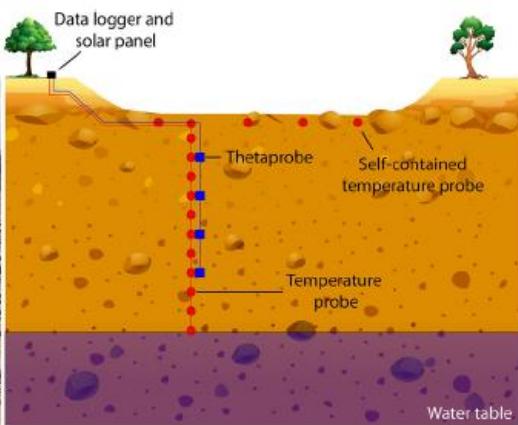


Functioning of High Atlas wadis

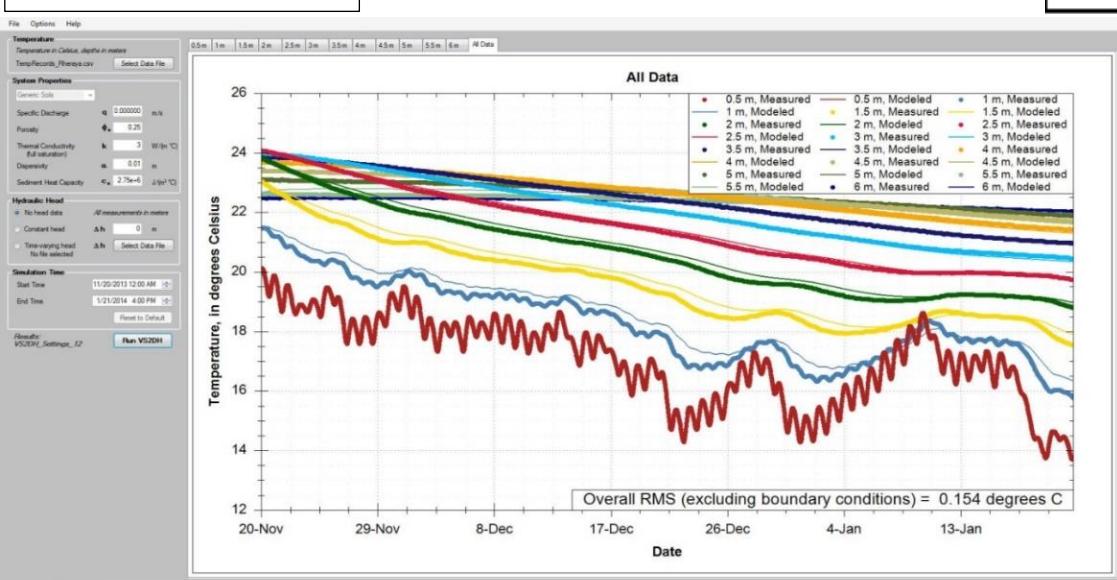


Hydrograph of the Ourika River flood of August 17, 1995

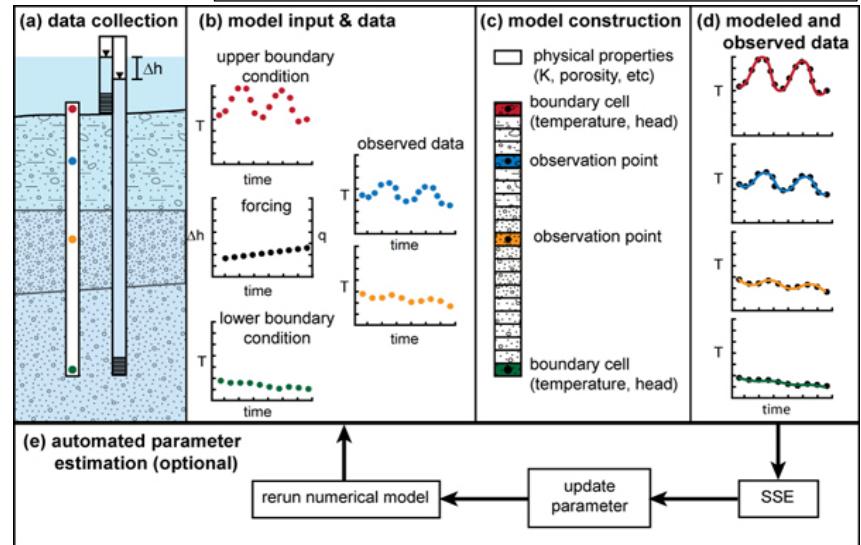
Heat as a tracer of streamlosses



Records



Numerical modeling



Fakir et al. (2021). Seasonality in intermittent streamflow losses beneath a semiarid Mediterranean wadi. Water Resources Research, <https://doi.org/10.1029/2021WR029743>

- Most groundwater recharge is generated by floods during winter and spring.
- Summer flashfloods over dry sediment resulted in shallower infiltration despite higher peak streamflows (dry sediment, low hydraulic conductivity, ...).
- A pair of factors contribute to seasonality of groundwater recharge, the duration of the streamflow events, and moisture conditions of the sediment.
- Low proportionality was found between streamflow and the amount of recharge (unique recharge coefficient)

CONCLUSION

- Several potential sources of groundwater recharge
- Large effects of irrigation practices on groundwater recharge
- winter and spring floods are important to recharge.
- Role of snow (Hanich et al. 2022).
- Quantitative assessment of gw is confronted to spatial and temporal scales, and research, more projects.

Merci شکرا