



# Climate change and drought in Provence



Erasmus+

Avec le soutien du programme Erasmus+ de l'Union Européenne



Plus vite, plus haut, plus fort !  
Collège Pierre de Coubertin



MÉTROPOLE NICE-CAGNES-VENCE  
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VENDREDI 10 MARS 2023 1,70 € - N° 27362



# SÉCHERESSE : DÉJÀ L'ALERTE

Already a drought warning  
10 march 2023

## Aucun nouveau permis de construire durant quatre ans : la mesure choc du pays de Fayence confronté à la sécheresse

Publié le 26/02/2023 à 17h08

Écrit par [Jean-Bernard Vitiello](#) et [Michel Bernouin](#)



Dans l'est Var, certains cours d'eau sont encore à sec cet hiver. © Denis Pardanaud / FTV

**No new building permits for 4 years:  
the shock measure for the town of Fayence faced with drought  
26 february 2023**



TF1

**VIDÉO - Flassans-sur-Issole : la rivière  
totalement asséchée, les habitants  
inquiets du manque d'eau**

Par La rédaction de TF1info | Reportage Vincent Capus, Bruno Taïb

Publié le 24 février 2023 à 16h08

**Flassans sur Issole :  
River completely dried up,  
residents worried about lack of water  
24 february 2023**

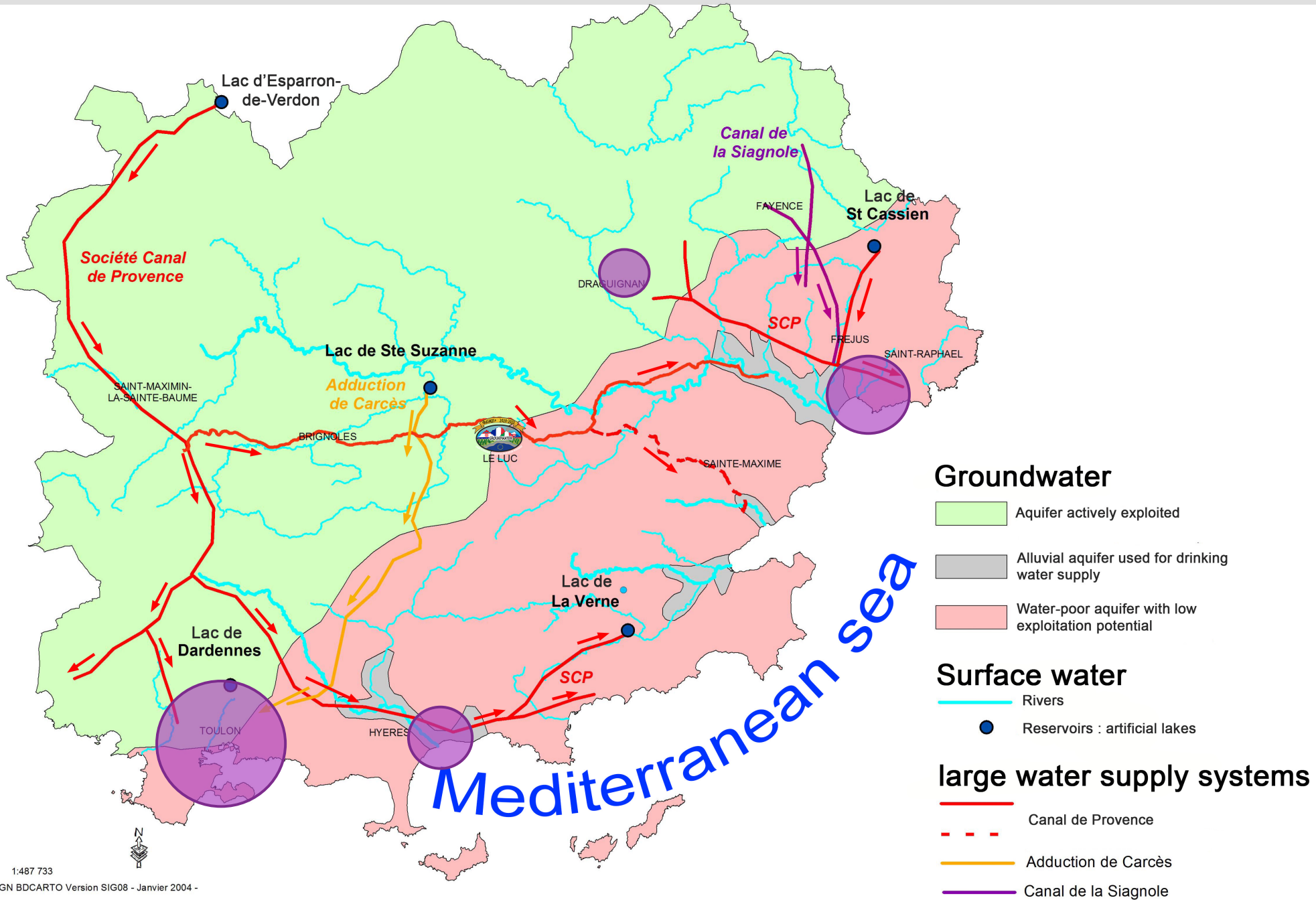


Fountain of the « Château des Vintimille »  
Le Luc





Picture : Frédéric D. ( September 2011)

F. Mourau (April 2023)

**We are looking to find out why there is no more water!**

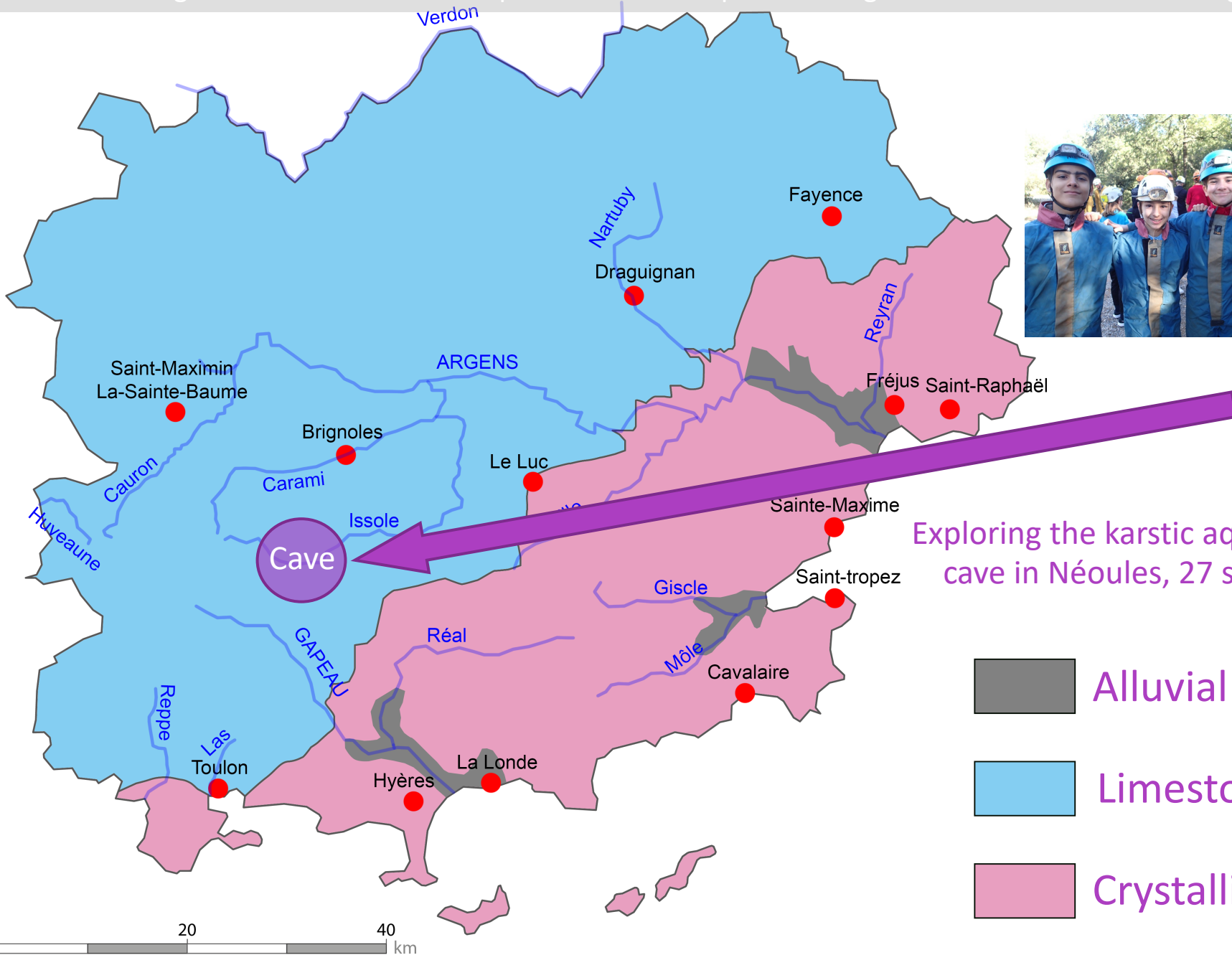


# Map of water resources in the area

-  Toulon-La Seyne  
230 000 hab.
-  Fréjus – St Raphaël  
60 000 hab.
-  Hyères  
60 000 hab.
-  Draguignan  
40 000 hab.

+ 65,000,000  
overnight stays  
in the tourist  
season

# Geological map

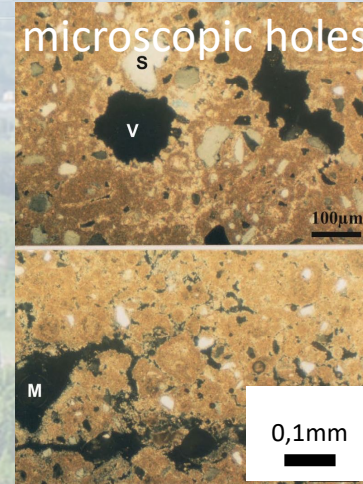
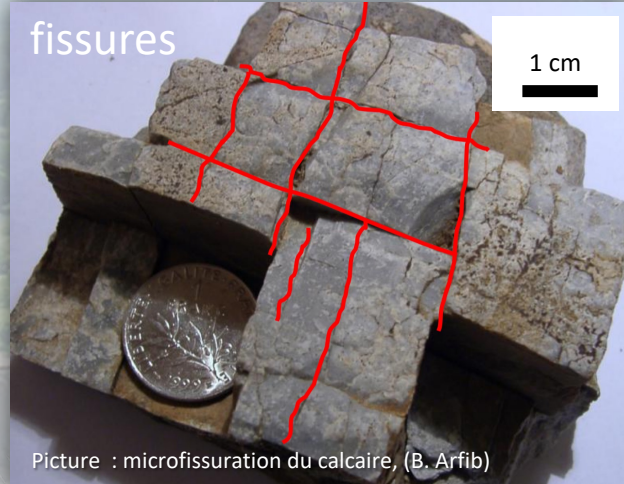


Exploring the karstic aquifer at the Regay cave in Nèoules, 27 september 2022

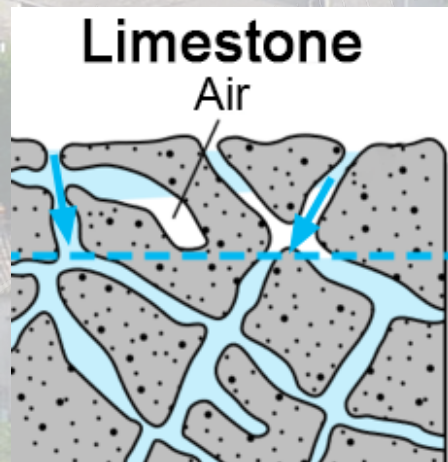
-  Alluvial deposits
-  Limestone
-  Crystalline rocks

# The limestone is an aquifer : a rock able to store water

We are boating in a cave under the city of Toulon !



The karst aquifer contains holes of different sizes



Rainwater seeps through the unsaturated zone to the water table

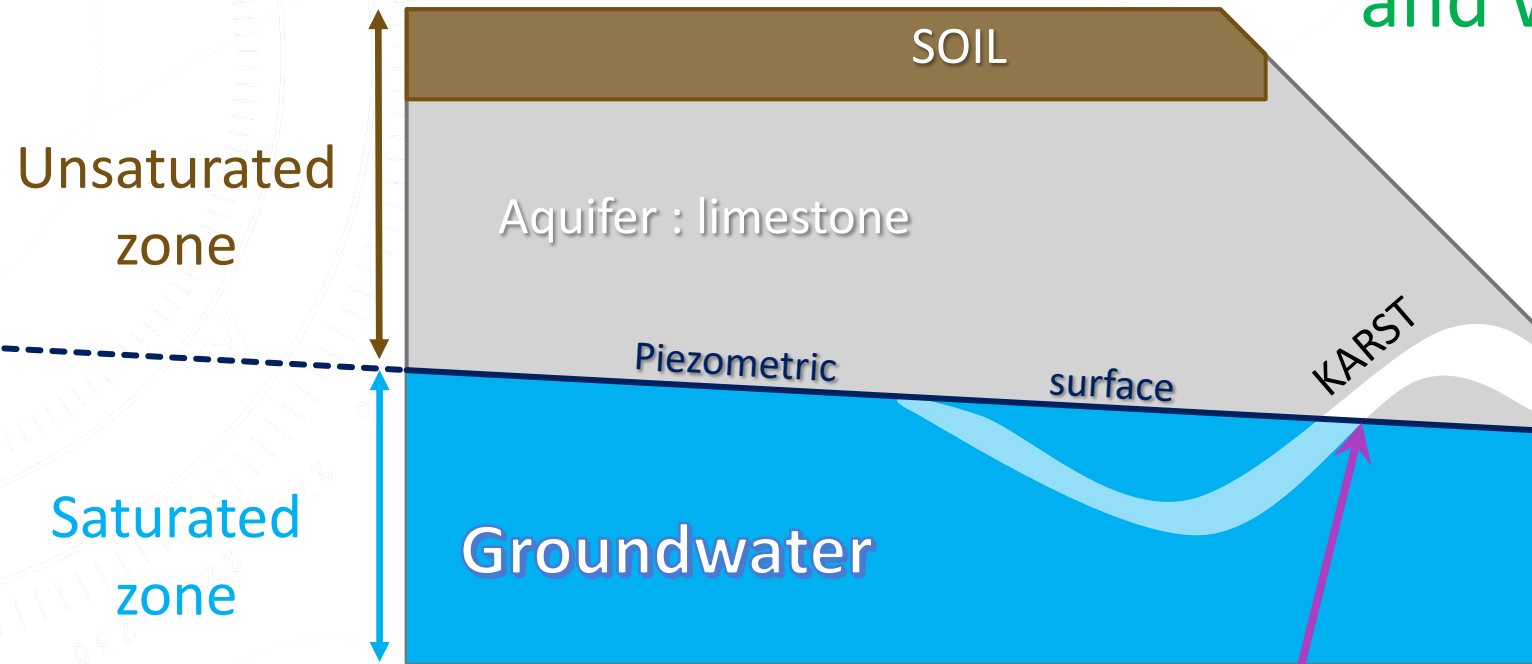
Approximate level of the piezometric surface

All cavities in the rock below the piezometric surface are filled with water



We found groundwater, but where does it come from and where does it go?

The sensor is in the tube



Springs

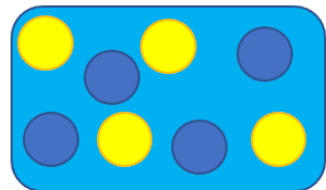
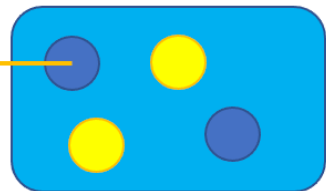
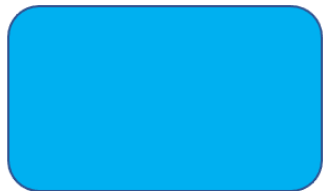
To find answers to our questions, we install a CTD-DIVER in the groundwater





# C

Water electrical **Conductivity**



Type of water	Electrical conductivity ( $\mu\text{S}/\text{cm}$ )
Pure water	0 (insulating)
Rain water	10-50
Groundwater (local)	400-700
Mineral water in Bardejov	2500- 5000
Sea water	55000

The unit of measurement is microsiemens per centimètre

$\mu\text{S}/\text{cm}$

# T

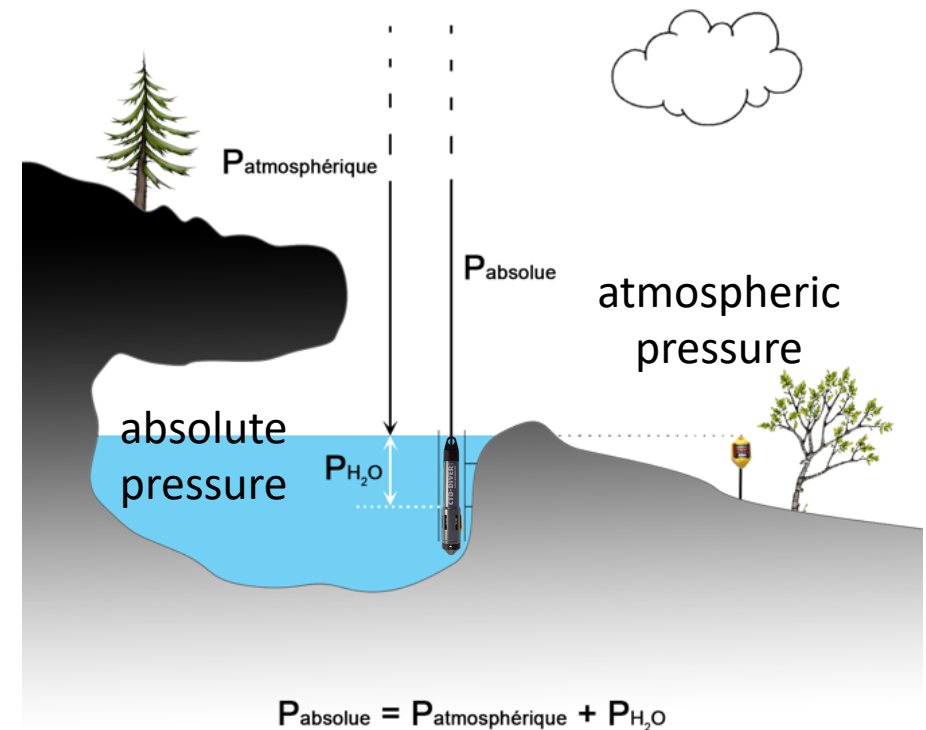
Water **Temperature**

$^{\circ}\text{C}$

# D

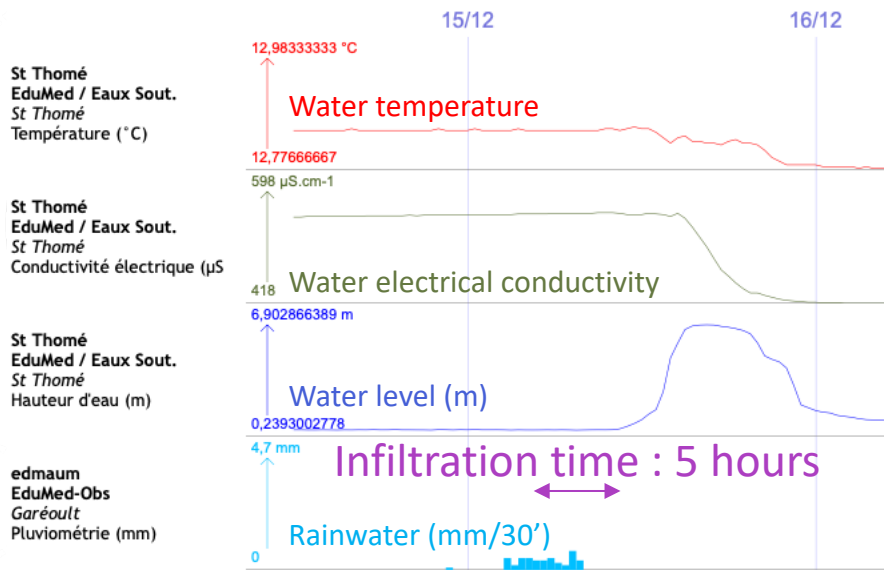
Water **Depth**

**Cm of water**



Water level = absolute pressure – atmospheric pressure

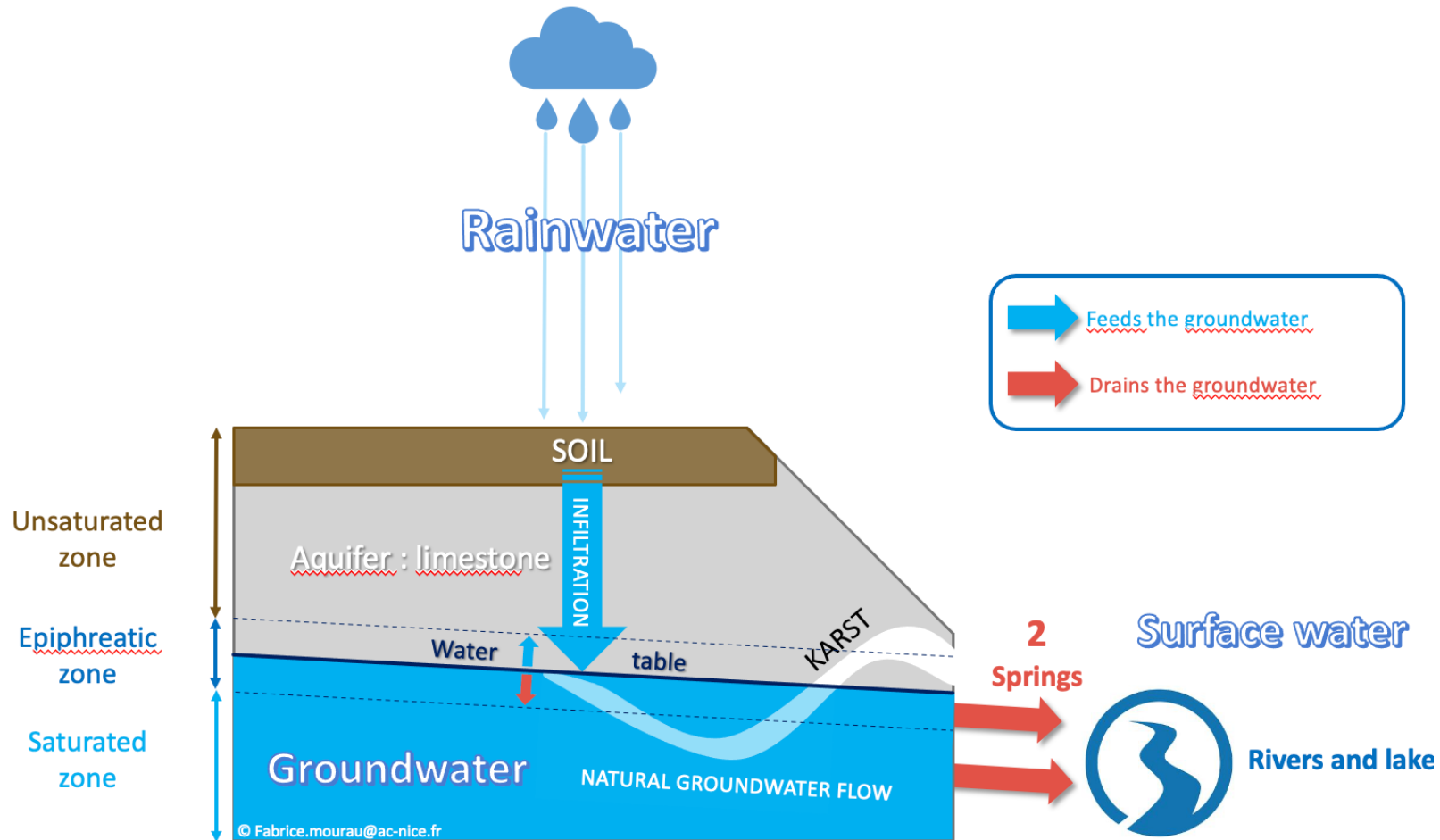




The water level increases after the rain.

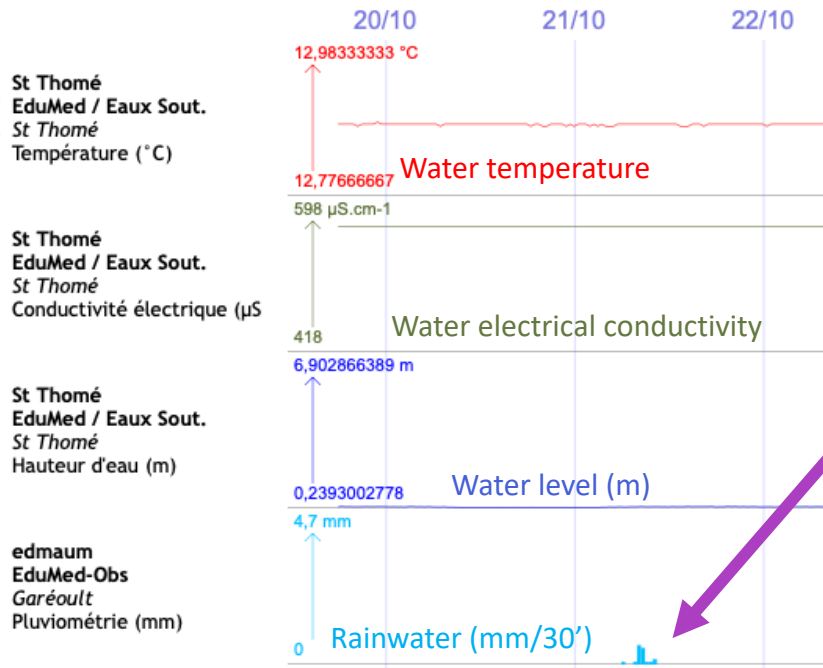
The decrease in electrical conductivity and temperature shows that it is the rainwater that infiltrates and feeds the water table.

The epiphreatic zone is sometimes drowned, sometimes dry: this is the balancing zone of the water table.



Data available online  
<http://edumed.unice.fr>





Sometimes it rains and there is no change in the water table.

1  
Evapotranspiration

Rainwater

Plants

SOIL

INFILTRATION

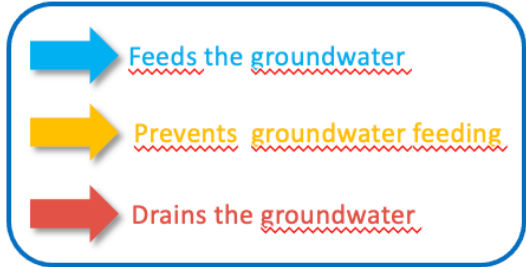
Aquifer : limestone

KARST

Water table

Groundwater

NATURAL GROUNDWATER FLOW



2  
Springs

Surface water

Rivers and lakes

The soil and vegetation absorb the rainwater before it seeps through.

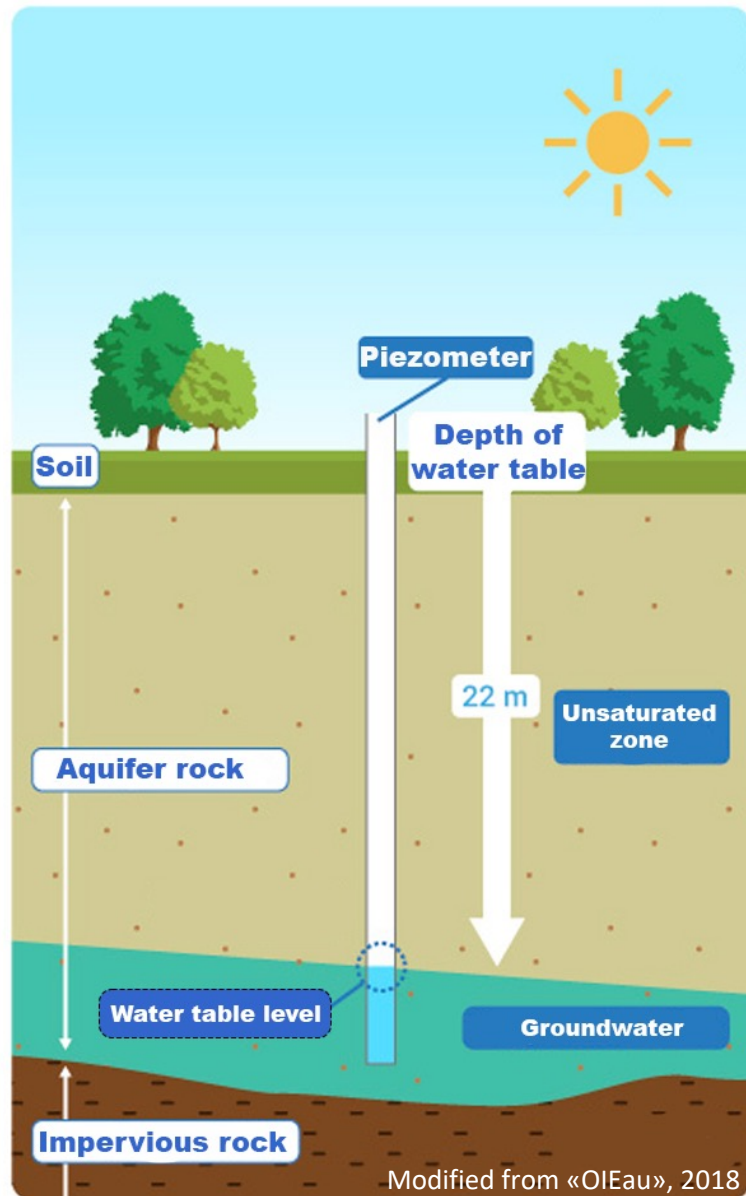
Through evapotranspiration, the leaves return water to the atmosphere

Unsaturated zone

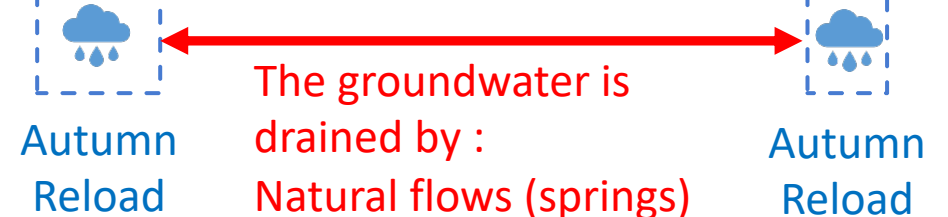
Epiphreatic zone

Saturated zone

# How has the water table evolved over the last 20 years?

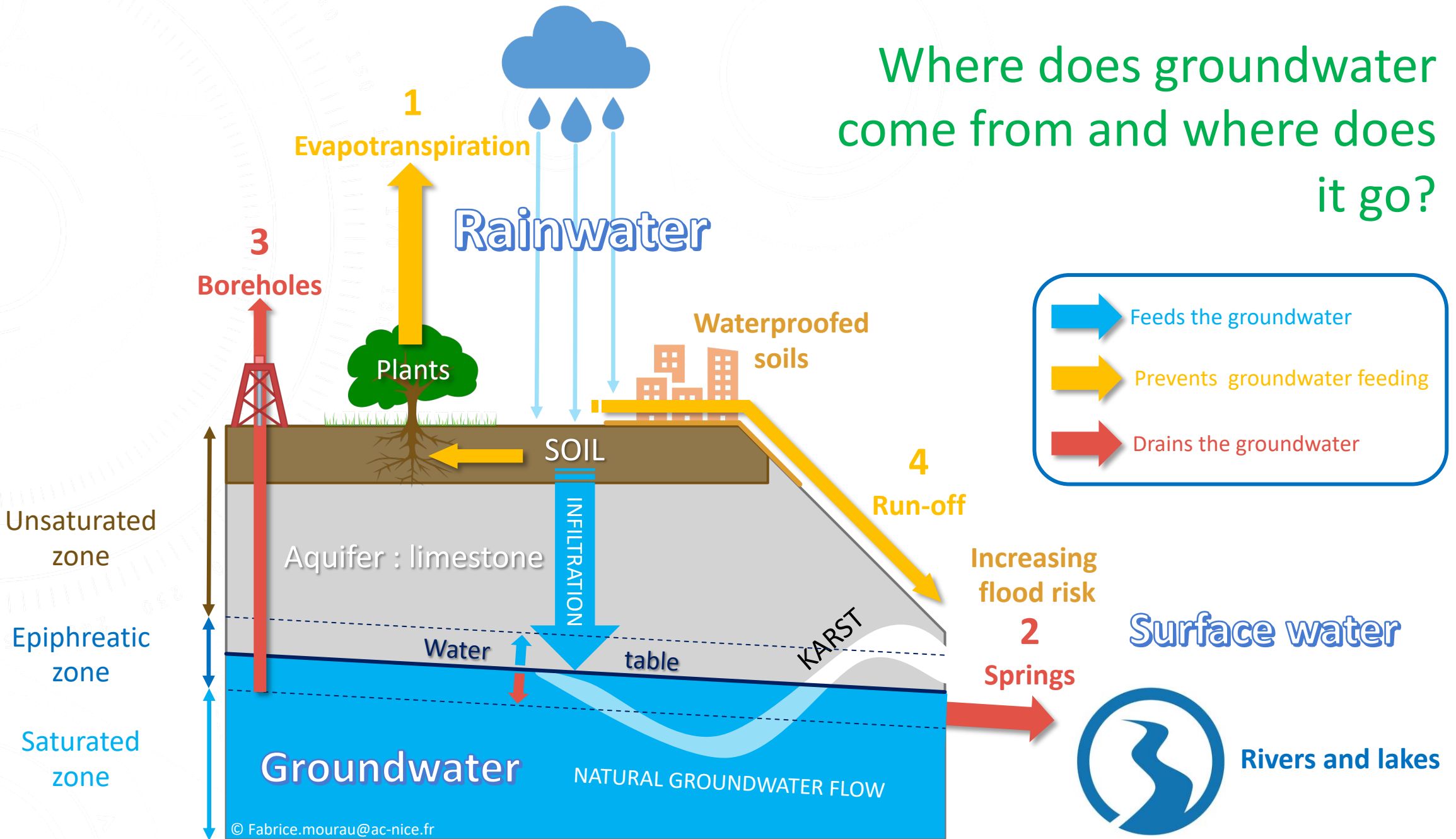


Water table level recorded in the piezometer of La Roquebrussane (Sce : ADES France)

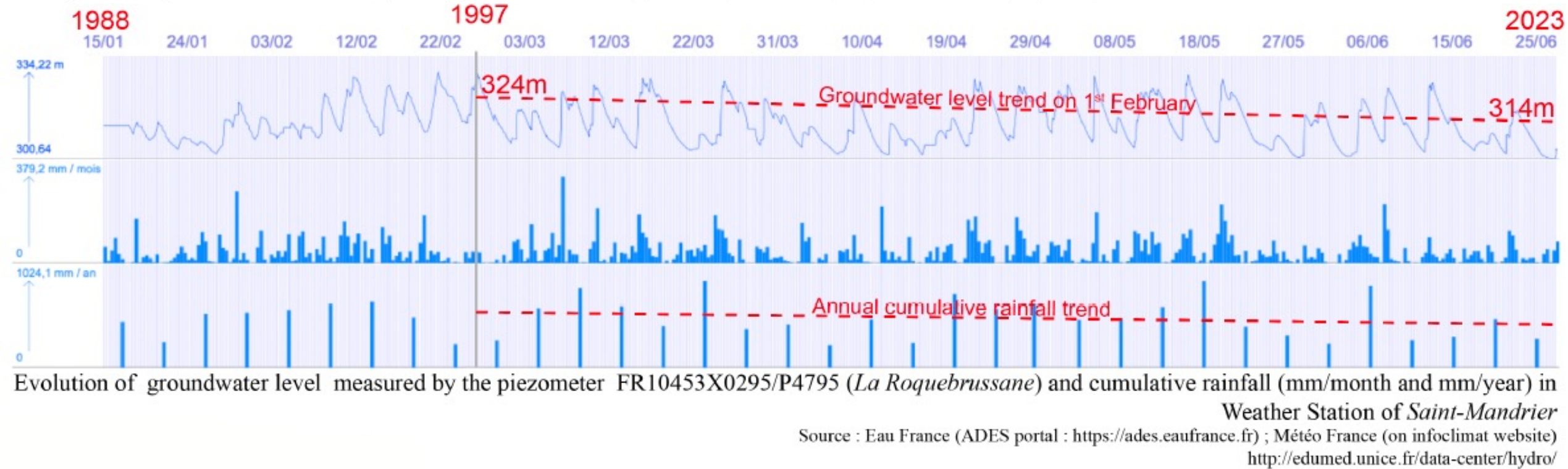


The groundwater is drained by :  
 Natural flows (springs)  
 Human withdrawals (boreholes)

# Where does groundwater come from and where does it go?

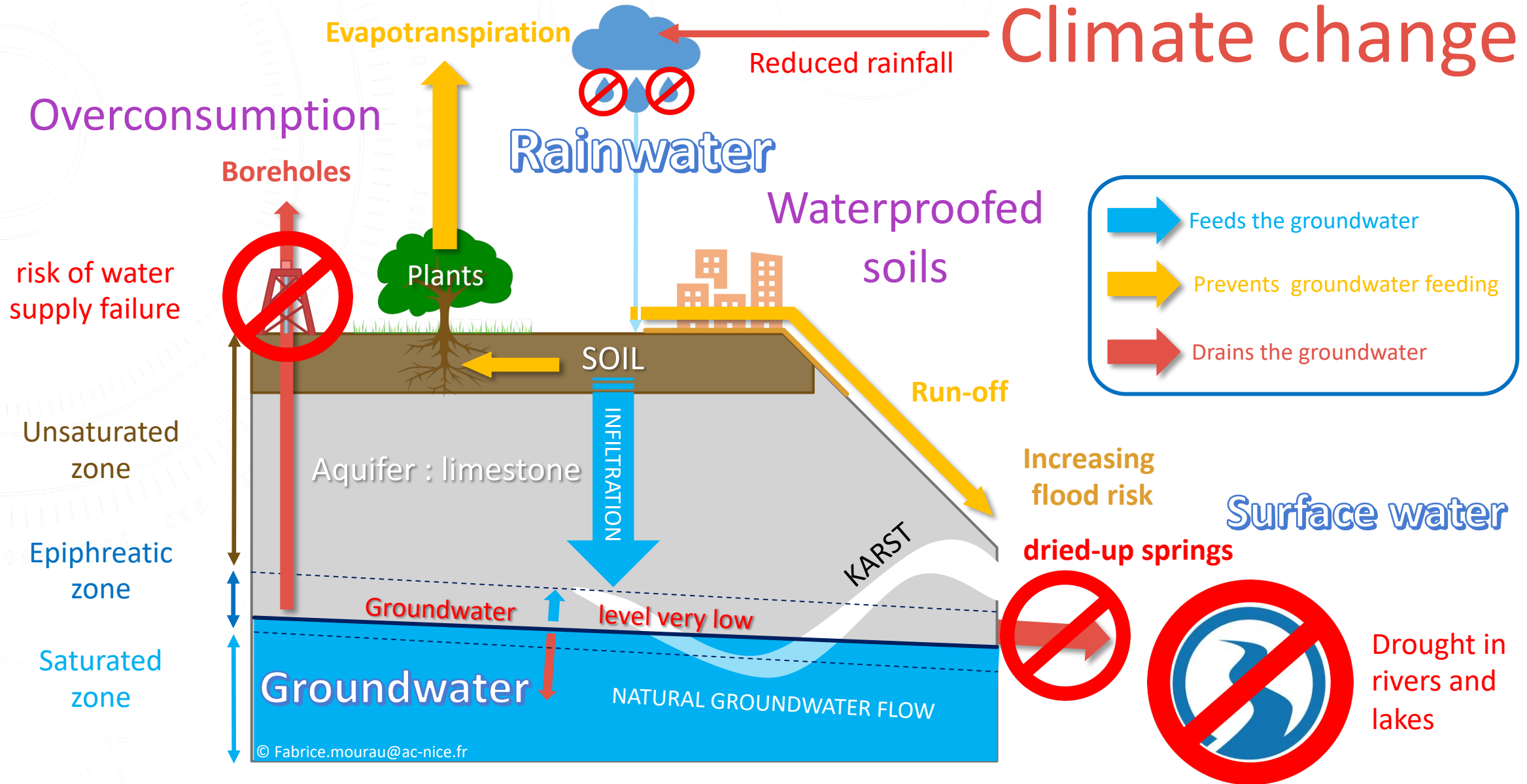


# How can the current drought be explained?



Since 1997, we have observed that it has been raining less and less in the region, which is a consequence of climate change. The groundwater table continues to be depleted and is no longer sufficiently recharged.

# How is groundwater affected by climate change and anthropogenic constraints ?



## Climate change



Julien bridge, Bonnieux (2023/08/24)

## Overconsumption



Water leaks waste 20% of drinking water in France

## Waterproofed soils



©Géoportail (IGN France)

# What to do ?

1

Fighting against climate change

Consume less energy and stop greenhouse gas emissions

2

Adapting our infrastructure

3

Changing our consumption habits

A mall near Toulon.

Rainwater can no longer infiltrate: the groundwater is no longer refilled and the risk of flooding increases through runoff.



Thank you for  
your attention