EGU GIFT WORKSHOP

Monday 19 and Wednesday 23 April 2021

European Geosciences Union

HYDROGEOLOGY AT SCHOOL

PART 1 : OBJECTS AND METHODS

Fabrice Mourau [1,2]

1 : Middle-school "Collège Pierre de Coubertin", Le Luc (France)

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Pictures : Besse's lake drought(Le Parc and Lombard/ Var Matin 2016) ; Dardennes dam (O. Pastor) ; Flood event (Hache/AFP) ; Biodiversity and environment (MRE PACA)

Please Download DataSet1 :
https://drive.google.com/file/d/1VJllaBoDWfaM5tAJyqogSnLHCjt5eJ9X/view?usp=sharing

EGU GIFT WORKSHOP

European Geosciences Union

Monday 19th April 2021 03:00 PM

PART 1 : OBJECTS AND METHODS

HYDROGEOLOGY AT SCHOOL

Today :

- Measuring water level with yours students
- Rainfall and water level : a simple relationship ?
- The water discharge : a difficult but very important concept
- Using the electrical conductivity to understand water paths

Wednesday 23th April 2021 11:00 AM

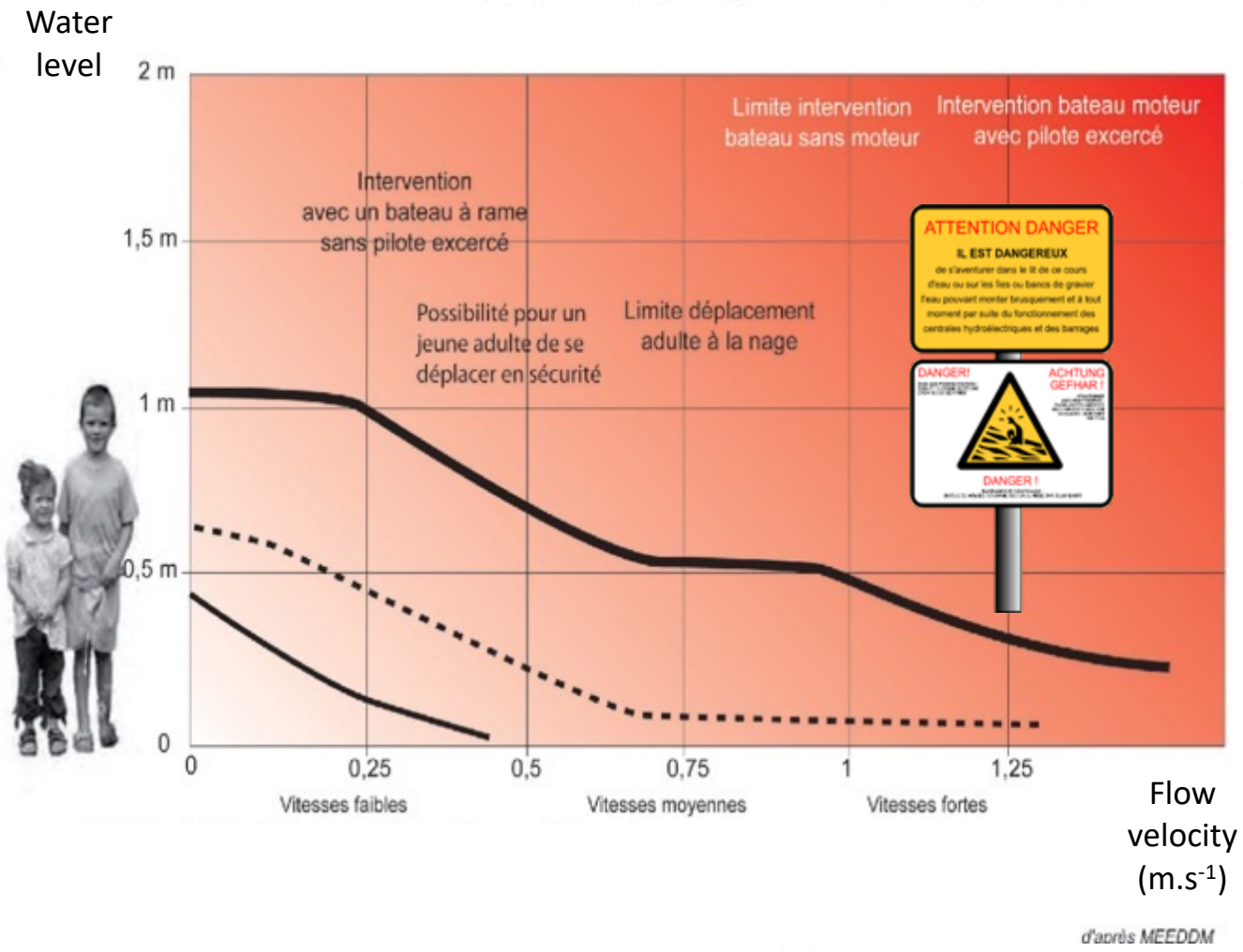
PART 2 : INTENSE MEDITERRANEAN RAIN

HYDROGEOLOGY AT SCHOOL

Don’t forget our second session Wednesday

- A recurrent risk for the population
- Meteorological phenomenon
- Effects on rivers
- Role of the karst and the underground
- Effect on the sea and consequences
- Intense mediterranean rain, global warming and citizen issues at school

first step: be careful !



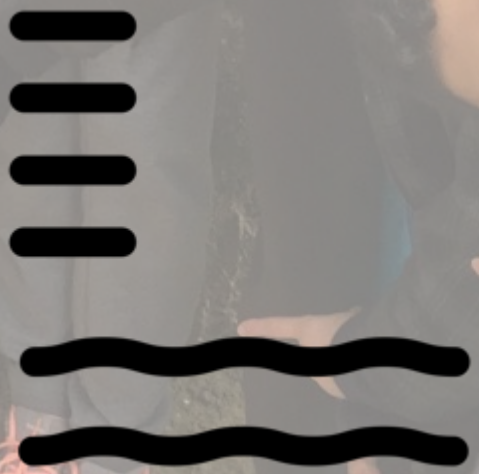
Safe movement limit for an athletic stressed adult

Safe movement limit for a non athletic adult/teenager

Safe movement limit for a standing child

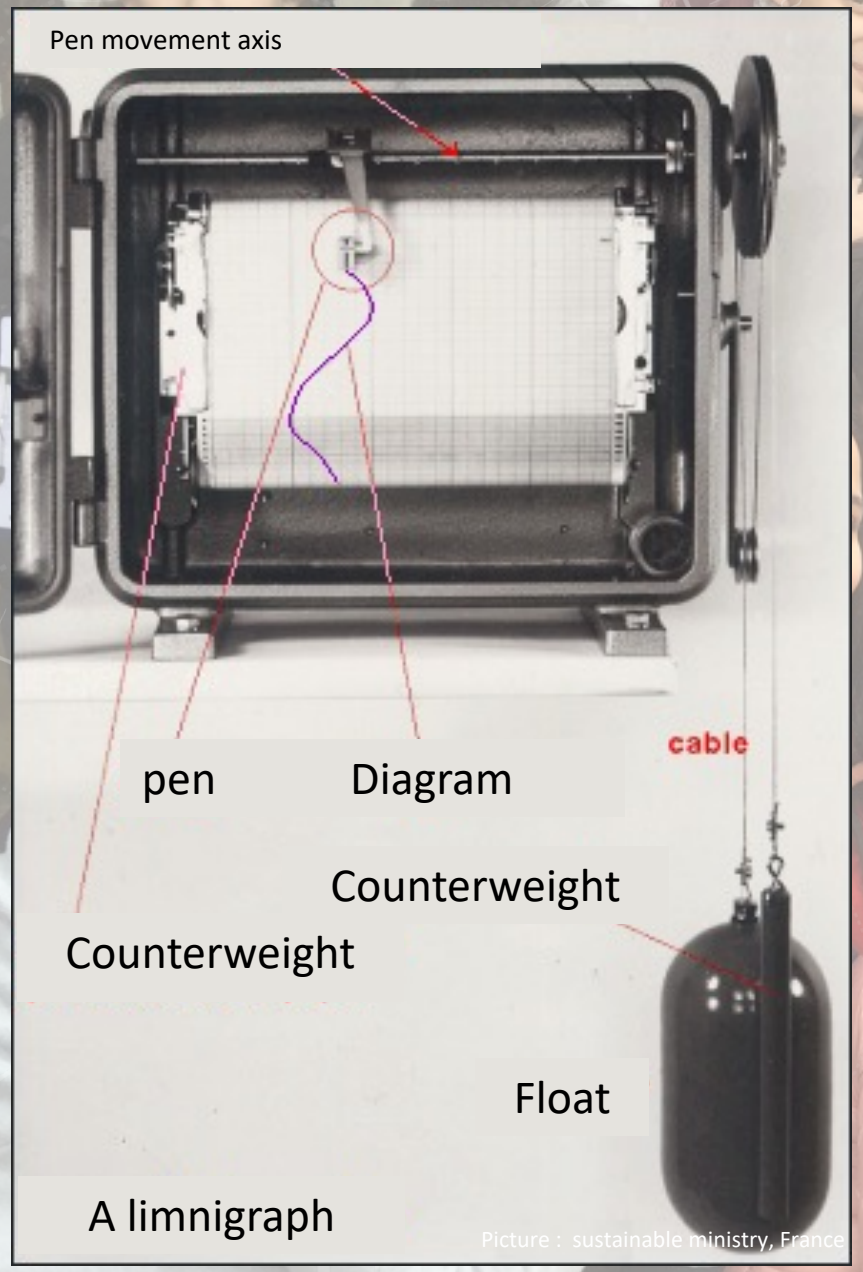
how to measure the water level with your students?

Water level Gauge

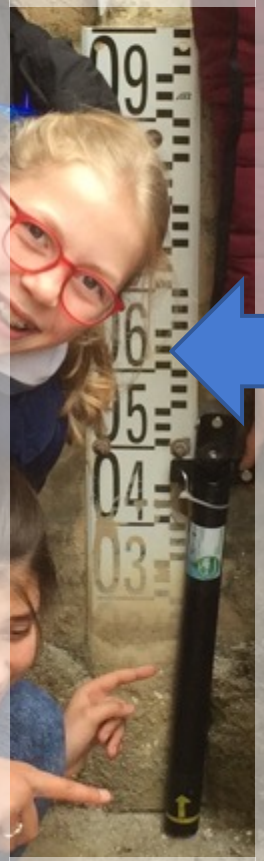


Picture : F. Mourau, january 2016

how to measure the water level with your students?



Hydrologic station : from the float water level gauge to electronic limnimeter



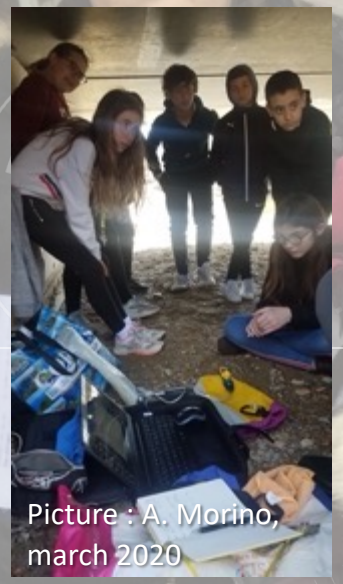
Water level Gauge

Radar sensor limnimeter →

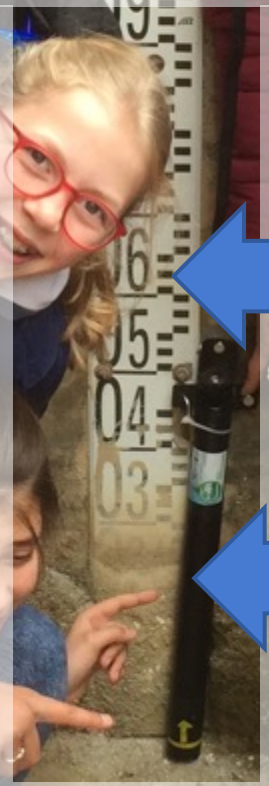
Picture with pupils: F. Mourau, january 2016

how to measure the water level with your students?

Operate pressure and temperature sensor with pupils



Picture : A. Morino, march 2020

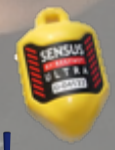


Water level Gauge

Operated by the city council

Water level probe

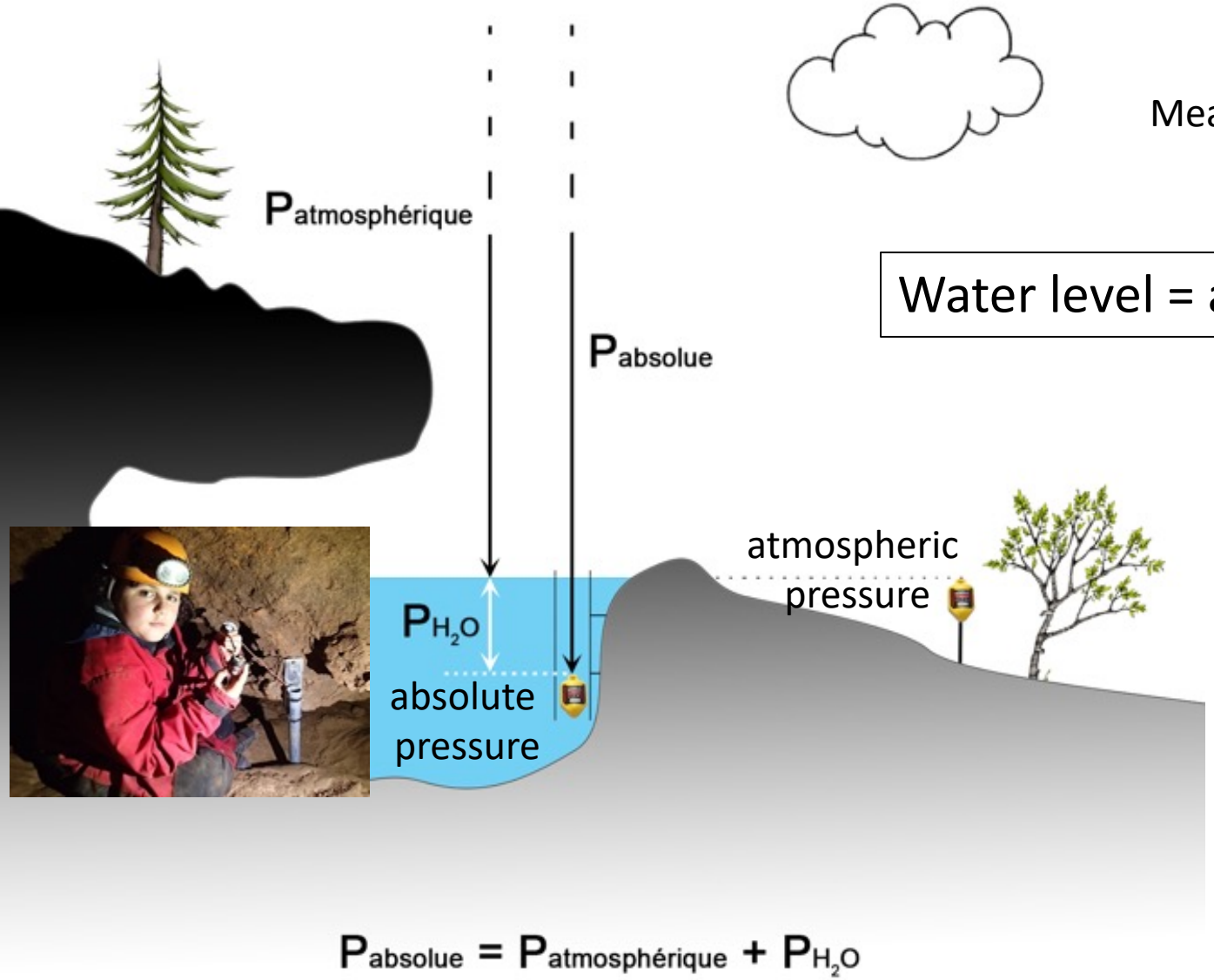
Operated by the pupils !!!



Sensus Ultra (reefnet©) sensor (pressure and temperature)

Picture : F. Mourau, january 2016

how to measure the water level with your students?



Measures realized with a sampling rate of 15 minutes

Water level = absolute pressure – atmospheric pressure

$$P_{absolue} = P_{atmosphérique} + P_{H_2O}$$

Sensus Ultra (reefnet©) sensor (pressure and temperature)

Using pressure sensors to measure water level

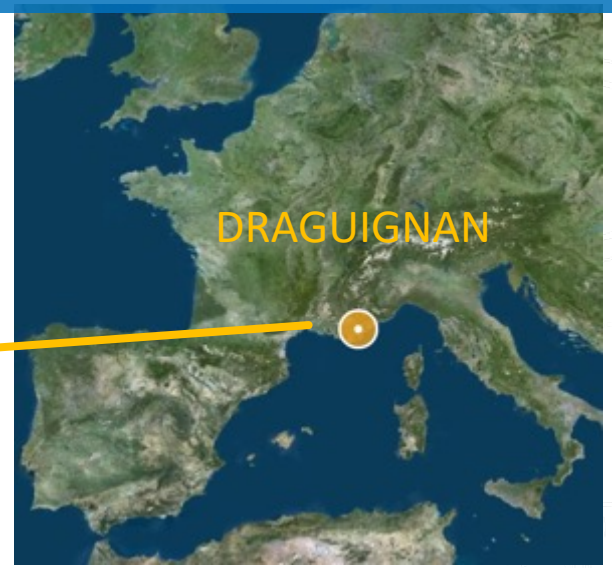
Fabrice.mourau@ac-nice.fr

how to measure the water level with your students?

Recording water level and temperature

	A	B	C	D	E	F
1	Date	T (°C)Nartuby	Pression air+eau (m)Nartuby	T (°C) Air collège J Rostand	Pression atmo collège J Rostand	
2	26/09/2019 09:21	22,84	10,16553	24,66	10,10429	
3	26/09/2019 10:21	23,43	10,17574	23,59	10,10429	
4	26/09/2019 11:21	24,07	10,15533	23,45	10,10429	
5	26/09/2019 12:21	25,23	10,16553	23,58	10,09409	
6	26/09/2019 13:21	25,16	10,15533	24,11	10,09409	
7	26/09/2019 14:21	25,24	10,17574	24,69	10,09409	
8	26/09/2019 15:21	23,76	10,15533	25,24	10,10429	
9	26/09/2019 16:21	22,95	10,16553	25,46	10,10429	
10	26/09/2019 17:21	21,88	10,16553	25,48	10,10429	
11	26/09/2019 18:21	20,22	10,17574	25,41	10,12471	
12	26/09/2019 19:21	19,3	10,19615	25,27	10,12471	
13	26/09/2019 20:21	18,76	10,19615	25,11	10,12471	
14	26/09/2019 21:21	18,37	10,18595	24,92	10,12471	
15	26/09/2019 22:21	17,93	10,19615	24,71	10,13491	
16	26/09/2019 23:21	17,28	10,18595	24,52	10,12471	
17	27/09/2019 00:21	16,78	10,19615	24,31	10,13491	
18	27/09/2019 01:21	16,76	10,19615	24,13	10,12471	
19	27/09/2019 02:21	16,77	10,18595	23,94	10,12471	
20	27/09/2019 03:21	16,94	10,18595	23,77	10,1145	
21	27/09/2019 04:21	16,97	10,19615	23,64	10,1145	
22	27/09/2019 05:21	16,14	10,19615	23,51	10,12471	
23	27/09/2019 06:21	15,91	10,19615	23,39	10,12471	
24	27/09/2019 07:21	17,67	10,20636	23,29	10,12471	
25	27/09/2019 08:21	20,22	10,20636	23,23	10,12471	

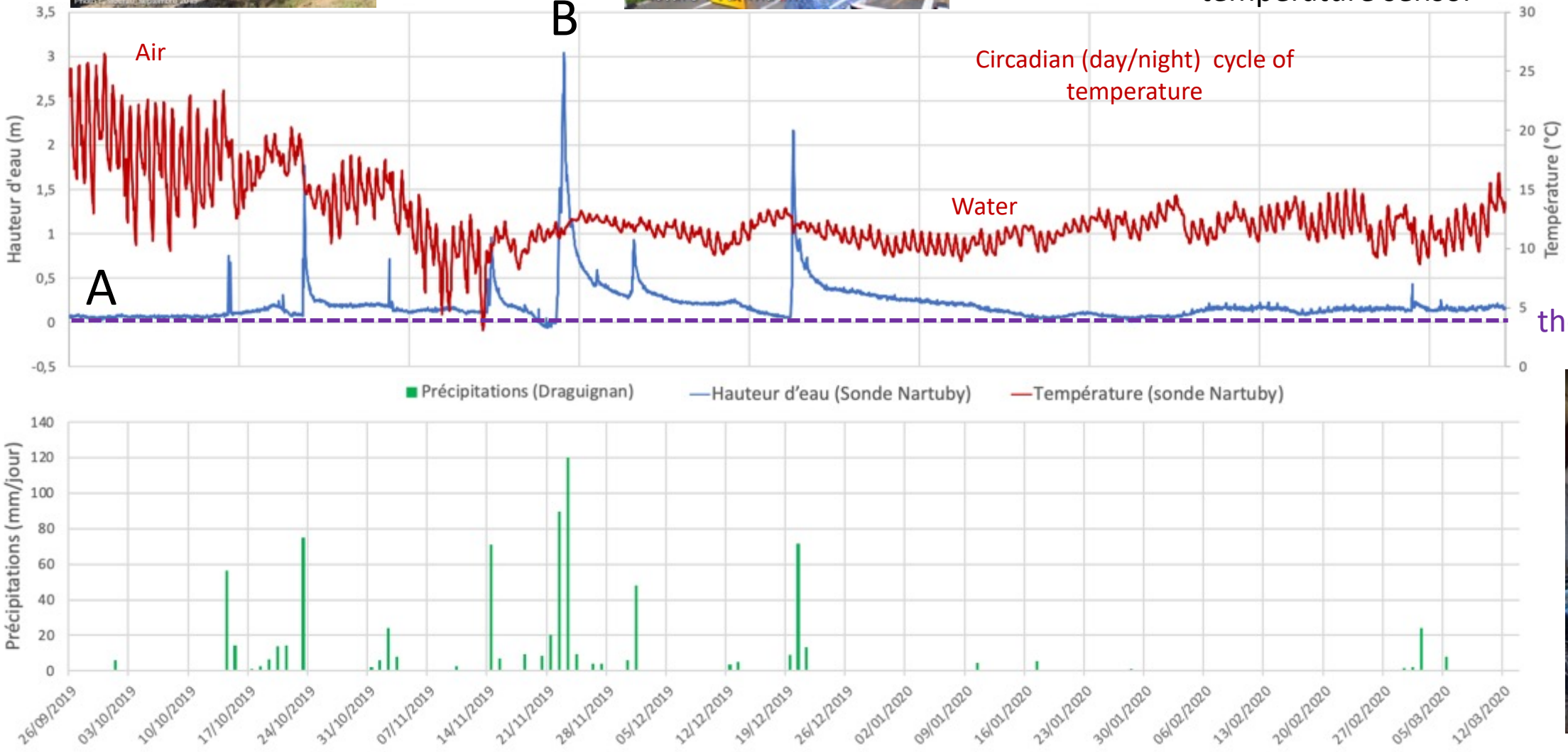
=C2-E2



Example: Middle school Jean Rostand (Draguignan); teacher: Aude Morino

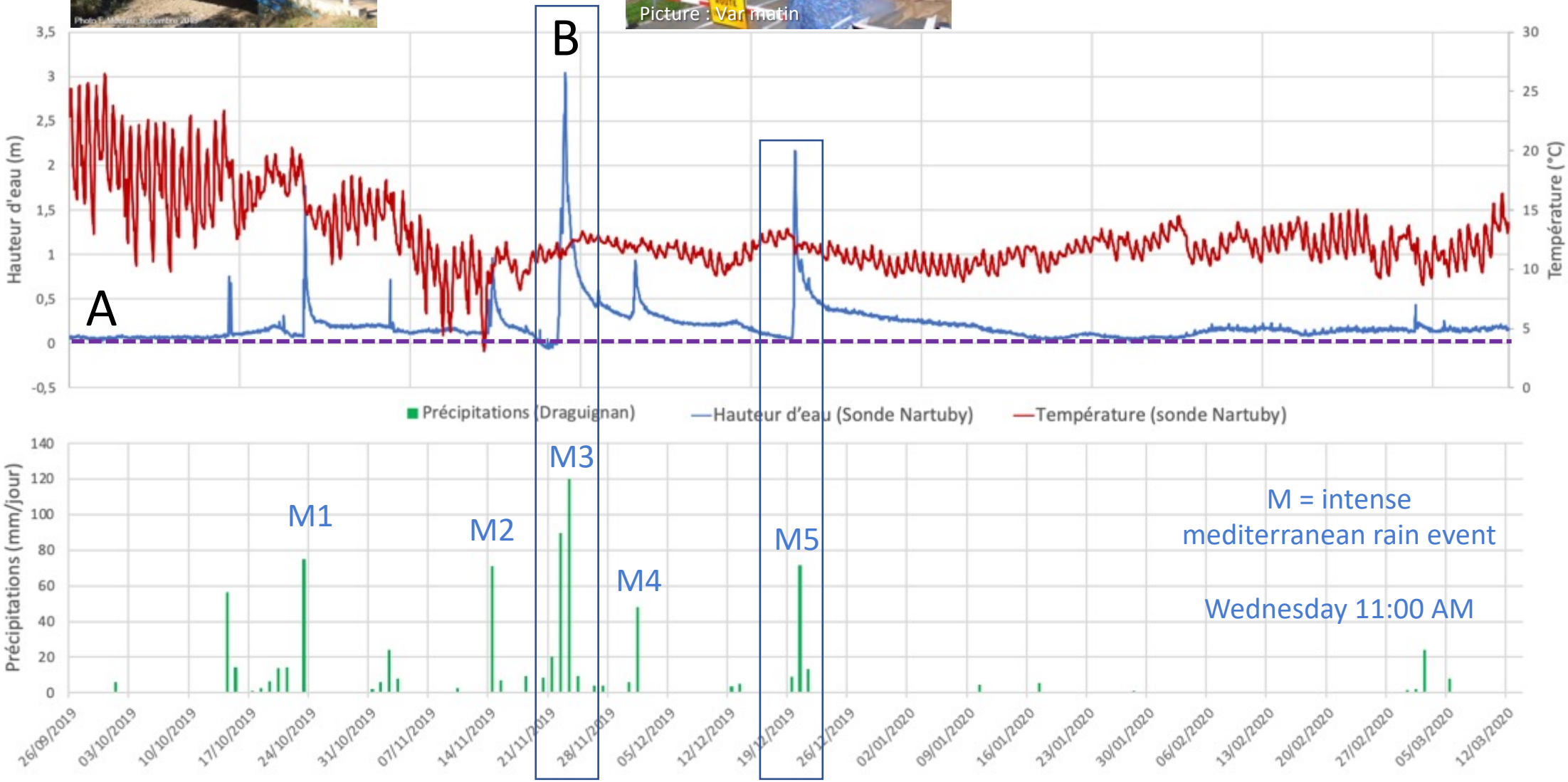
how to measure the water level with your students?

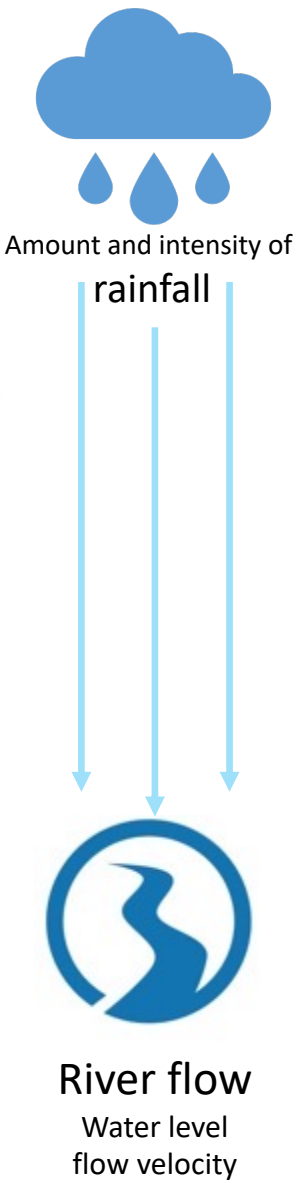
Monitoring of the Nartuby river (Var) by students of the Jean Rostand middle school (C) during the winter of 2019-2020 using an in-situ pressure and temperature sensor



the river is dry

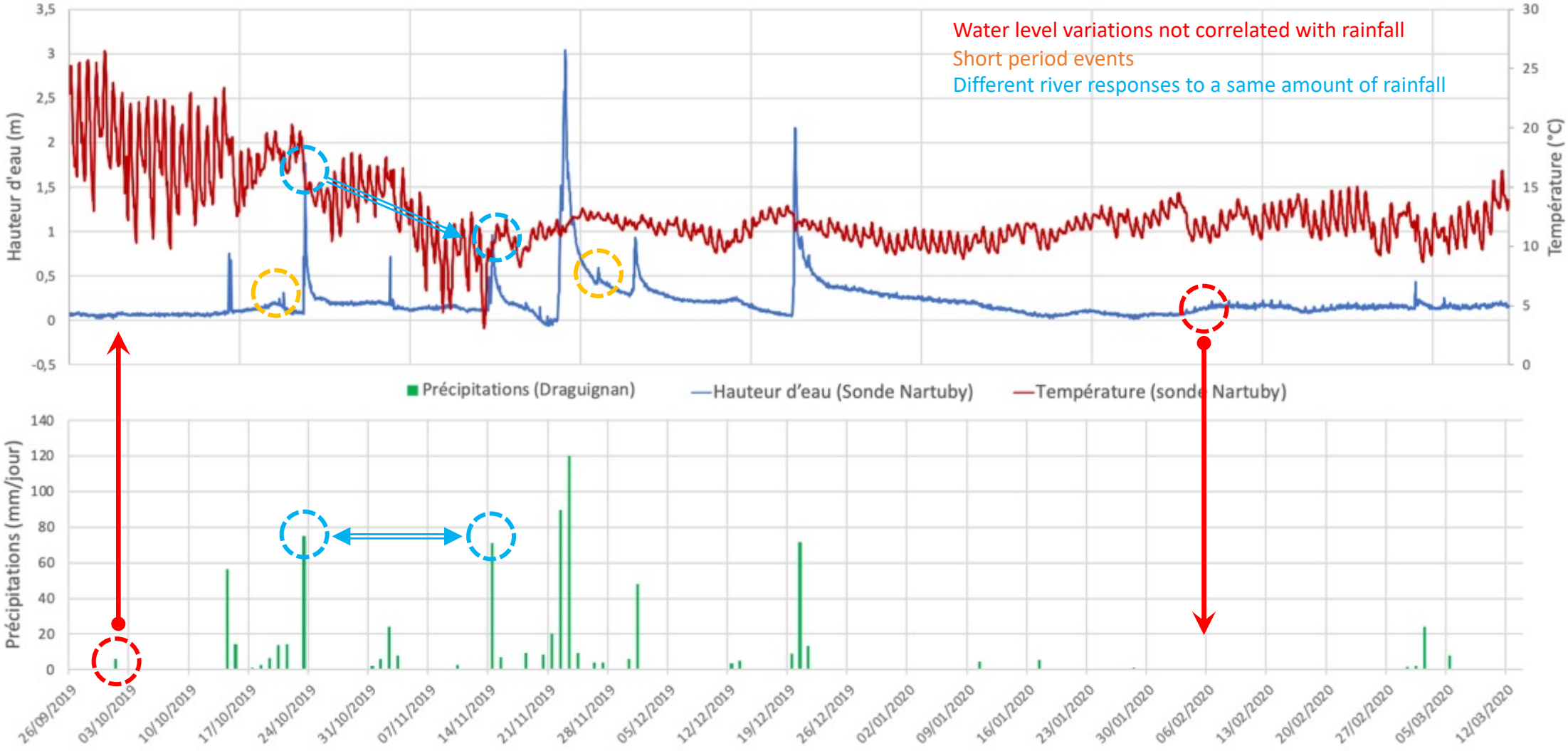
Rainfall and water level : a simple relationship ?

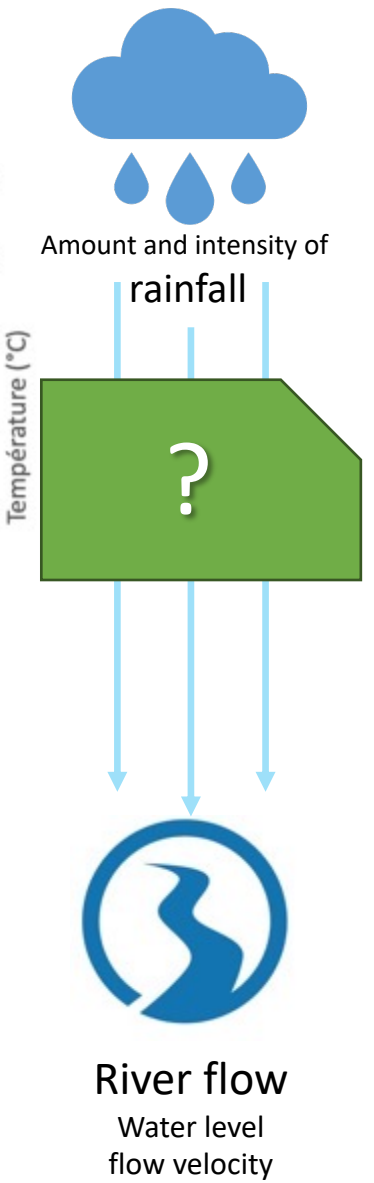




Rainfall and water level : a simple relationship ?

But the rain does not explain all the phenomena observed…

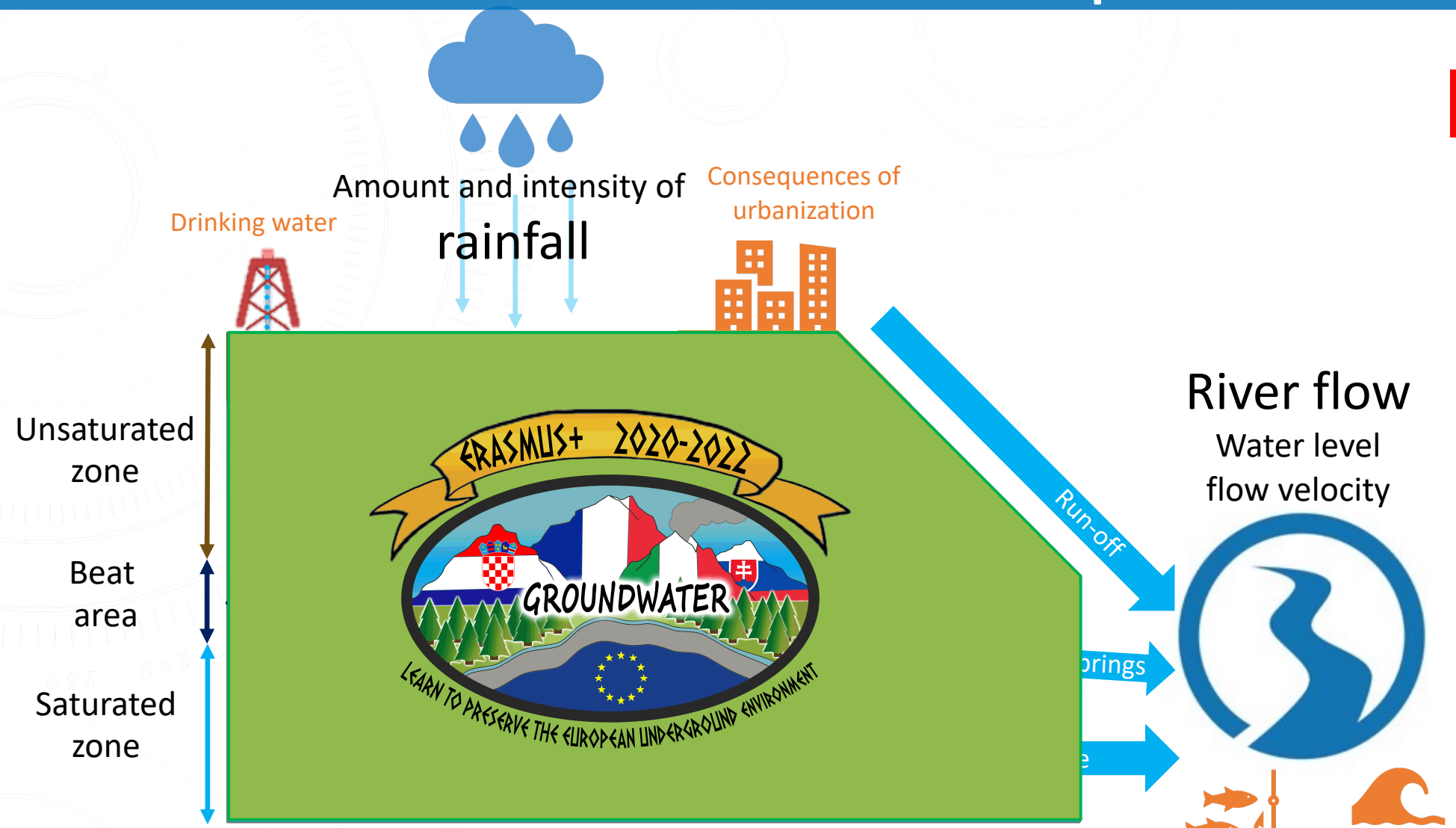




Rainfall and water level : a simple relationship ?

spoiler alert !

more details on
This scheme
wednesday 11:00 am



The underground controls transfers between the atmosphere and the hydrosphere

The water discharge : a difficult but very important concept

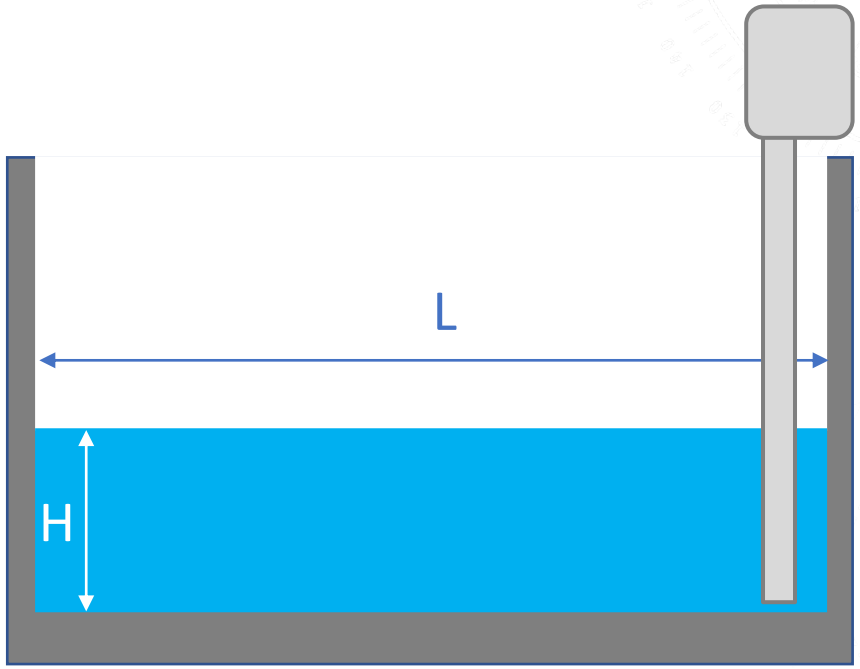
The flow rate (Q) of a river is the volume of water flowing through a section of the river per unit time, expressed in cubic meter per second (m^3/s). It is calculated by multiplying the surface area of the section (m^2) by the flow velocity (m/s).

Volume : available water resource for humans and biodiversity

Velocity : assessment of flood hazard and transport phenomena

Hydrological station of Solliès-Pont (Var) on the Gapeau river (Photo: SMBVG).

Liminimeter



Q: water discharge (m^3/s)
H : Water level (m)
L : river width (m)
V : Flow velocity (m/s)

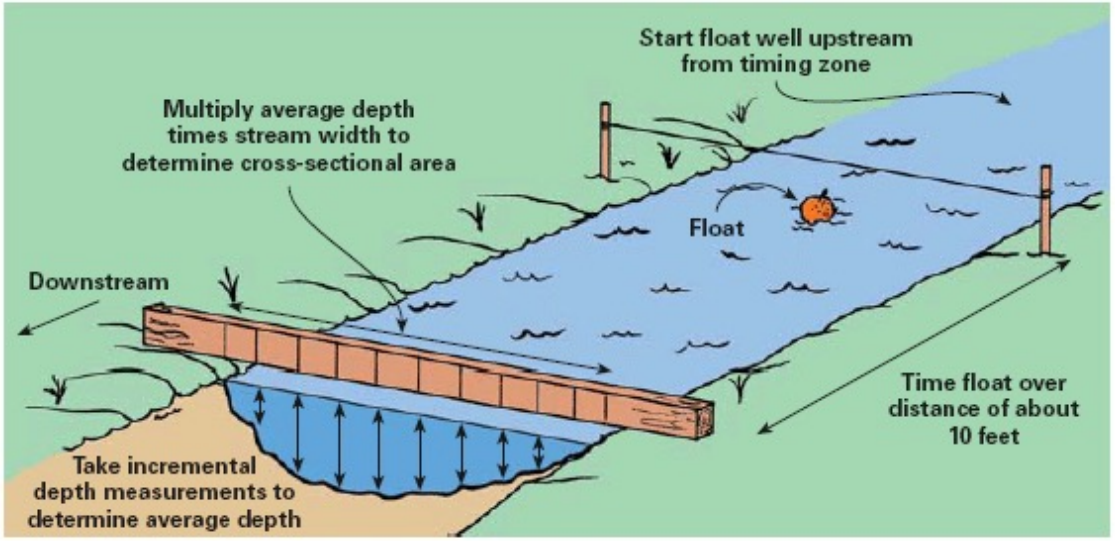
$$Q = H \times L \times V$$

The water discharge : a difficult but very important concept

How to measure/estimate the flow rate and velocity with pupils ?

The float method

Picture : JL Berenguer (2020)



Attention, to correct the variation of speed with depth, a coefficient of 2/3 is applied

The water discharge : a difficult but very important concept

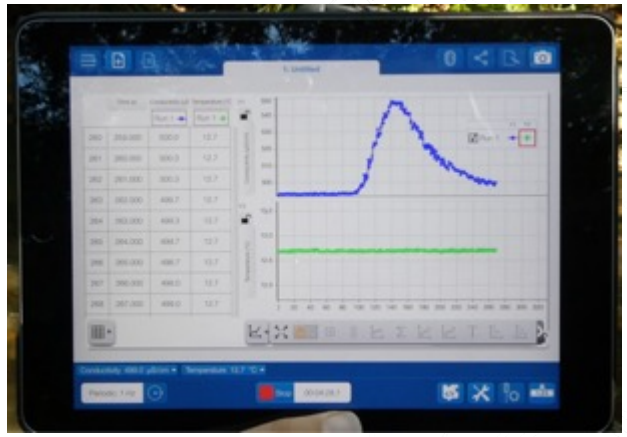
How to measure/estimate the discharge and velocity with pupils ?

The water current meter

An interesting solution but difficult to implement with students

Stream flow gauging

by sodium chloride dilution



More details :

http://edumed.unice.fr/files/teachers-room/files/Jaugeage_article.pdf

https://www.youtube.com/watch?v=vZLXHjxBtck

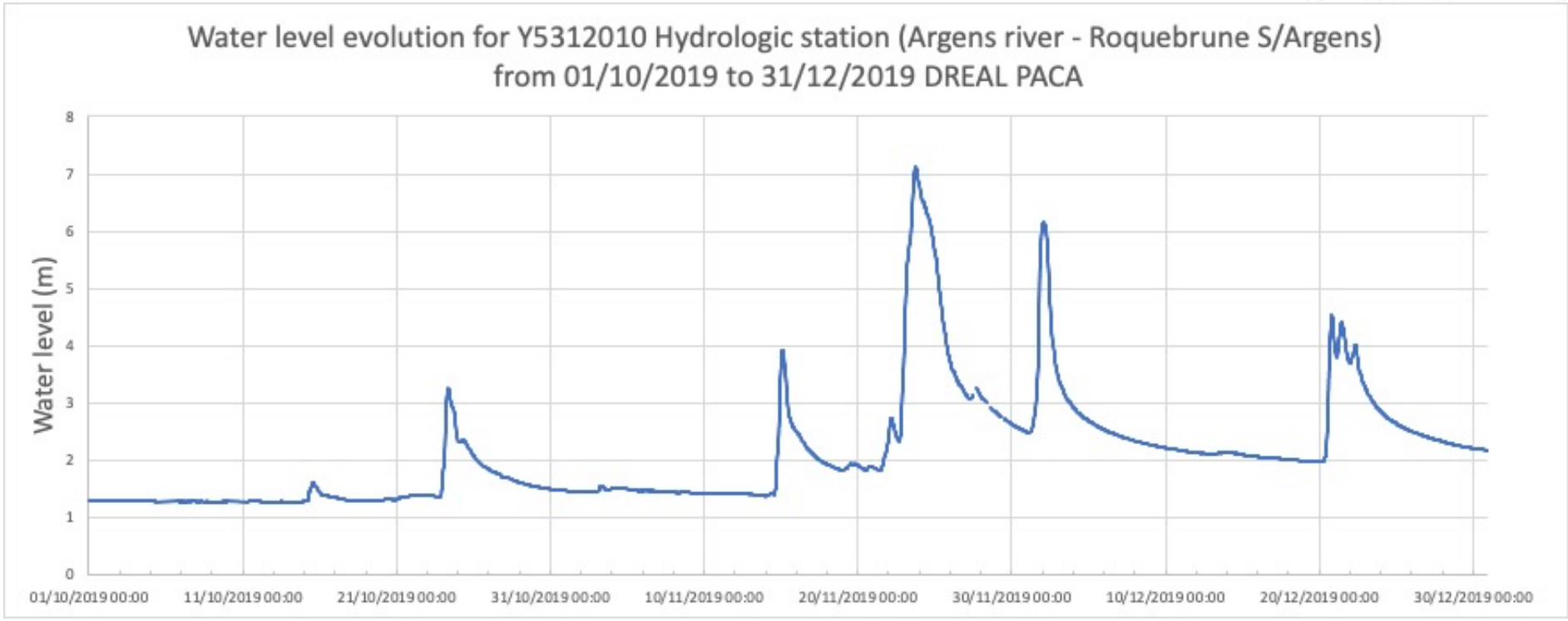
The water discharge : a difficult but very important concept

Case study :

The Argens river (France)

https://edugeo.ign.fr/carte/5538e68bfd44dcff1d797f41c0570031/Inondations+Puget+sur+Argens+

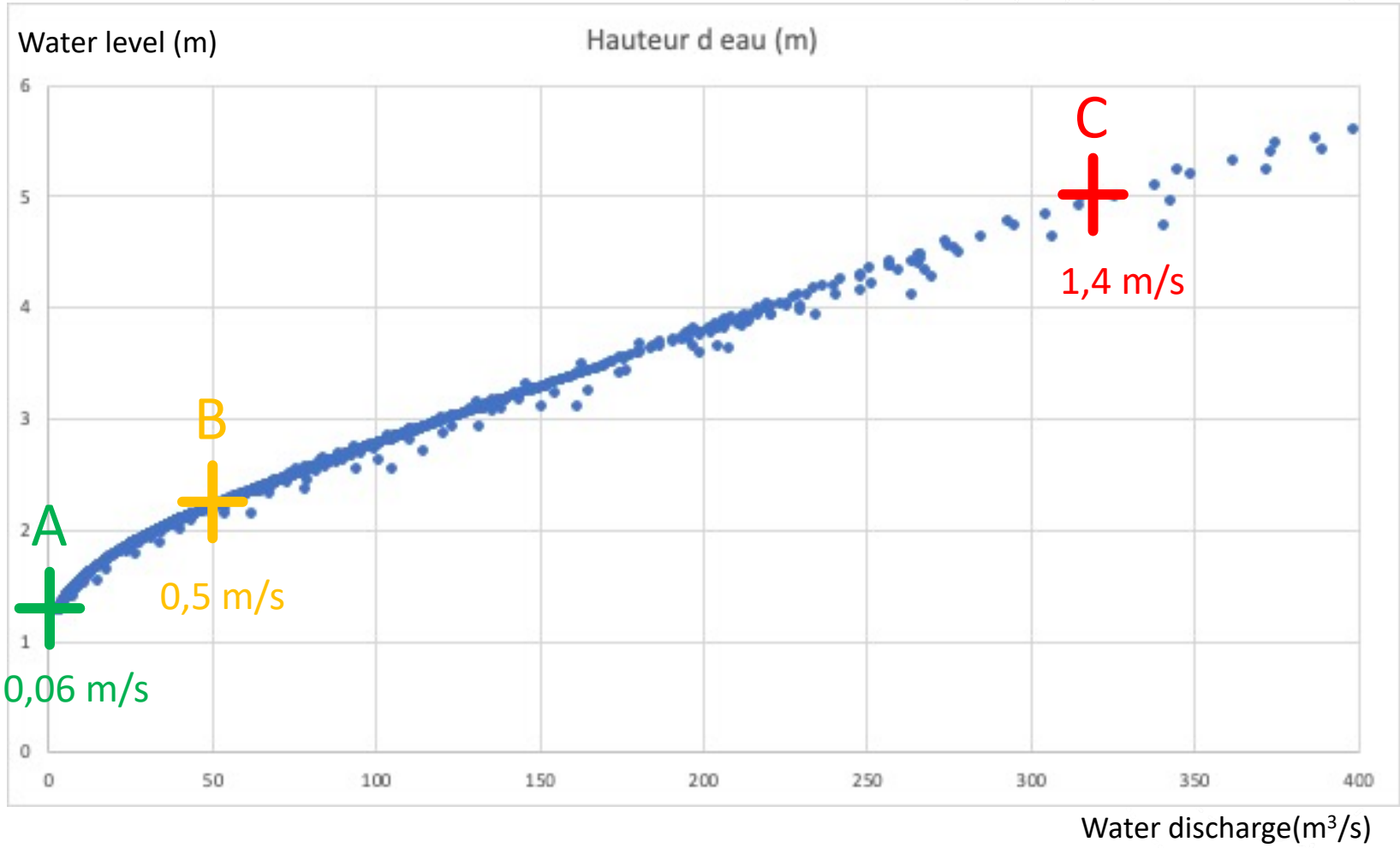
SIG EduGeo, Pouzin j. (2019)



The flow : a difficult but very important concept

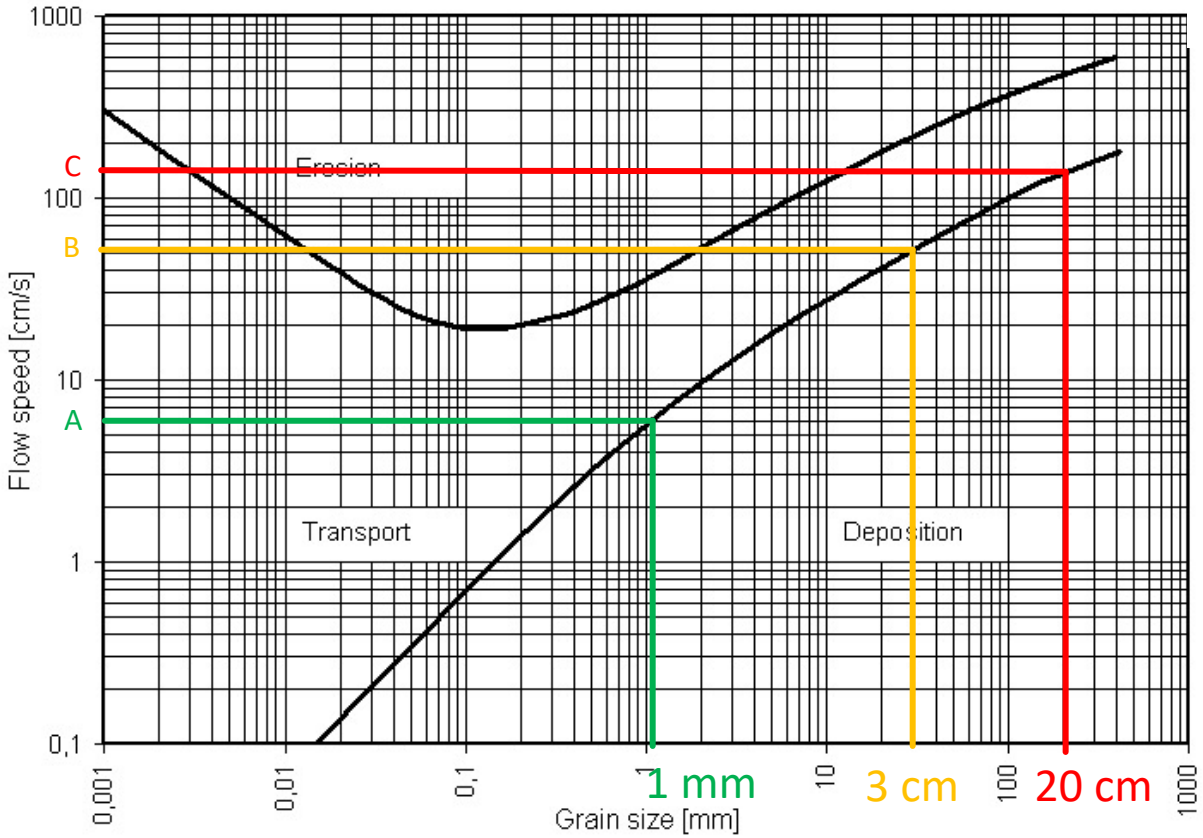
The rating curve

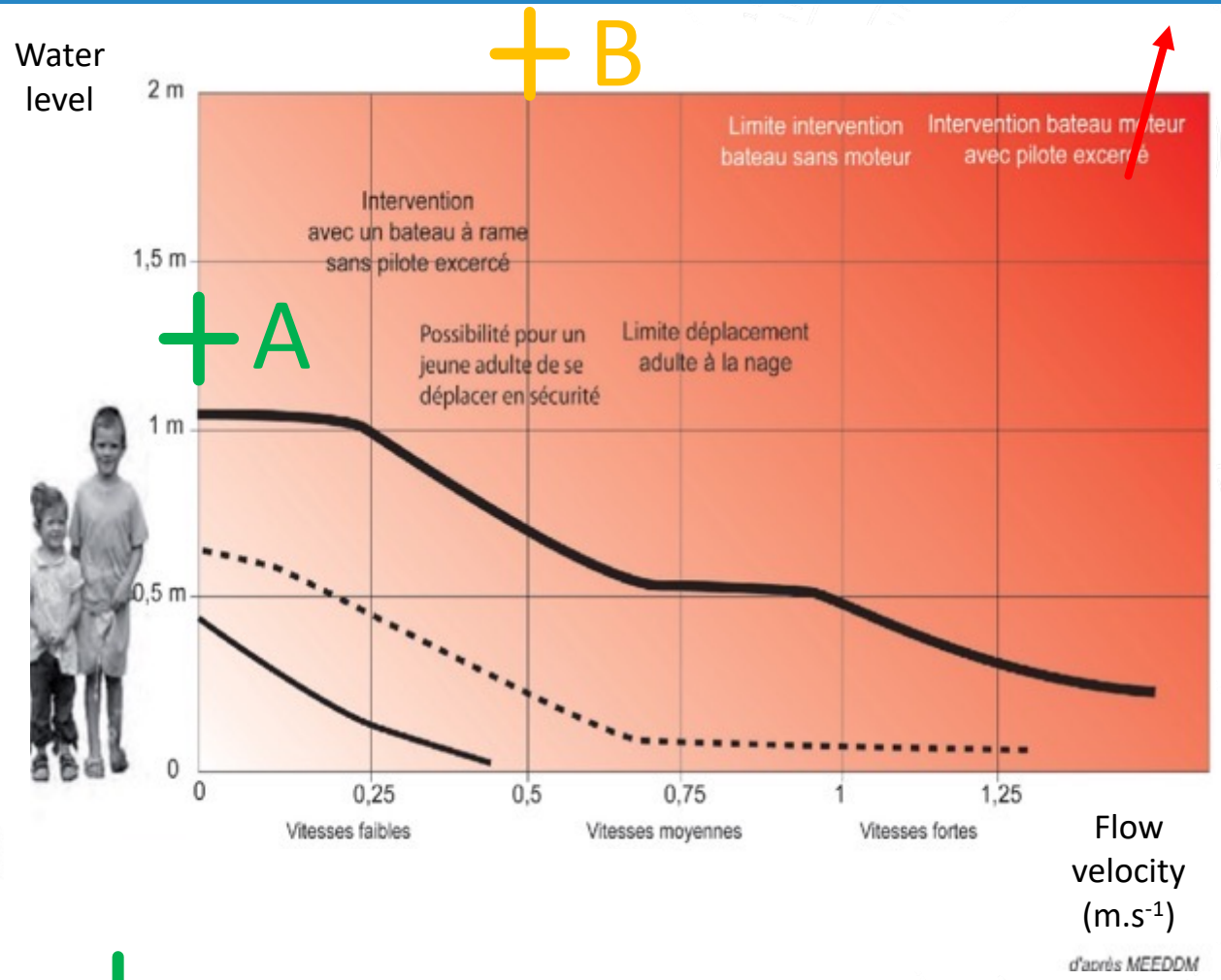
$$V(m.s^{-1}) = \frac{Q(m^3.s^{-1})}{L(m) \times H\ (m)}$$



For example : at 1.27 meters water depth, the discharge is 3.4 cubic meters per second (point A), at 2.2 metres water depth, the discharge is 50 cubic meters per second (point A) and at 5 metres water depth, the discharge is 316 cubic meters per second (point B). The flow velocities can be approximated at : 0. 06 m/s (A), 0.5 m/s (B) and 1.4 m/s (C)

The flow : a difficult but very important concept C





In case A, the river transports sediment up to 1 mm equivalent hydraulic diameter, there is no erosion, only transport and sedimentation.

In case B, the river transports sediment up to 3 cm equivalent hydraulic diameter.

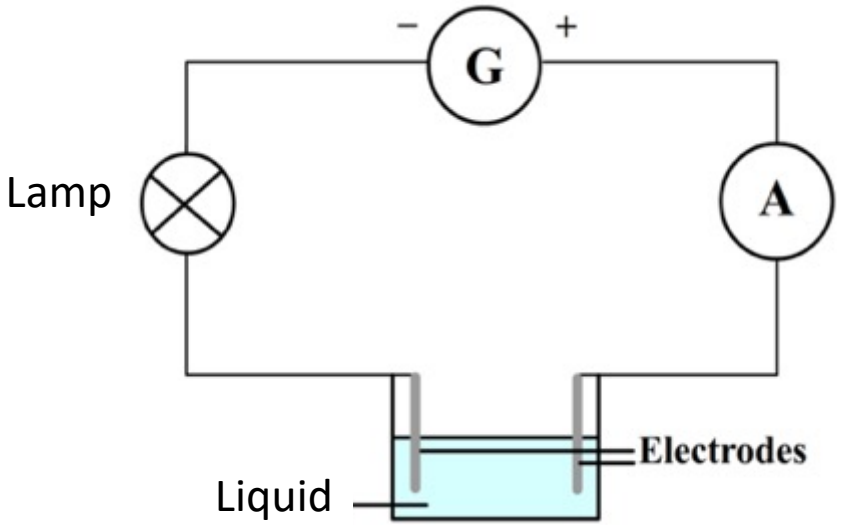
In case C, the river transports sediment up to 20 cm equivalent hydraulic diameter.

\+ A healthy young adult can move around safely

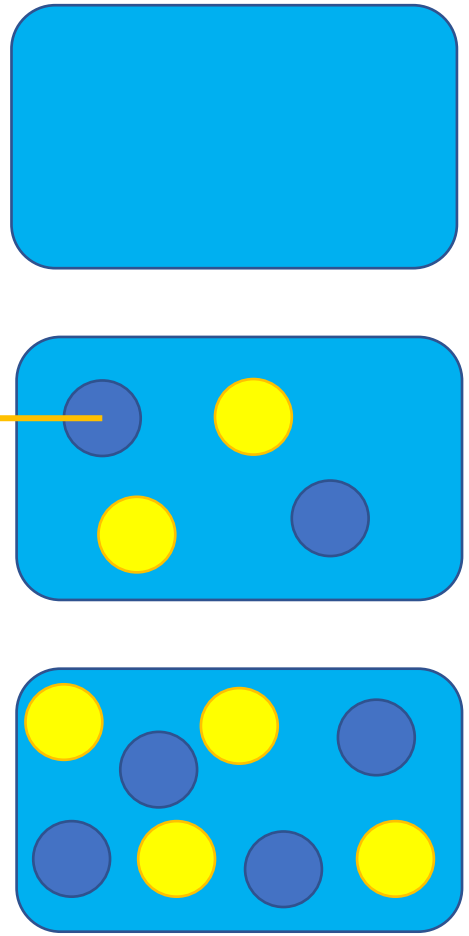
\+ Possible use of a rowing boat

\+ intervention by a motorboat with a trained pilot

Using the Electrical conductivity to understand water paths



In the field, probes are used that incorporate a conductivity meter



Pure water is insulating

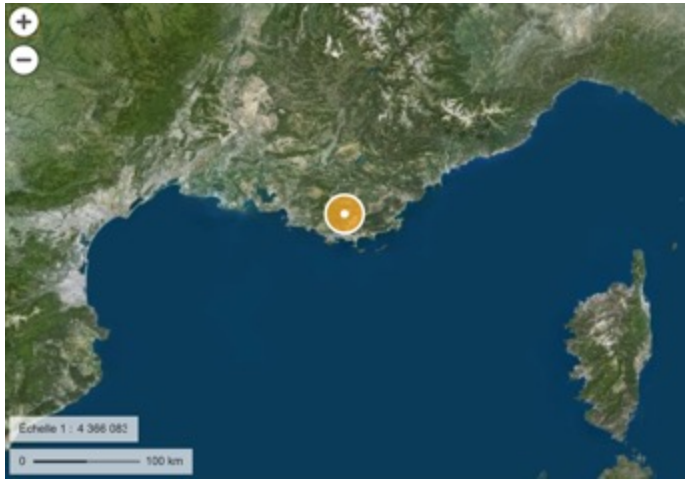
The electrical conductivity of fresh water depends on what it contains: which ions and in what quantity

Seawater is good conductive

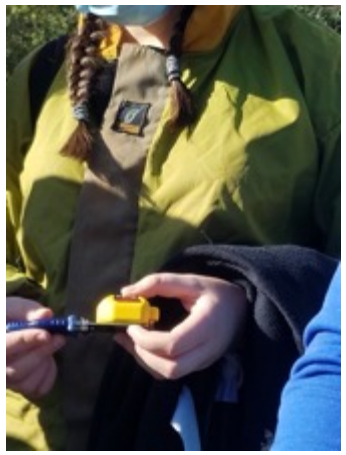
Using the Electrical conductivity to understand water paths

Case study :

The regaï de Néoules cave (France)



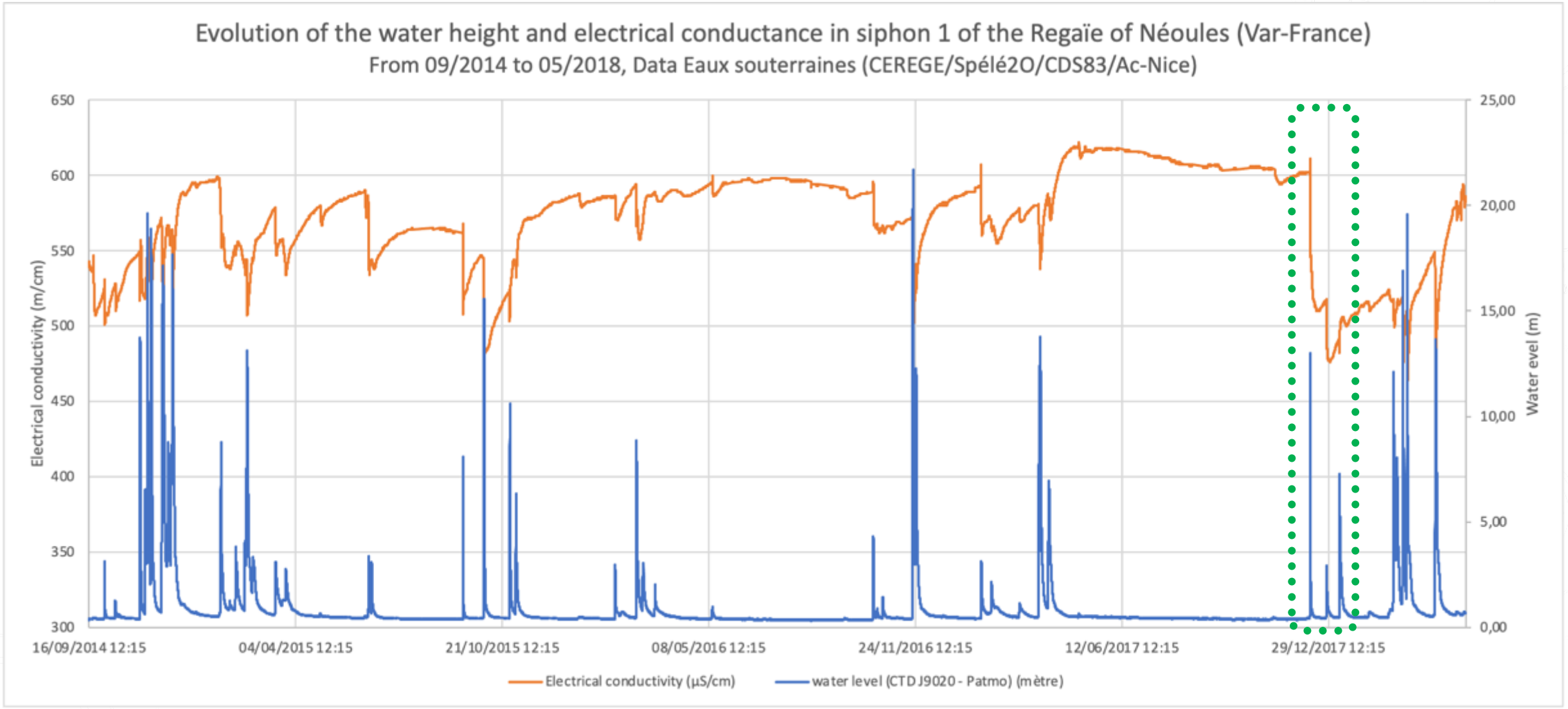
EAUX SOUTERRAINES



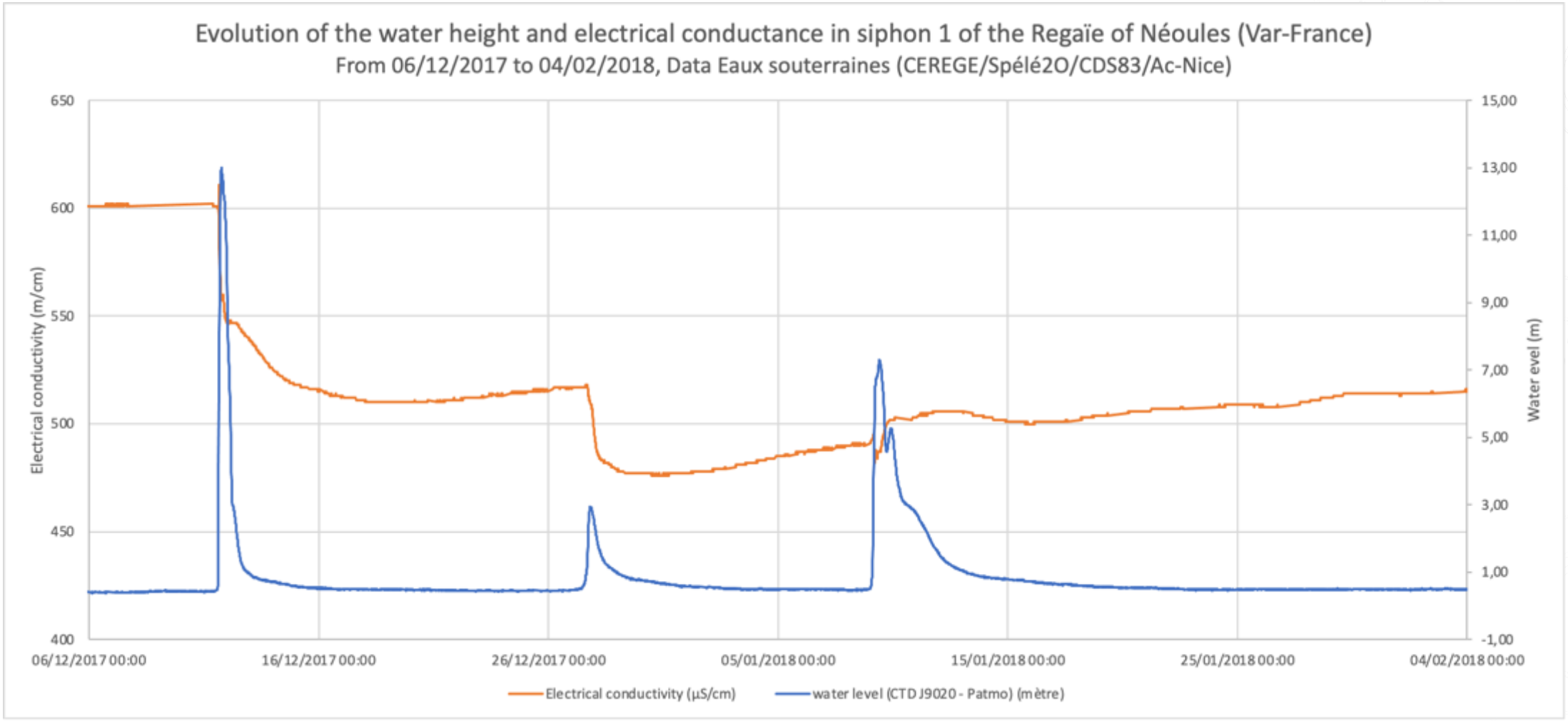
Fieldworking : pupils program and install the probe in the karst groundwater

Pictures : F. Mourau (2019-2021)

Using the Electrical conductivity to understand water paths



Using the Electrical conductivity to understand water paths



Each increase in water level is accompanied by a decrease in electrical conductivity:
this is rainwater entering the groundwater !

Validation du prototype sur le terrain et dans le cadre de notre projet ERASMUS+ :

GROUNDWATER : LEARN TO PRESERVE THE EUROPEAN UNDERGROUND ENVIRONMENT

density difference

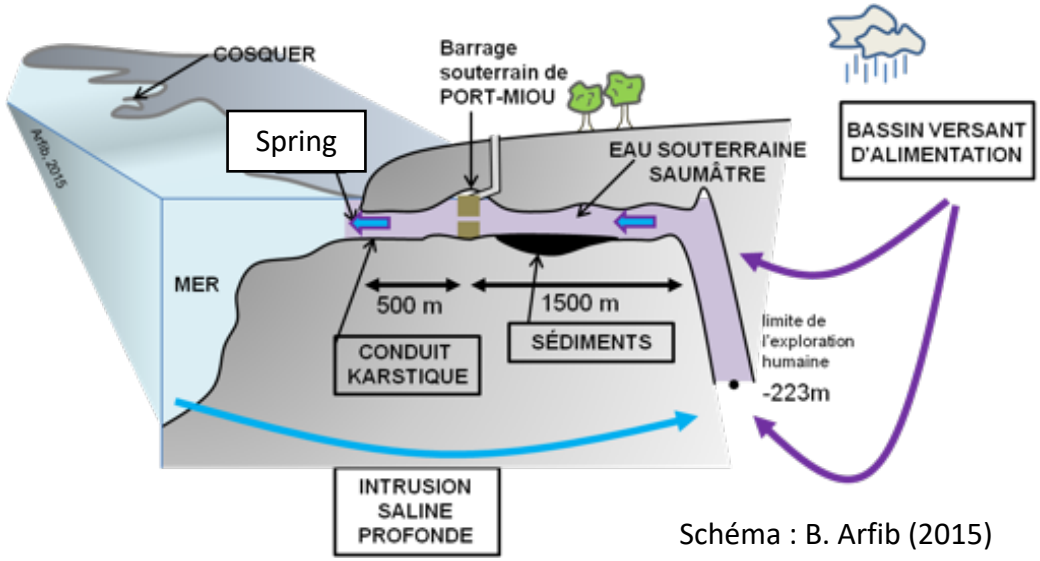


Schéma : B. Arfib (2015)

L'esprit Sourcier

En route pour Cassis
et ses sources sous-marines

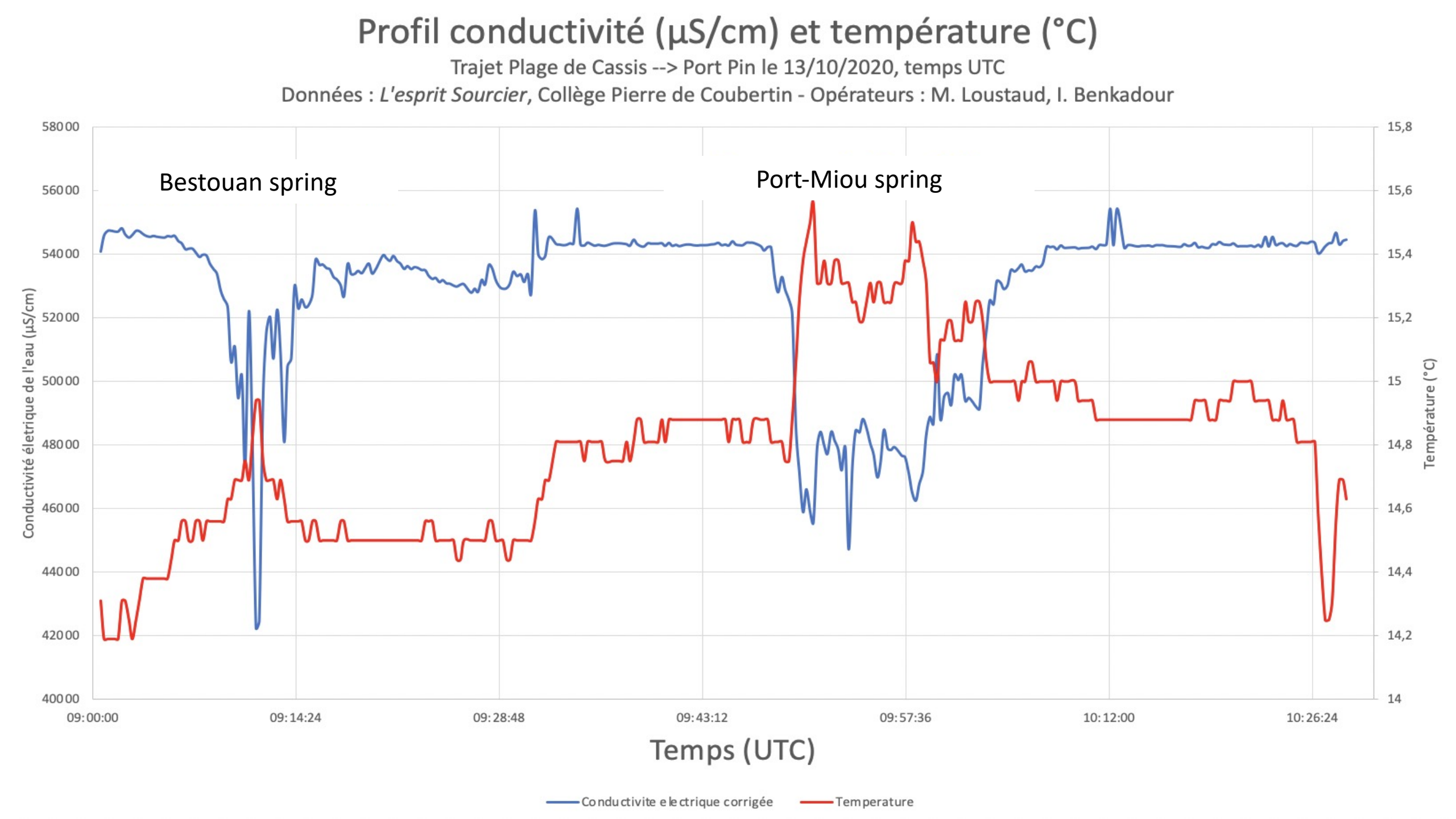
At sea : We paddle...

À terre :

On identifie les roches, les failles, les chemins de l'eau (SVT)

(And it does its measurements...)

Photo : En mer, test du flotteur le mardi 13 octobre 2020


Profil conductivité (µS/cm) et température (°C)
Trajet Plage de Cassis --> Port Pin le 13/10/2020, temps UTC
Données : L'esprit Sourcier, Collège Pierre de Coubertin - Opérateurs : M. Loustaud, I. Benkadour
Bestouan spring
Port-Miou spring
Conductivité électrique de l'eau (µS/cm)
Température (°C)
58000
56000
54000
52000
50000
48000
46000
44000
42000
40000
15,8
15,6
15,4
15,2
15
14,8
14,6
14,4
14,2
14
09:00:00
09:14:24
09:28:48
09:43:12
09:57:36
10:12:00
10:26:24
Temps (UTC)
Conductivite electrique corrigée
Temperature

Pique-nique :
plage de Port-Pin

Source de
Bestouan

Source de
Port-Miou

Départ/arrivée

1 point = 1 mesure

Pas d'échantillonnage :
15 secondes

La couleur du point représente la conductivité électrique de l'eau

45 mS/cm

55 mS/cm

Analyse des données 2 : Arcgis online

Now, you know :

- How to measure water level with yours students
- That the underground controls part of the water transfer to the rivers
- How to measure the flow rate and using water velocity
- how to use electrical conductivity to identify rainwater

You're ready for

EGU GIFT WORKSHOP

European Geosciences Union

Wednesday 23th April 2021 11:00 AM

PART 2 : INTENSE MEDITERRANEAN RAIN

HYDROGEOLOGY AT SCHOOL