



PRELIMINARY ASSESSMENT OF SEDIMENT TRANSPORT AND ASSOCIATED BACTERIOLOGICAL CONTAMINATION IN A MOUNTAINOUS RURAL KARST AREA (SIERRA DE UBRIQUE, S SPAIN)

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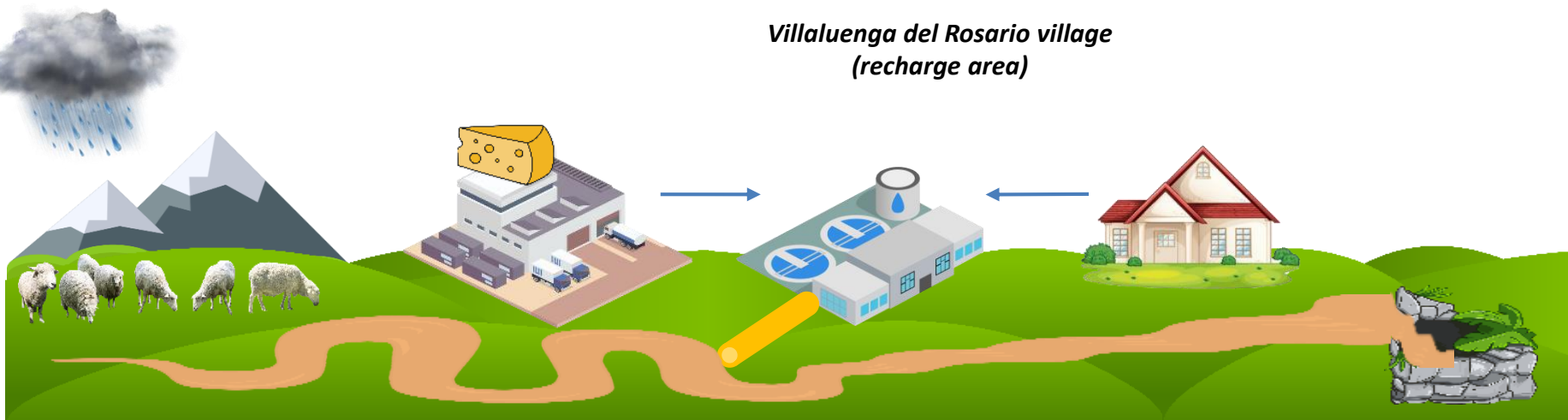


Results and discussion

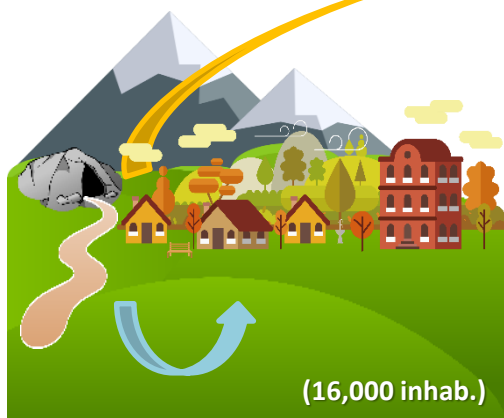


Conclusion and future perspectives

Water quality issues



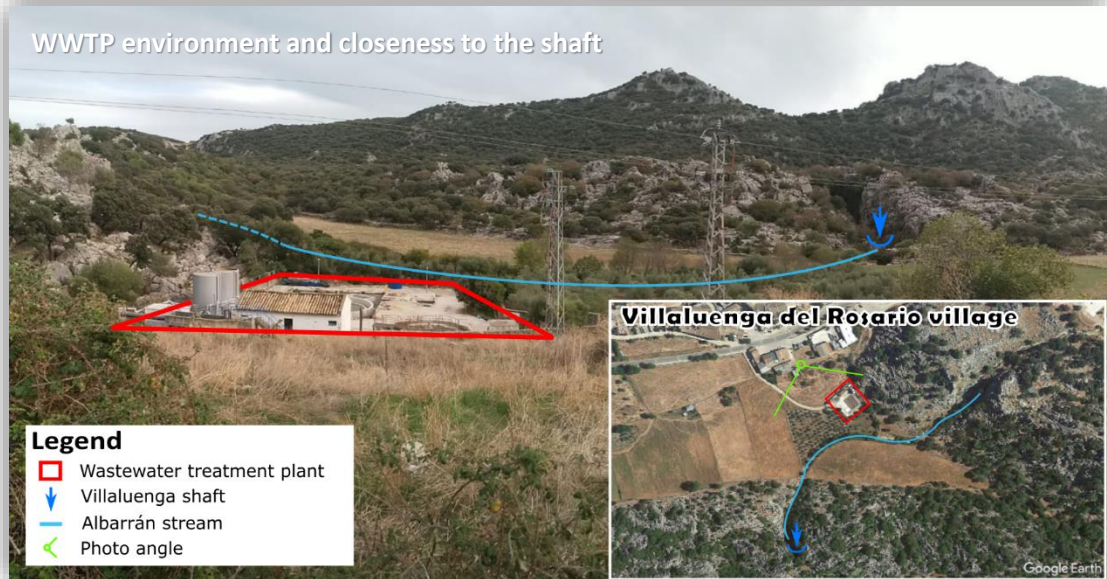
Ubrique town (discharge area)



Spanish regulation for drinking water RD140/2003

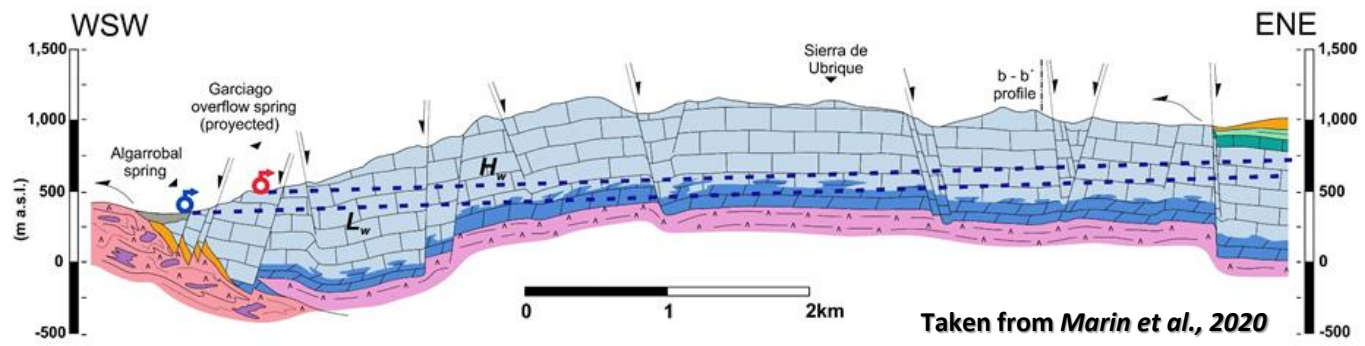
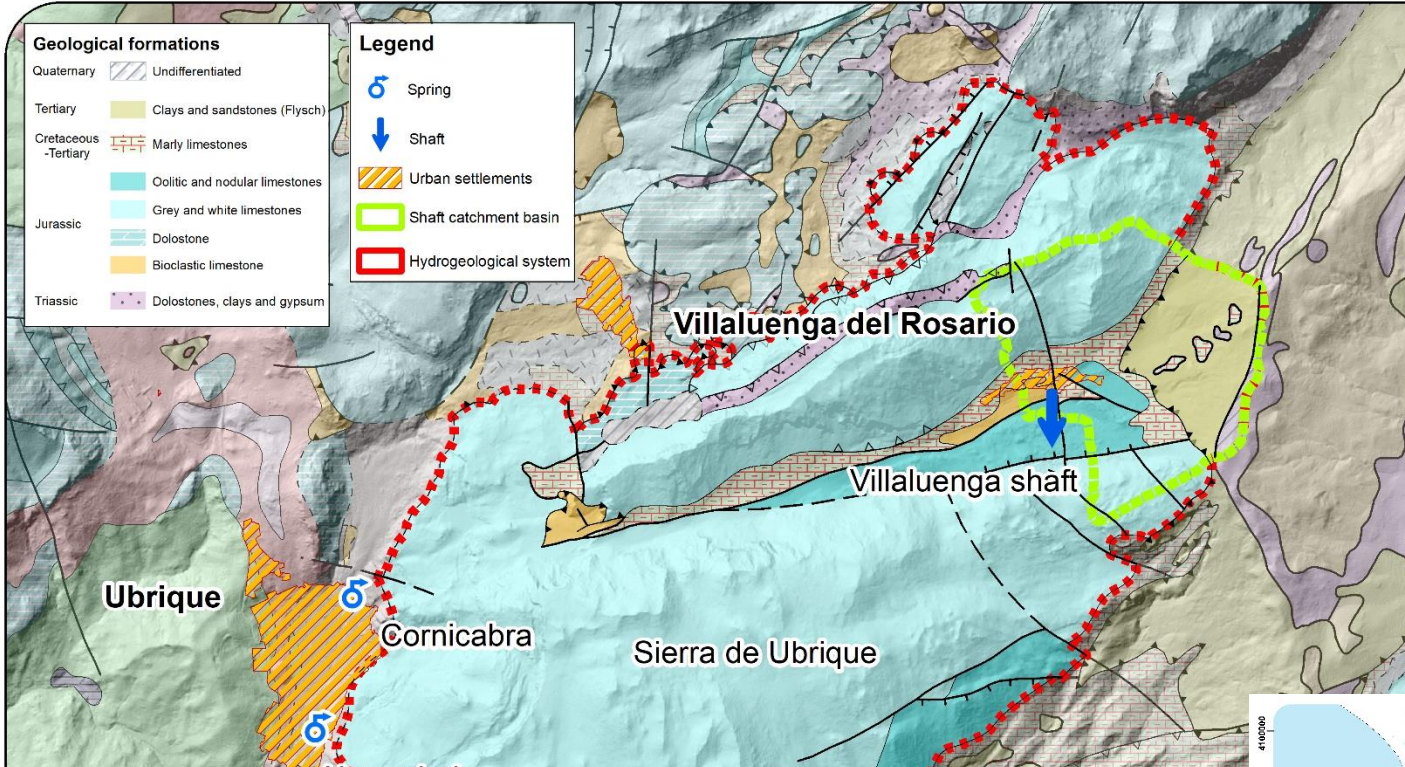
Parameter	Max. Value
Turbidity	5 NTU
pH	6.5-9.5
Escherichia coli	0 CFU/100 ml
B	1mg/l
Cl ⁻	250 mg/l
Ni	20 µg/l
NO ₃ ⁻	50 mg/l
Al	200 µg/l

Main pressures to karst groundwater

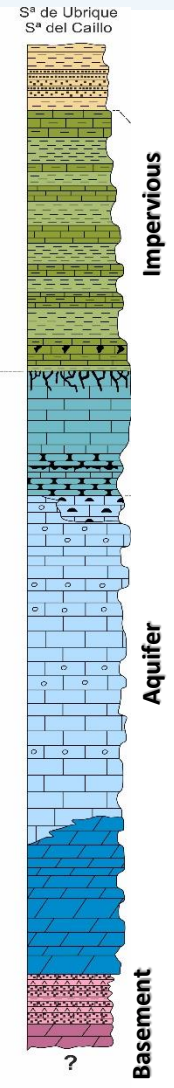


Main goals

- to **identify** and **characterize** the main **contamination sources**
- to **understand** the role of **sediment transport** in the occurrence of polluted groundwater episodes



Escala (m)	Edad	Grupo	Formación
800	TERCIARIO		
	CRETÁCICO	Turon. Senoniense	Capas Rojas
			C. Blancas
	700	JURÁSICO	Malm
Libar			F. Endrinal
Lias		Doi. Jarastejar	
		Capas Lifa	
600	TRIÁSICO	Superior	Doi. Lirio
		Med.	C.P. Verde
			Form. Meleguet.
500			
400			
300			
200			
100			
50			
0			



Taken from *Martin-Rodriguez, 2021*

Cornicabra spring



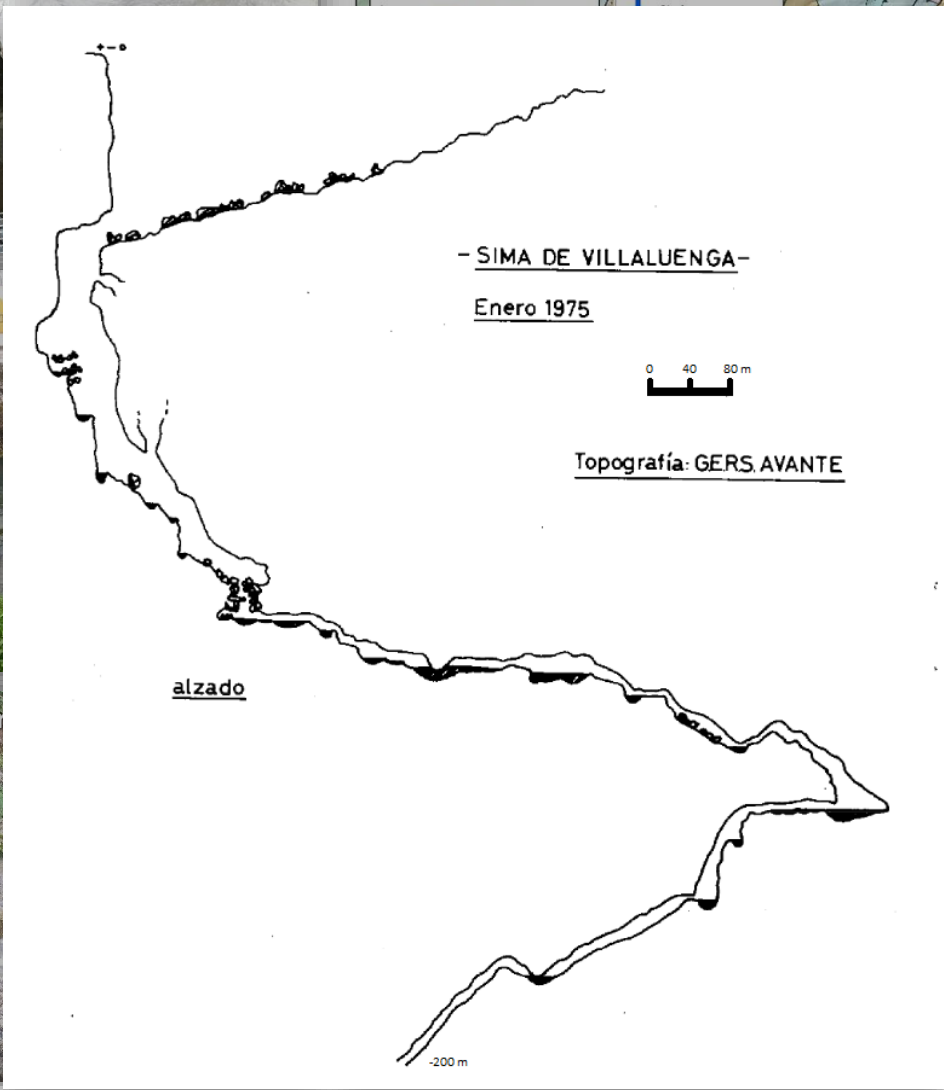
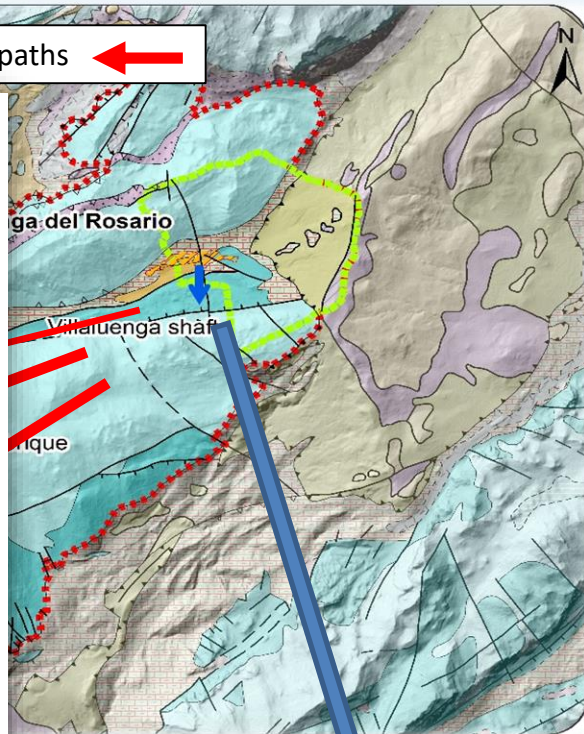
Algarrobal spring



Garcíago spring (over)



Main flowpaths ←



Monitoring network

Preliminary assessment of sediment transport and associated bacteriological contamination in a mountainous rural karst area (Sierra de Ubrique, S Spain)



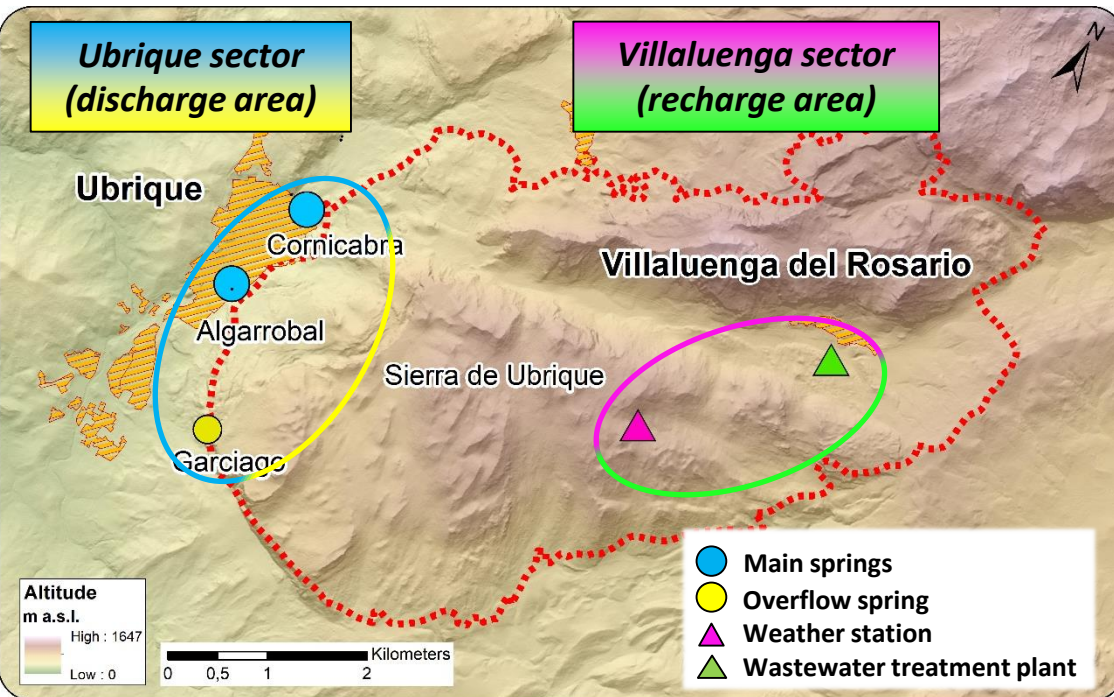
GGUN probe setting at Algarrobal spring



GGUN and autosampler at Cornicabra spring



Weather station at Sierra de Ubrique



Water level logger setting at Villaluenga shaft



WWTP effluent sampling

Field and laboratory equipment

Preliminary assessment of sediment transport and associated bacteriological contamination in a mountainous rural karst area (Sierra de Ubrique, S Spain)



Total Organic Carbon
Shimadzu mod. TOC-VCSN + TNM-1



Turbidity and TLF
GGUN fluorometer- Albillia



Trace metals – ICP-MS
Thermo Scientific ICAP- RQ



Weather parameters
Davis Weather Station



Total coliforms – MPN method
IDEXX Colisure



GW samples
Autosampler- ISCO 3700

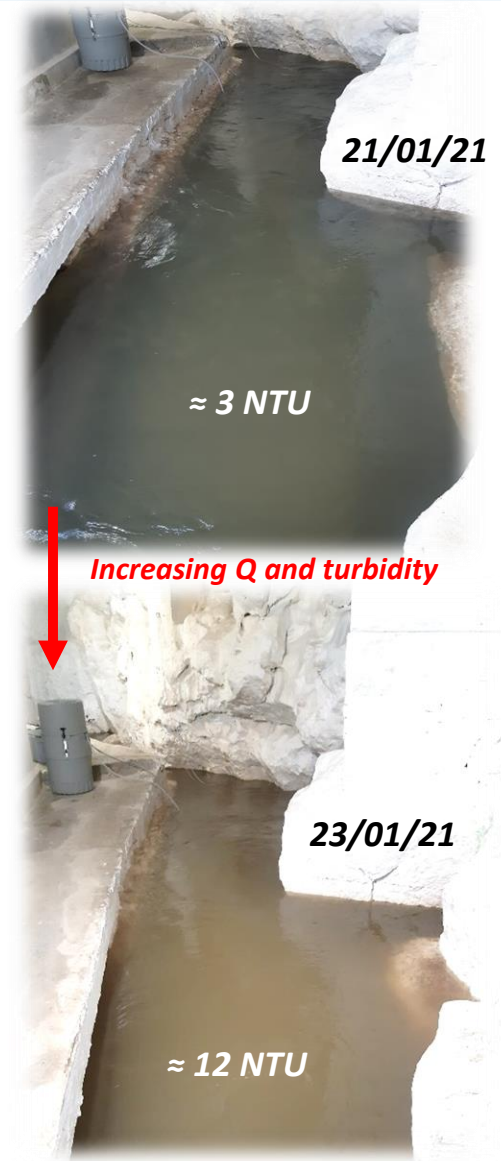
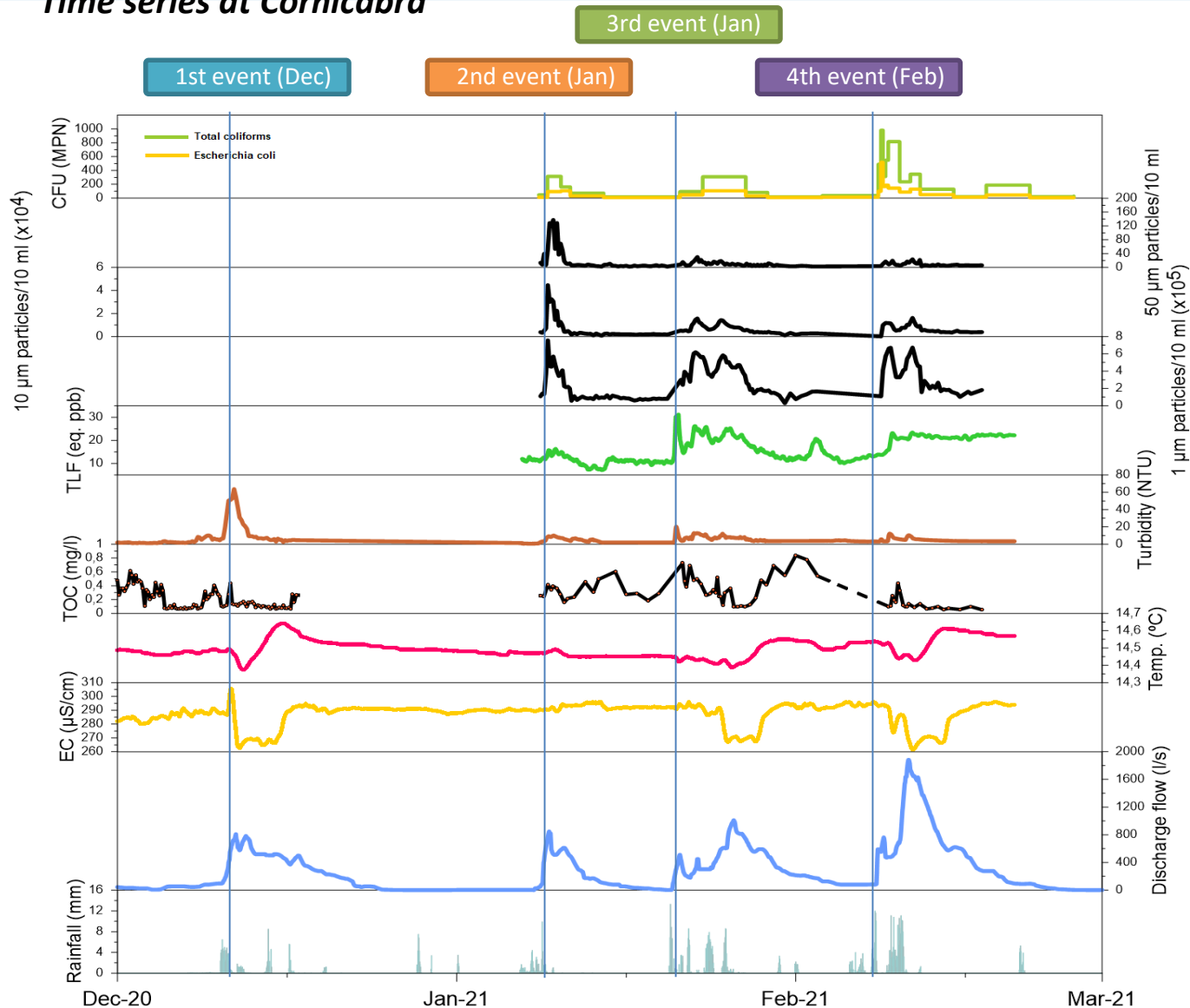


Water level
Odyssey data
logger

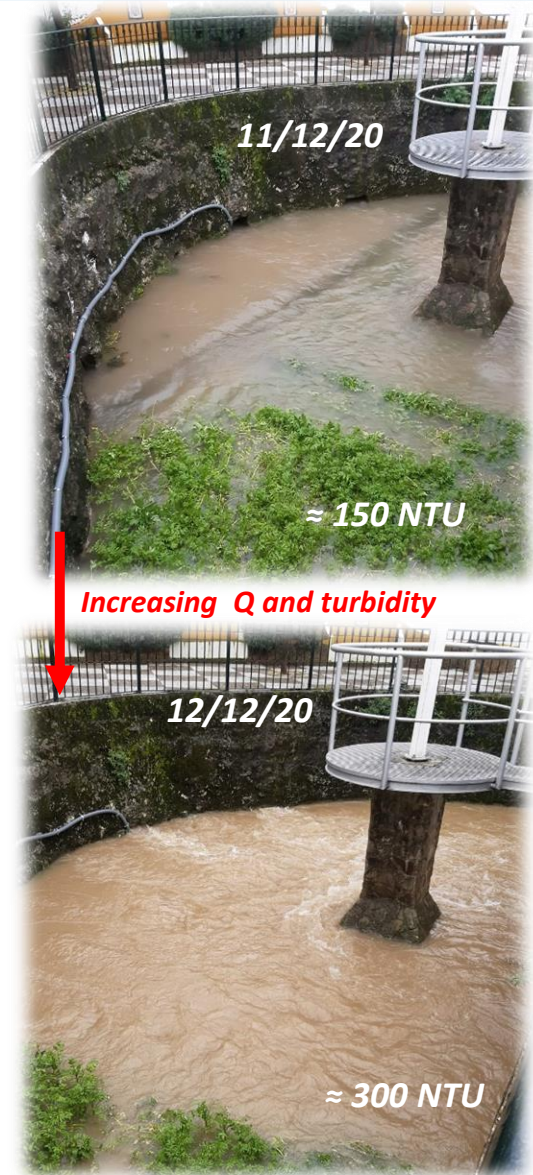
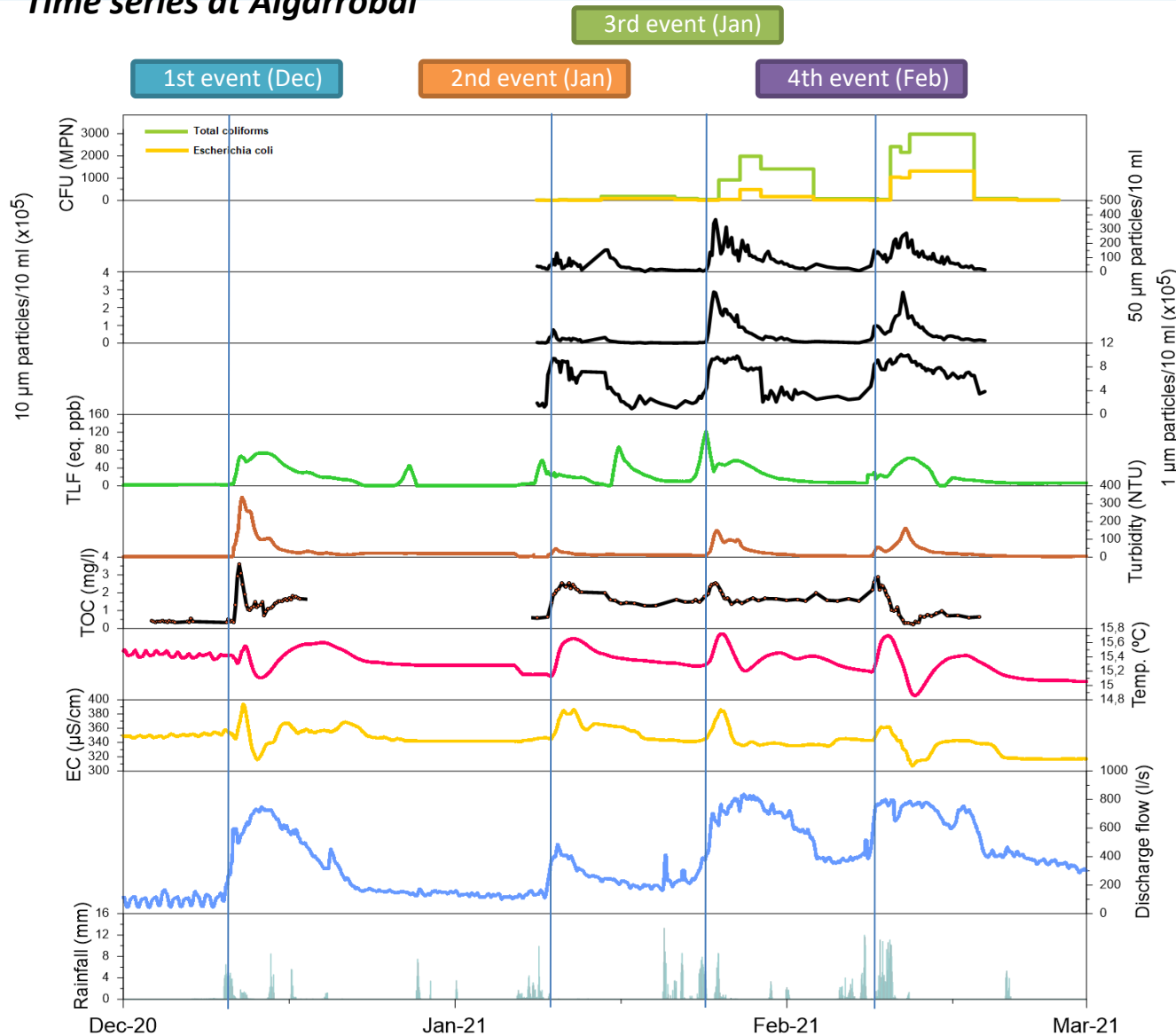


Particle size
distribution
Klotz - PCS
fluid lite

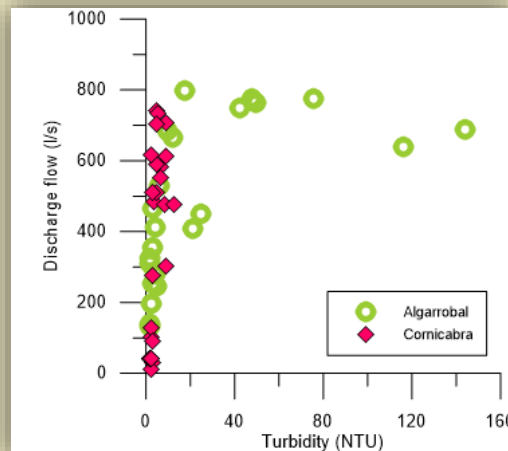
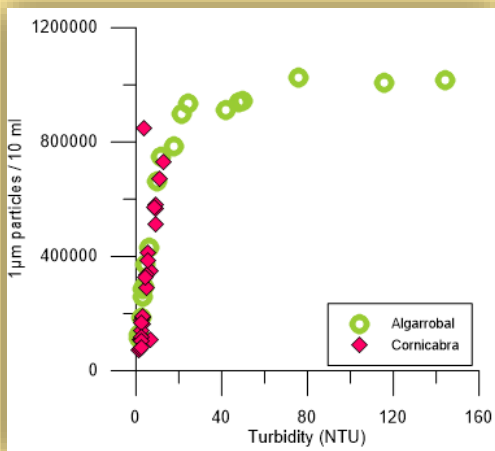
Time series at Cornicabra



Time series at Algarrobal

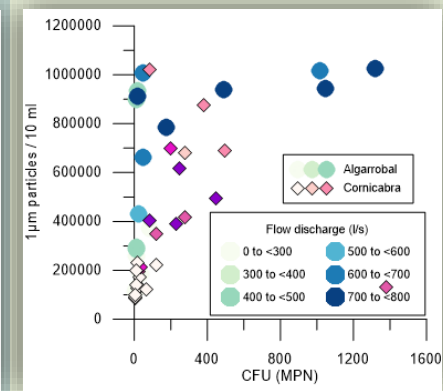
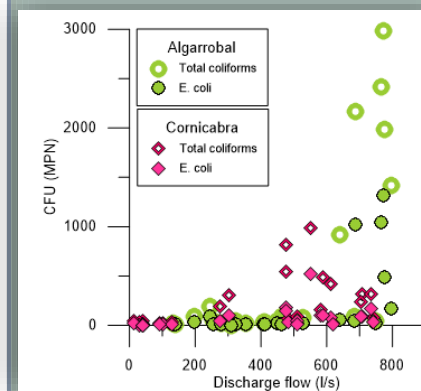
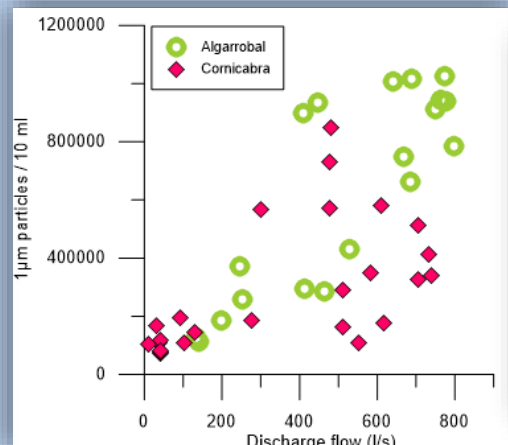
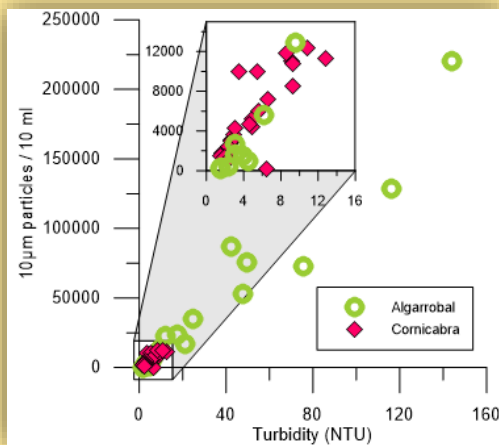
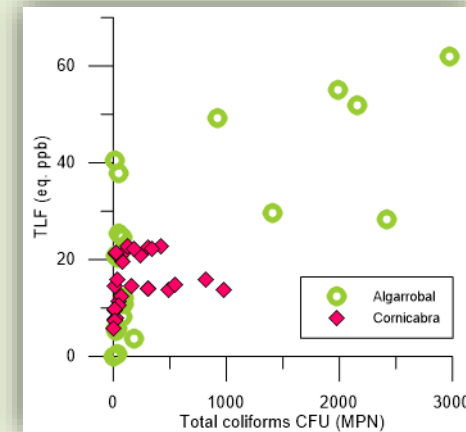


Biplot analysis of contamination related parameters



Coliforms

- Good correlation between TLF and bacterial load at Aljarrobal
- The highest bacterial load is usually registered during high Flow conditions (>500 l/s) at both springs



Turbidity

- Over 40 NTU at Aljarrobal, not related to small particles (turbidity increased because of large particles/bacterial flocculum)
- Constant increase at Cornicabra but triggered at Aljarrobal over ≈600 l/s

Discharge flow

- Direct relationship between small particles presence and discharge flow
- High discharge flow favours sediment transport, specially fine particles (coloidal), so that the presence of bacteria is also enhanced

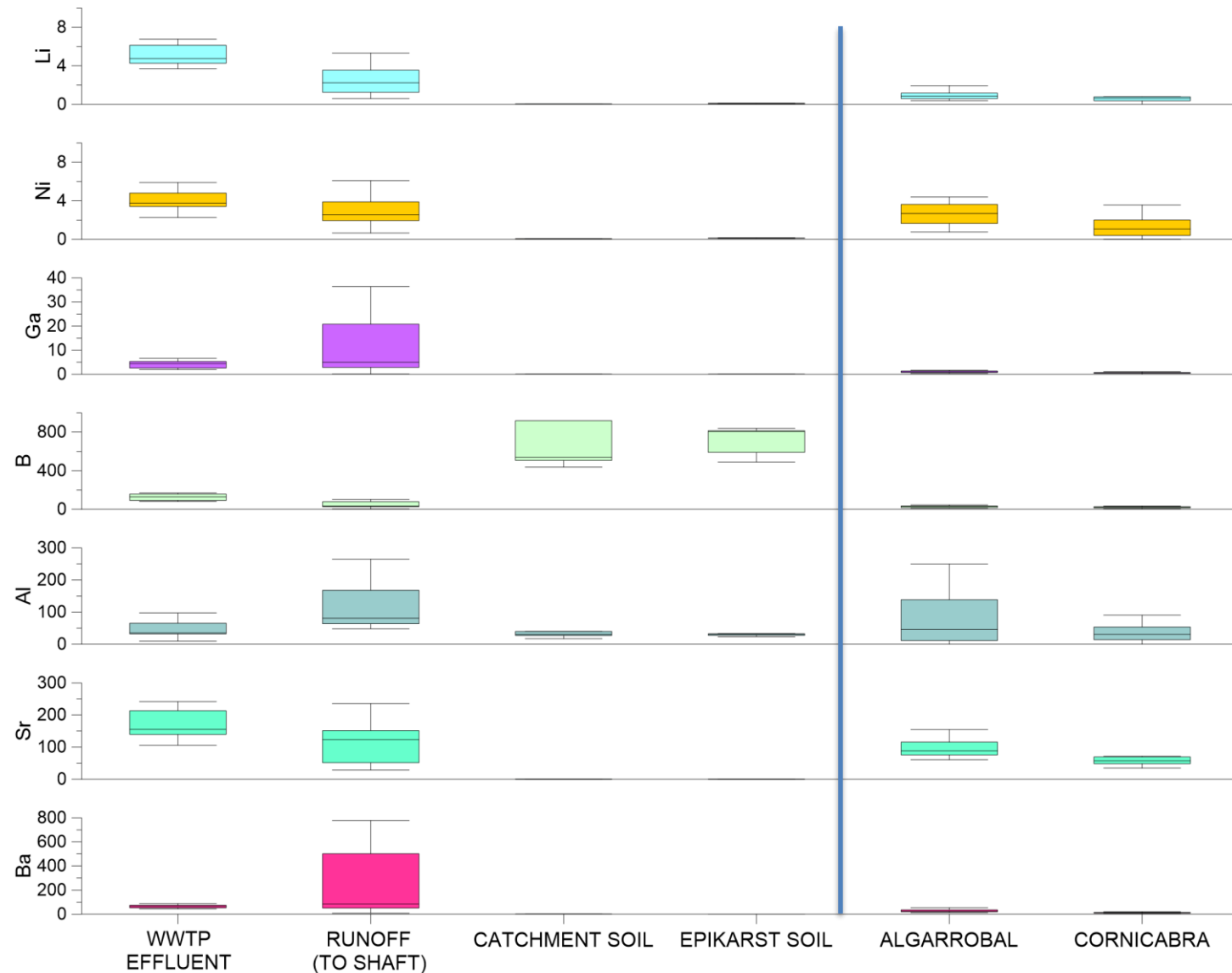
Trace elements spatial distribution and concentration

Origin

- B (Soil)
- Al – Ga – Ba (Catchment soil)
- Li – Ni – Sr (WWTP)

Springs

- Little attenuation of Ni and Al

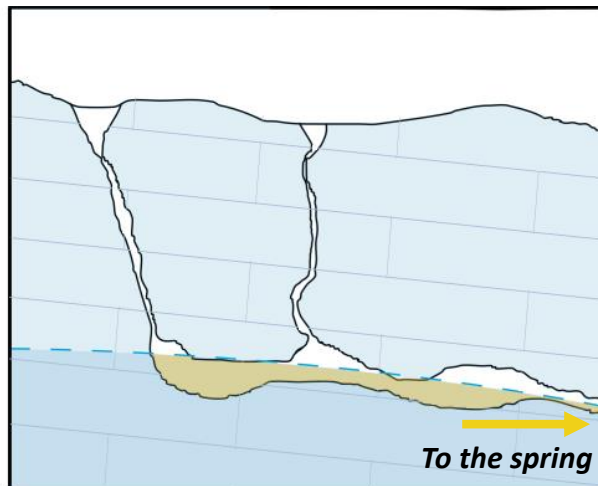
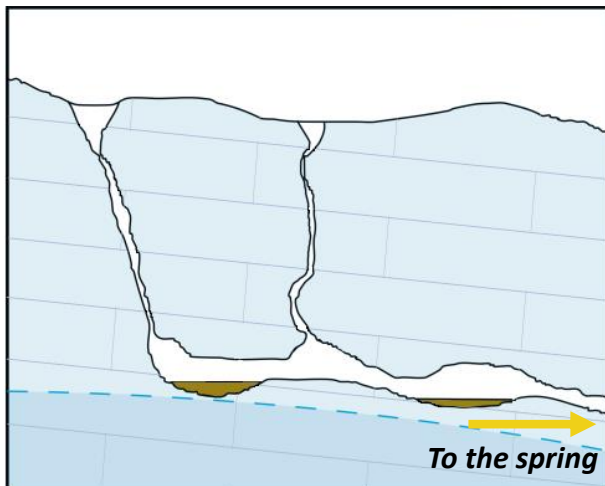


Sediment transport conceptual model

1st flooding event

Following flooding events

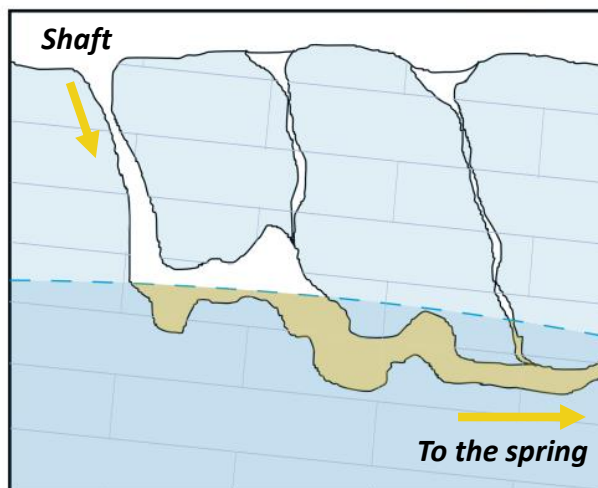
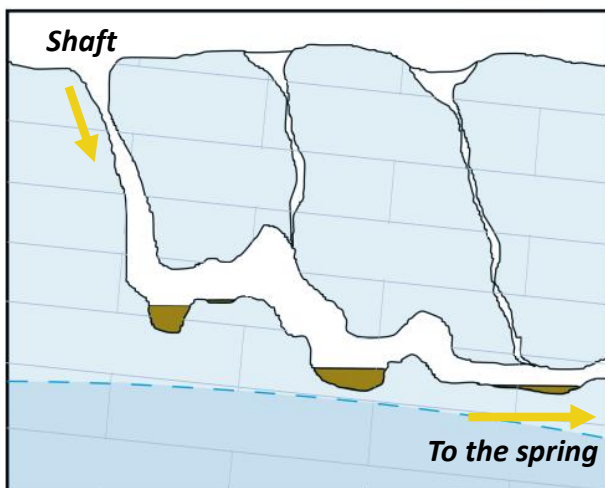
Cornicabra



1st flooding event

- Pre-event conditions: low water level
- Storm pulse mechanism
- Highest turbidity peak record
≈350 NTU at Algarrobal
≈60 NTU at Cornicabra
- Sediment remobilization from siphons and conduits
- Highest TOC record at Algarrobal

Algarrobal



Following flooding events

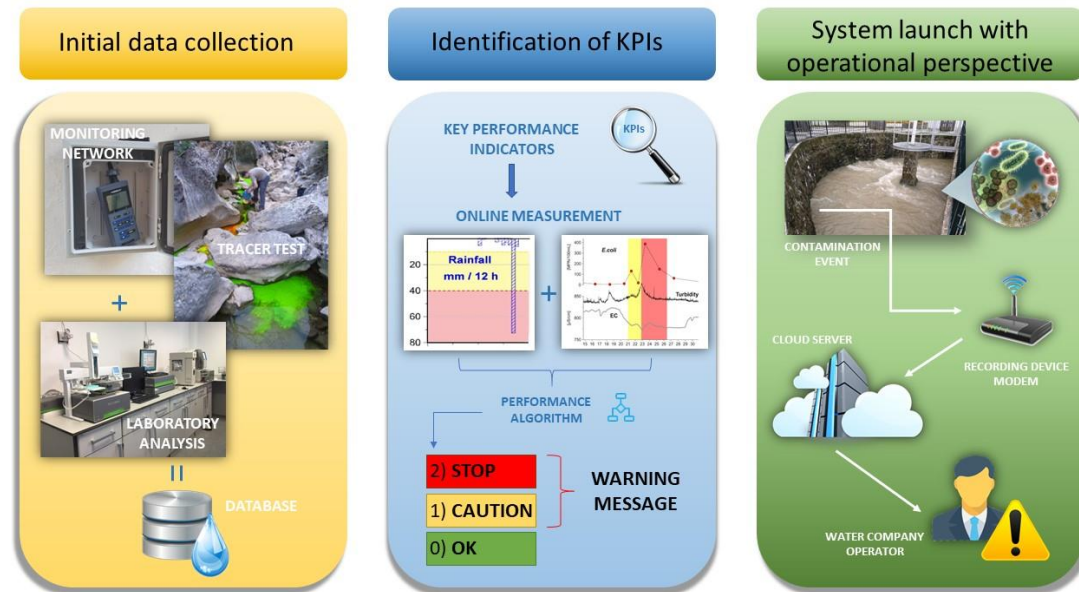
- Pre-event conditions: variable water level (intermediate)
- Transient flow mechanism
- Smooth turbidity peaks record
≈100-200 NTU at Algarrobal
≈10-20 NTU at Cornicabra
- Sediment from recent infiltration (shaft/dolines)
- Highest TOC records at Cornicabra

Conclusions

- The main contamination sources or pressures have been identified and the potential contaminants have been characterized regarding concentration and occurrence at the springs.
- However, different origins can be related to the same contaminant (E. coli: livestock feces or wastewater treatment plant).
- Fine or colloidal particles show the highest correlation to bacterial load during high water conditions (>600 l/s)
- The particular features of Algarrobal (higher karstification and shaft direct connection) favor sediment transport, which clearly enhances contaminant load.
- Novel monitoring methods like TLF show a good correlation to bacterial load at both springs, specially at Algarrobal.

Future perspectives (EWS)

- These contamination events hinder the total groundwater exploitation for Ubrique town drinking water supply.
- The acquired database and monitoring network set the essential knowledge to understand contaminant transport.
- The implementation of an **Early Warning System** would help to optimize groundwater catchment operations.



Taken from Marin et al., 2020



Karlsruhe Institute of Technology (KIT) - Germany



Federal Institute for Geosciences and Natural Resources (BGR) - Germany



University of Malaga (UMA) - Spain



University of Montpellier (UM) - France



Sapienza University of Rome (URO) - Italy



American University of Beirut (AUB) - Lebanon



National Engineering School of TUNIS (ENIT) - Tunisia



Partnership for Research and Innovation in the Mediterranean Area (PRIMA)



Federal Ministry of Education and Research (BMBWF) - Germany



Ministry of Economy, Industry and Competitiveness – through the State Research Agency - Spain



Agence Nationale de la Recherche (ANR) - France



MIUR – Ministry of Education, University and Research - Italy



National Council for Scientific Research - Lebanon (CNRS-L) - Lebanon



Ministry of Higher Education and Scientific Research (ANPR) - Tunisia

Thanks for your attention

