

Using stable isotopes and multi-spatial variable parameters in characterising the karstic aquifer of the Ajloun area, NW-Jordan - A case study of the Tanour and Rasoun springs

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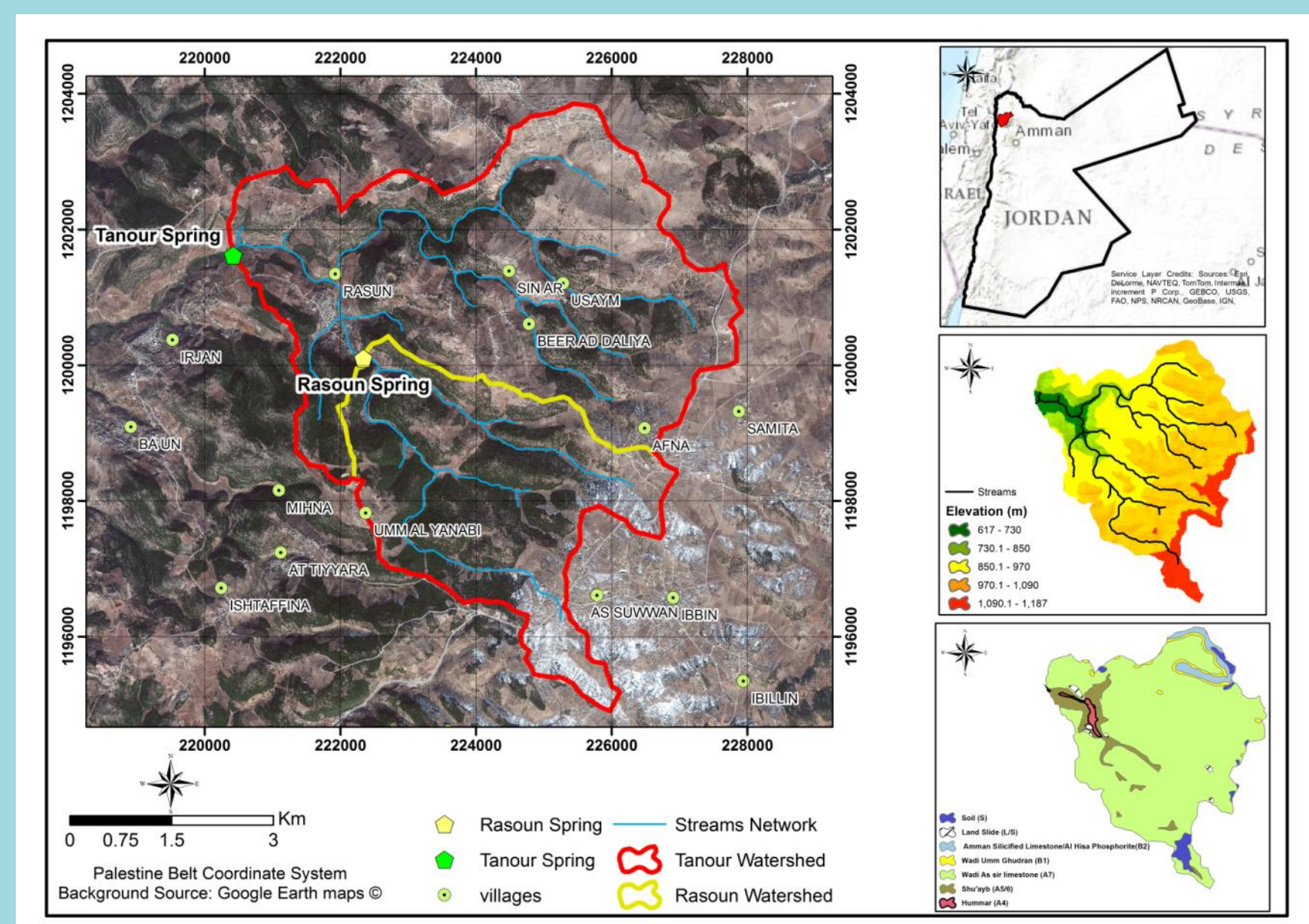
1. Introduction

Water resources are extremely scarce in Jordan. Jordan is considered as one of the 4th poorest countries in the world with respect to water resources [1]. More than 90% of the country areas receives rainfall less than 200 mm/year [2]. The available water resources per capita is very low approximately 150 m³/capita/year compared to the international standards of 500 m³/capita/year [3].

The study area is locating in Ajloun governorate, about 75 kilometers northwest of the city of Amman. Tanour and Rasoun karst springs has been selected for this study, where they consider as the main local domestic water supply in the study area. The average discharge for Tanour spring is around 200 m³/h between the years 2000 and 2012, while in Rasoun is around 60 m³/h for the same time period [4]. The mean pumping rate from Tanour and Rasoun springs for the years 2000 - 2012 was 1,100,000 m³ and 110,000 m³ respectively [5].

Jordan is a country with a large area of limestone, where much of the groundwater abstracted for different uses in Jordan is stored in limestone. The level of karstification can be considered as moderate to low. As a result, the understanding of the karst aquifers system and the water pathways and movement within the epikarst and the unsaturated zone and then estimating its residence time within the aquifer is very important factors in order to managing and evaluating the risk from the pollutants which can reach and affect the groundwater.

During the last years the water supply from these two springs had to be interrupted, sometimes for a period of several weeks due to high contamination of the groundwater. This contamination sources in Tanour and Rasoun springs mainly is: microbiological contamination and contamination from the Zeebar (local name for industrial olive presses wastewater).



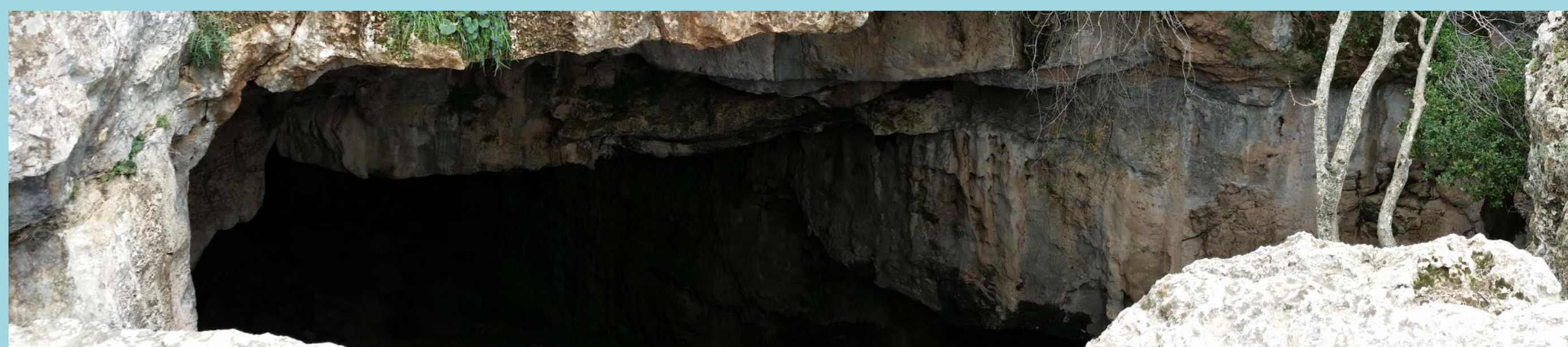
Location of the study area, Topography and Geology.



Polluted water in Tanour spring from the olive presses wastewater.



Panorama view for part of the study area representing the geomorphology for the study area.



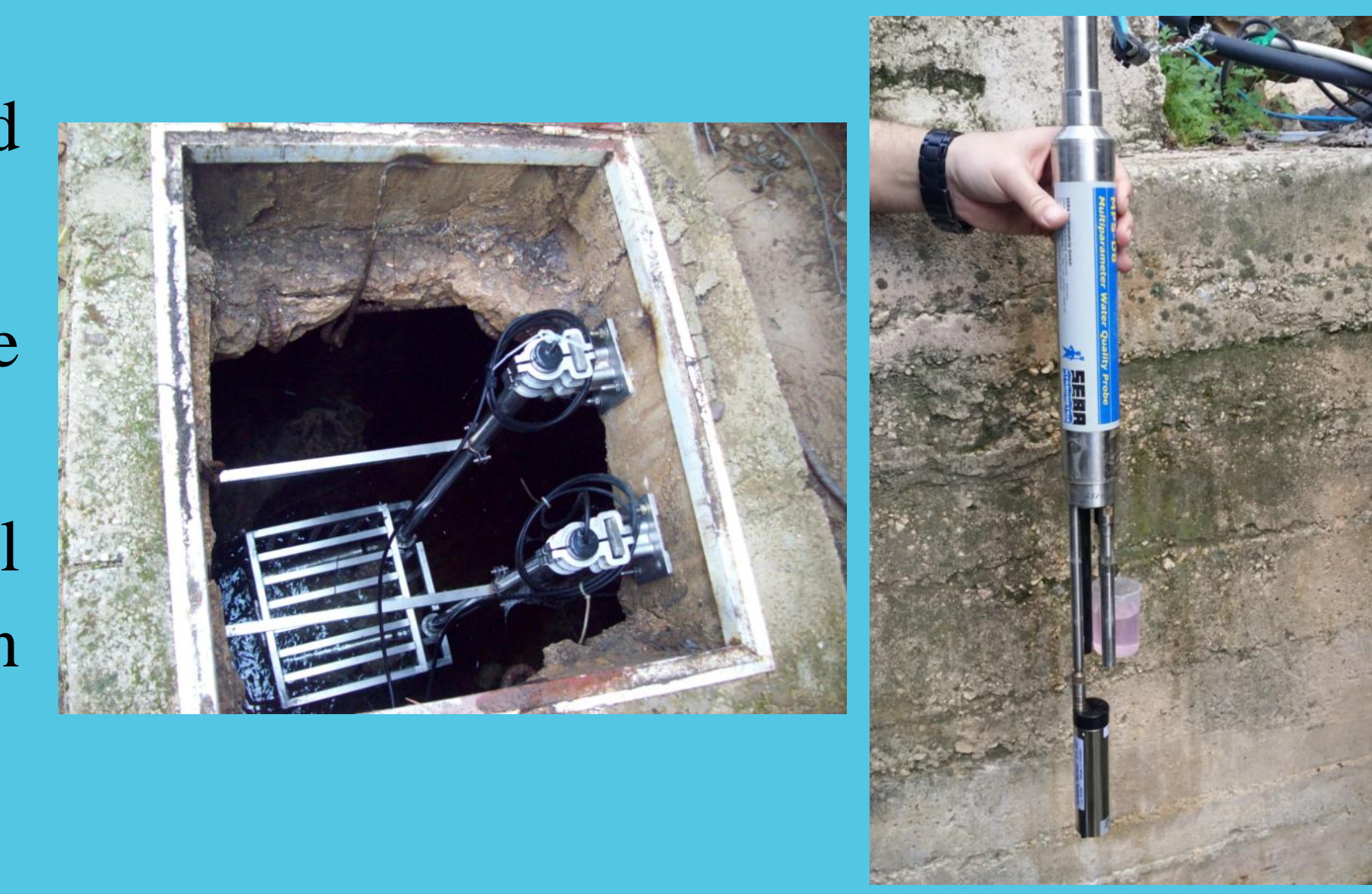
One of the big caves within the study area.

2. Aims and Methods

This study aims in general to: (1) Studying and characterizing the karst aquifer system within the study area by using different methods, and monitoring different hydrogeological parameters in the springs, and (2) Developing a process oriented method for vulnerability assessment in the semi arid areas based on determining spatially variables for travel time.

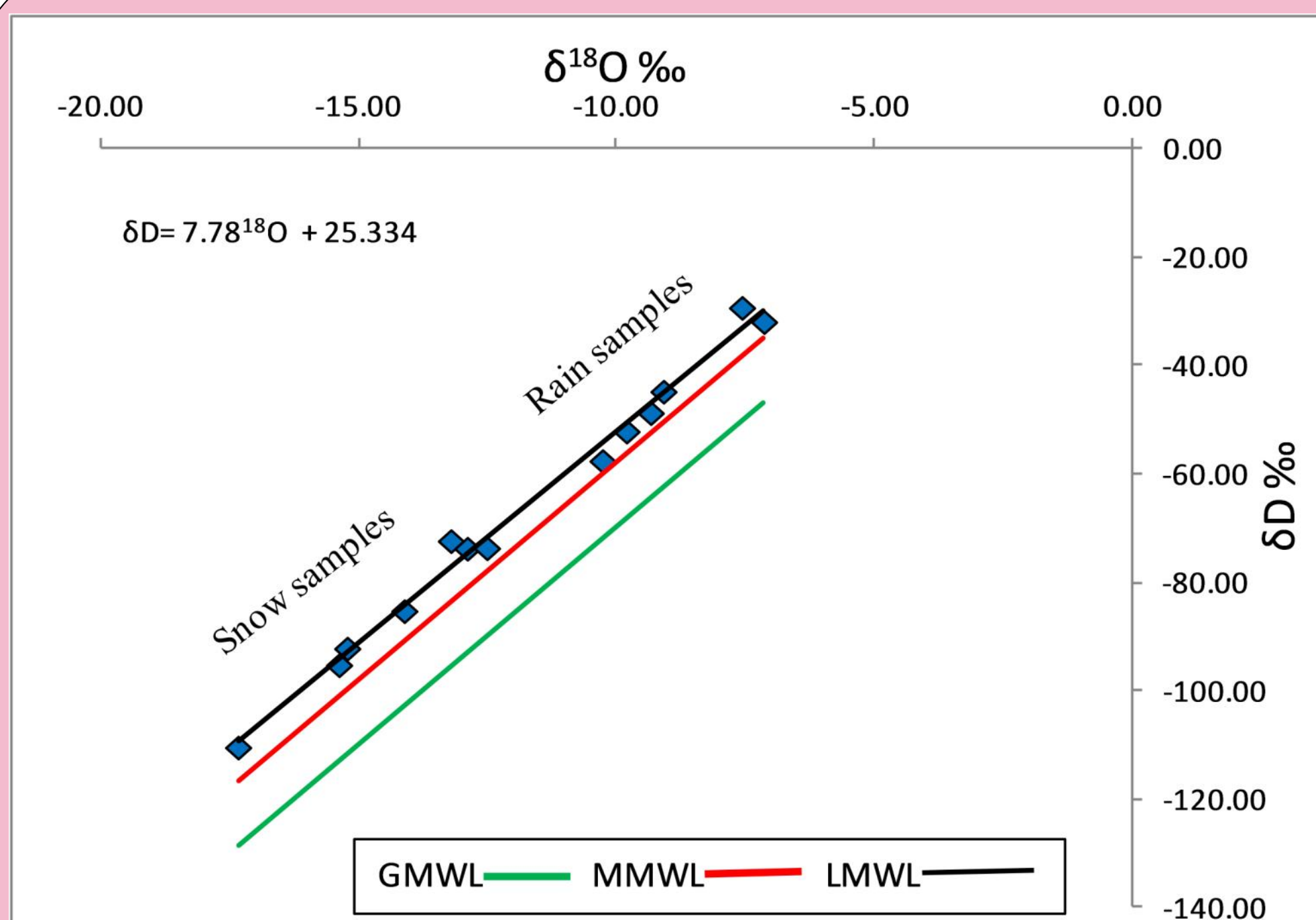
In order to achieve these aims, following procedures and methods will be applied:

1. Determining spatially variables for travel time by obtaining characteristic signatures from field measurements. In order to that, regular online telemetry measurements for different parameters from Tanour and Rasoun springs will be received.
2. Collecting spring water samples during the winter season in order to analyze the major ions and stable isotopes of oxygen and hydrogen.
3. Collecting rainwater samples from different location differs in elevation in order characterizing the origin of the rainfall.
4. Applying travel time vulnerability method (by using ArcGIS) in order to determine the water travel time from each pixel within the catchment towards the streams (as a final infiltration point) based on the lateral flow within epikarst zone.
5. Applying different intrinsic vulnerability methods against pollution specially for the karst areas.

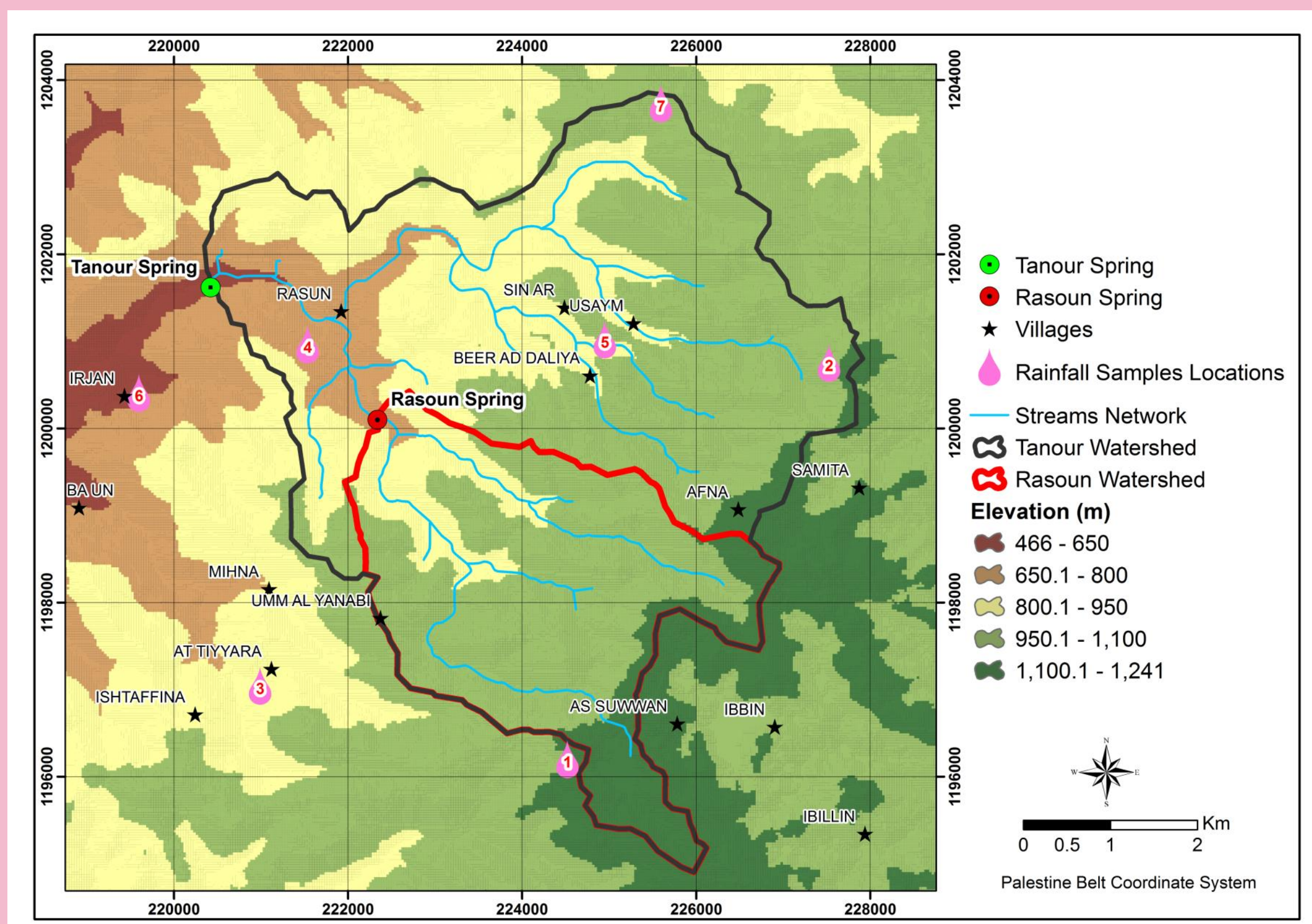


Online telemetry instruments which has been installed in Tanour Spring.

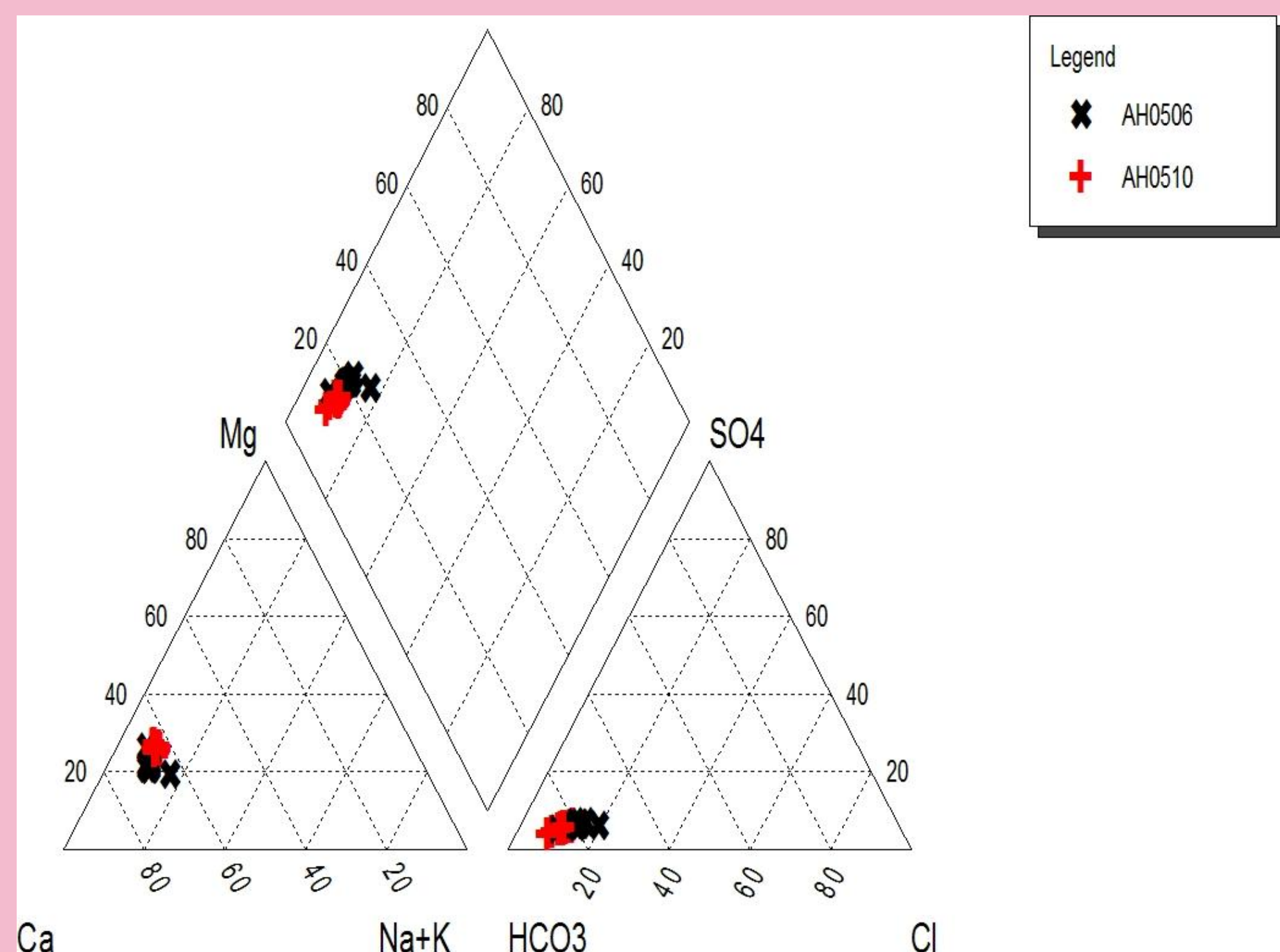
3. Results



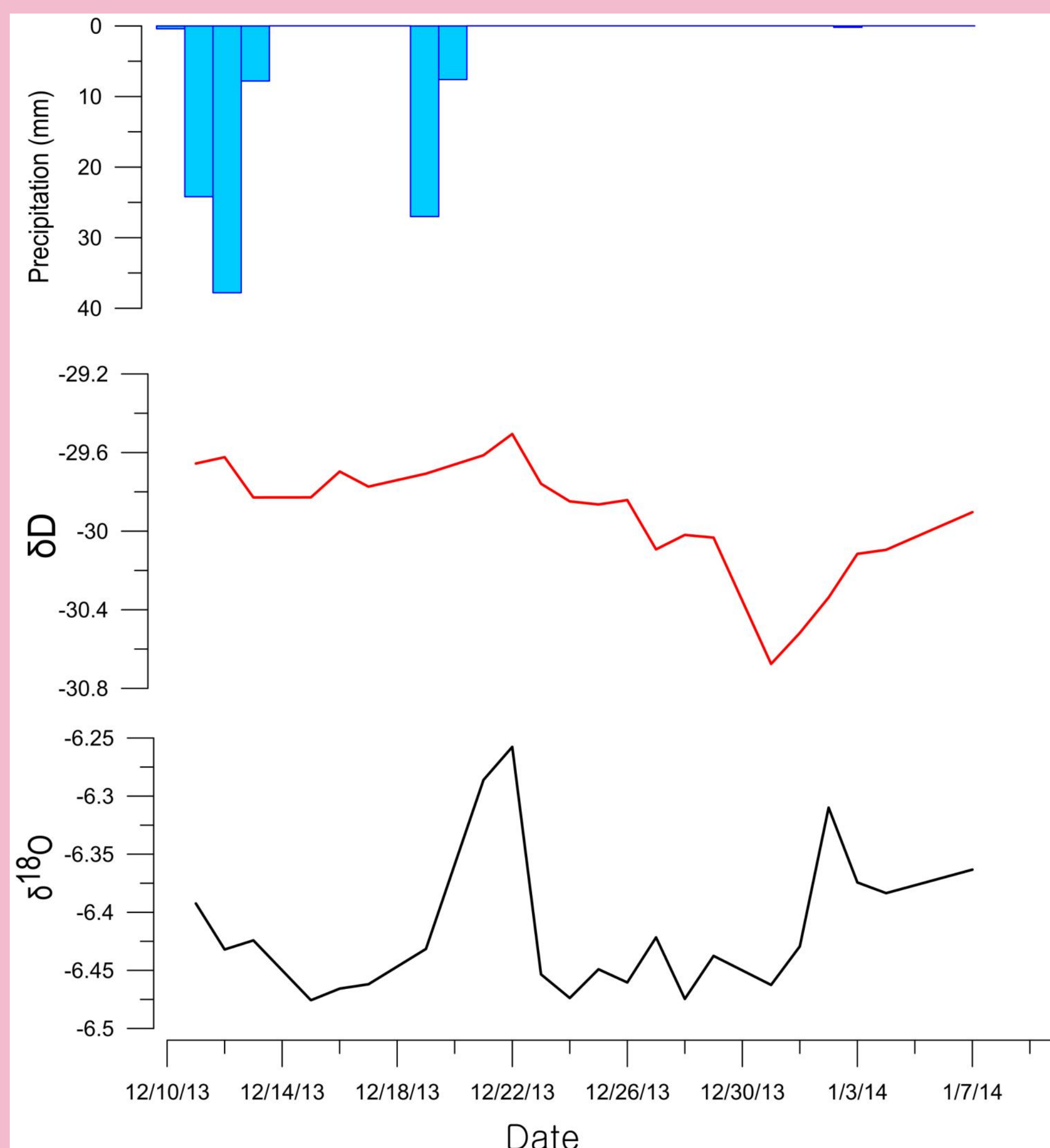
Rain and snow water samples deviation from the Global Meteoric Water Line (GMWL) and the Mediterranean Meteoric Water Line (MMWL). The Local Meteoric Water Line (LMWL) for the study area calculated as: ($\delta D = 7.78 * \delta^{18}O + 25.33$ ‰).



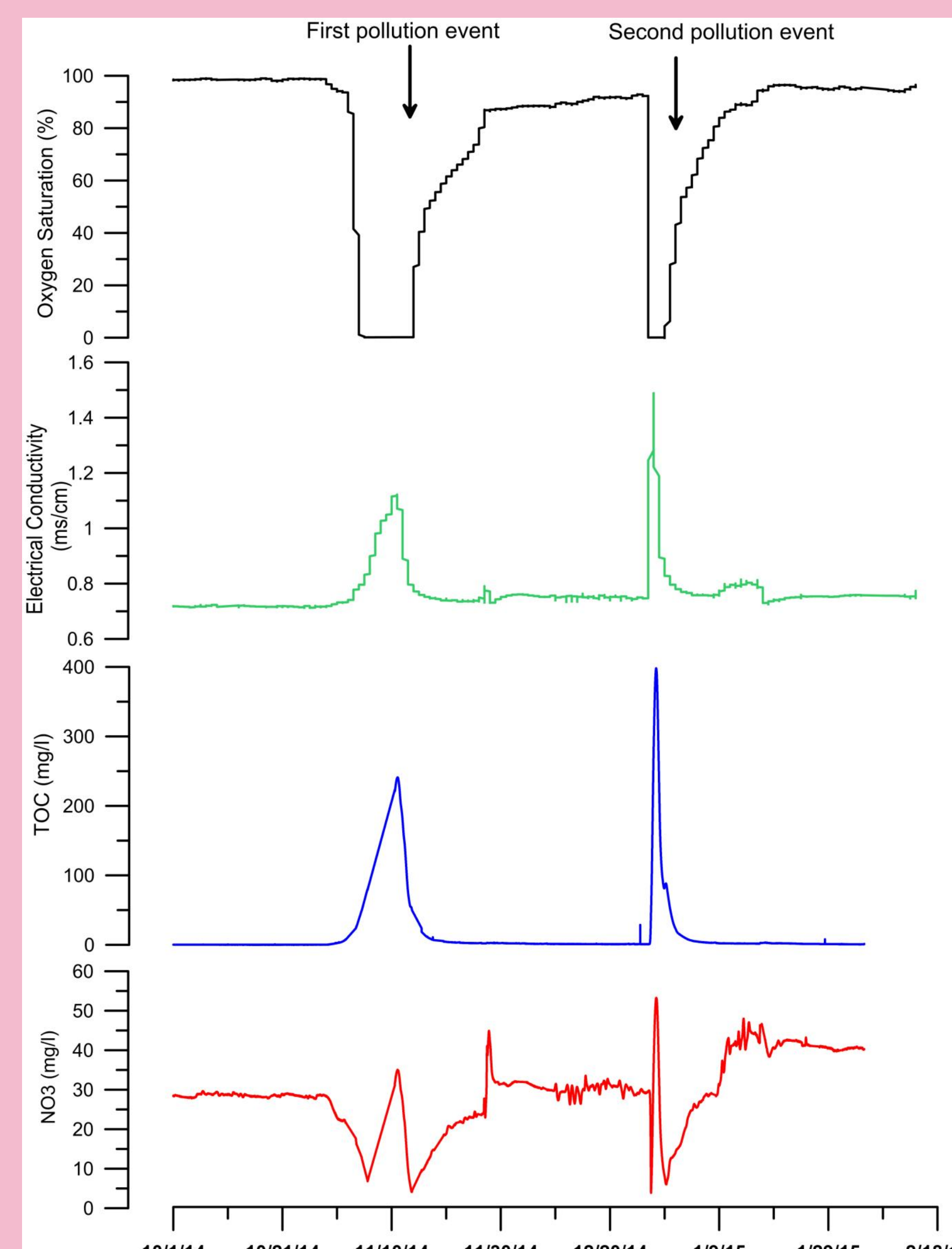
Locations of the rain and snow water samples compared with the elevations.



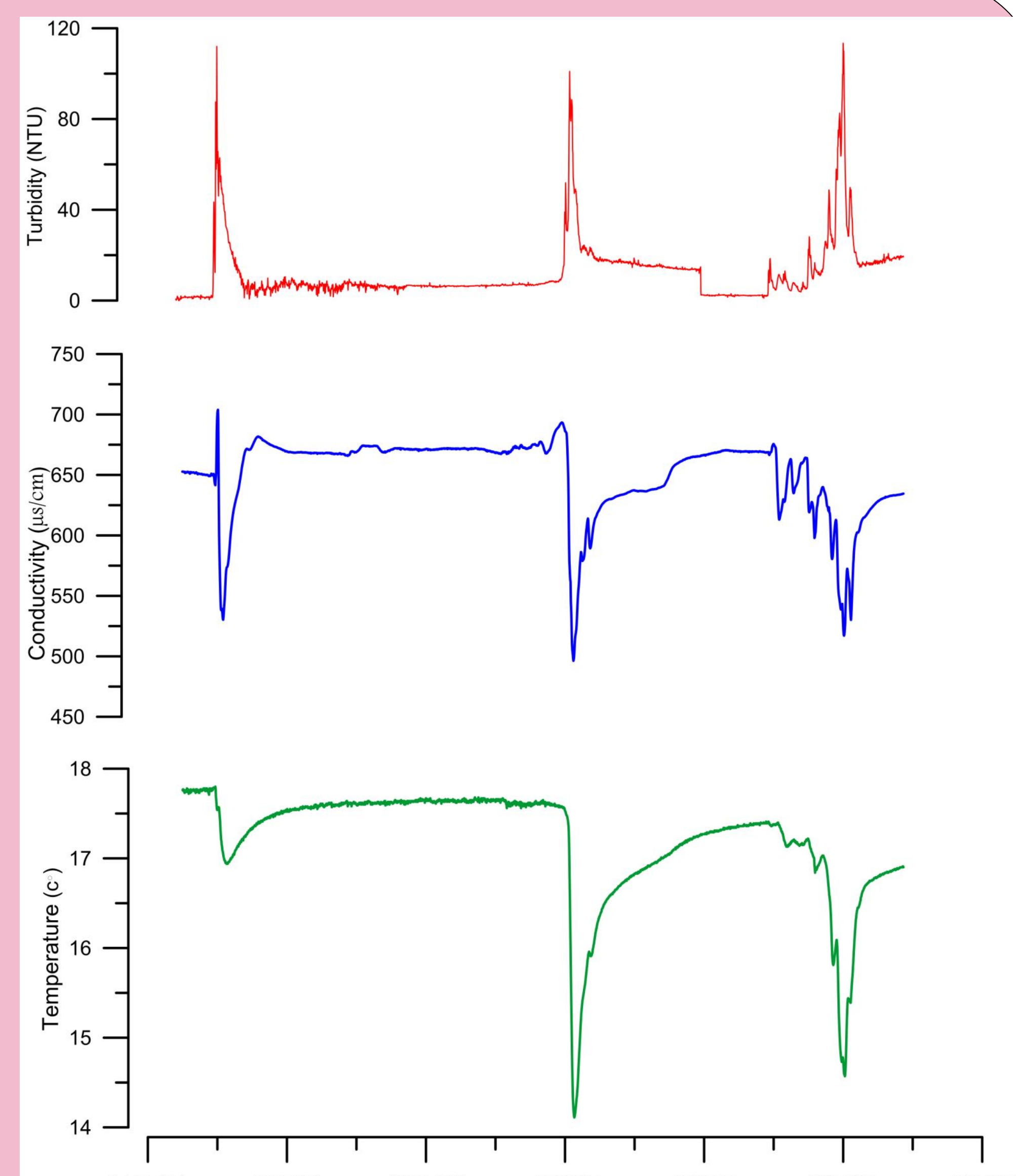
Piper diagram for the water samples from Tanour (AH0510) and Rasoun (AH0506) springs. Based on Langguth classification [6]; the water type is: "Normal alkaline water with prevailing bicarbonate".



Changing in the isotopic composition of $\delta^{18}O$ and δD with respect to the rainfall events.



Variation in the Oxygen saturation, TOC, EC and Nitrate concentration in Tanour spring water during the pollution events from the olive presses wastewater.



Rasoun spring water response during and after the recharge events from the rainfall.

4. Conclusion

- Understanding water pathways within the karst aquifers are important regarding management and protection of water resources within the Tanour and Rasoun catchment area.
- Tanour and Rasoun springs water shows a rapid and sudden response to precipitation events. The karst aquifer system within the study area is characterized by fast groundwater travel times, low storage in the karst network, and short water residence time within the aquifer system.
- All the results from the automated continuous measurements, stable isotopes ($\delta^{18}O$ and δ^2H), major ions and the vulnerability maps against pollution will be used as spatially variables for determining the karst aquifer characteristics within the study area .

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Screen shot from the online telemetry web page for Tanour spring.