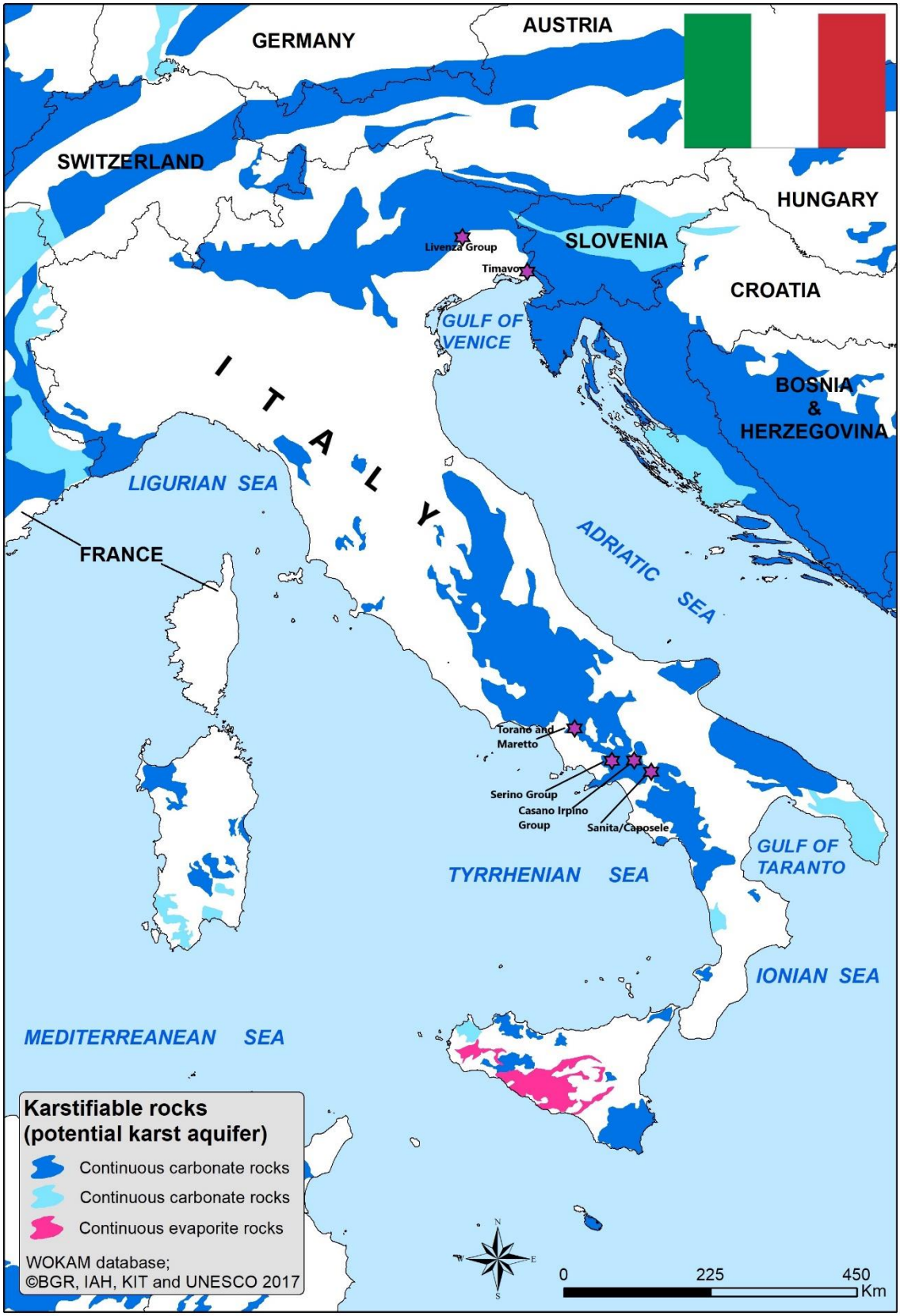

GERMANY
AUSTRIA
SWITZERLAND
HUNGARY
SLOVENIA
CROATIA
Livenza Group
Timavo
GULF OF VENICE
I T A L Y
BOSNIA & HERZEGOVINA
LIGURIAN SEA
FRANCE
ADRIATIC SEA
Torano and Maretto
Serino Group
Casano Irpino Group
Sanita/Caposele
GULF OF TARANTO
TYRRHENIAN SEA
IONIAN SEA
MEDITERREANEAN SEA
Karstifiable rocks (potential karst aquifer)
Continuous carbonate rocks
Continuous carbonate rocks
Continuous evaporite rocks
WOKAM database;
©BGR, IAH, KIT and UNESCO 2017
N
W
E
S
0
225
450
Km

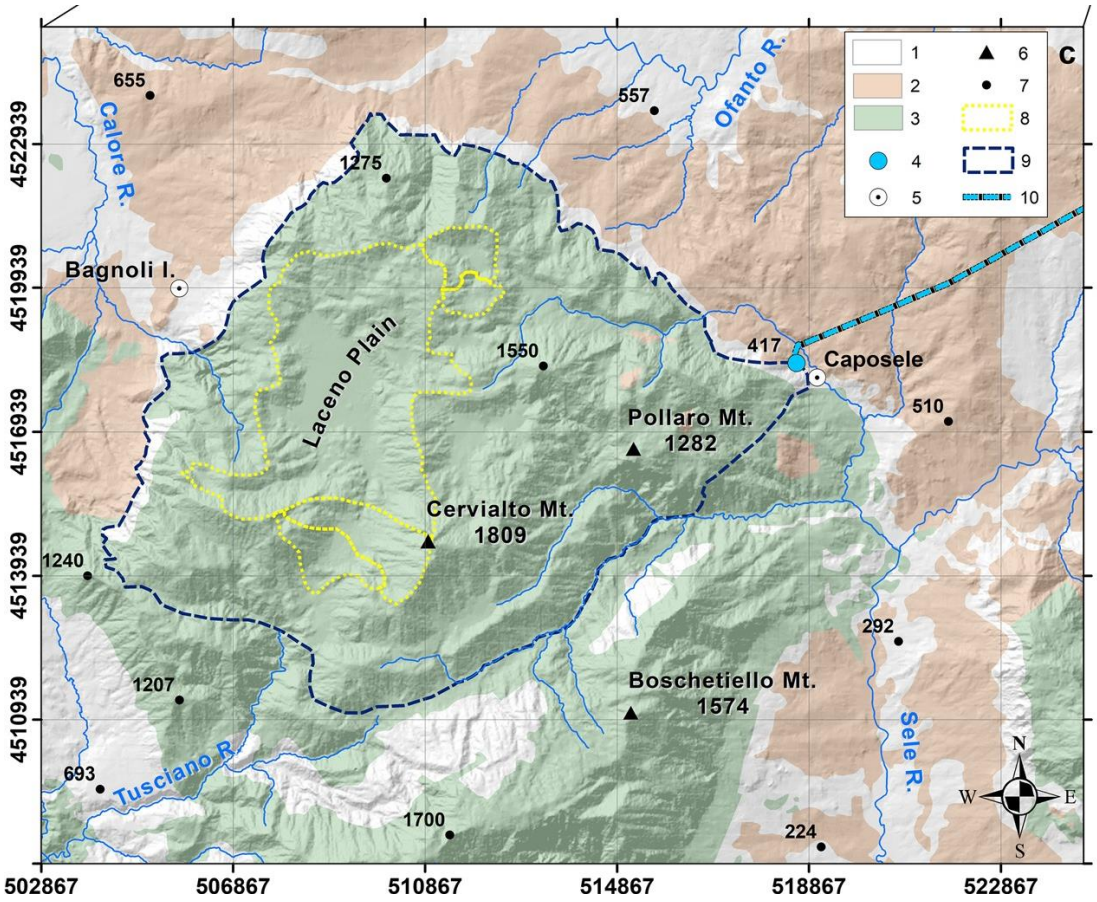
Country	MIKAS springs	Coordinates / Nearby City	Spring discharge (Q in l/s,min/av/max) / tapped or not	Criteria* in order / Main justification */ H-historic, A-aesthetic, S-scientific, E-Economic, Ec-ecologic	Data collected by
Italy 	1. **Sanita/ Caposele**	N 40°48'59.24 E 15°13'14.97" Z = 417 m asl Caposele, Campania	2750/3960/5200* **7200 after the earthquake of 23th November 1980* Tapped from 1906 by Acquedotto Pugliese Aqueduct Company for drinking water supply of entire territory of Apulia Region (Southern Italy)	***E, S, H, Ec, A*** *Permanent basal spring issuing from thick limestone and dolomite aquifer, located along a fault contact with argillaceous terrain. The Sanità represents the most important water source in Southern Italy used mainly for drinking purposes. The hydraulic works of Pugliese Aqueduct constitute the widest and complex aqueduct system of Italy. There is no large variation of its discharge, the hydrograph shape is smooth, with absence of peaks, indicating that the groundwater flow occurs mainly in laminar regime (diffuse flow). The period of high flow occurs in spring or summer seasons, after a time lag with respect to the rainy season, and it is connected to a long period of antecedent cumulative rainfall. During dry years the discharge decreases for all the year, and the period of high flow is absent (drought periods). The systematic monitoring of spring discharges started in 1920. and discharge time series is one of the longest in the world. Spring and its catchment are part of the Regional Picentini Mountain Natural Park.*	Francesco Fiorillo, Libera Esposito, Michele Ginolfi, Guido Leone, Mario Parise
	2. **Cassano springs group**	N 40°52'18.80" E 15° 1'50.40" to N 40°52'4.20" E 15° 1'54.24" Z = 473-476 m asl Cassano Irpino, Campania	1700/2650/4800 Tapped for water supply since 1965 of the entire Apulia Region and of 100 municipalities, together with other springs of Campania Region	***E, S, A, H, Ec*** *The group of Cassano springs feed two wide aqueducts systems in the area, representing a water source of strategic importance. The spring hydrograph is smoothed with a very low or absent quick flow component. The spring discharges were affected by the Irpinian earthquake of 23th November 1980, showing a spring discharge peak of 5500 l/s. The main recharge area is represented by Dragone Lake Polje. Tracer tests carried out in the area allowed to highlight the linking between Bocca del Dragone ponor draining the polje and Cassano springs. This spring water is a strategic resource for the ecological flow of the Calore River. Since the spring tapping, the flow of the Calore River is reduced during the period of low, and drought. Springs and their catchment are part of the Regional Picentini Mt. Natural Park.*	Francesco Fiorillo, Libera Esposito, Michele Ginolfi, Guido Leone, Mario Parise
	3. **Serino springs group**	N 40°52'3.27" E 14°51'52.17"	820/2200/3030 Tapped for water supply	***H, E, A, S, Ec*** *Group of permanent springs of fresh water in alluvial deposits, fed by an upwelling water flux from underlying*	Francesco Fiorillo, Libera

		Z = 330-370 m asl S. Lucia di Serino, S. Michele di Serino, Campania		*karst aquifer. The recharge is from Terminio-Tuoro karst massif. Serino springs were tapped since the Roman Times (I century A.D.) with Augustan and Sannitico Aqueduct. The former tapped Acquaro and Pelosi spring water for the water supply of Neapolitan area, the latter collected Urciuoli spring water for the supply of Benevento city. The tapping works of Urciuoli are still well preserved, while ruins of ancient Roman aqueduct are still visible. In 1885-1888, Urciuoli spring and later, in 1934, Acquaro-Pelosi springs were re-tapped by Acqua Bene Comune, Neapolitan Aqueduct Company. Actually, discharge of Serino springs with a gravity tunnel fed several municipalities of Campania region such as Naples and other areas of Naples, Caserta, Benevento and Avellino provinces. For this springs there is a long historical discharge and piezometric time series. The area is characterized by a lush vegetation, typical of wet environments. Springs and their catchment are part of the Regional Picentini Mt. Natural Park.*	Esposito, Michele Ginolfi, Guido Leone
	4. **Torano and Maretto springs**	N 41°21'40.25"; E 14°22'46.84” N 41°21'29.41"; E 14°22'13.12" Z = 175-201 m asl Piedmonte Matese, Campania	1290/3030/10590 Tapped and conveyed towards Naples metropolitan area, for 3 millions of inhabitants living in Campania Region	***H, A, E, S, Ec*** *The two springs was tapped since 1960 by Campano Aqueduct and there is historical museum. The tapping works of Torano spring are represented by a long tunnel with several wells at its end. The tapping work of Maretto spring are constituted by a reservoir collecting water discharge. Torano spring is connected with Matese Lake polje. Its hydrograph is characterized by a quick and low flow components. This spring is fed mainly by a karst conduit, similarly to a vauclusian spring. Before the hydraulic works carried out for hydroelectric exploitation of the Matese Lake, the peak discharges were higher than actual ones. The hydrograph of Maretto spring is similar to that of Torano spring, indicating the same groundwater source; the emergence occurs in a restricted area, currently protected. The valley of Torano River is a wonderful deep karst canyon, which drains the northern sector of the Matese Massif. The valley is generally dry, and the runoff develops after intense rainfalls. Most of the meteoric precipitation recharge a huge groundwater system (540 km²), which is drained by the Torano and Maretto springs.*	Francesco Fiorillo, Libera Esposito, Michele Ginolfi, Guido Leone, Mario Parise

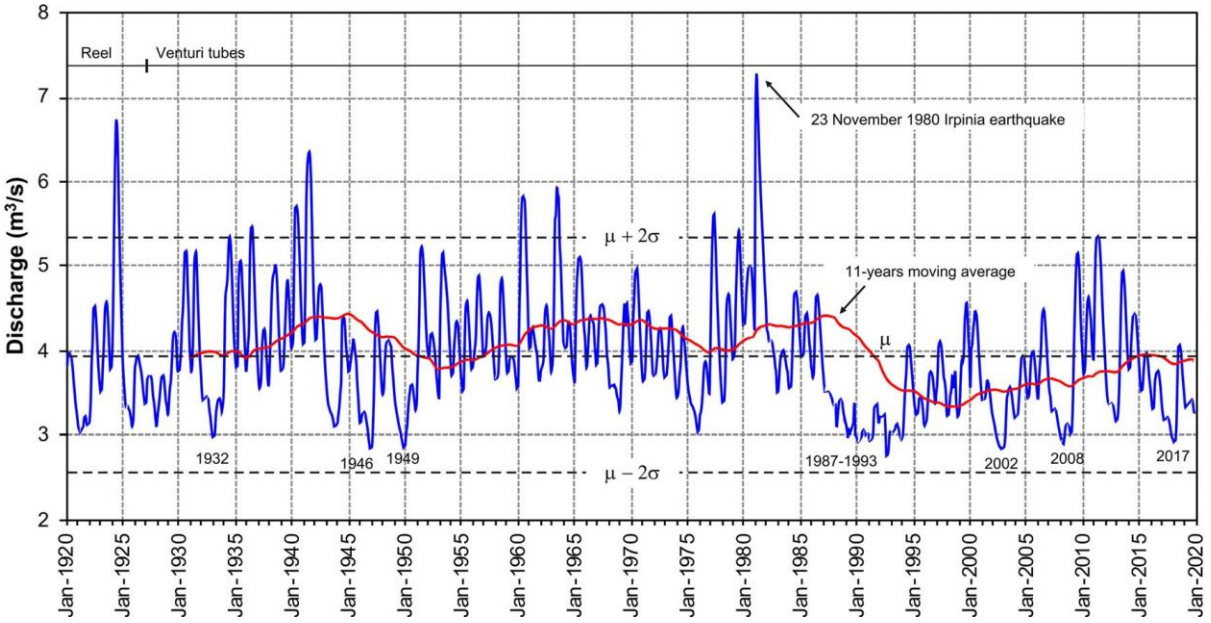
	5. **Livenza springs group** (Santissima, Gorgazzo, Molinetto)	Santissima: 46°01'17.8" N, 12°28'31.4" E Gorgazzo: 46°02'23.8" N, 12°29'48.8" E Molinetto: 46°00'26.0" N, 12°28'24.7" E Z= 28-45 m asl Polcenigo, Friuli Venezia Giulia	3500/10700/32600 The Livenza spring system is partially captured: Santissima spring has been historically used for potable water supply (1100 l/s av.), while Gorgazzo and Molinetto remain largely free-flowing	***S, Ec, E, A, H*** *The Livenza springs complex is a permanent, freshwater multi-outlet system that drains a large karst aquifer of Upper Triassic to Miocene age (mainly upper Cretaceous). Gorgazzo is a very deep vauclusian spring with a highly irregular regime, whereas Santissima and Molinetto are overflow springs with steadier regime. It is the second largest groundwater emergence in the Alps after the Timavo spring, providing unique opportunities to study conduit flow mechanisms, recharge dynamics, and karst aquifer behaviour. The springs sustain wetland ecosystems in the Palù di Livenza, maintain baseflow for the Livenza River, and provide habitat for protected and endangered species. Santissima emerges in a picturesque wetland and holds historical and religious value for local communities. The Gorgazzo is a stunning deep turquoise pool, leading to a world-renowned underwater cave, explored down to -222m. The Cansiglio - Cavallo karst plateau hosts over 2,500 caves. The basin is a part of Natura 2000 network, and trans-regional aquifer spanning Friuli Venezia Giulia and Veneto.*	Luca Zini, Tullio Quaia, Mario Parise
	6. **Timavo**	N 45°47’19” E 13°35’22” Z = 1.5-2 m asl San Giovanni di Duino, Friuli Venezia Giulia	7400/29300/158000 Main springs are captured through concrete intake structures and conduits for municipal and industrial water supply, while other outlets remain free-flowing	***S, Ec, H, E, A*** *The group of four springs are permanent, gravity-fed, and discharge freshwater typical of karst conduit springs. It drains a large transboundary aquifer system of Cretaceous – Paleogene age, which belongs to the “Classical karst” (Italy-Slovenia). This is a conduit-controlled multi-outlet discharge system connected with the Reka River (disappearing in the Škocjan Caves – UNESCO heritage site) and is characterized by rapid response to rainfall. The site has millennial significance, mentioned in Virgil’s Aeneid and home to the ancient Temple of Diomedes. It has been a focal point for local community development since Roman times. The springs are of high strategic importance as a reserve water resource for the public supply of Trieste (~200,000 inhabitants). The urban water system is currently supplied mainly by wells (~85%) and secondarily by karst springs (~15%), with the Timavo system available for emergency use. Timavo – Škocjan provide a unique habitat for the*	Luca Zini, Tullio Quaia, Mario Parise

				endangered Proteus anguinus (Olm) and maintain the baseflow of the Timavo River, which is essential for the downstream wetlands and the Northern Adriatic coastal biodiversity. Timavo is located within the two Natura 2000 sites.	

MIKAS – Sanita / Caposele

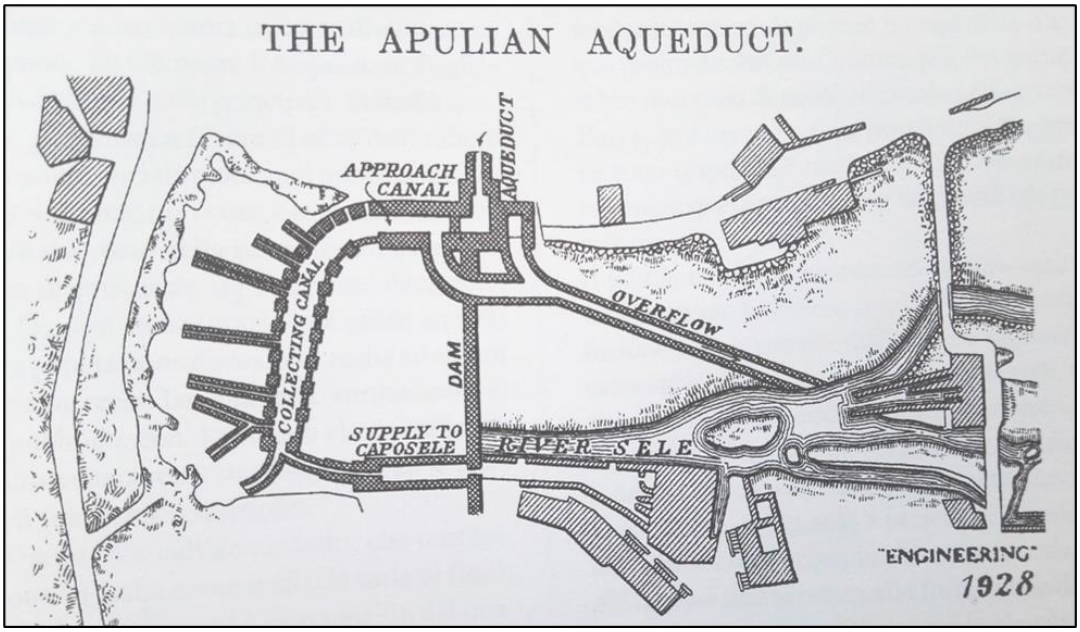


Hydrogeological sketch map. Legend: 1. slope and alluvial deposits (Quaternary); 2. argillaceous complex and flysch sequences (Paleocene-Miocene); 3. limestone and limestone-dolomite series (Late Triassic-Miocene); 4. Caposele spring; 5. village; 6. peak (with elevation in m a.s.l.); 7. elevation point (m a.s.l.); 8. endorheic area; 9. spring catchment; 10. Pavoncelli tunnel (Apulian aqueduct) (Fiorillo et al., 2020)



Spring hydrograph (Leone et al., 2020)

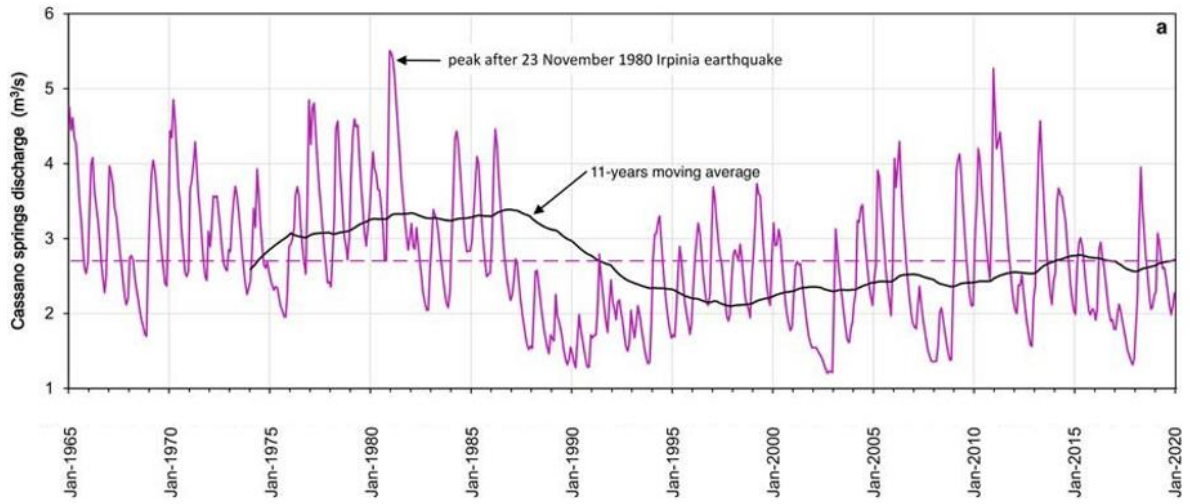
Sanità spring before tapping works (Courtesy of Acquedotto Pugliese)



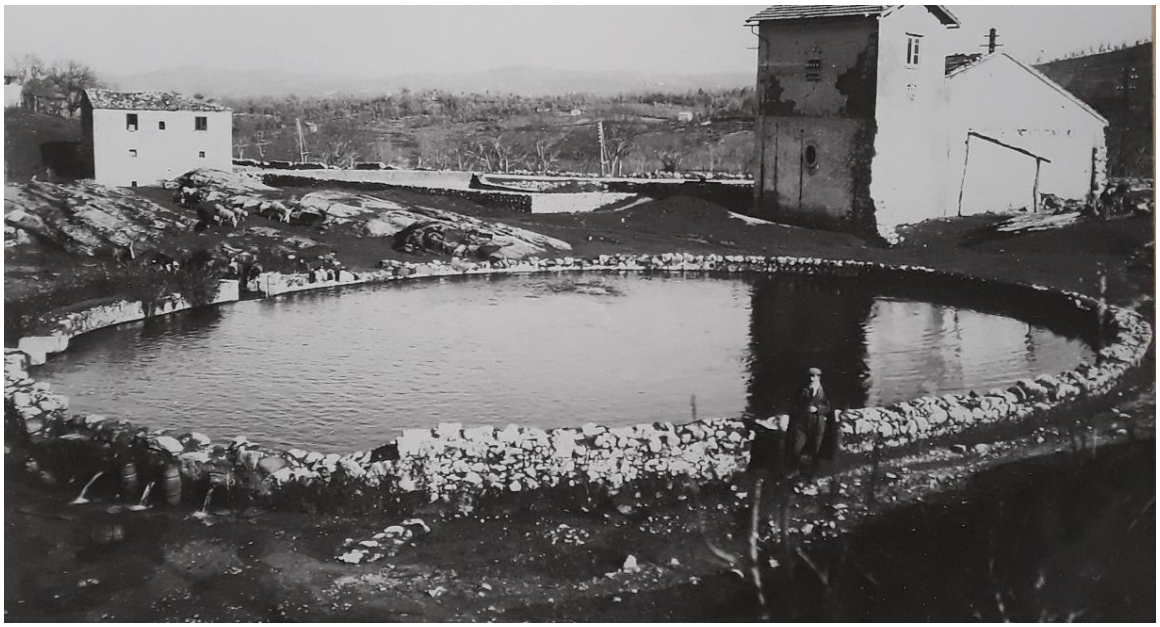
Design of tapping works of Sanità spring (Courtesy of Acquedotto Pugliese)

Interior of tapping structure of Sanità spring (Photo by F. Fiorillo)

MIKAS – Cassano springs group



Cassano springs hydrograph (Fiorillo et al., 2020)



Pollentina spring before tapping works of sixties' (courtesy of Pugliese Aqueduct)

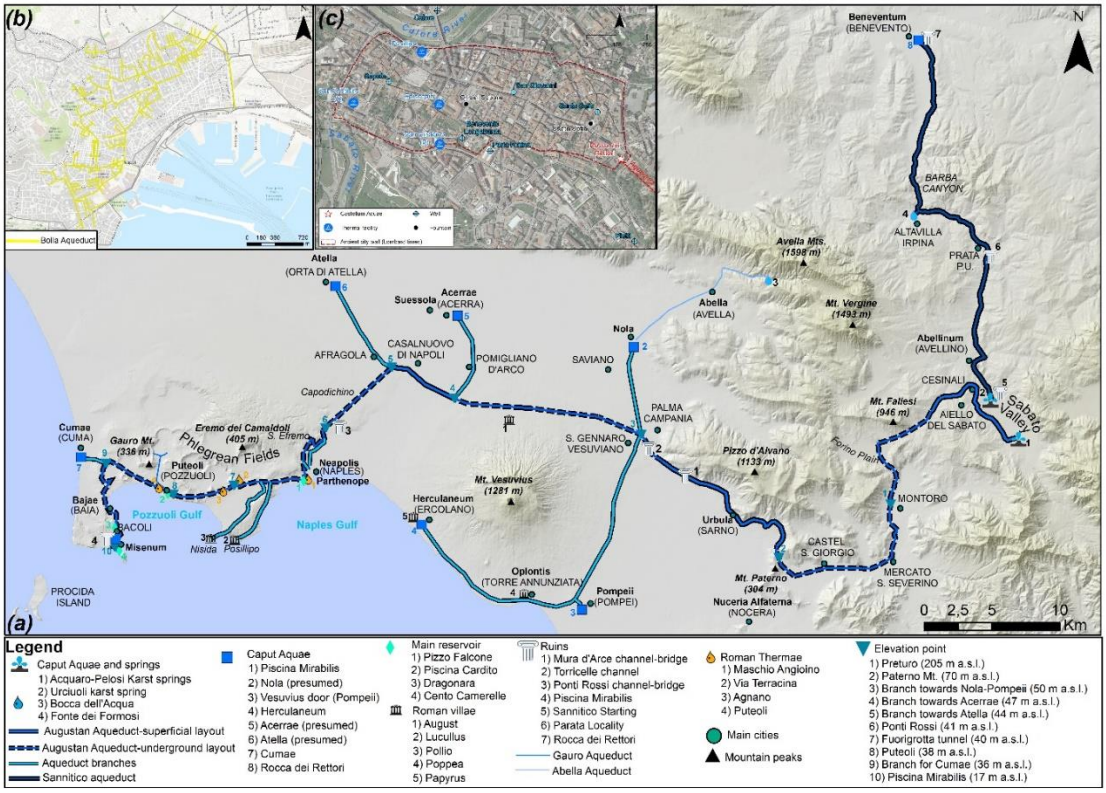
Interior of tapping structure of Pollentina spring (Photo by F. Fiorillo)

Interior of tapping structure of Peschiera spring (Photo by F. Fiorillo)

Dragone Plain polje (photo by F. Fiorillo)

Bocca del Dragone ponor, and its hydraulic channel system (photo by L. Esposito)

MIKAS – Serino springs group



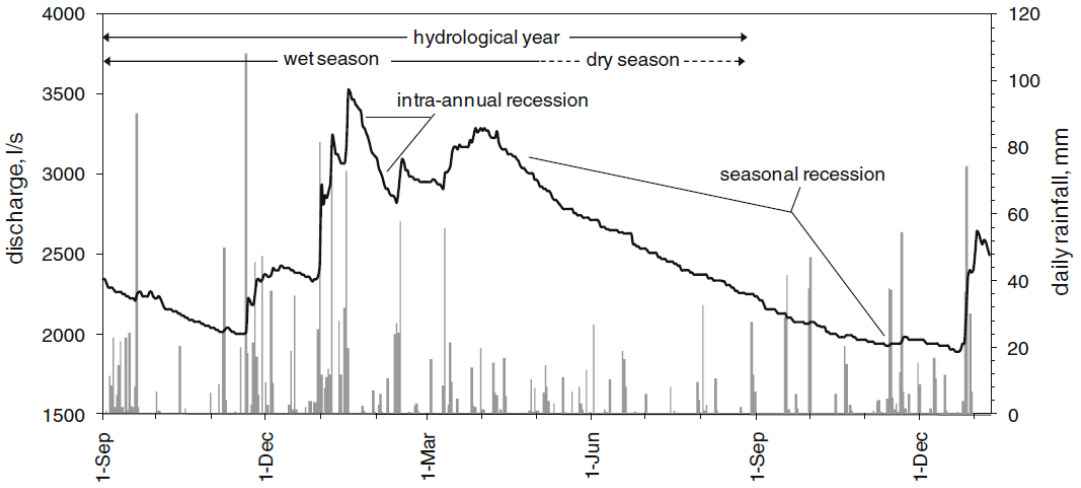
Layout of Roman Aqueducts tapped Serino springs (from Esposito et al., 2025-modified)

Interior of tapping structure of Acquaro-Pelosi spring (Photo by L. Esposito)

Tapping structure of Urciuoli spring (Photo by L.Esposito)

Ruins of Roman Aqueduct near Urciuoli spring tapping structure (Photo by F. Fiorillo)

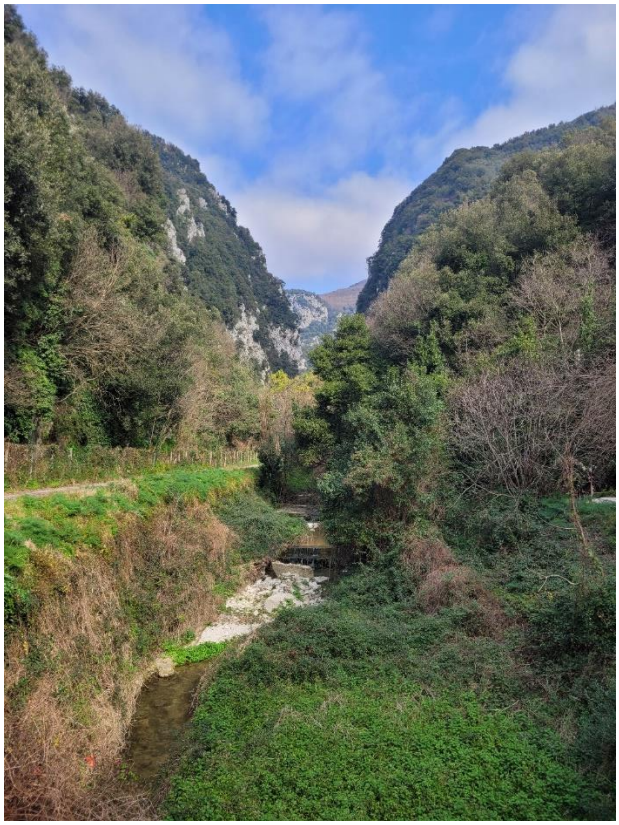
MIKAS – Torano and Maretto



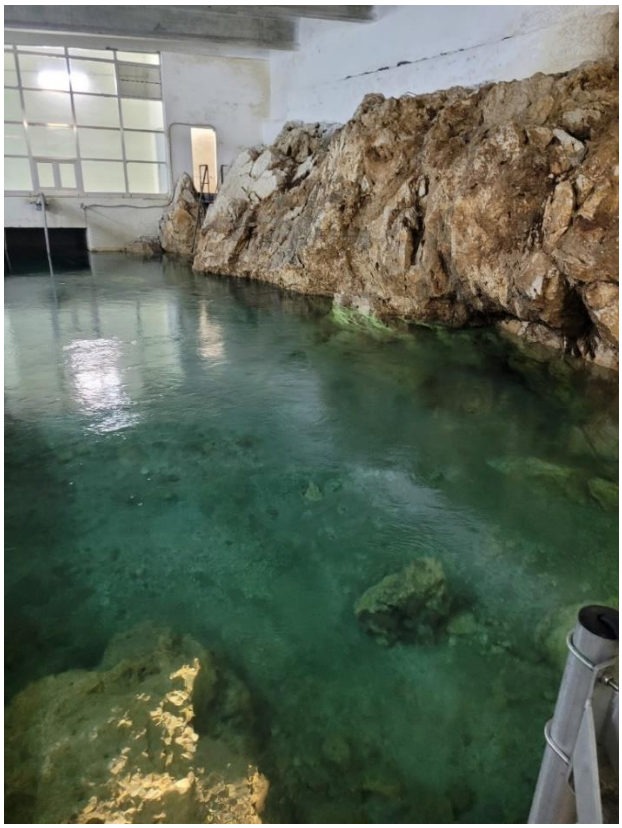
Torano daily spring discharge (Matese Mountain, southern Italy; spring details in Fiorillo and Doglioni 2010) and daily rainfall recorded in the recharge area (Lago Matese rain gauge, annual mean 1.948 mm). Intra-annual recession occurs during the wet season, interrupted by the following rainfall event; during these periods, recharge processes progressively increase the basal water table level of the aquifer. A seasonal recession begins when recharge processes decrease as consequence of temperature increase and rainfall decrease; it covers all the (Mediterranean) summer and can extend in the following hydrological year (Fiorillo, 2014).

Torano spring tapping zone (photo by L. Esposito).

Natural emergence (karst conduit) of the Torano spring before its capture (photo by F.Fiorillo).



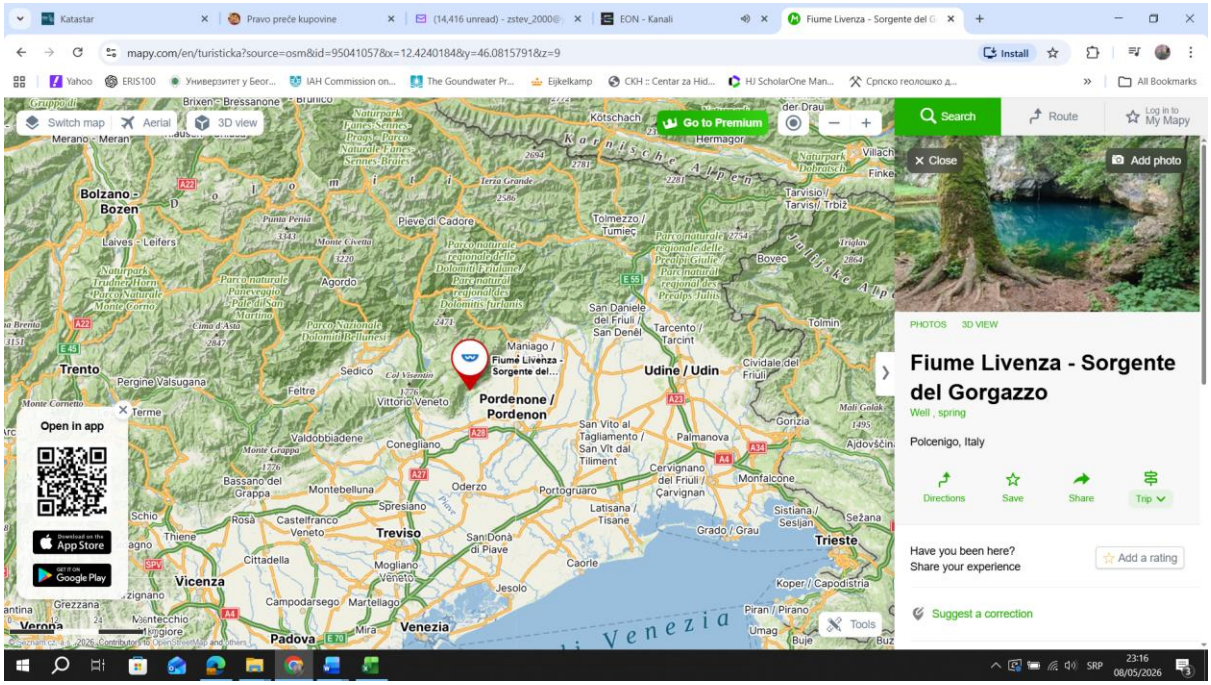
Torano karst canyon (photo by F.Fiorillo)



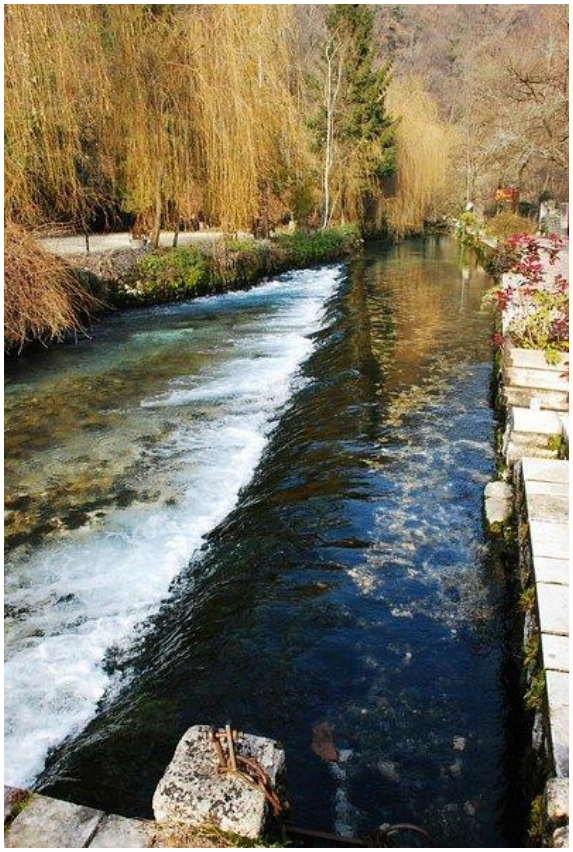
Maretto spring tapping zone (photo by L. Esposito).

Matese Lake polje (photo by F. Fiorillo).

MIKAS – Livenza springs group (Santissima, Gorgazzo, Molinetto)

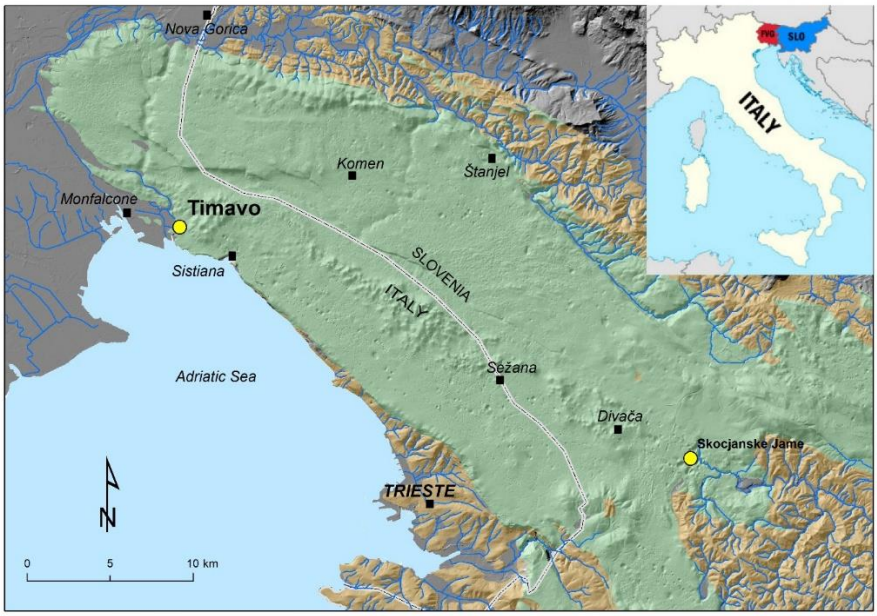


Gorgazzo spring (https://www.nordicwalkingtreviso.net/escursione/sorgenti-del-livenza-tra-natura-e-arte-domenica/)



https://www.tripadvisor.it/LocationPhotoDirectLink-g1201162-d2645715-i87368062-Sorgenti_del_Gorgazzo-Polcenigo_Province_of_Pordenone_Friuli_Venezia_Giu.html

MIKAS - Timavo



Location map of Timavo and its transboundary catchment (Italy – Slovenia)

One of the outlets of Timavo springs sgroup

Timavo springs' flow