DIPARTIMENTO DI INGEGNERIA CIVILE, EDILE E AMBIENTALE
DEPARTMENT OF CIVIL, ENVIRONMENTAL AND ARCHITECTURAL ENGINEERING

UNIVERSITÀ DEGLI STUDI DI PADOVA

# Groundwater assessment for a proper management and sustainable use of the resources in the middle-high venetian plain

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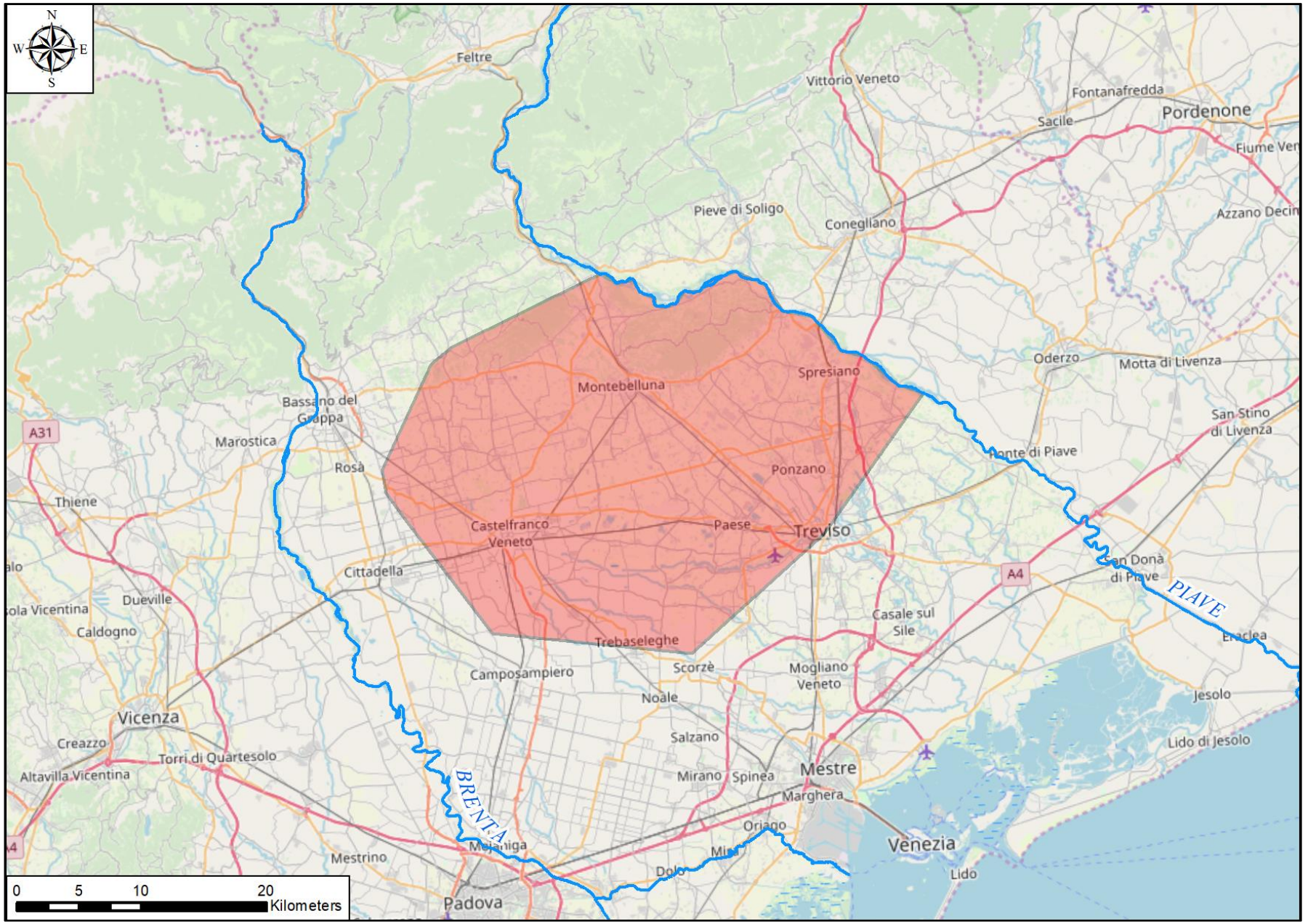
Session HS 8.2.2 | EGU General Assembly - Online | 4 - 8 May 2020

# Area

Northern Italy, 20 km far from Venice (Fig. a)

Study area about 900 km$^2$

… more than 50% exploited for agricultural purposes

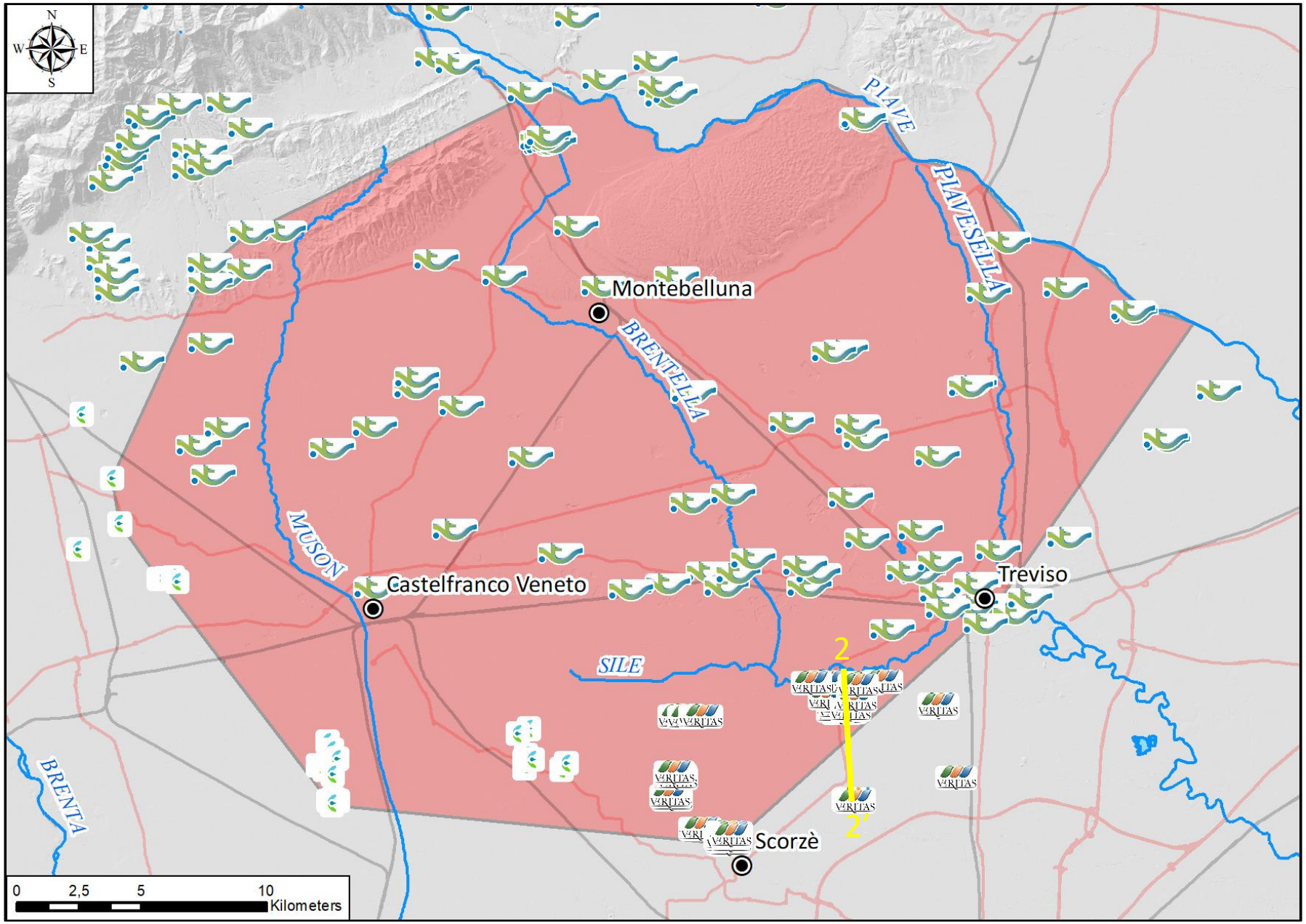
# Area

AREA DETAILS
900 km$^2$

<u>152 wells</u> owned by three Water Service Companies

- 78 Alto Trevigiano Servizi
- 42 Veritas
- 32 Etra

which extract a large amount of water for human consumption from the phreatic aquifer in the whole area and from 8 artesian aquifers in the south portion of the domain



# Area

AREA
900 k

<u>152 v</u>
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- 42
- 32

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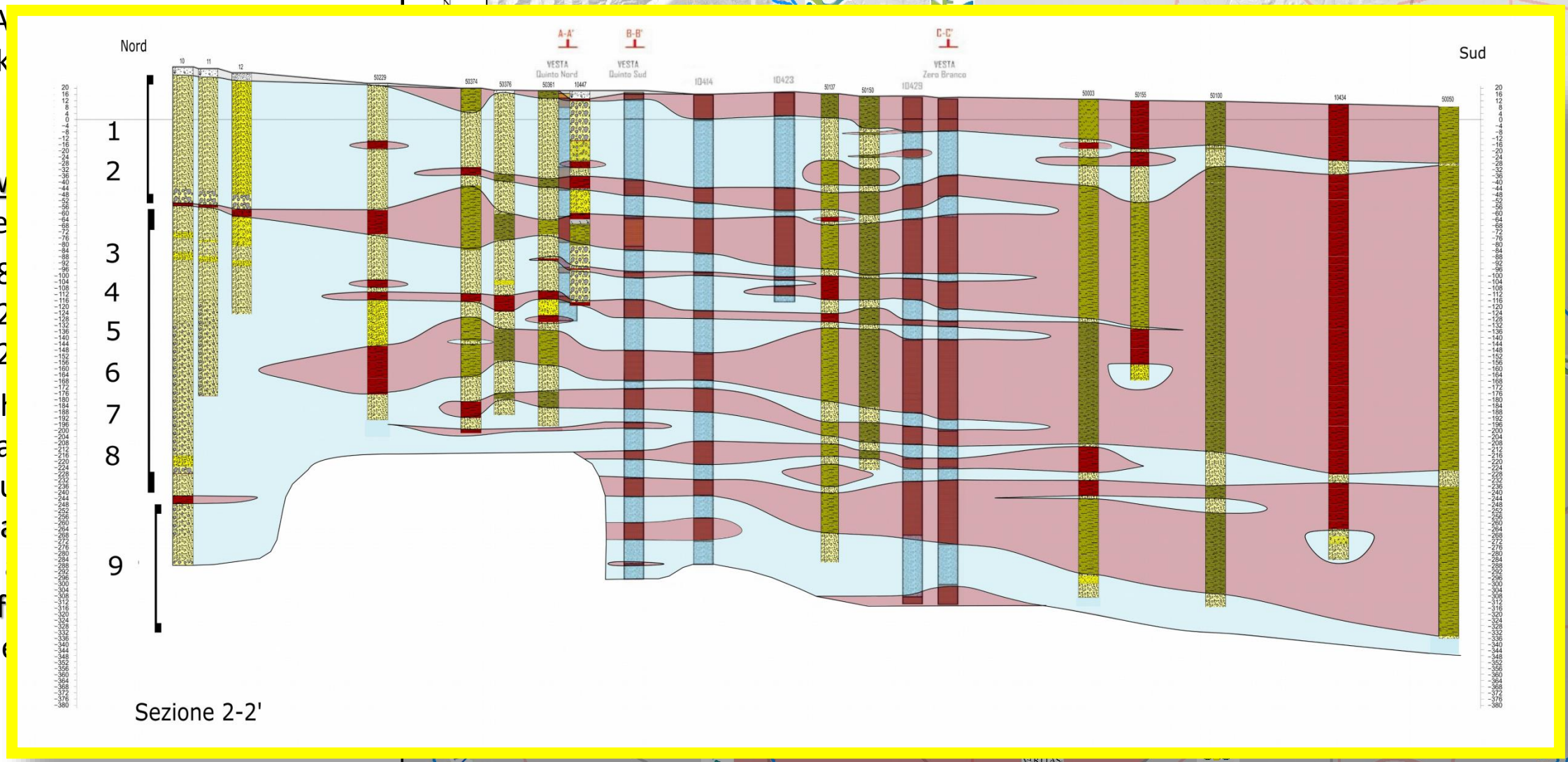


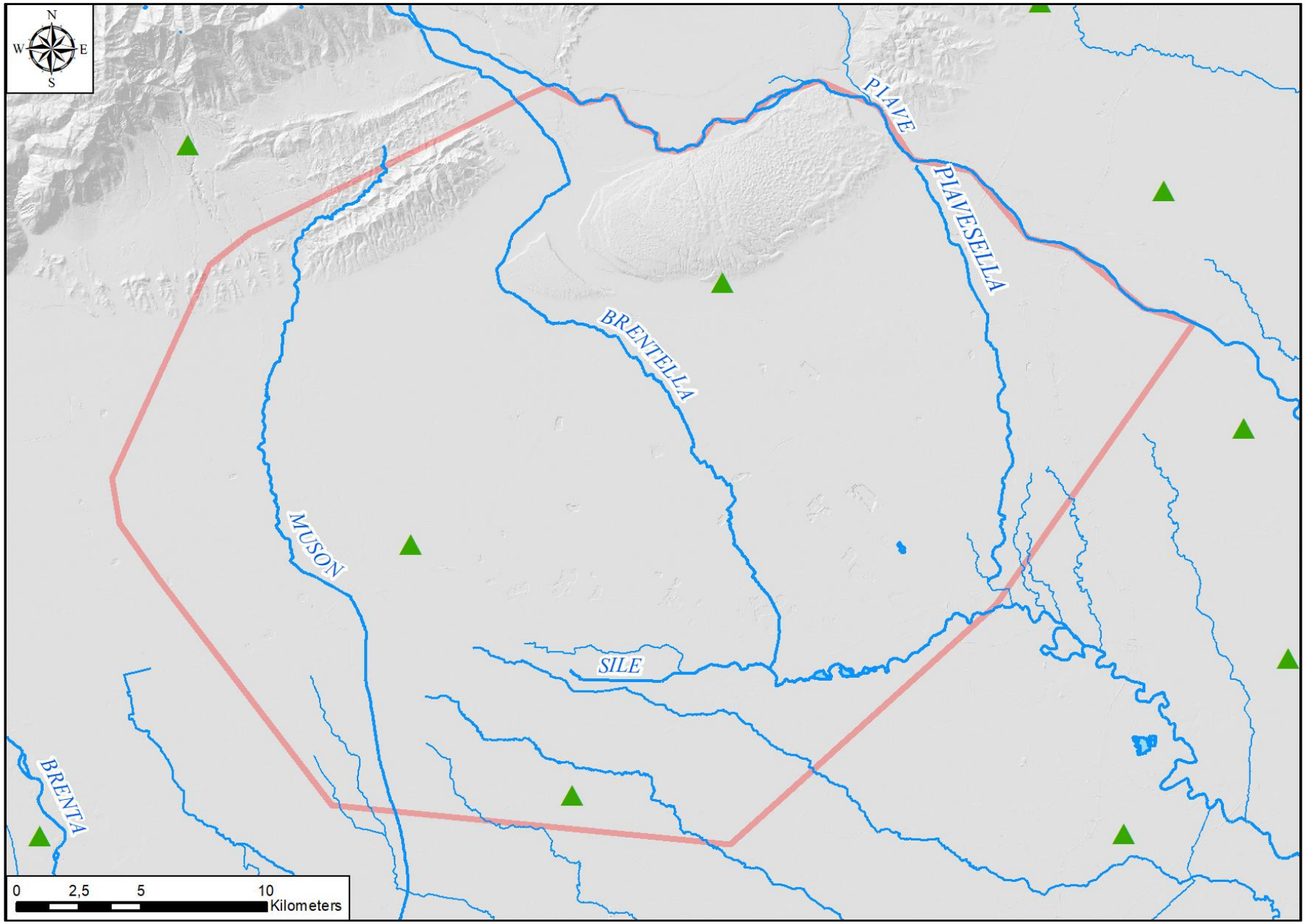
# Rainfall and evapotranspiration

AREA DETAILS
900 km$^2$
152 wells

14 weather stations (ARPAV) recording rainfall data and other parameters (humidity, solar radiation, pressure, etc.)

Evapotranspiration FAO method (Penman-Monteith)

Spatial distribution of meteorological forcing obtained by kriging from daily data



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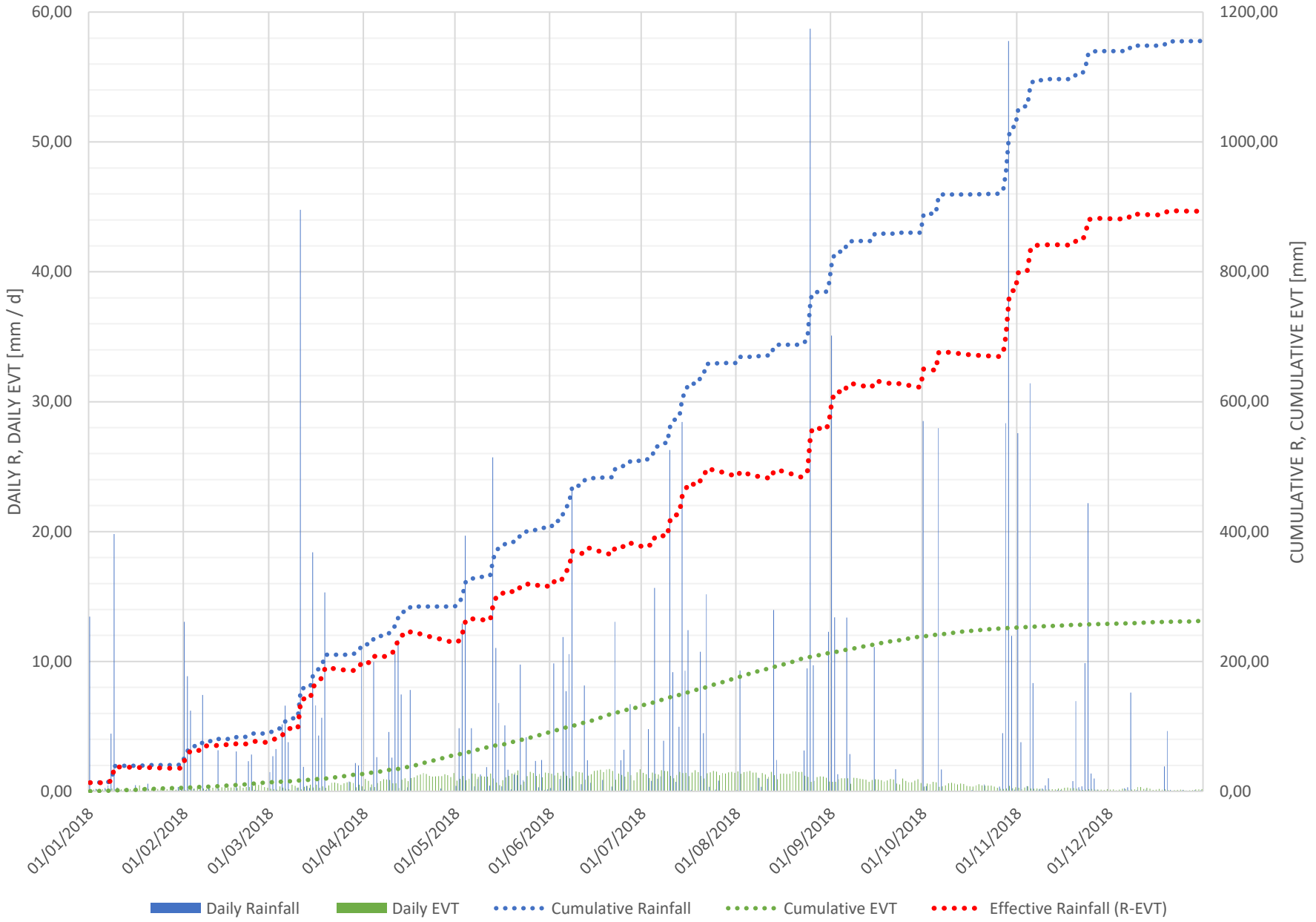
Meteorological forcing
(Year 2018)



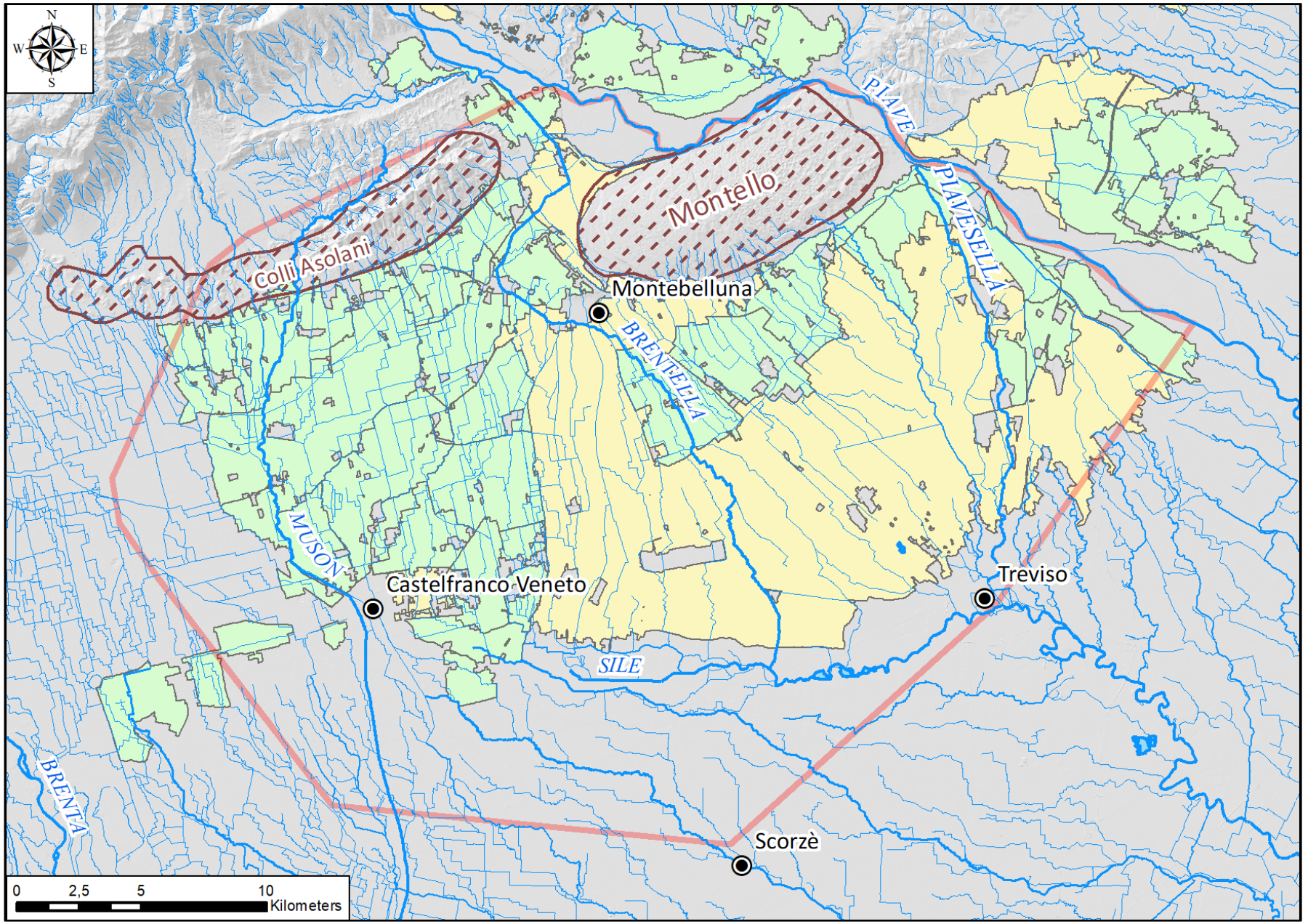
# Irrigation system

AREA DETAILS
900 km$^2$
152 wells
14 weather stations

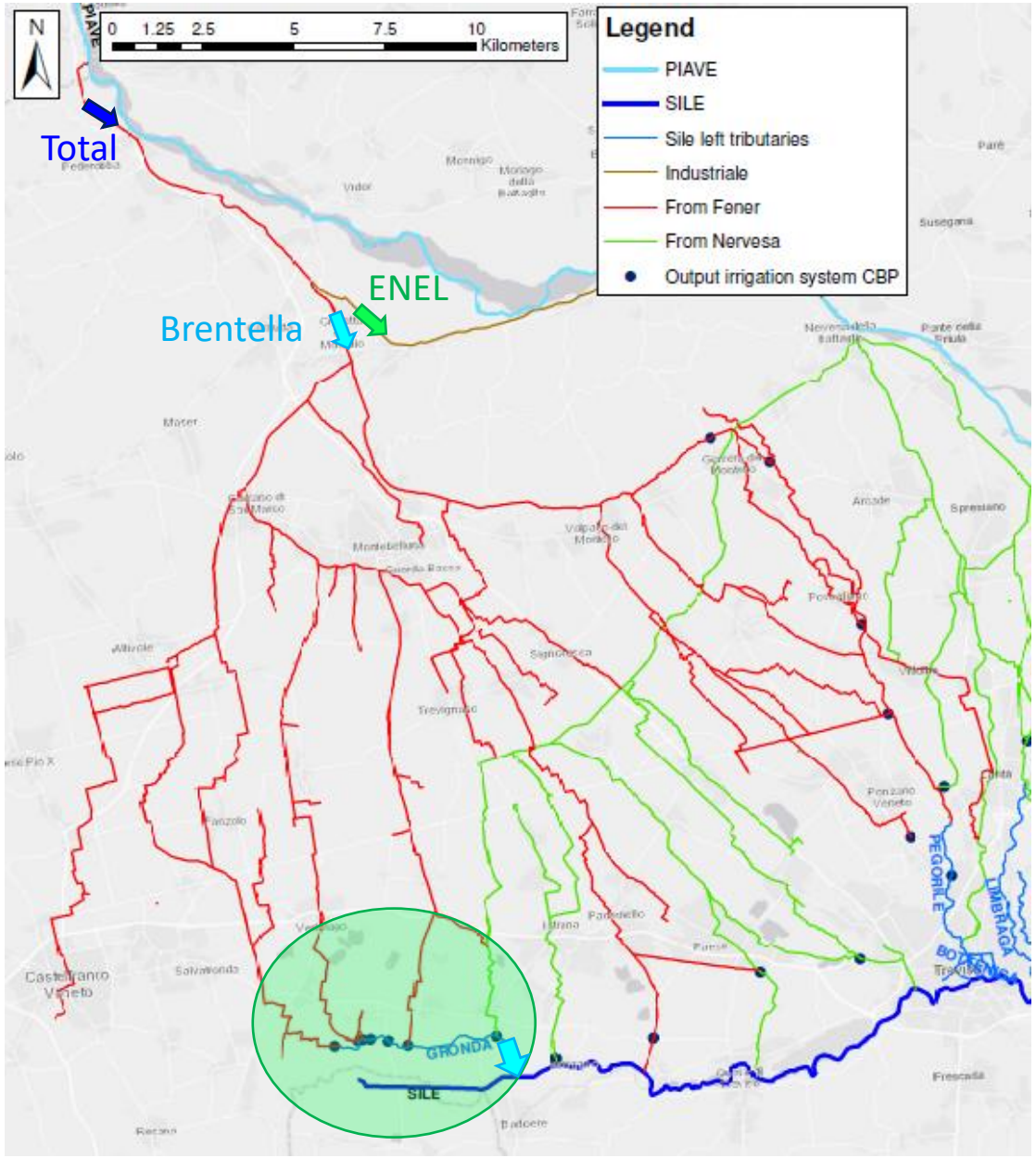
Irrigation system (canals and pressurized pipes development = 3950 + 2360 km)

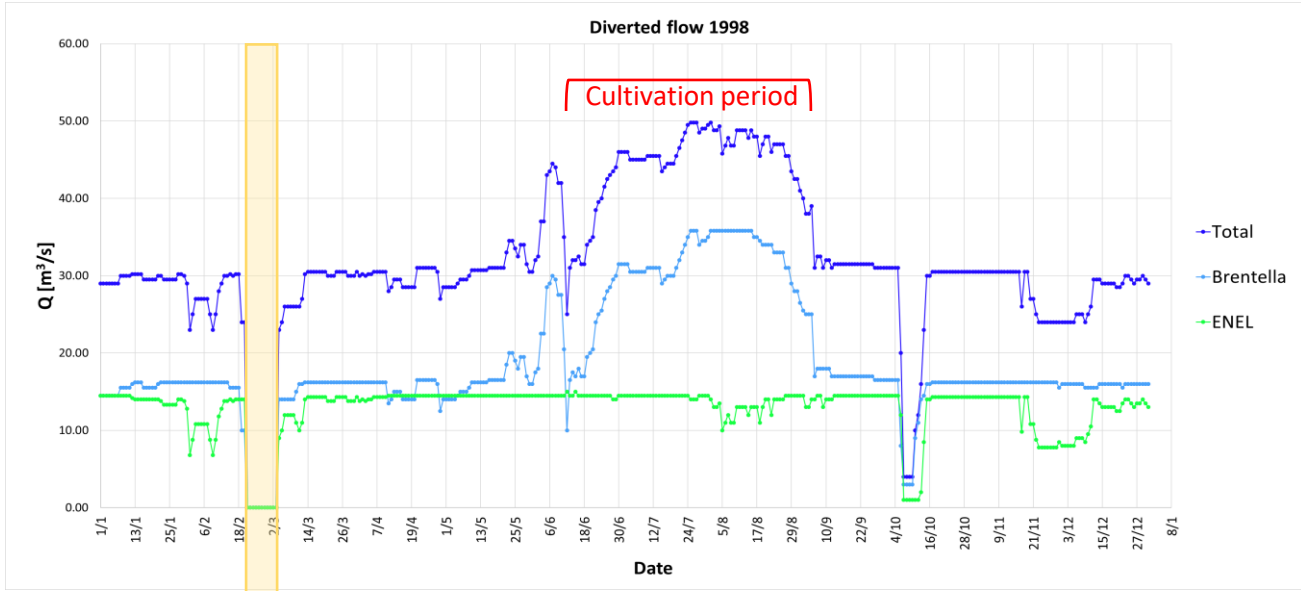
Irrigated area 63000 ha:
- 31000 ha flood and furrow
- 32000 ha sprinkler

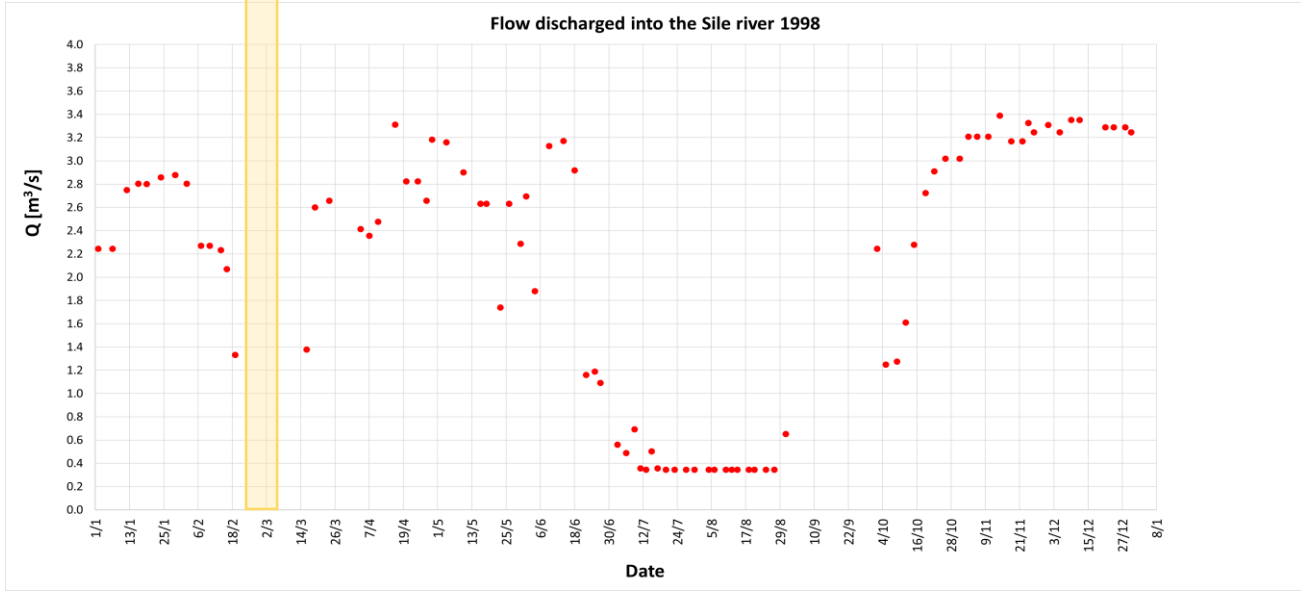
*(Data from reclamation authorities Consorzio di Bonifica Piave and CdB Acque Risorgive)*



# Analysis of the input (diverted flow at Fener) and output (Gronda canal) discharge from the irrigation system in 1998



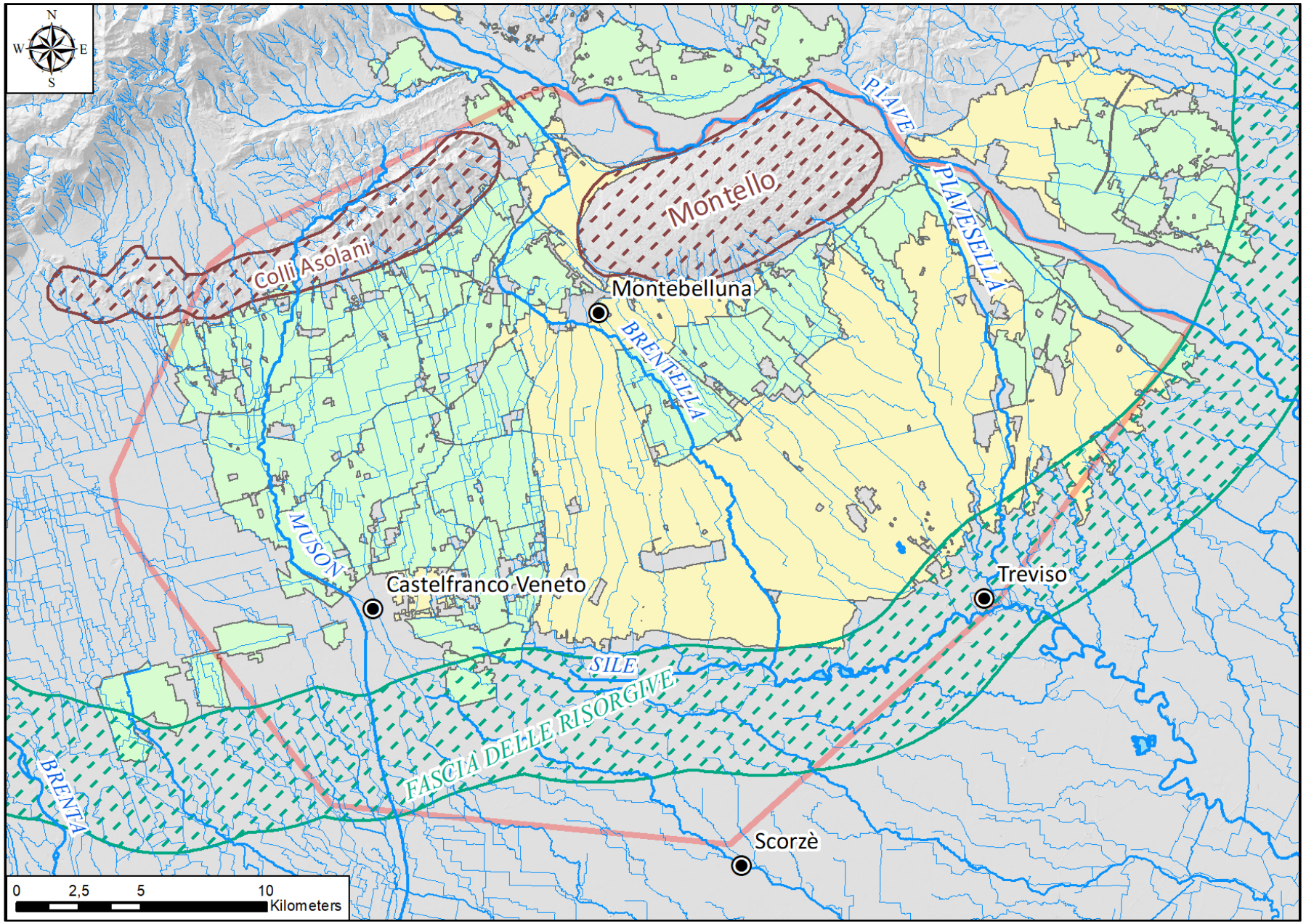



# Springs and river Sile

AREA DETAILS
900 km$^2$
152 wells
14 weather stations
3950+2360 km irrigation canals + pipes
63000 ha irrigated area

Springs: natural drainage and <u>River Sile flow rate</u>



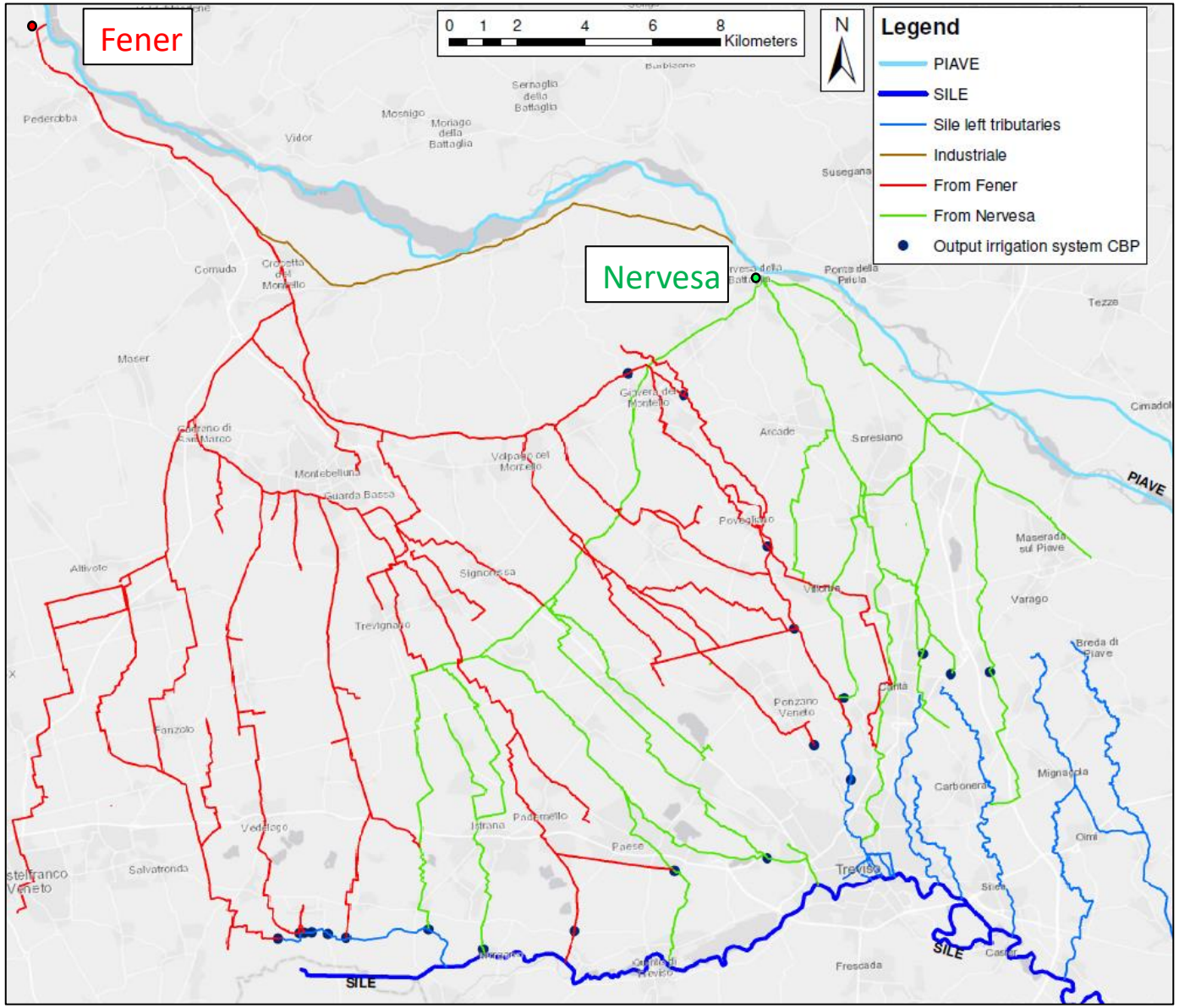
# Springs and river Sile

Flows contributing to the amount of water in the river Sile

Water dispersed from the river Piave and irrigation canals that recharges the aquifers

Effective rainfall on the Sile basin

Diverted water from river Piave at Fener and Nervesa and released into the irrigation network



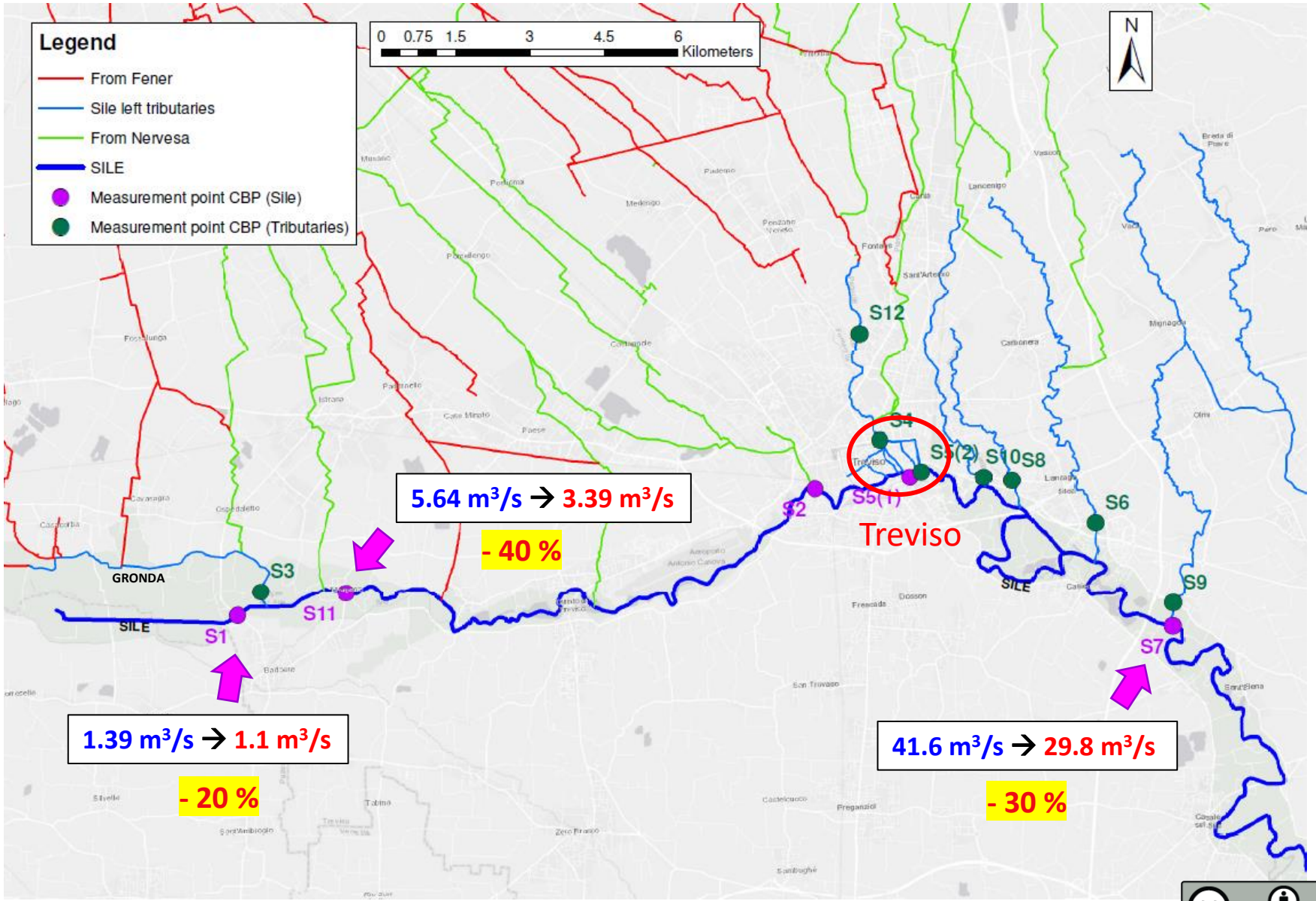
# Measured discharge before and after the interruption of Fener and Nervesa derivations 2018

**Upstream Treviso**

Flow rate almost halved causing great difficulties for fish farms and fauna

**Downstream Treviso**

Flow rate reduced of about 30% and as a consequence also the quality of the water decreased (the release of fluids from the sewer systems and other outputs are less diluted)




Report "Monitoraggio e sperimentazione sulle grandi derivazioni dal fiume Piave ", 2018, Consorzio di Bonifica Piave.

# Measured discharge before and after the interruption of Fener and Nervesa derivations 2018

**GRONDA (S3)**

Artificial canal that collects the output discharge from the irrigation system

→ during the water deviation interruption very little/no water is present in the irrigation canals and so the output discharge into the river Sile is 0 $m^3/s$

Between **S11** and **S2** only few irrigation canals with small discharge (0.7 $m^3/s$)

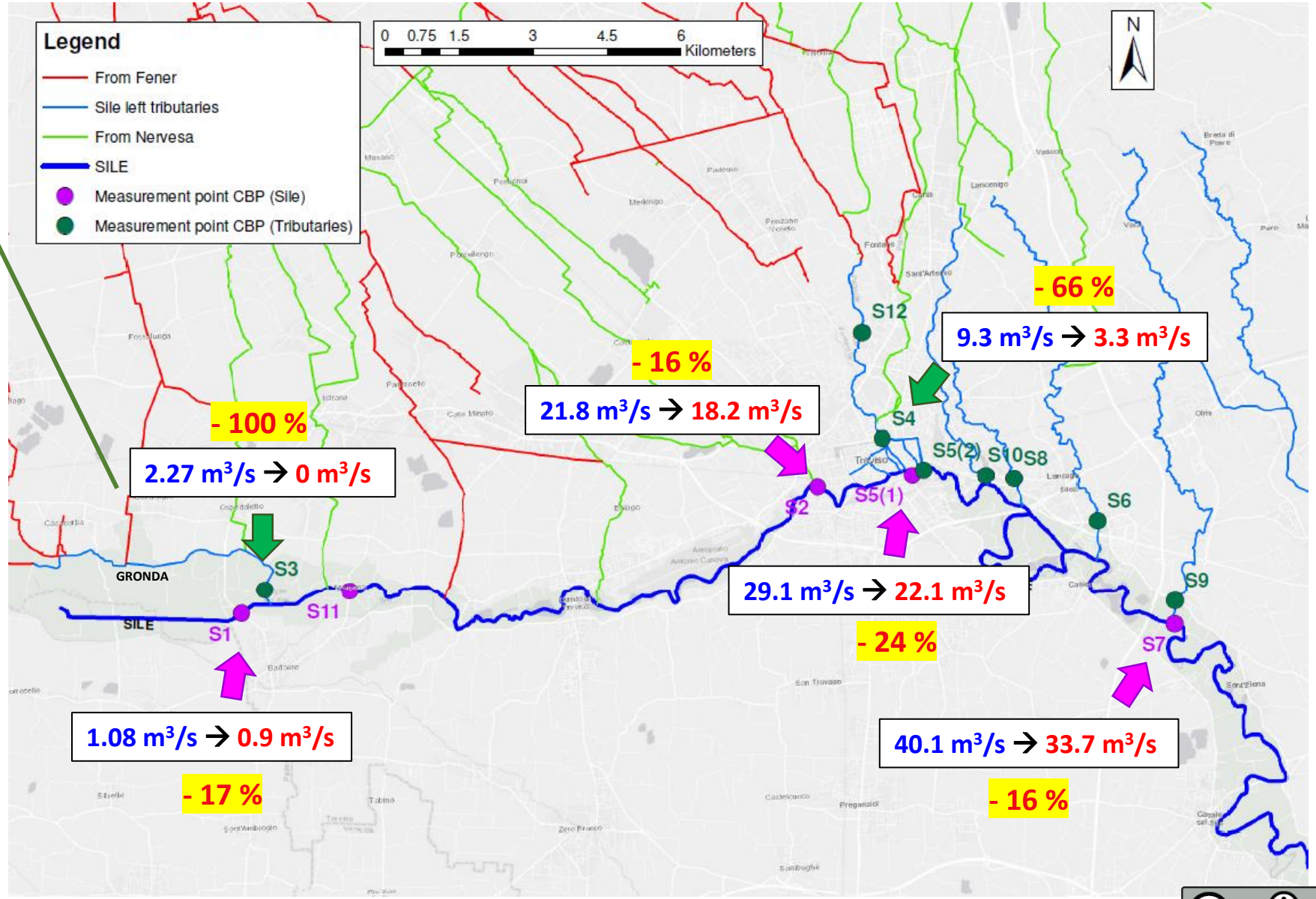
**Discharge related to springs**

**15/02**

S2 - (S1 + S3) - 0.7 $m^3/s$ = 17.2 $m^3/s$

**26/02**

S2 - (S1 + S3) - 0 $m^3/s$ = 17.3 $m^3/s$



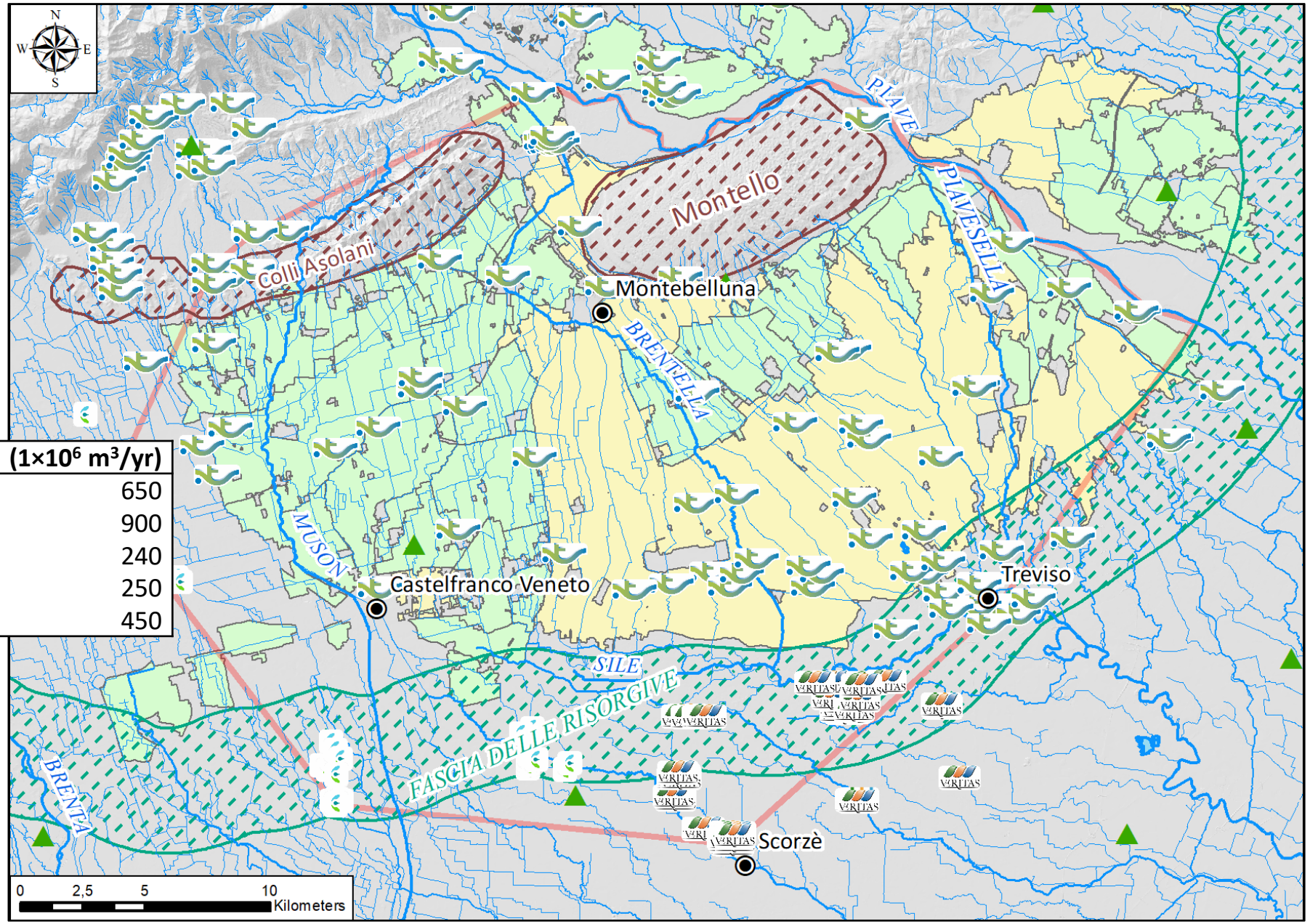

Report "Monitoraggio e sperimentazione sulle grandi derivazioni dal fiume Piave ", 2018, Consorzio di Bonifica Piave.

# Balance

AREA DETAILS
900 km$^2$
152 wells
14 weather stations
3950+2360 km irrigation canals + pipes
63000 ha irrigated area
Springs and Sile

## Balance Year 2018:

| Term | (1×10$^6$ m$^3$/yr) |
|---|---|
| Irrigation | 650 |
| Rainfall | 900 |
| EVT | 240 |
| Water extraction from wells | 250 |
| Springs (Sile river) | 450 |

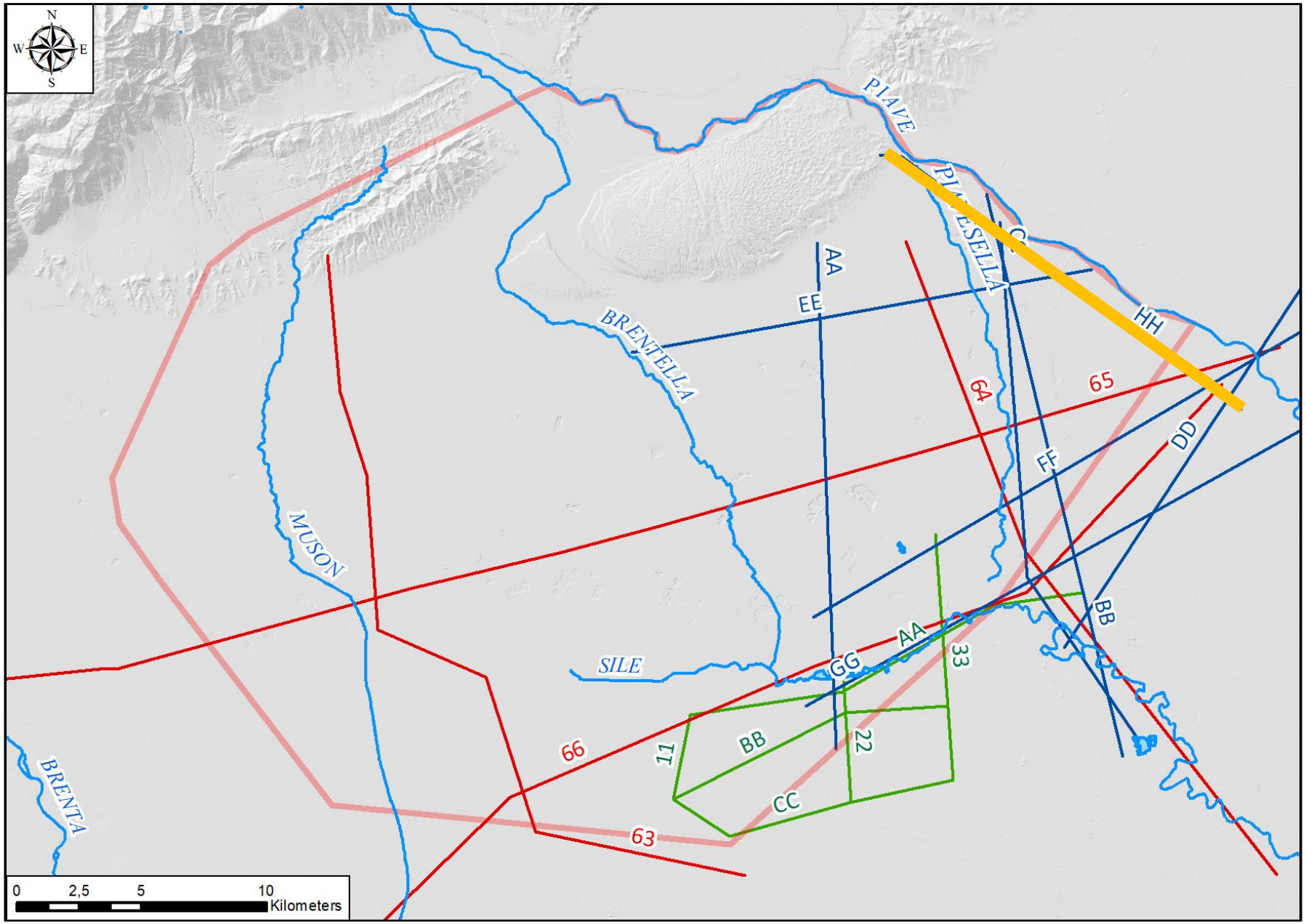


# Geology

AREA DETAILS
900 km$^2$
152 wells
14 weather stations
3950+2360 km irrigation canals + pipes
63000 ha irrigated area
Springs and Sile

<u>18 geological sections</u>

- Dal Pra & Antonelli
- ISPRA
- Cambruzzi et al.



# Geology

~900 km$^2$

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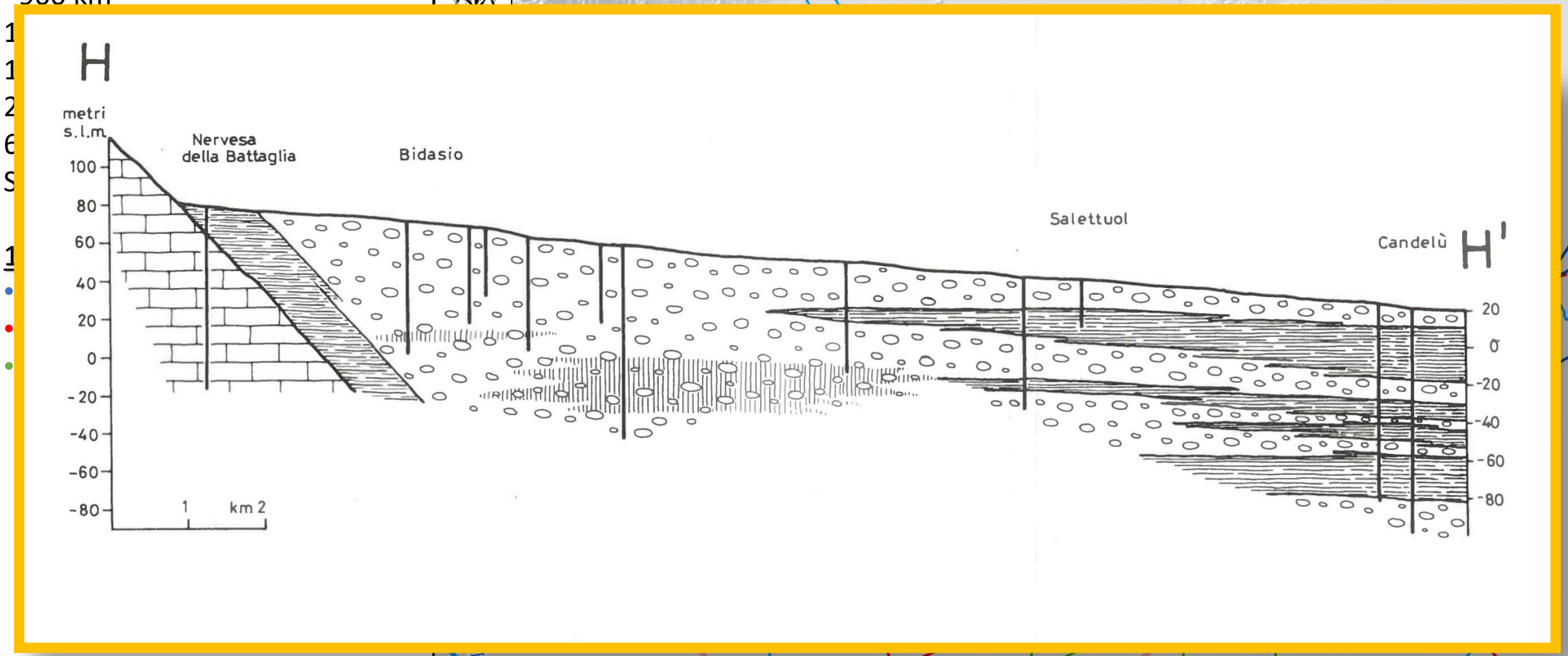
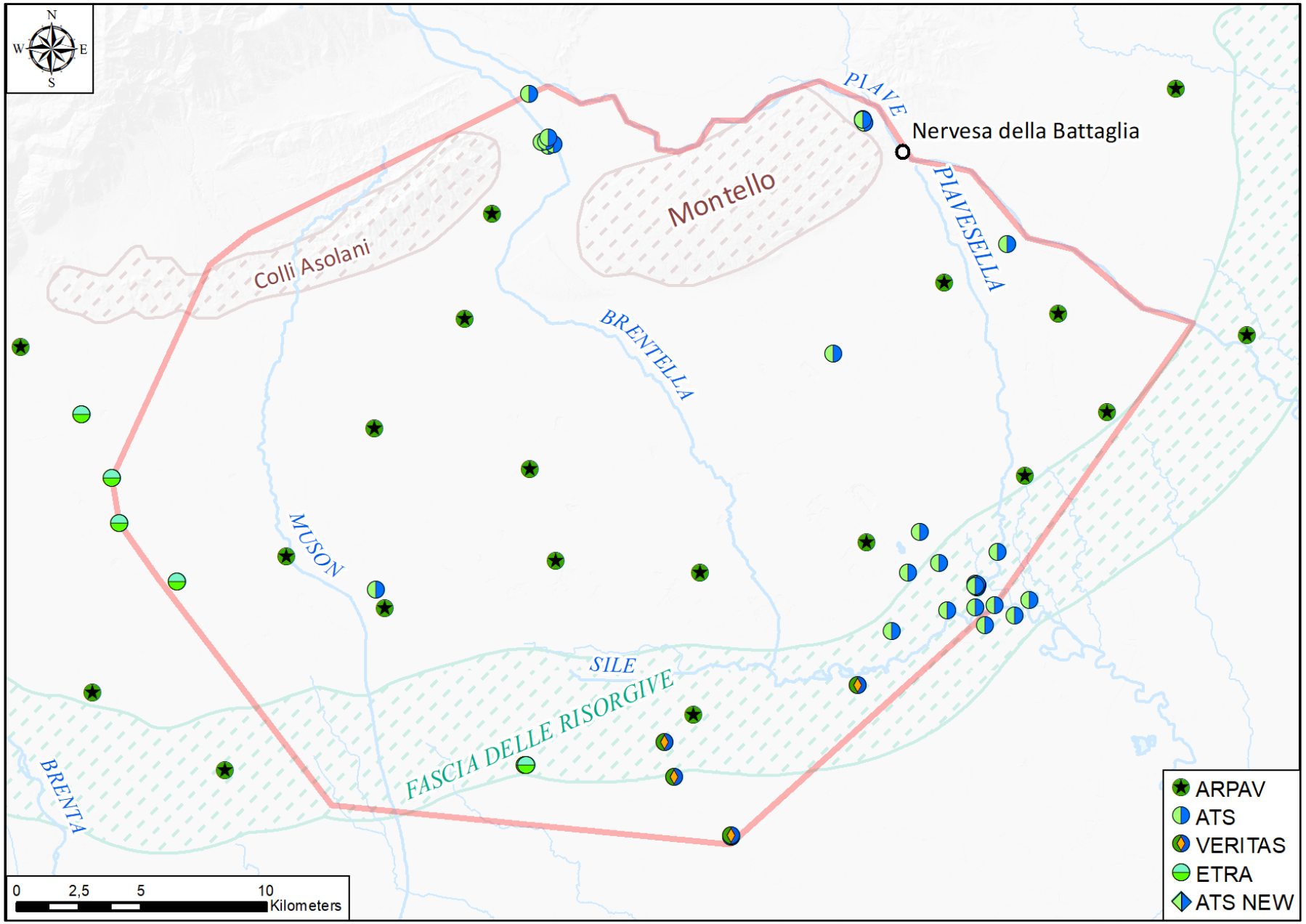


# Monitoring network

AREA DETAILS
900 km$^2$
152 wells
14 weather stations
3950+2360 km irrigation canals + pipes
63000 ha irrigated area
Springs and Sile
18 geological sections

January 2019: 59 sensors for water-table levels

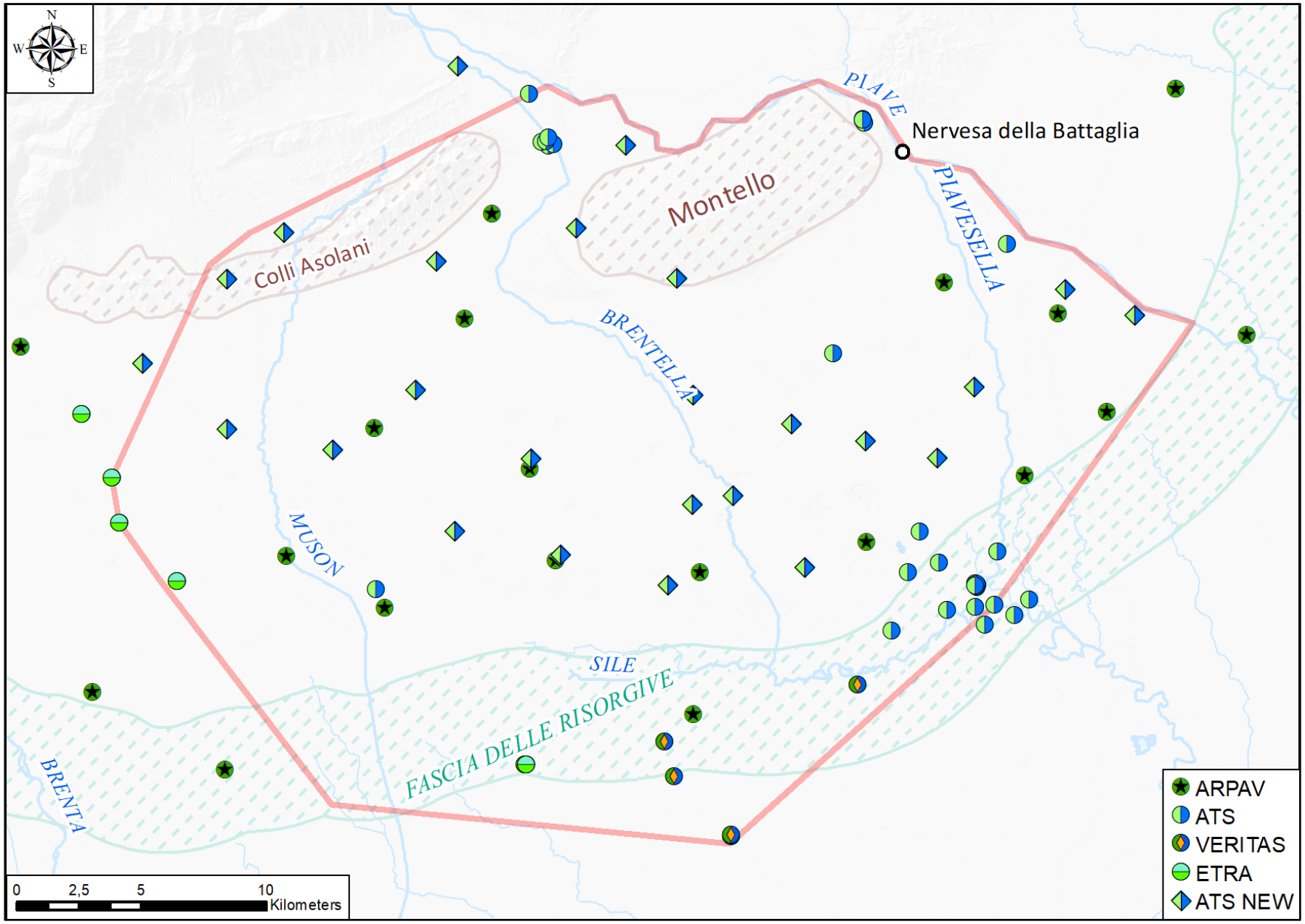
- 10 ARPAV
- 36 ATS
- 6 Etra
- 7 Veritas



# Monitoring network: improving in progress

AREA DETAILS
900 km$^2$
152 wells
14 weather stations
3950+2360 km irrigation canals + pipes
63000 ha irrigated area
Springs and Sile
18 geological sections

December 2019: <u>84 sensors,</u>
25 new measuring levels and temperature

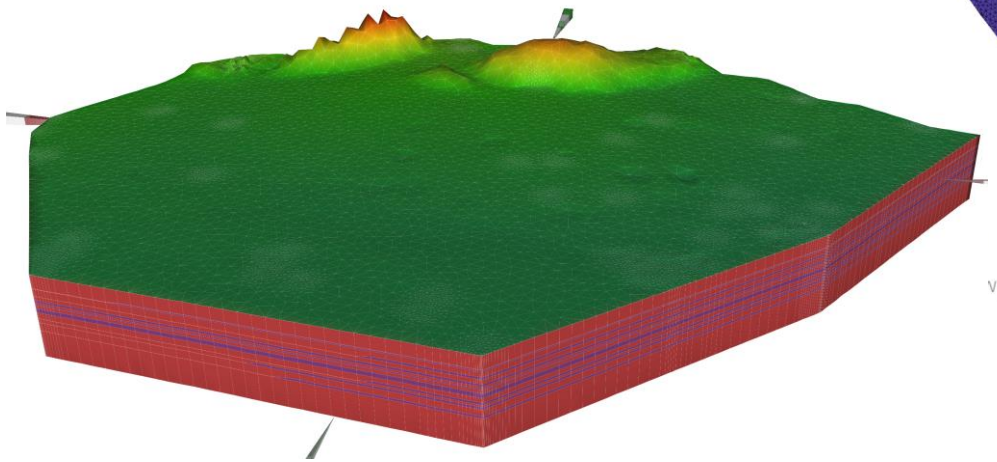


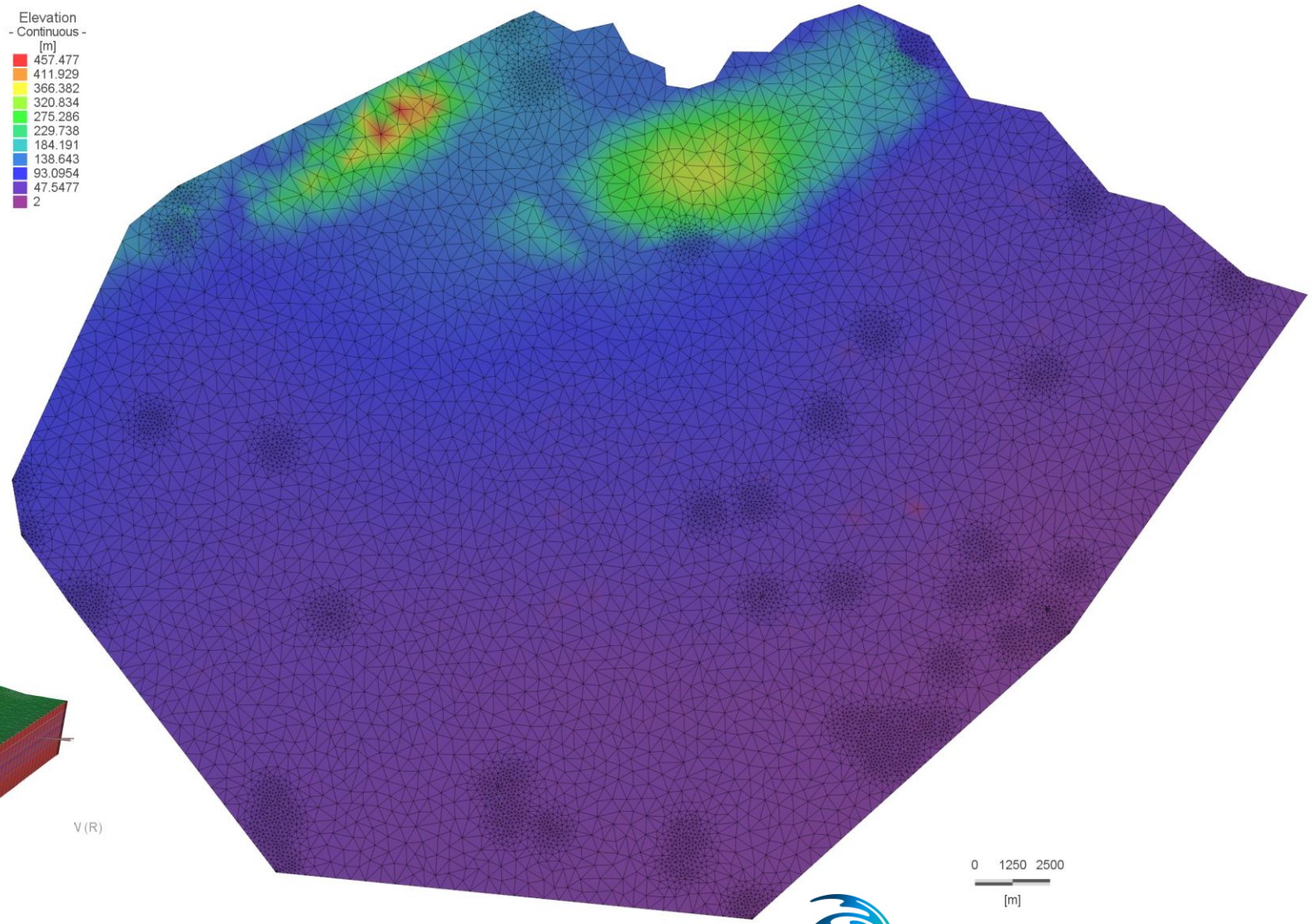
# Numerical model

~900 km$^2$
152 wells
14 weather stations
2400 km irrigation canals
63000 ha irrigation area
Springs and Sile
18 geological sections
84 sensors

<u>Numerical model</u>

- DTM
- Geological informations
- BCs
- <u>Calibration with Pest</u>






Feflow® kindly provided by DHI

# Numerical model

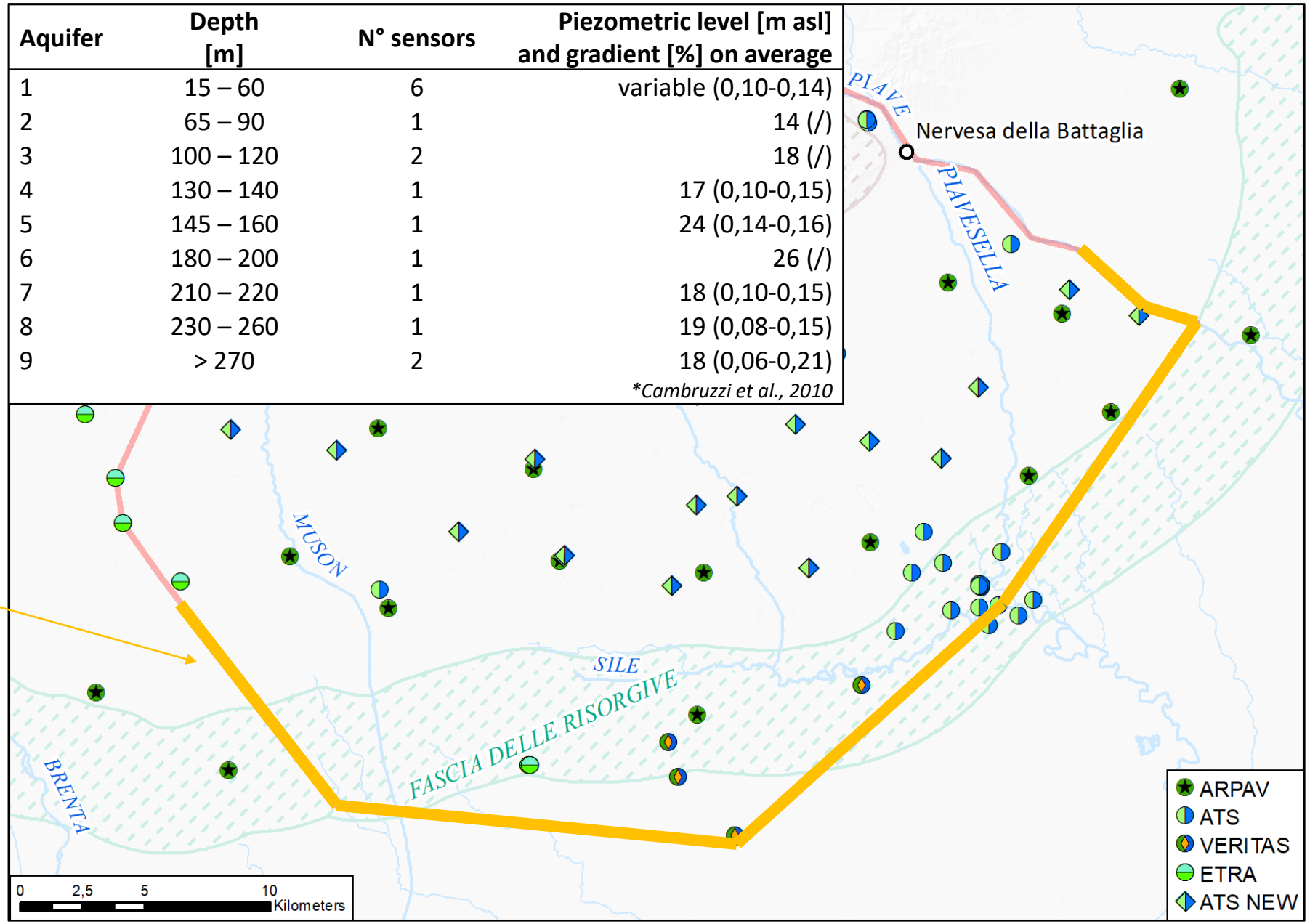
AREA DETAILS
900 km$^2$
152 wells
14 weather stations
3950+2360 km irrigation canals + pipes
63000 ha irrigated area
Springs and Sile
18 geological sections
84 sensors

**BCs:** only 16 points are instrumented on the multi aquifer boundary

**First calibration runs unsuccessfully**

| Aquifer | Depth [m] | N° sensors | Piezometric level [m asl] and gradient [%] on average |
|---|---|---|---|
| 1 | 15 – 60 | 6 | variable (0,10-0,14) |
| 2 | 65 – 90 | 1 | 14 (/) |
| 3 | 100 – 120 | 2 | 18 (/) |
| 4 | 130 – 140 | 1 | 17 (0,10-0,15) |
| 5 | 145 – 160 | 1 | 24 (0,14-0,16) |
| 6 | 180 – 200 | 1 | 26 (/) |
| 7 | 210 – 220 | 1 | 18 (0,10-0,15) |
| 8 | 230 – 260 | 1 | 19 (0,08-0,15) |
| 9 | > 270 | 2 | 18 (0,06-0,21) |

*Cambruzzi et al., 2010



# Preliminary results

We are defining the aquifer structure model, looking for the intersection between the phreatic surface and the piezometric of each artesian aquifer (data from available literature).

| Aquifer | Depth [m] | N° sensors | Piezometry [m asl] and gradient [%] on average |
|---|---|---|---|
| 1 | 15 – 60 | 6 | variabile (0,10-0,14) |
| 2 | 65 – 90 | 1 | 14 (/) |
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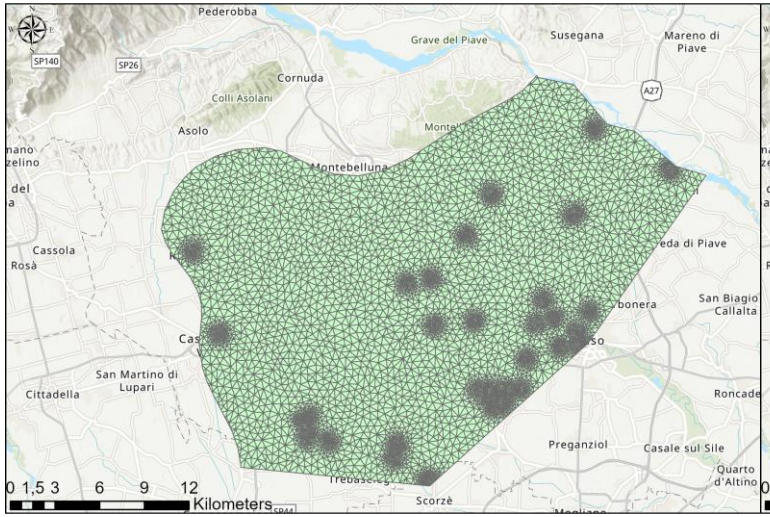
| 9 | > 270 | 2 | 18 (0,06-0,21) |

*Cambruzzi et al., 2010*

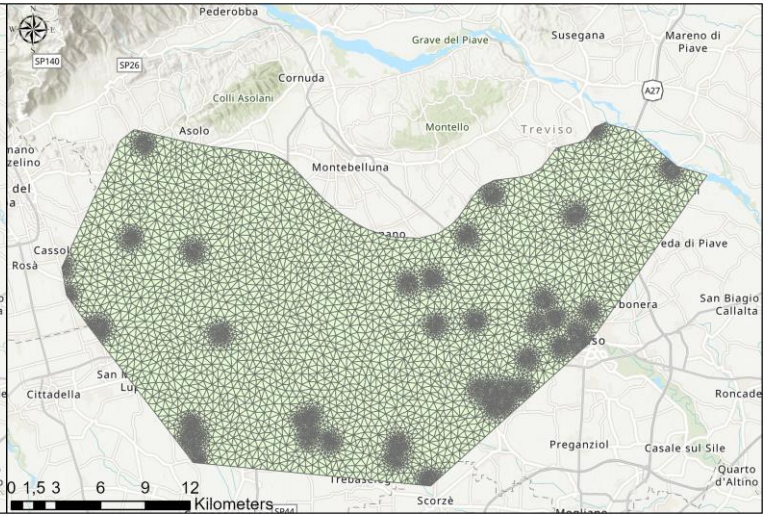
Data must be validated by field surveys.

Due to the actual pandemic emergency only preliminary results are available at the moment.

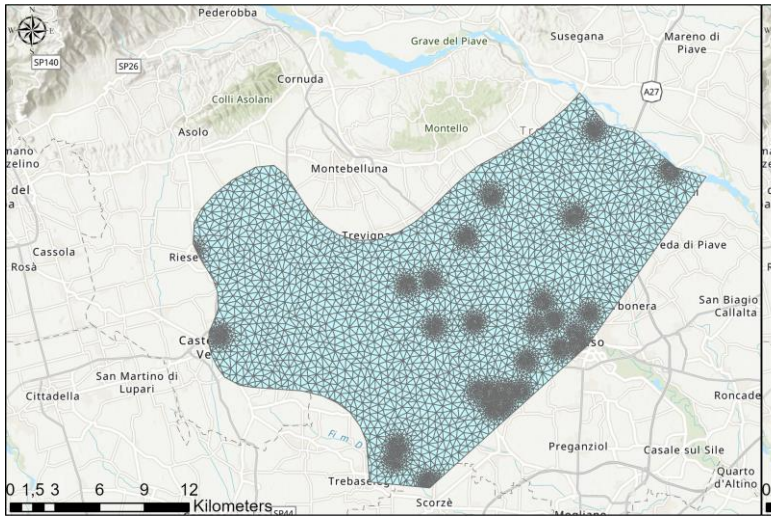
Aquitard between I and II aquifers



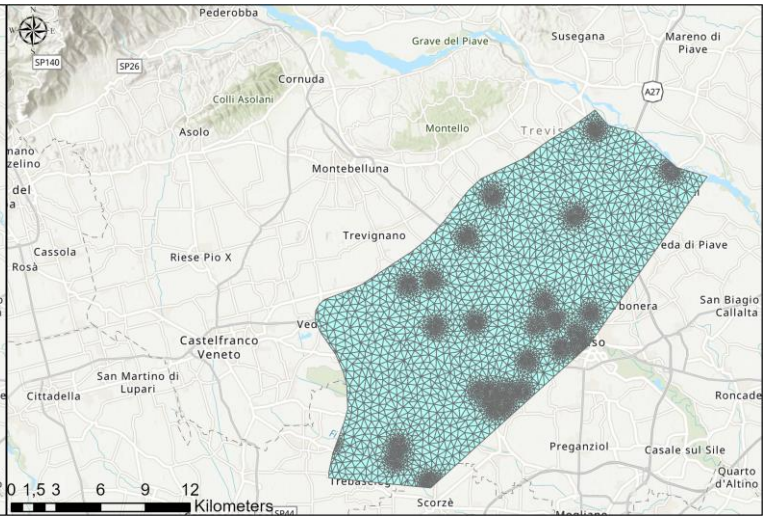

Aquitard between VI and VII aquifers




Aquitard between IV and V aquifers




Aquitard between VIII and IX aquifers



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# Thank you!
# Questions?

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