GEOPHYSICAL TECHNIQUES FOR MONITORING THE CLIMATE CHANGE EFFECTS ON GROUNDWATER AVAILABILITY AND QUALITY

Marco Sabattini[1], Francesco Ronchetti[1], Diego Arosio[1], Gianpiero Brozzo[2], Andrea Panzani[3]

[1] Università di Modena e Reggio Emilia, Dipartimento di Scienze Chimiche e Geologiche (Modena, Italy); [2] ACAM acque S.p.A., IREN group (La Spezia, Italy); [3] Alfa Solutions S.p.A. (Reggio Emilia, Italy)

INTRODUCTION

The reduction in the availability of groundwater resources (80% of the main human water supply in Italy) is one of the main issues related to climate change. Sustainable water-related development depends on the introduction of new and more efficient groundwater monitoring methodologies.

The alluvial plain of the lower Val Magra (Liguria, Italy) is an intensively urbanised coastal area. In this area, the main aquifer is **qualitatively and quantitatively vulnerable** to the effects of climate change.

The aquifer is unconfined and very close to ground level (3-7 m depth). It is located in a coarse alluvial deposit with high permeability. The aquifer is closely connected to the Magra River and is affected by interaction with seawater near the coast.

Periods of drought favour the **marine intrusion phenomenon** (saltwater rising upstream along the Magra River), the main responsible for the deterioration of groundwater quality in the area.

Three years objective	Investigate the effects of climate change on the availability and quality of groundwater resources using traditional and innovative monitoring techniques
First period (now)	Hydrogeological characterisation of test sites
Middle period	Experimental monitoring using geophysics
Last period	Numerical groundwater modelling

METHODS

The project is focused on the passive seismic techniques as **innovative methods** for monitoring groundwater variation. Changes in soil water content can be measured by geophones as a change in VS over time (seismic noise cross-correlation methods).

The **main advantages**: versatility, low cost, easy (to install and use), portable, non-invasive.

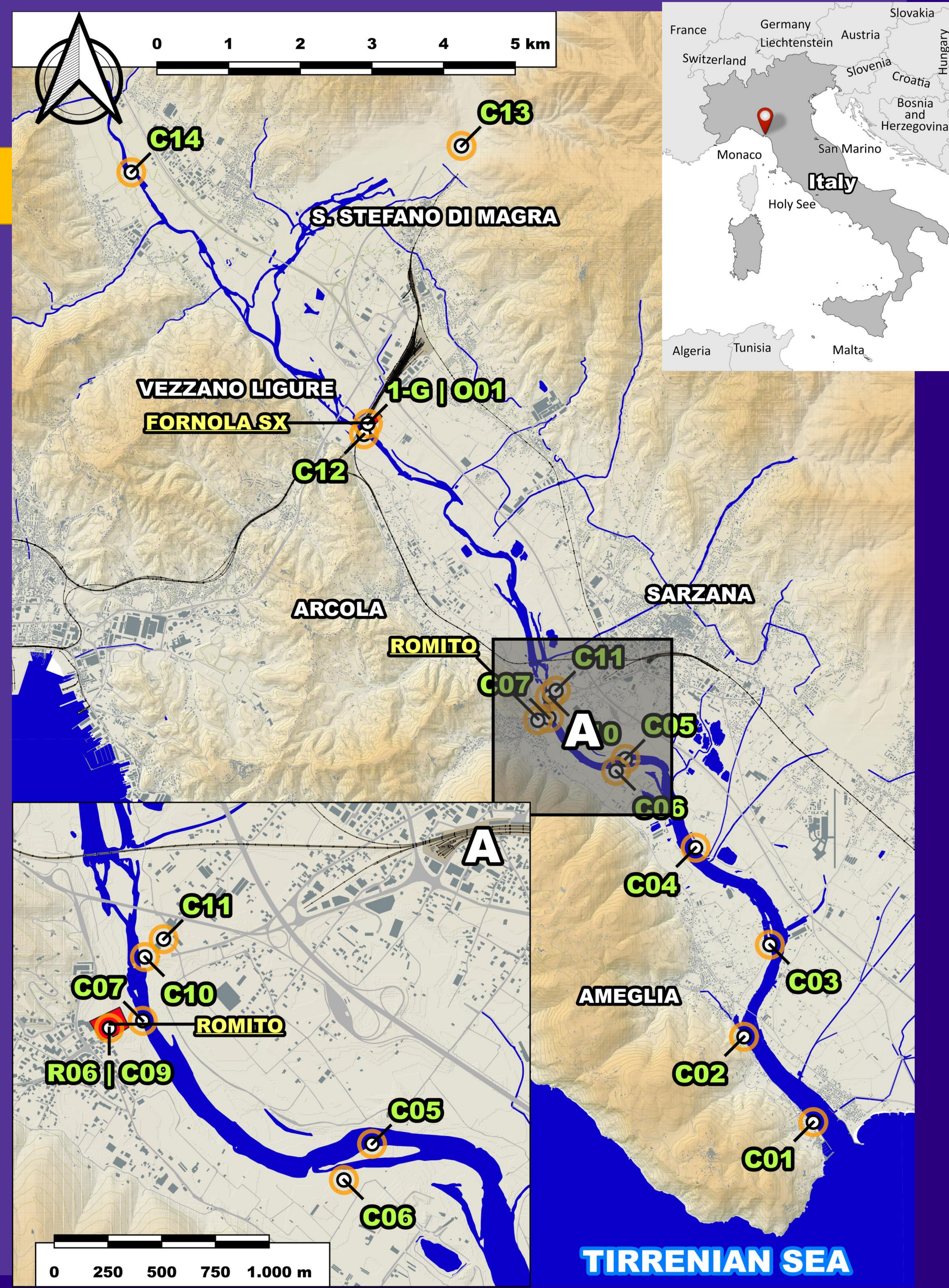
The effectiveness and accuracy of these techniques will be evaluated directly in the field, in real case studies. For this purpose, two test sites were selected:

1) **Romito well field** (where high chloride concentrations have been recorded in the past).
2) **Fornola SX well field** (near the largest and most industrialised town in the area).

The innovative experimental methods will be integrated by:

1. Direct monitoring	continuous measurements with multi-parametric probes in wells and piezometers
	chemical and isotopic analyses (O and H) of sample of surface water and groundwater
	water electrical conductivity measurements
2. Geophysical surveys	active (refraction) and passive seismic (MASW, HVSR)
	geoelectric (SEV)
3. Hydrogeological numerical models (in the final phase of the project will replace direct monitoring)	

A

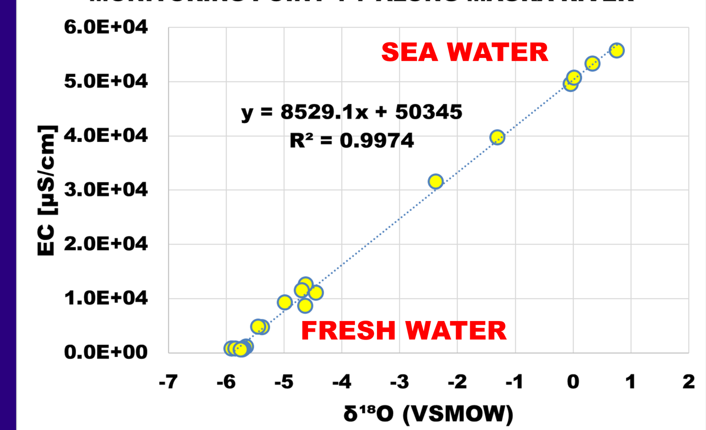


B

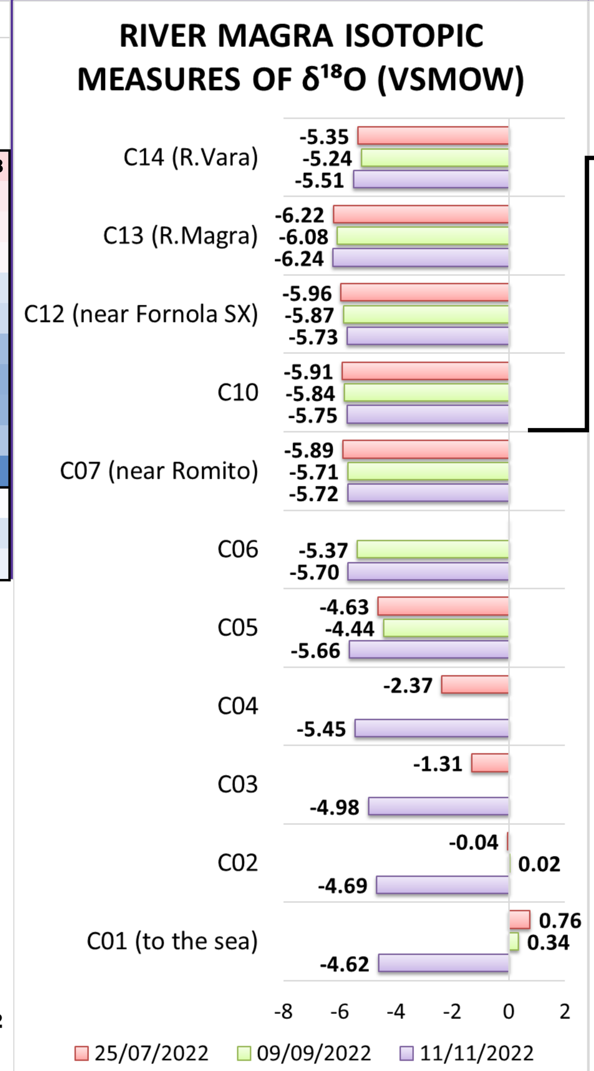
ELECTRICAL CONDUCTIVITY MEASURES [µS/cm]

		03 Feb 22	08 Mar 22	24 May 22	15 Jun 22	25 Jul 22	09 Sep 22	11 Nov 22	10 Feb 23
SURFACE WATER	C01				33660	55750	53350	12600	13818
	C02					49600	50700	11520	8081
	C03					39700		9235	5838
	C04					31550		4750	3284
	C05					8685	11090	1134	676.2
	C06						4695	769	635
	C07		459	562	569.5	737	803	603	498.1
	C10				548	734	752	577	447.7
	C12					761	803	582	462.8
	C13					1247	1275	926	540.1
	C14					395	376	372	284.8
WELL	C09	1070	700	852	911			957.5	1116
	C11				574	757	766	775	667.8
	O01							666	729

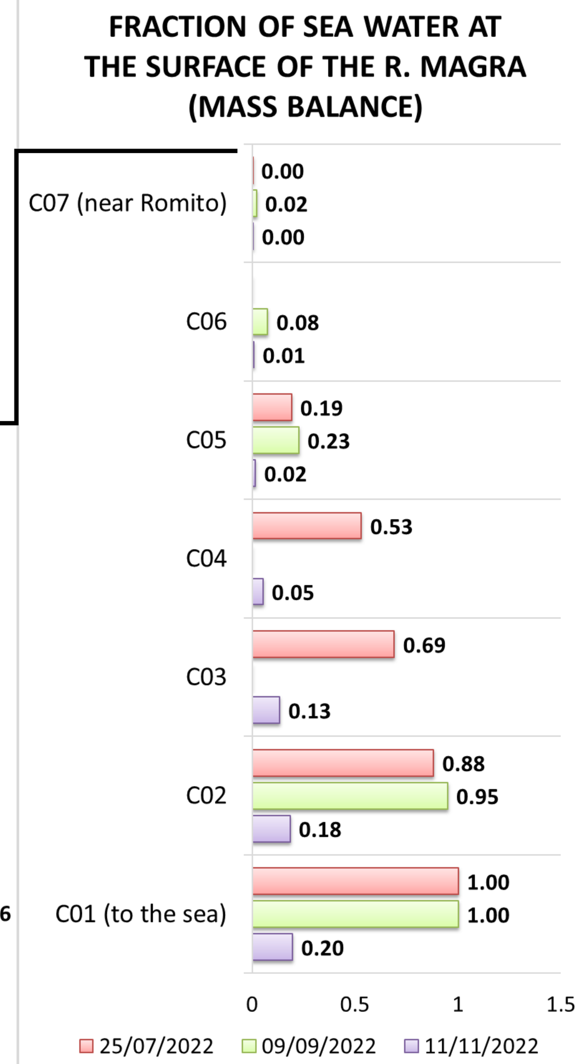
CORRELATION BETWEEN EC AND δ¹⁸O FOR MONITORING POINT 1-7 ALONG MAGRA RIVER



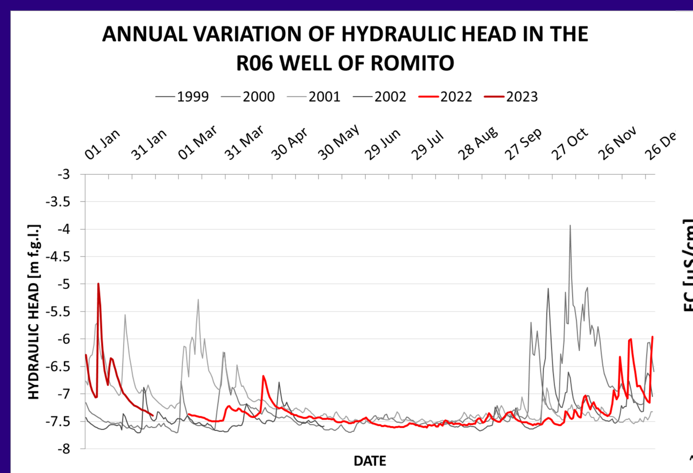
RIVER MAGRA ISOTOPIC MEASURES OF δ¹⁸O (VSMOW)

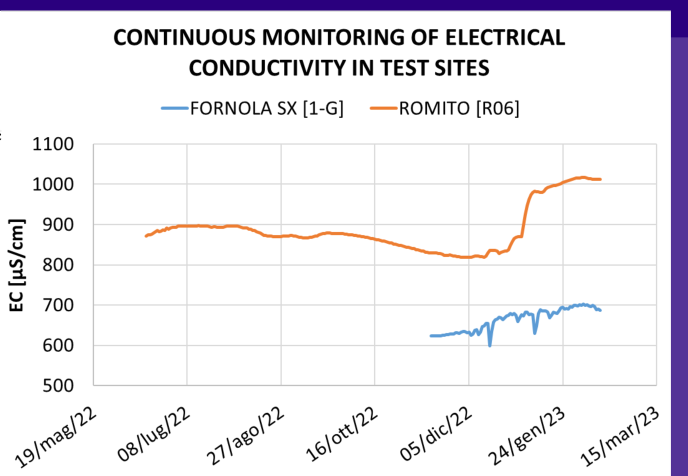


FRACTION OF SEA WATER AT THE SURFACE OF THE R. MAGRA (MASS BALANCE)

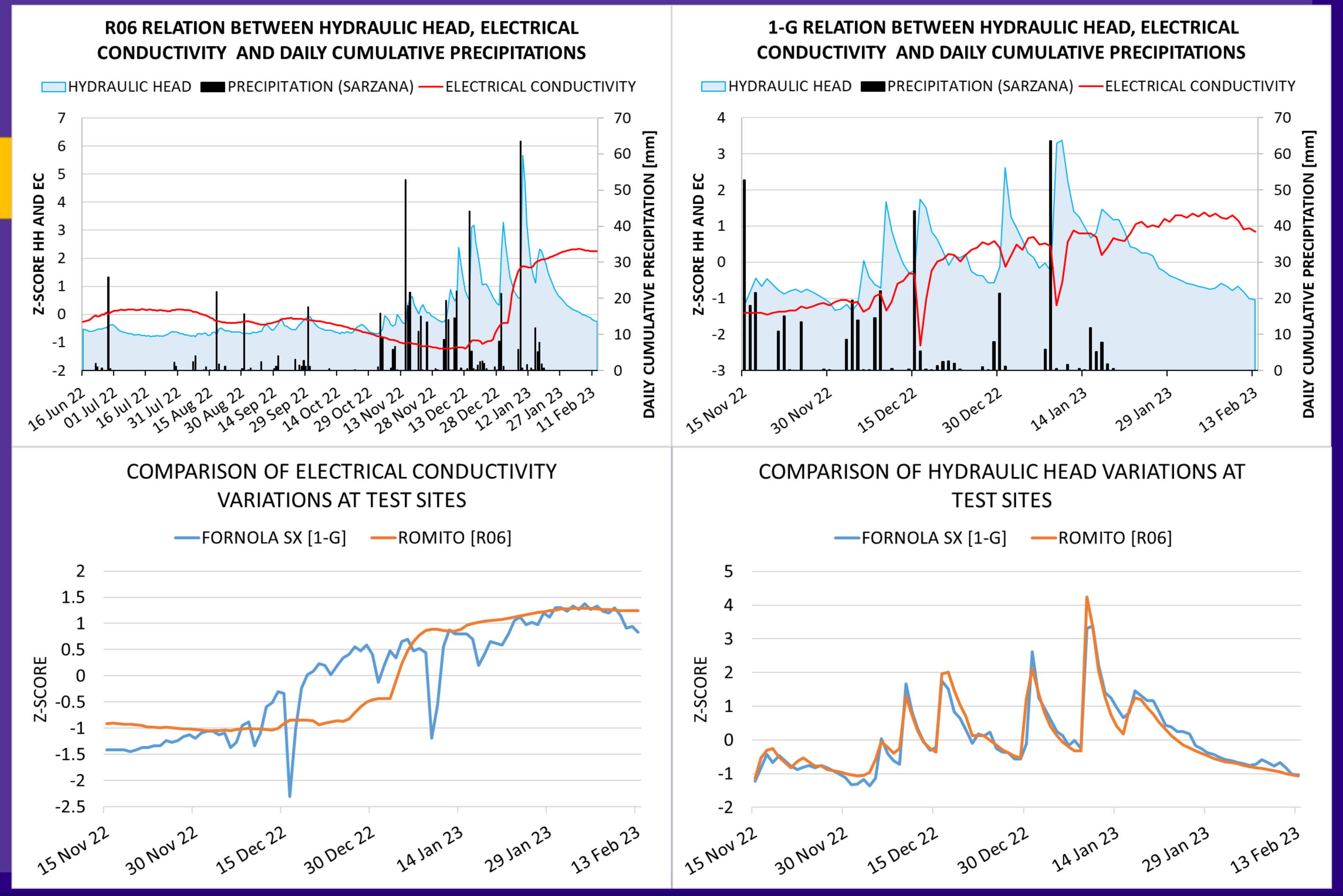


C

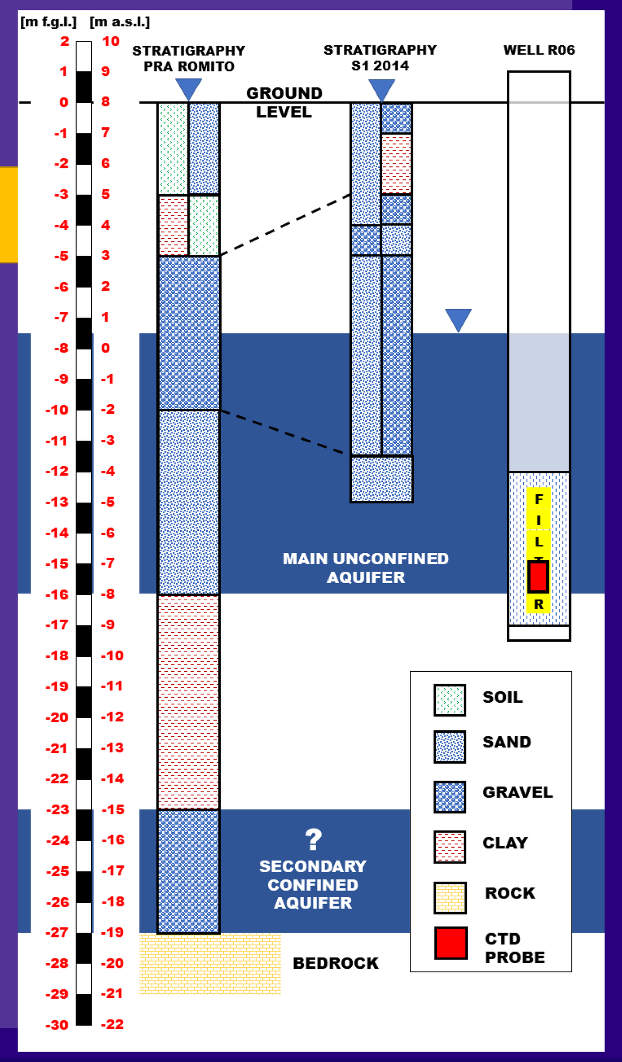




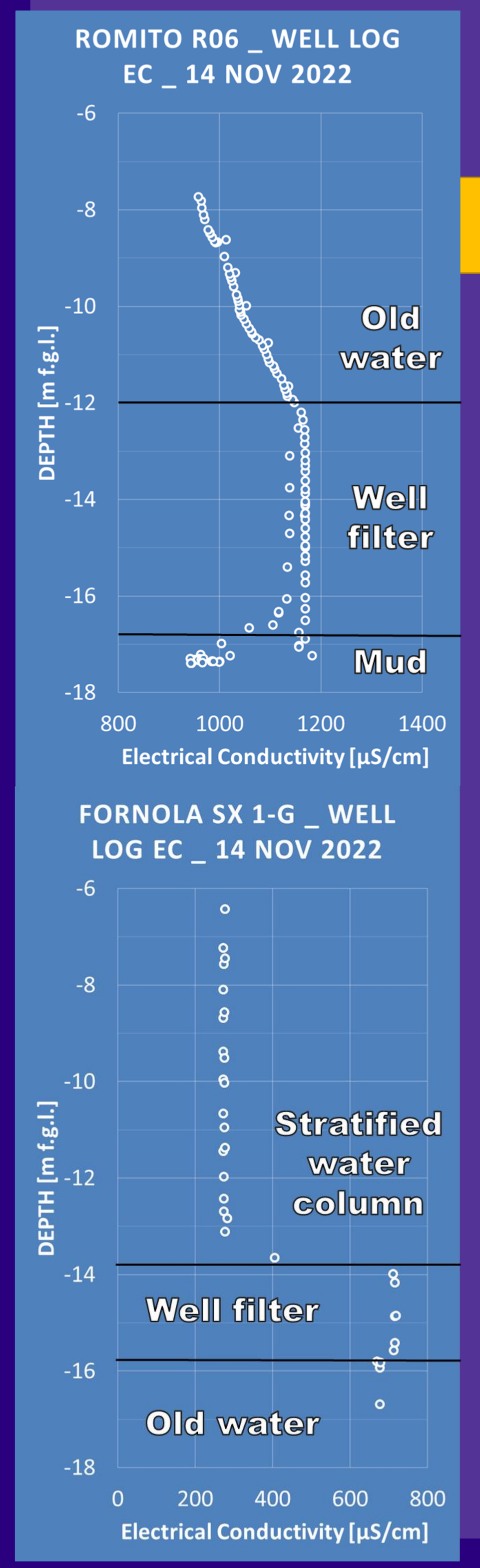
F



D



E



RESULTS

A. Magra alluvial plain map and monitoring points.
B. Physico-chemical reconstruction of the marine intrusion phenomenon along the Magra river. Electrical conductivity (sea water intrusion) is directly correlated with δ18O. The mass balance reveals mixing with 2% seawater in the surface waters of the Magra river near Romito.
C. Continuous monitoring does not show a difference with the past in the hydraulic head data (Romito).
D. The stratigraphic reconstruction of the Romito area reveals the possible existence of a second confined lower aquifer where the saline wedge may be present.
E. The well logs do not show the presence of a stratified water column due to the saline wedge in the Romito subsoil.
F. The comparison of variations in EC and HH over time at the two test sites suggests that:
   - the alimentation system is the same;
   - the Magra river is probably the main source;
   - The EC long-term response is controlled by different mechanisms.

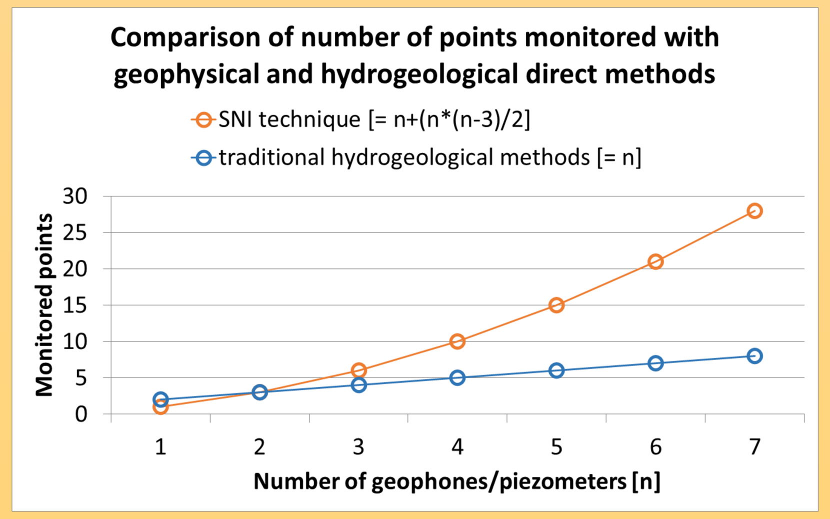
NEXT ACTIVITIES

Main aquifer quantitative monitoring:

+ Passive seismic will be used to indirectly record the groundwater depletion during pumping tests at Romito.
+ A fixed geophone network will be installed at Fornola SX. The geophones will acquire data for a long period during the well exploitation activity. These data will be processed (SNI technique) and correlated with direct monitoring data (well 1-G) to define the piezometric surface and its variations.

Main aquifer quality monitoring:

+ Periodic geoelectrical surveys will detect the presence of pollutants (all test sites) and the salt wedge (Romito).



FOR MORE INFO

Mail:
marco.sabattini@unimore.it

To abstract