Hydrogeological Map of the City of Rome

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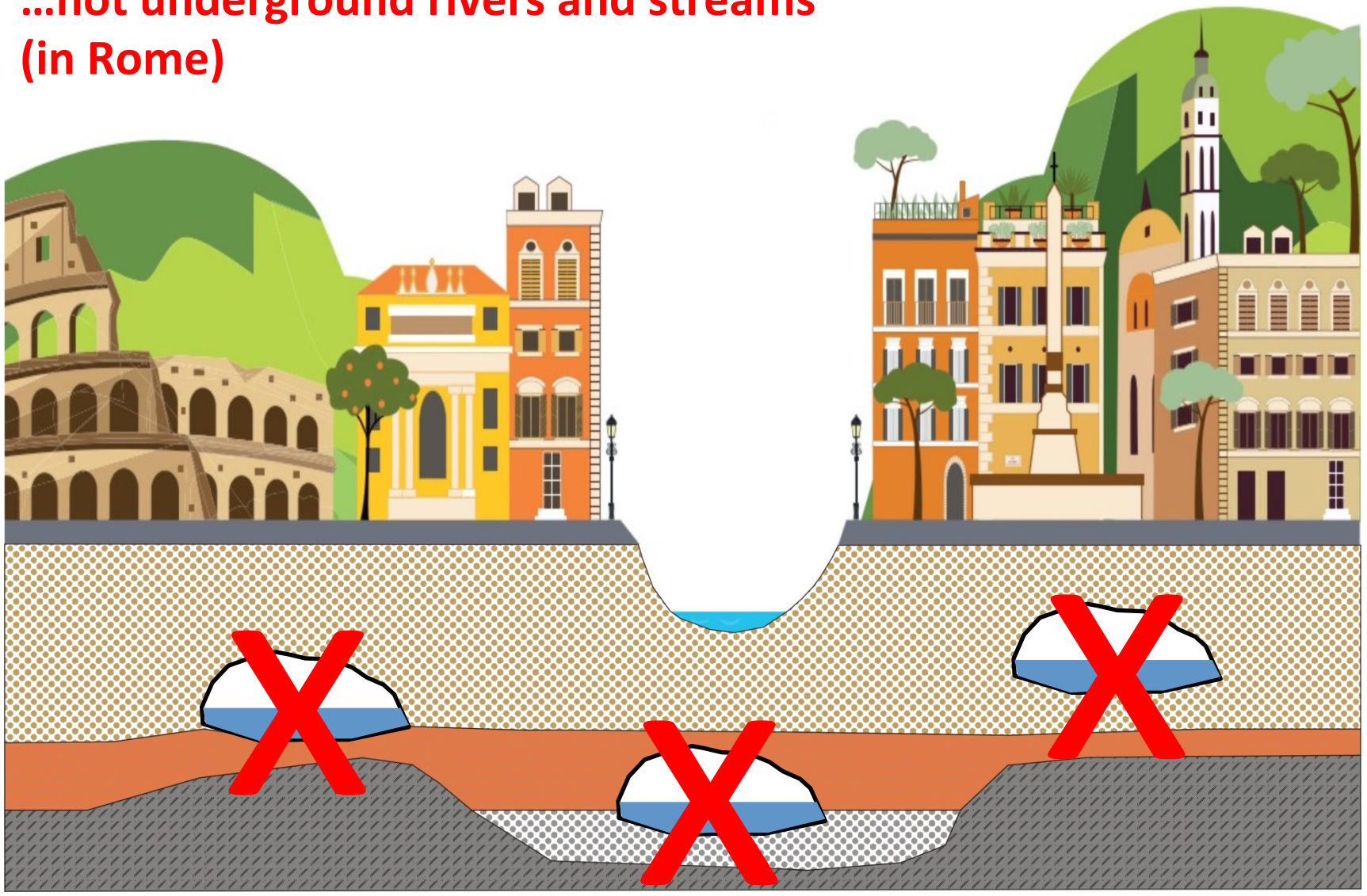
Outline

- Introduction – what is groundwater
- *Roma Regina Aquarum*
- Previous maps
- A project for the new Hydrogeological Map of Rome
- ReMas Project (Groundwater Monitoring Network of Rome)
- The new Hydrogeological Map of Rome – 1:50.000 scale
- The benefits for Rome to have a new Hydrogeological Map
- Is groundwater playing some roles in the resilience of cities?
- Conclusion

What is not groundwater

…not underground rivers and streams (in Rome)



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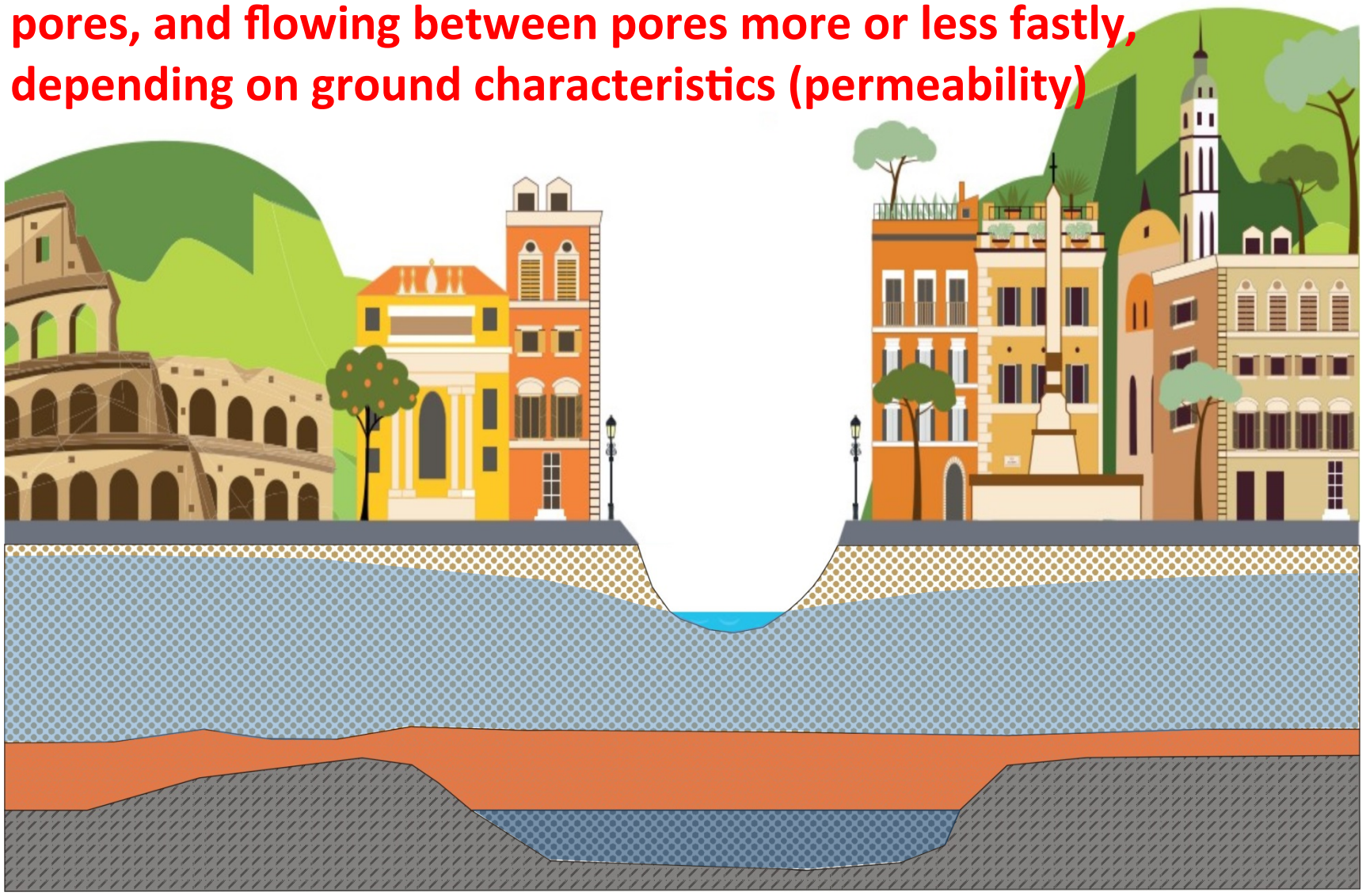
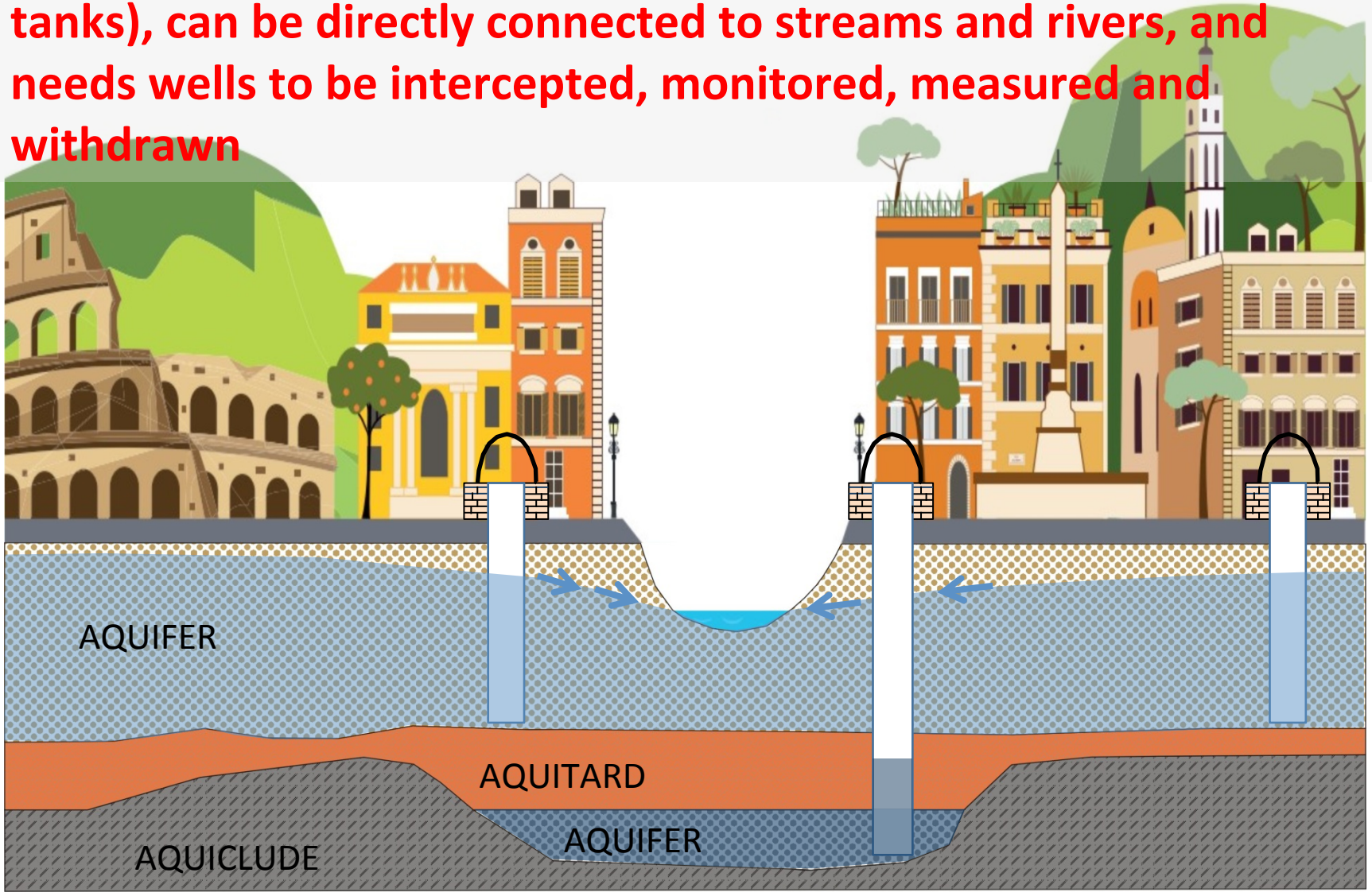
What is groundwater

It is infiltred water in the ground, saturating underground pores, and flowing between pores more or less fastly, depending on ground characteristics (permeability)



What is groundwater

Groundwater flows trough aquifers (natural underground tanks), can be directly connected to streams and rivers, and needs wells to be intercepted, monitored, measured and withdrawn



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Roma «Regina Aquarum»

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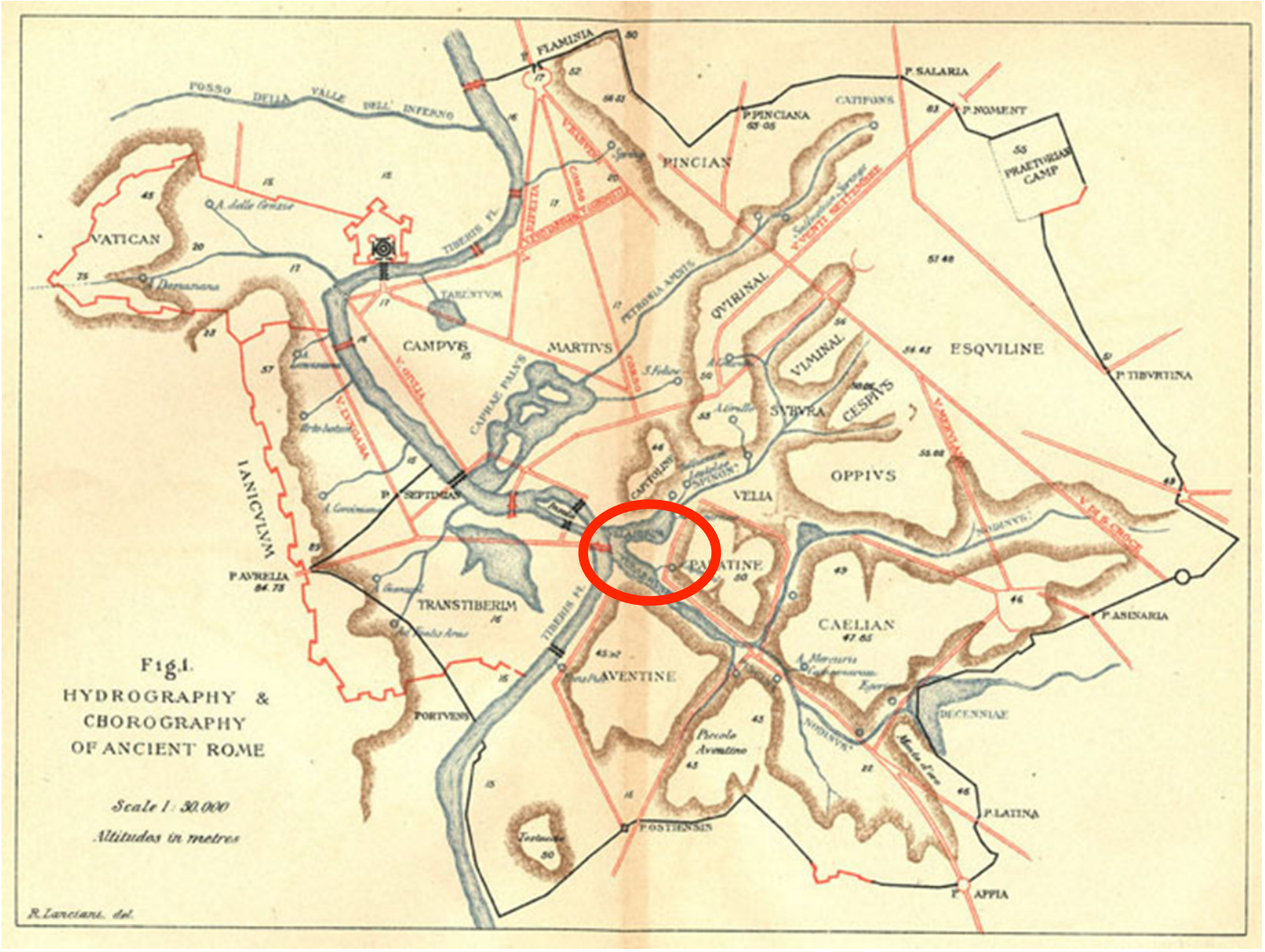
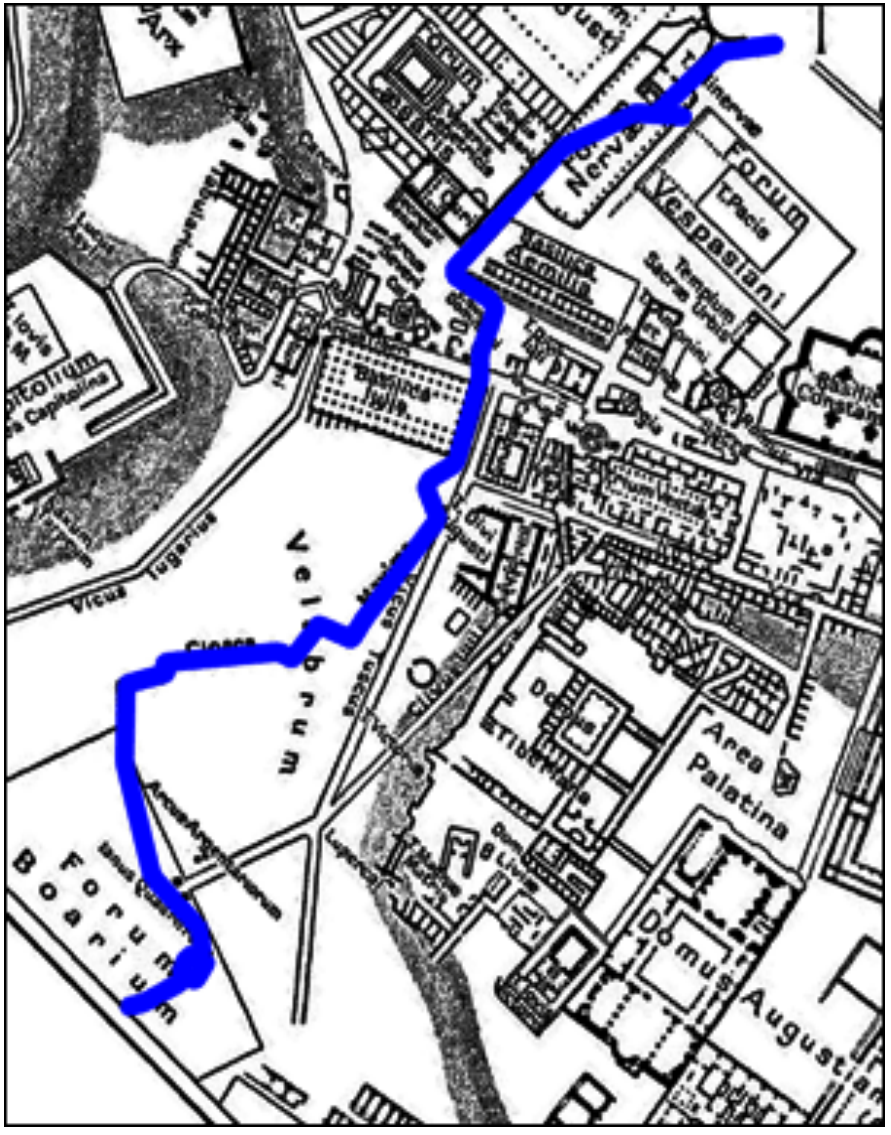
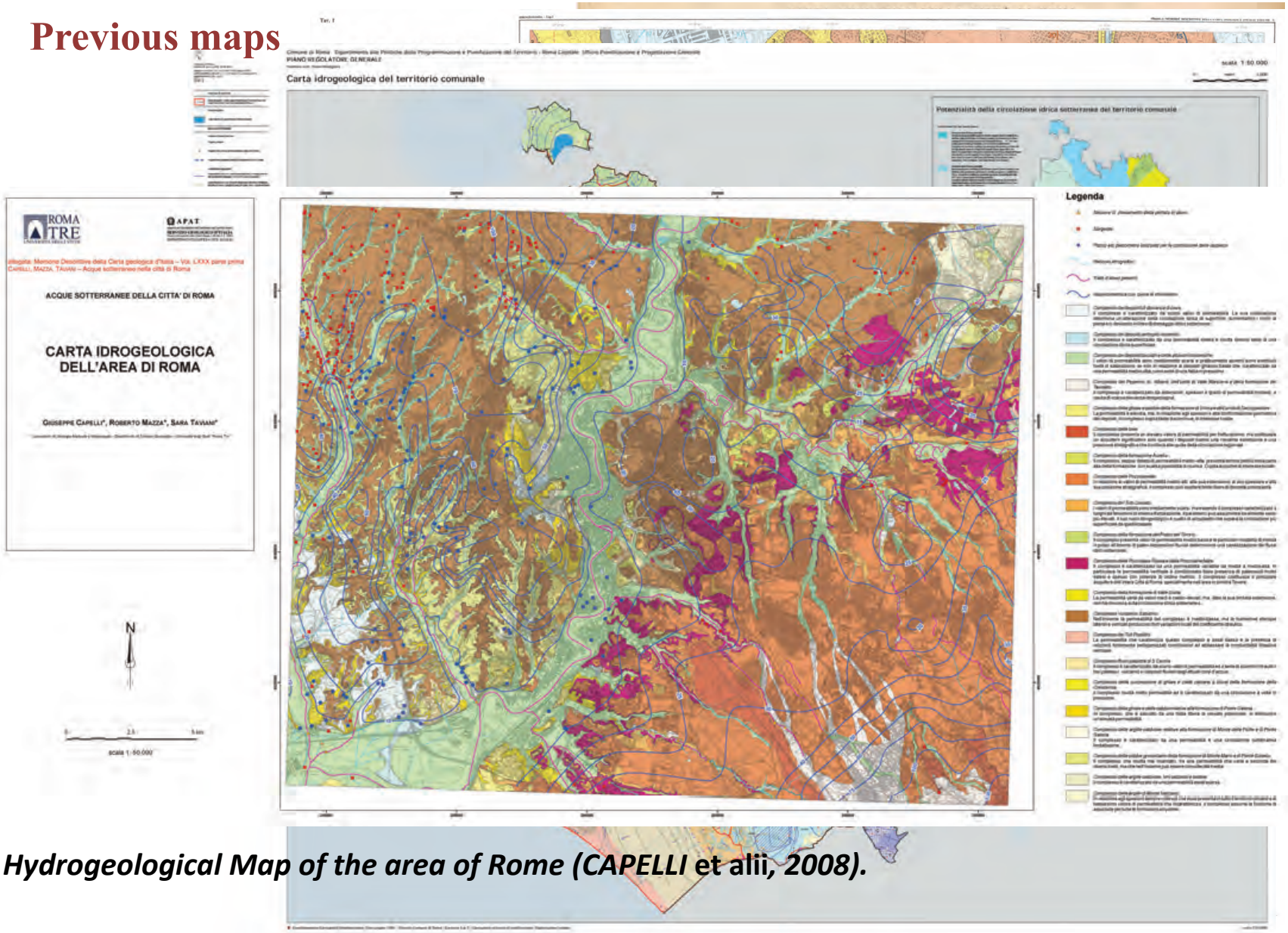
Roma «Regina Aquarum»



Roma «Regina Aquarum»



Previous maps



Hydrogeological Map of the area of Rome (CAPELLI et alii, 2008).

Hydrogeological Map of Rome Municipality (SUCCHIARELLI & D'OTTAVIO, 2008).

A project for the new Hydrogeological Map of Rome

The project to create a new hydrogeological map of Rome comes from different needs and will:

- **The need to implement policies for the protection, monitoring and conservation of water resources**

- **The need to provide the city with an updated and homogeneous base map concerning groundwater, with particular reference to the protection of water resources from the many critical environmental issues in the area**

- **The need to bring into a single shared model the knowledge and experience of those describing for decades the Roman hydrogeology**

- **The will to know more in detail the groundwater of Rome to be able to take full advantage in terms of sustainability**

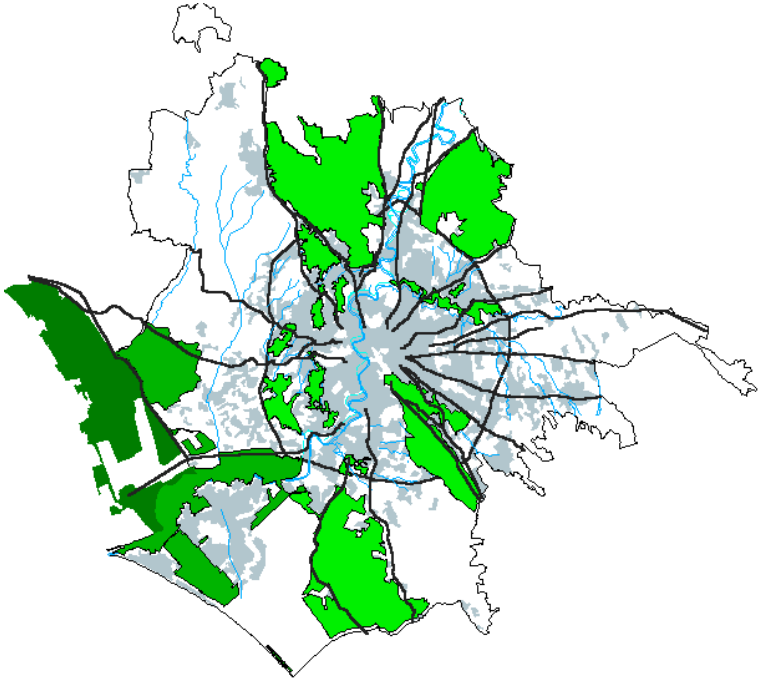
April 2014 - ReMas Project (Groundwater Monitoring Network of Rome)

1) Rome is a City with many parks, thus with many irrigation plants, thus with many public wells

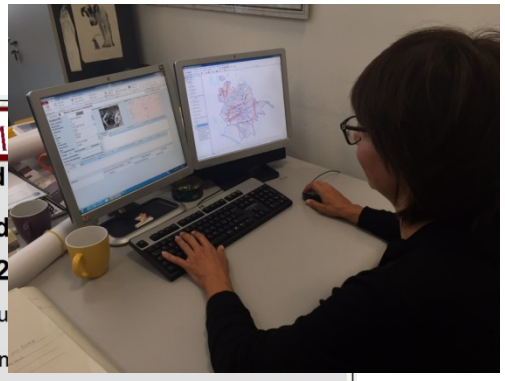
2) The project had the aim of reviewing categorize and collect all of the existing wells owned by the Administration and used for various purposes

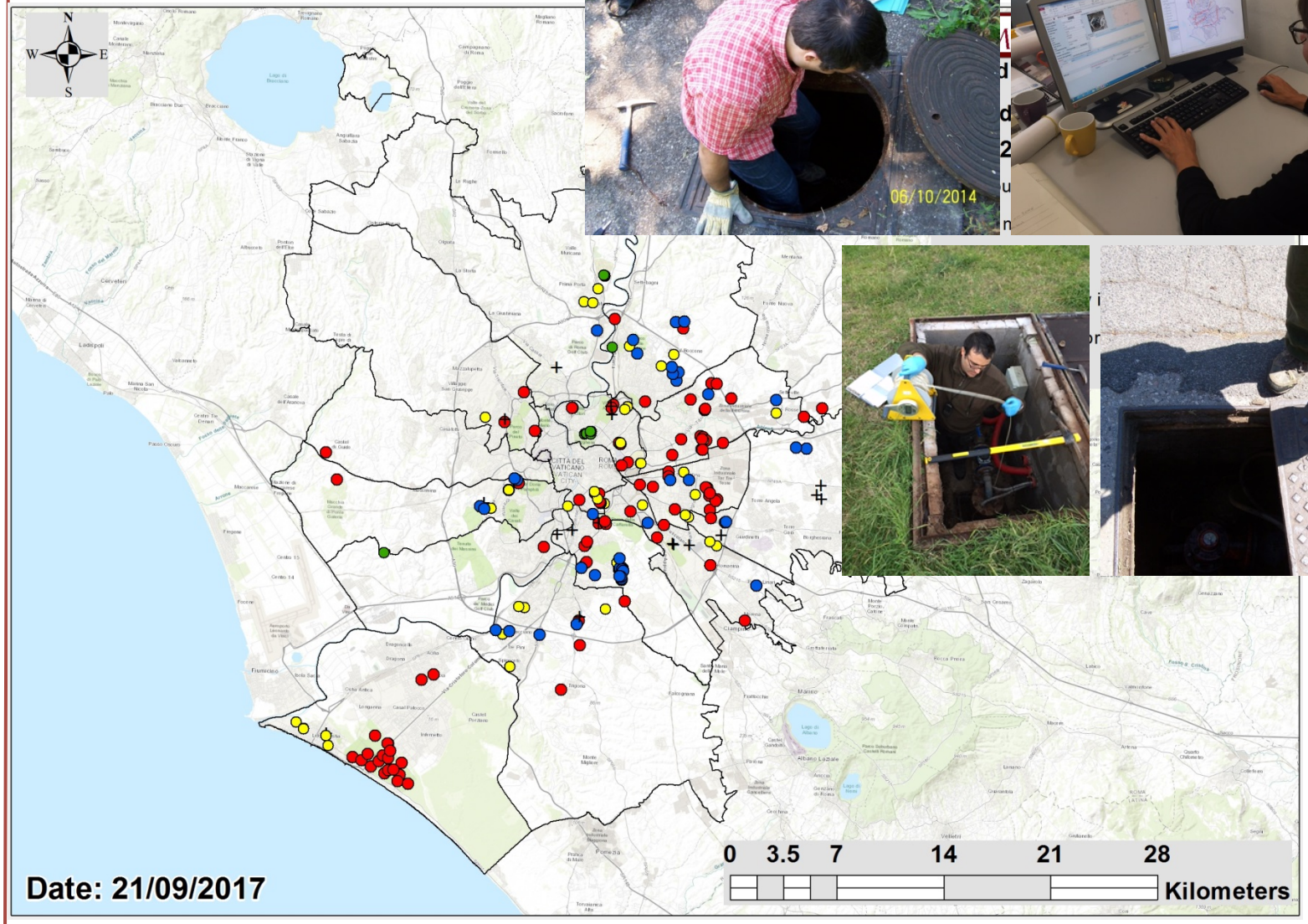
3) It has been the first time that a project like this has been developed by Rome Municipality

4) The project was absolutely at "zero" costs for the Administration



ReMas Project (Groundwater Monitoring Network of Rome)





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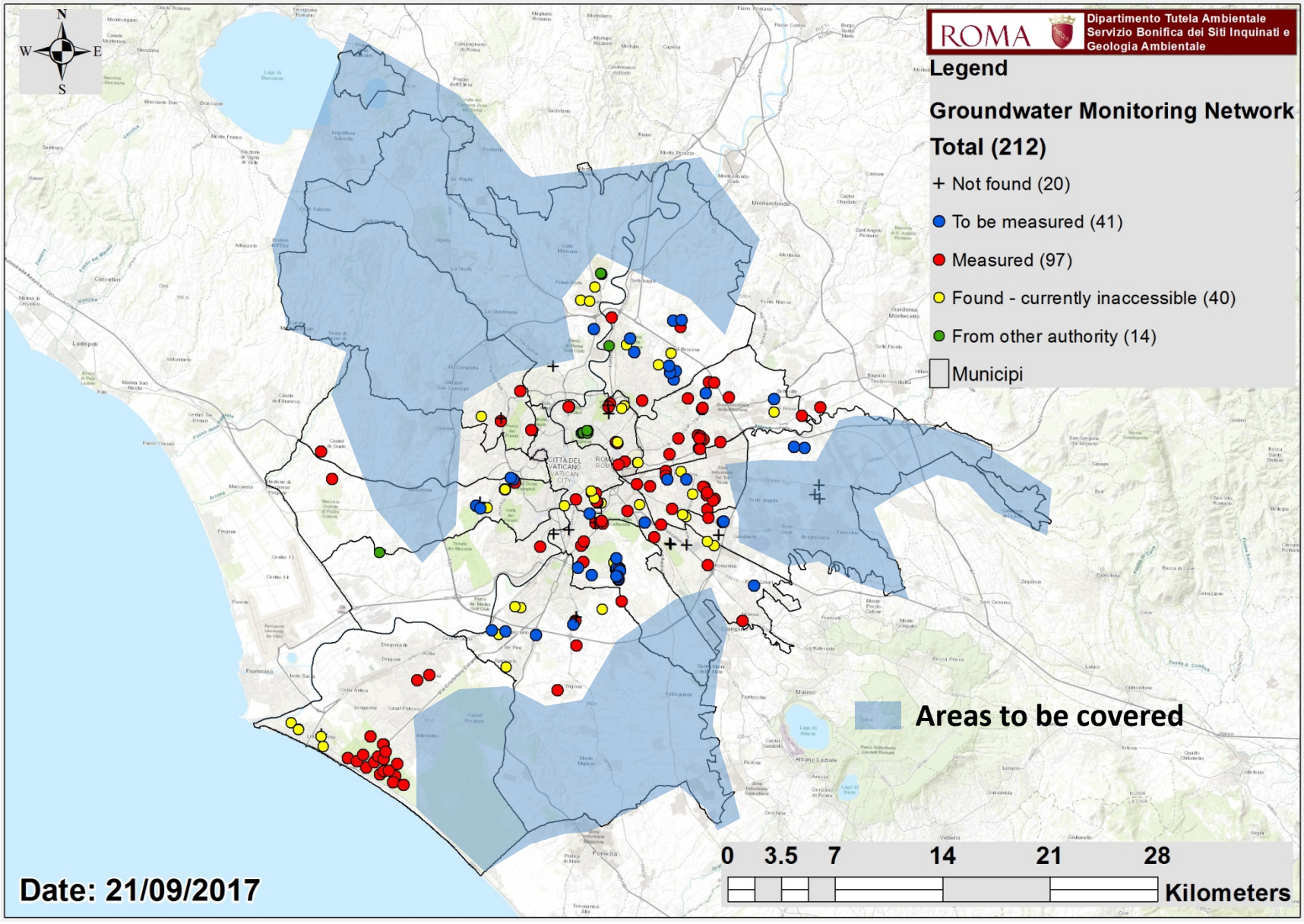
Groundwater Monitoring Network needed extension



Groundwater Monitoring Network participation form - 2016

In 2016 it has been decided to try to increase the number of monitoring points with the inhabitants involvement, using the official web site of the Rome Municipality and realizing a downloadable form to take part in the network.

Groundwater Monitoring Network participation form

ROMA

Modulo adesione
alla Rete di Monitoraggio delle Acque Sotterranee di Roma Capitale
Da inoltrare al seguente indirizzo di PEC
protocollo.tutelaambientale@pec.comune.roma.it

Alla cortese attenzione del
Servizio Bonifica Siti Inquinati e Geologia Ambientale
Ufficio Geologia e Idrogeologia Ambientale
Dott. Francesco La Vigna

Premesso che con determinazione dirigenziale n. 711 del 29 aprile 2014 è stato approvato il Progetto "Rete di Monitoraggio Acque Sotterranee di Roma Capitale"[1] con lo scopo di realizzare una rete distribuita di punti di accesso alle acque sotterranee,

il sottoscritto……,

nato a ……(……),il……,

telefono……, email……,

rappresentante legale/proprietario della società……

…… ovvero proprietario del terreno

sito in Roma……

ADERISCE

alla Rete di Monitoraggio delle Acque Sotterranee di Roma Capitale, mettendo a disposizione dei tecnici dell'Amministrazione di Roma Capitale i seguenti pozzi per acqua per le seguenti attività di monitoraggio

☐ misura periodica di livello e temperatura dell'acqua di falda[2]

☐ valutazione speditiva periodica delle caratteristiche chimico-fisiche dell'acqua di falda[3]

☐ analisi chimica dell'acqua di falda da parte degli enti competenti per scopi istituzionali e di interesse pubblico[4]

Pozzo 1 – Ubicato in Roma[5]

3° July 2014 – First meeting of the working group

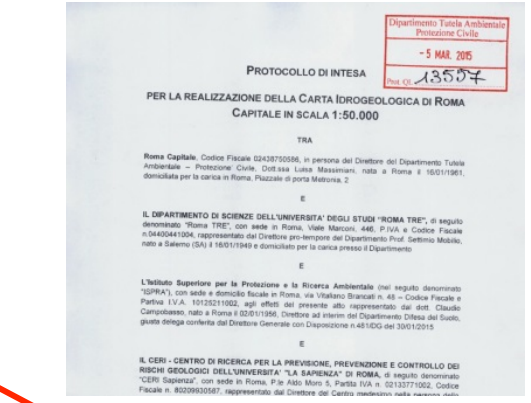
ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale
SERVIZIO GEOLOGICO D'ITALIA
Organo Cartografico dello Stato (legge N°68 del 2-2-1960)
Dipartimento Difesa del Suolo

ROMA TRE
UNIVERSITÀ DEGLI STUDI

ROMA

SAPIENZA
UNIVERSITÀ DI ROMA
CERI CENTRO DI RICERCA PREVISIONE, PREVENZIONE E CONTROLLO DEI RISCHI GEOLOGICI

INGV
terremoti
vulcani
ambiente
ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA


Dipartimento Tutela Ambientale Protezione Civile
- 5 MAR. 2015
Prot. QL 13554

PROTOCOLLO DI INTESA

PER LA REALIZZAZIONE DELLA CARTA IDROGEOLOGICA DI ROMA CAPITALE IN SCALA 1:50.000

TRA

Roma Capitale, Codice Fiscale 02438750586, in persona del Direttore del Dipartimento Tutela Ambientale – Protezione Civile, Dott.ssa Luisa Massimiani, nata a Roma il 16/01/1961, domiciliata per la carica in Roma, Piazzale di porta Metronia, 2

E

IL DIPARTIMENTO DI SCIENZE DELL'UNIVERSITA' DEGLI STUDI "ROMA TRE", di seguito denominato "Roma TRE", con sede in Roma, Viale Marconi, 446, P.IVA e Codice Fiscale n.04404411004, rappresentato dal Direttore pro-tempore del Dipartimento Prof. Settimio Mobilio, nato a Salerno (SA) il 16/01/1949 e domiciliato per la carica presso il Dipartimento

E

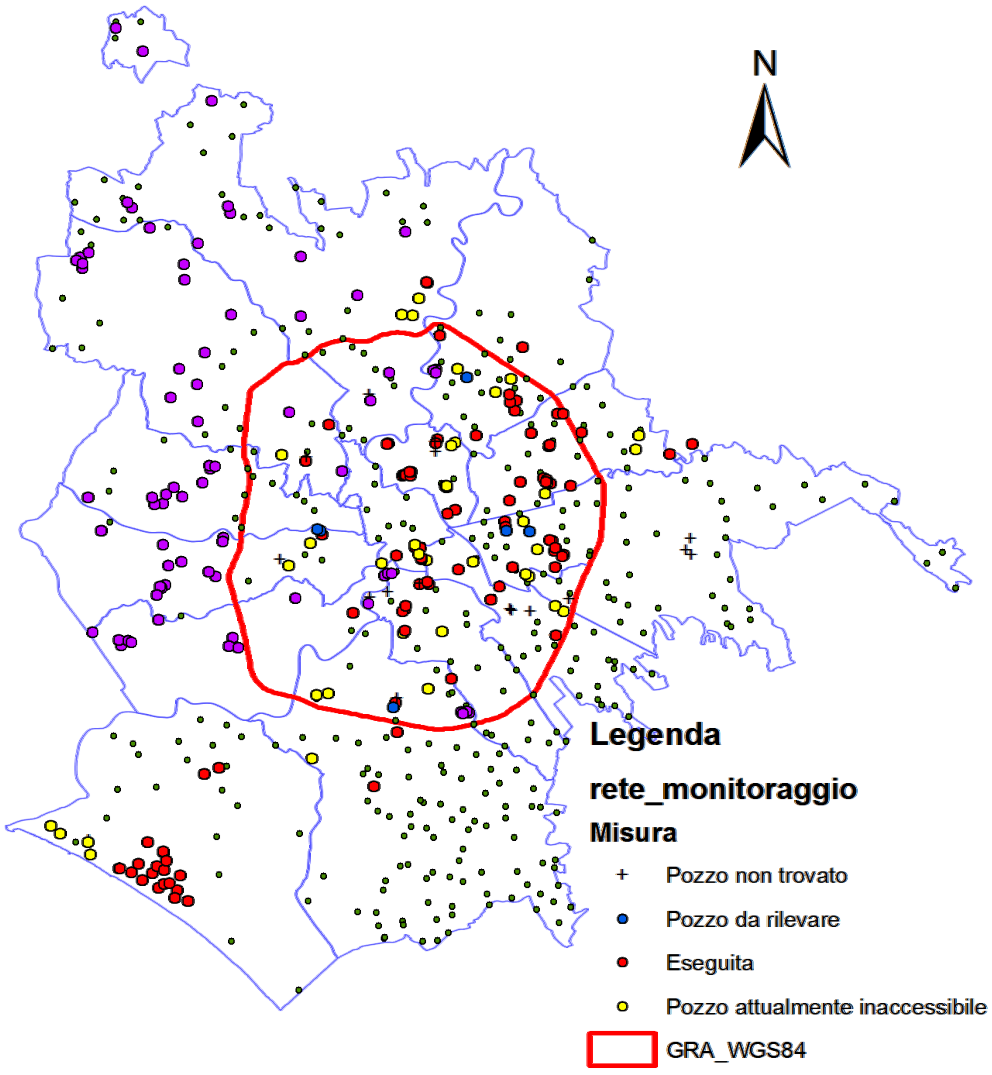
L'Istituto Superiore per la Protezione e la Ricerca Ambientale (nel seguito denominato "ISPRA"), con sede e domicilio fiscale in Roma, via Vitaliano Brancati n. 48 – Codice Fiscale e Partiva I.V.A. 10125211002, agli effetti del presente atto rappresentato dal dott. Claudio Campobasso, nato a Roma il 02/01/1956, Direttore ad interim del Dipartimento Difesa del Suolo, giusta delega conferita dal Direttore Generale con Disposizione n.481/DG del 30/01/2015

E

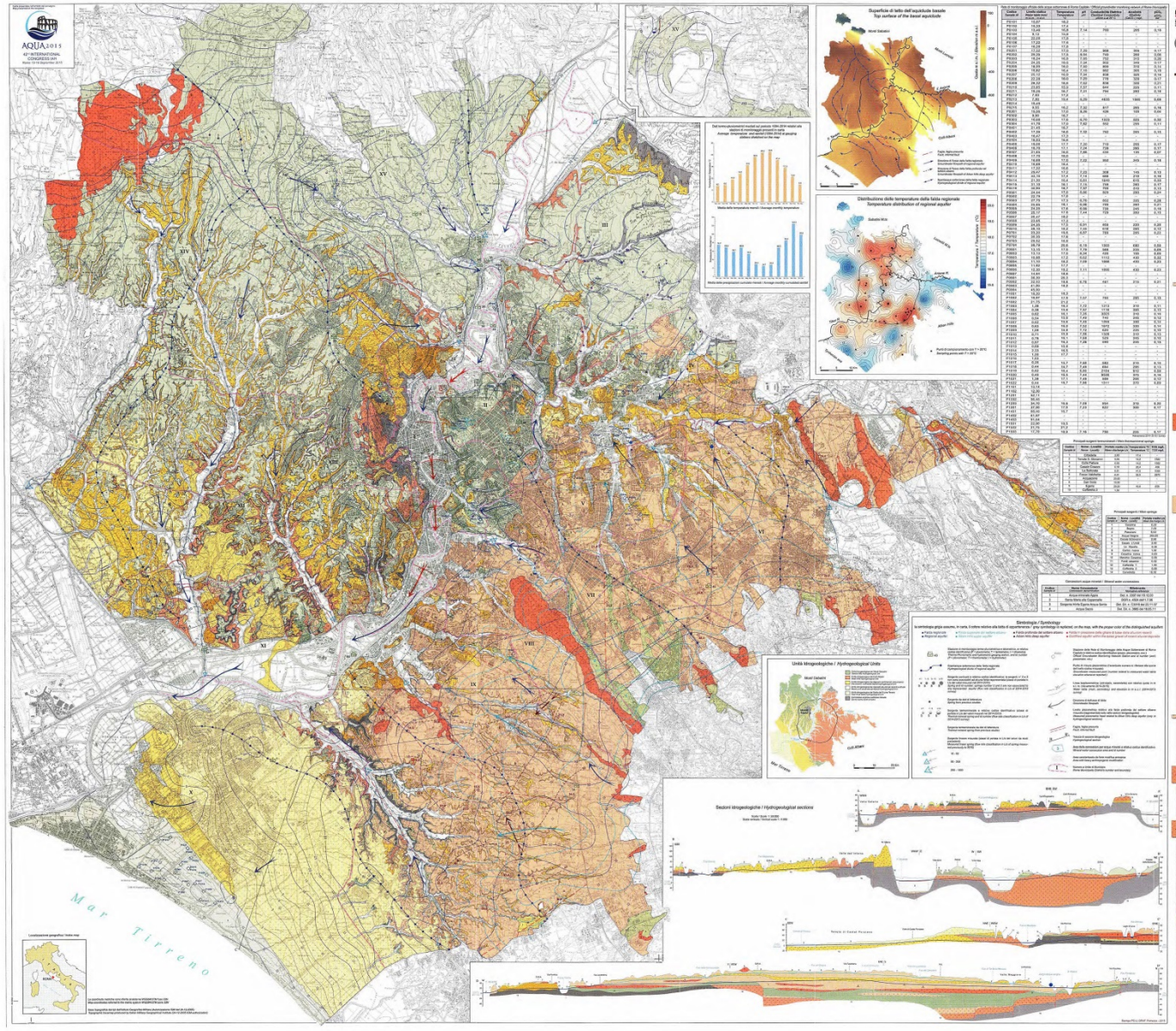
IL CERI - CENTRO DI RICERCA PER LA PREVISIONE, PREVENZIONE E CONTROLLO DEI RISCHI GEOLOGICI DELL'UNIVERSITA' "LA SAPIENZA" DI ROMA, di seguito denominato "CERI Sapienza", con sede in Roma, P.le Aldo Moro 5, Partita IVA n. 02133771002, Codice Fiscale n. 80209930587, rappresentato dal Direttore del Centro medesimo nella persona dello

IGAG

Dataset of the working group



The new Hydrogeological Map of Rome – 1:50.000 scale



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The new Hydrogeological Map of Rome – 1:50.000 scale

Simbologia / *Symbology*

la simbologia grigia assume, in carta, il colore relativo alla falda di appartenenza / *grey symbology is replaced, on the map, with the proper color of the distinguished aquifers*

- Falda regionale / *Regional aquifer*
- Falda superiore del settore albano / *Alban Hills upper aquifer*
- Falda profonda del settore albano / *Alban Hills deep aquifer*
- Falda in pressione delle ghiaie di base delle alluvioni recenti / *Confined aquifer within the basal gravel of recent alluvial deposits*

PTI 43
Stazione di monitoraggio termo-pluviometrica e idrometrica, e relativo codice identificativo (P = pluviometro; T = termometro; I = idrometro)
Thermo-Pluviometric and hydrometric gauging station, and id number (P = pluviometer; T = thermometer; I = hydrometer)

Spartiacque sotterraneo della falda regionale
Hydrogeological divide of regional aquifer

≤ 1 | 1 - 5 | 5 - 10 | ≥ 10
5 5 5 5
Sorgente puntuale e relativo codice identificativo; le sorgenti n° 2 e 3 non sono associabili ad alcuna falda rappresentata (classi di portata in L/s dei valori misurati nel 2014-2015)
Spring and id number; springs number 2 and 3 are non associated to any represented aquifer (flow rate classification in L/s of 2014-2015 survey)

Sorgente da dati di letteratura
Spring from previous studies

≤ 1 | 1 - 5 | ≥ 10
5 5 5
Sorgente termominerale e relativo codice identificativo (classi di portata in L/s dei valori misurati nel 2014-2015)
Thermal-mineral spring and id number (flow rate classification in L/s of 2014-2015 survey)

Sorgente termominerale da dati di letteratura
Thermal-mineral spring from previous studies

Sorgente lineare misurata (classi di portata in L/s dei valori da studi precedenti)
Measured linear spring (flow rate classification in L/s of spring measured previously to 2015)

10 - 50

50 - 250

250 - 1000

P1012
Stazione della Rete di Monitoraggio delle Acque Sotterranee di Roma Capitale e relativo codice identificativo (pozzo, piezometro, ecc.)
Official Groundwater Monitoring Network Station and id number (well, piezometer, etc.)

28,4
Punto di misura piezometrico (l'eventuale numero si riferisce alla quota del livello statico misurato)
Groundwater measured point (number related to measured water table elevation whenever reported)

20
Linea isopiezometrica (principale, secondaria) con relativa quota in m s.l. m. (rilevamento 2014-2015)
Water table (main, secondary) and elevation in m a. s. l. (2014-2015 survey)

Direzione di deflusso di falda
Groundwater flowpath

Livello piezometrico relativo alla falda profonda del settore albano misurato (rappresentato solo nelle sezioni idrogeologiche)
Measured piezometric head related to Alban Hills deep aquifer (only in hydrogeological sections)

Faglia, faglia presunta
Fault, inferred fault

B B'
Traccia di sezione idrogeologica
Hydrogeological section

3
Area delle concessioni per acque minerali e relativo codice identificativo
Mineral water concession area and id number

Area caratterizzata da forte modifica antropica
Area with heavy anthropogenic modification

I
Numero e limite di Municipio
Rome Municipality District's number and boundary

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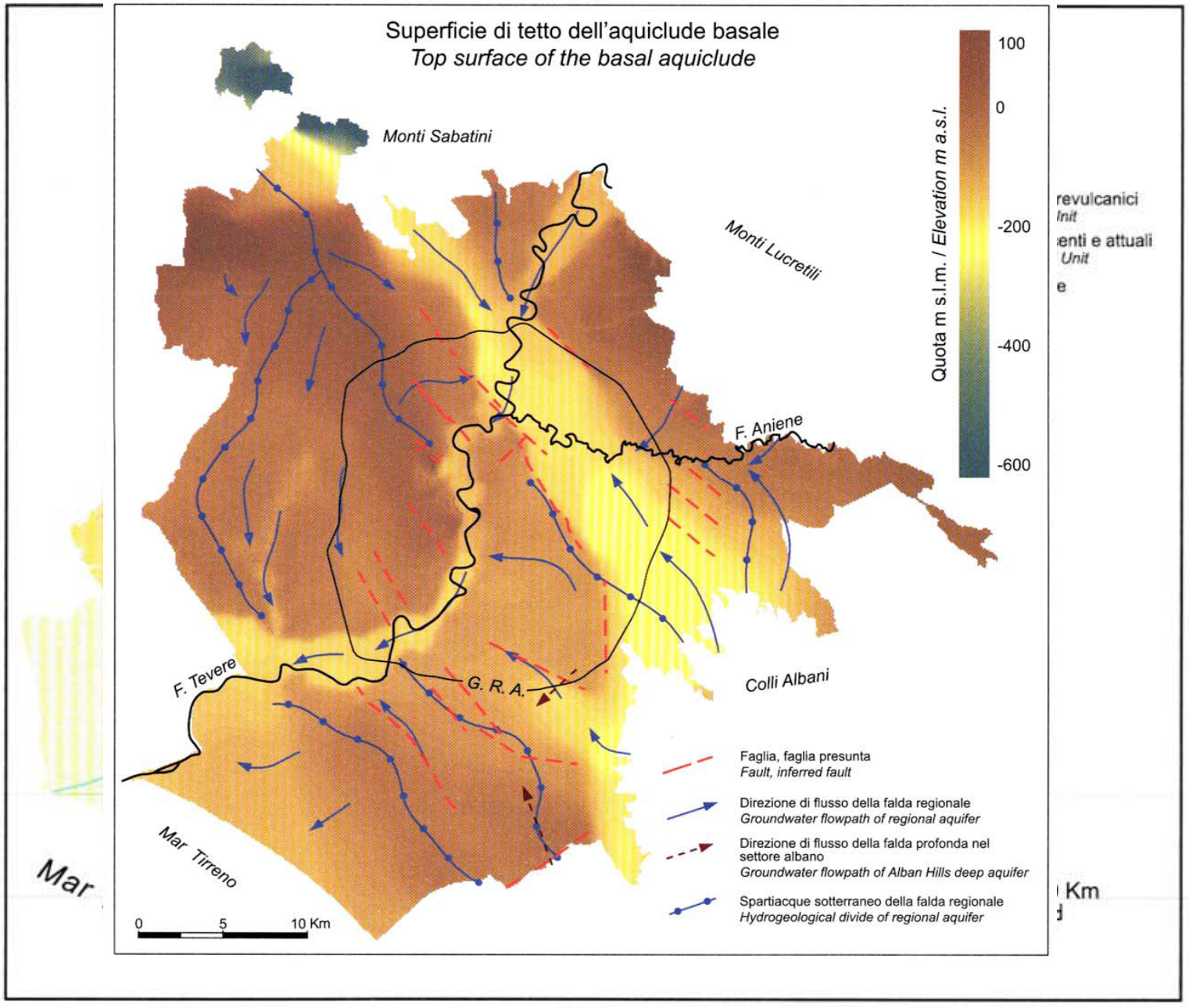
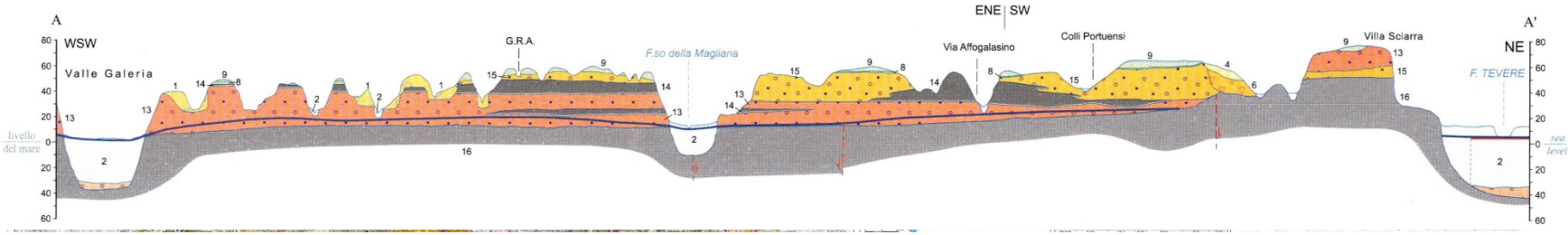
The new Hydrogeological Map of Rome – 1:50.000 scale

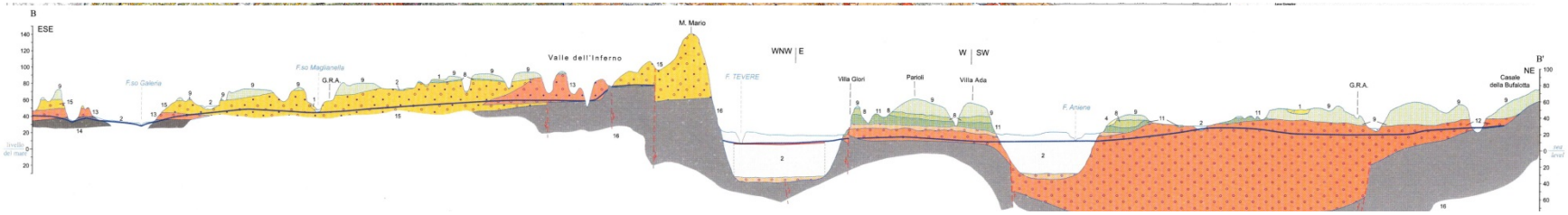


The new Hydrogeological Map of Rome – 1:50.000 scale

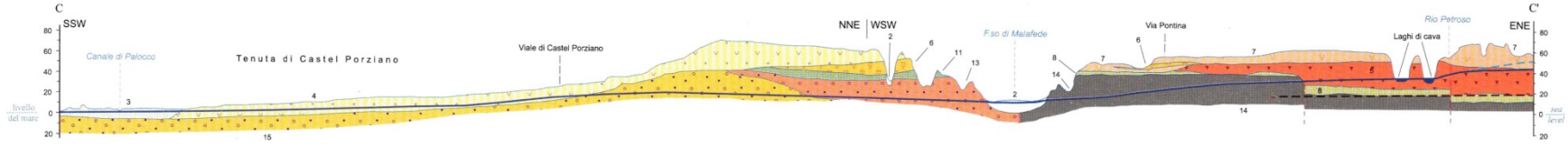
SECTION A – A'



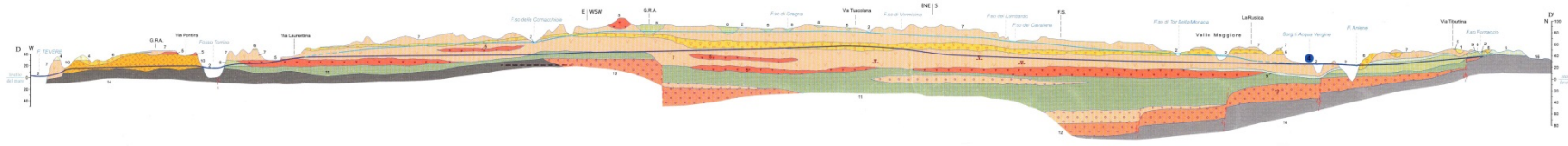
SECTION B – B'



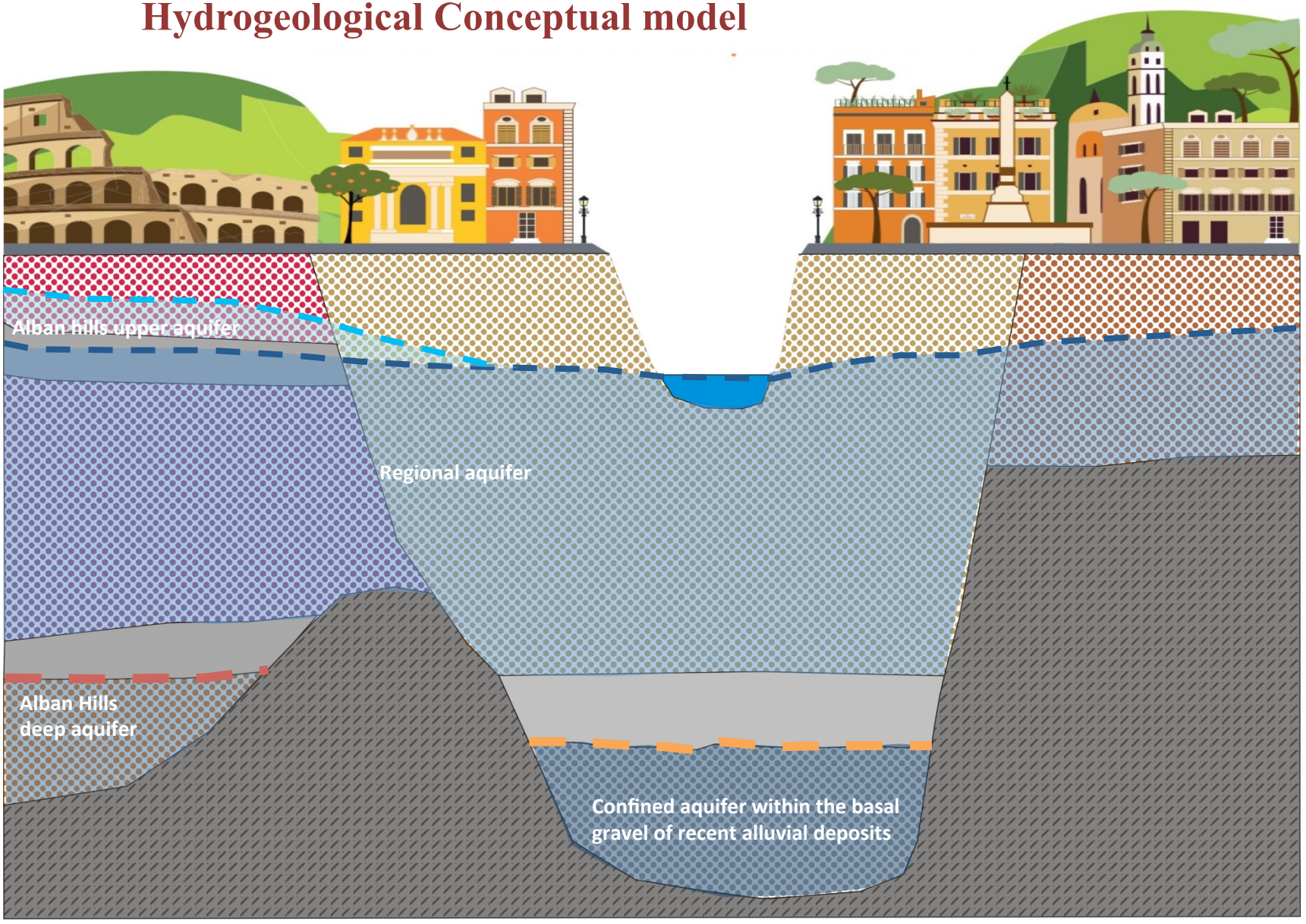
SECTION C – C'

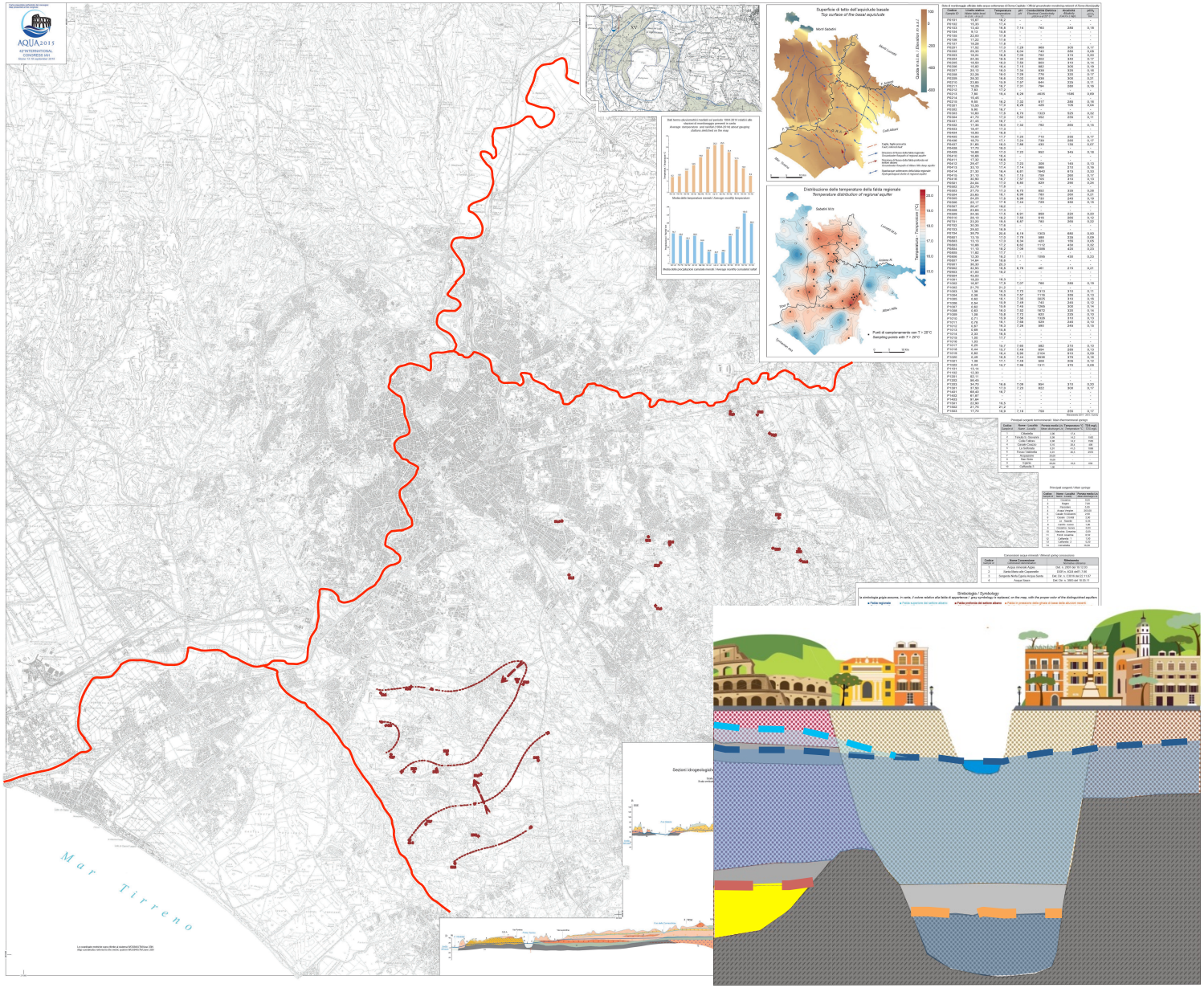


SECTION D – D'

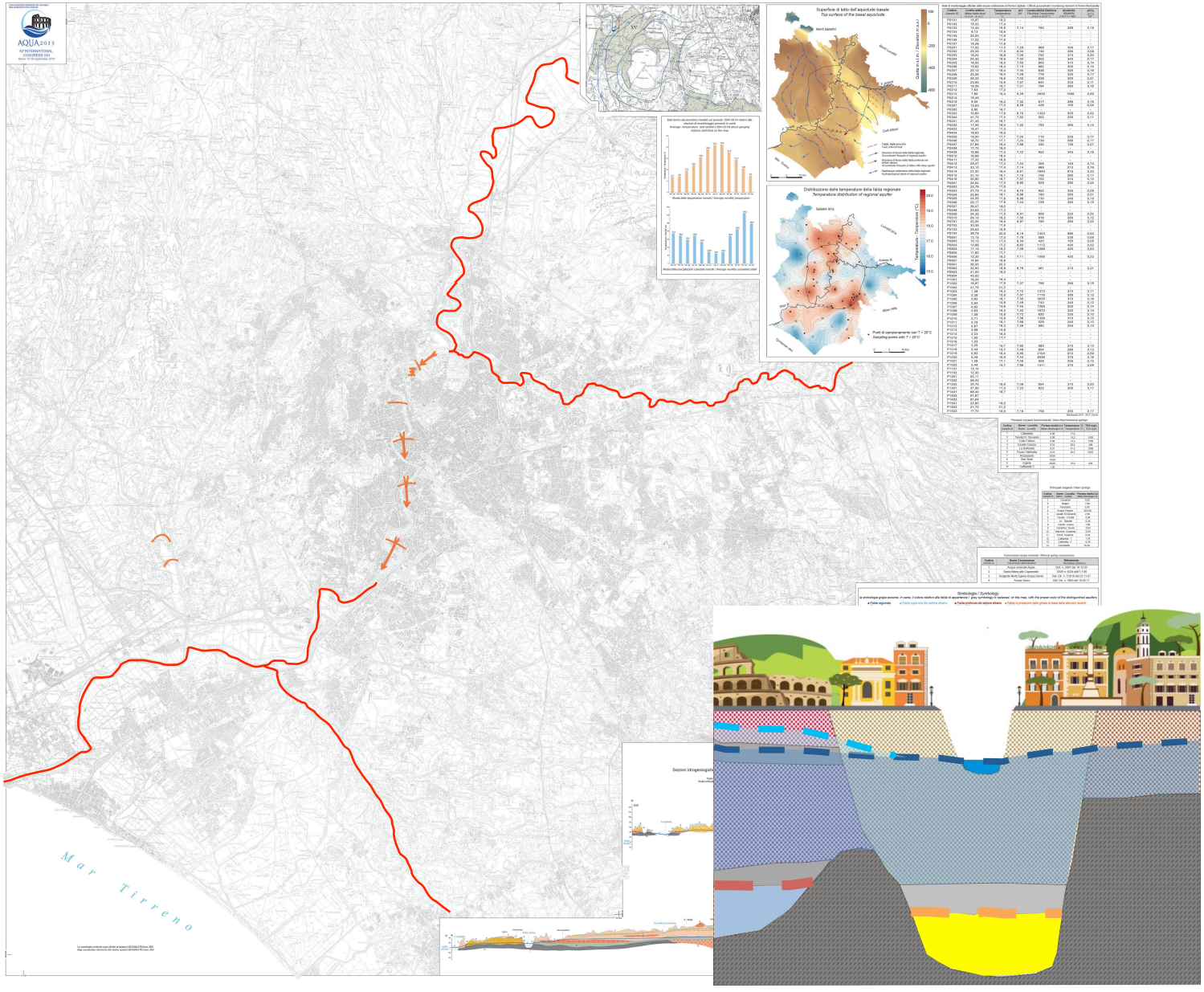


Groundwater of Rome
Hydrogeological Conceptual model

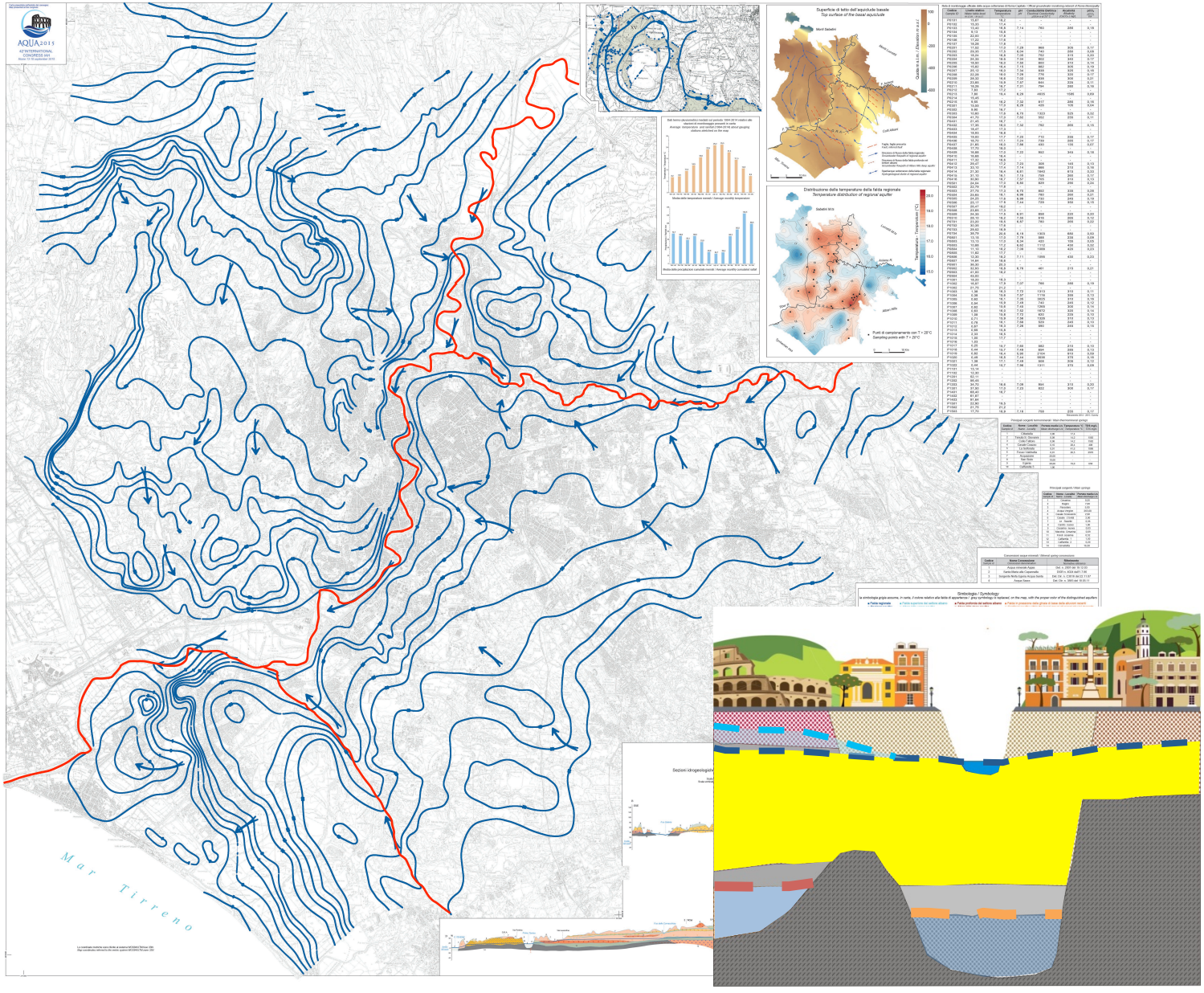




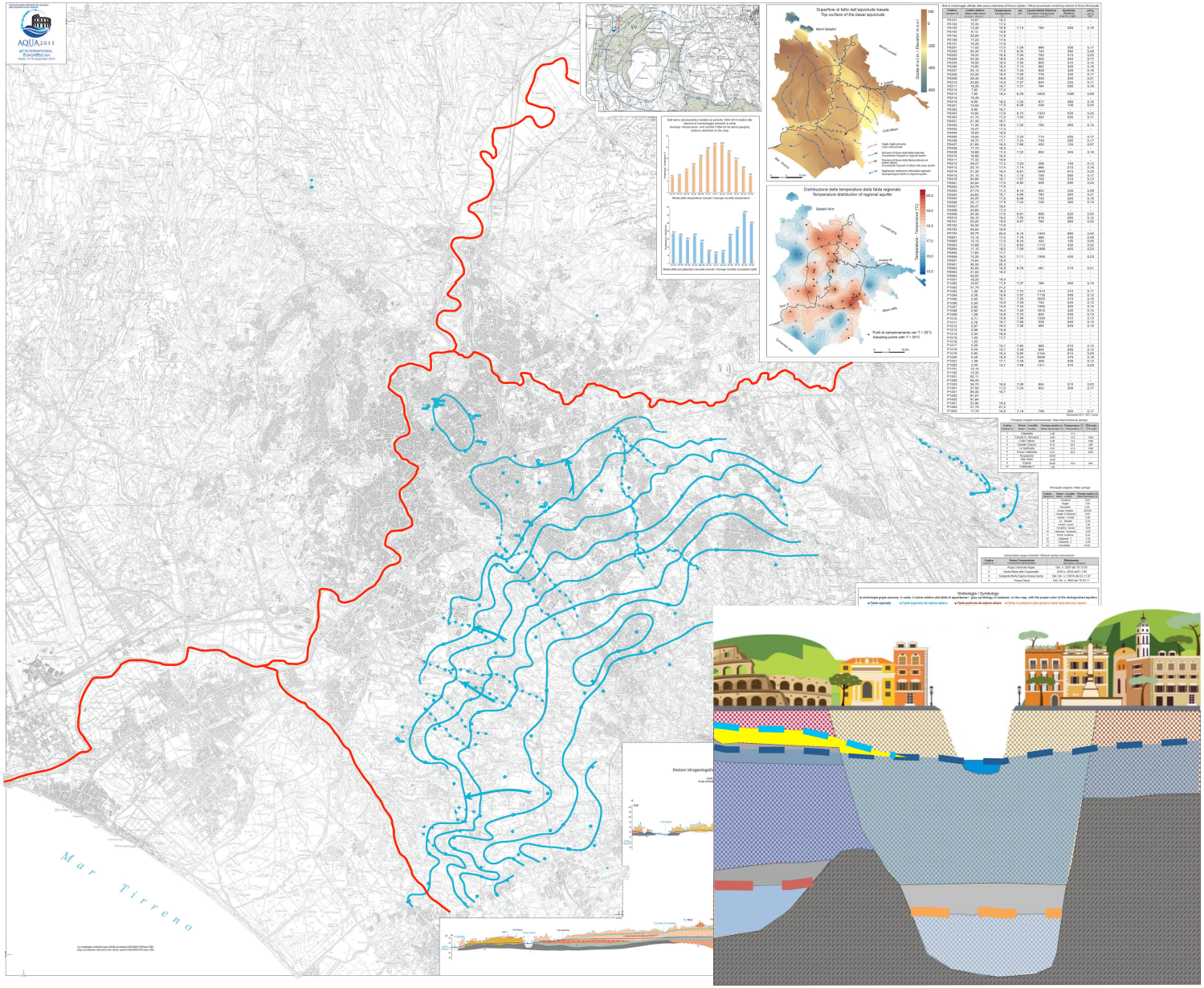
ALBAN HILLS DEEP AQUIFER



CONFINED AQUIFER WITHIN THE BASAL GRAVEL OF RECENT ALLUVIAL DEPOSITS



REGIONAL AQUIFER



ALBAN HILLS UPPER AQUIFER

The new Hydrogeological Map of Rome – Supplementary Notes

The benefits to Rome to have a new Hydrogeological Map

1) It's a city with a remarkable, also underground, infrastructural development, thus the increased knowledge of the groundwater flows will help in the design and planning of surveys for small and large works.

2) It's a city where, even on groundwater, several critical environmental issues insist (many cases of potential contaminated sites collected by our Service). The map will help the administrative procedure and will be a reference point for the remediation projects approval.

3) It's a city with many natural hazards such as landslides, sinkholes, subsidence and flooding and emissions of gas, and the knowledge of the groundwater dimension is often necessary to deal with some situations of risk related to these hazards.

4) There are, even today, even if the water network is well developed, a number of users in the peripheral areas that use groundwater as domestic sourcing and sometimes drinking, as also part of the recharge area of the drinking water catchment of Salone (ACEA) is located in the territory of Rome. Proper knowledge of the groundwater flow can help to plan and protect these supply areas of underground reservoirs.

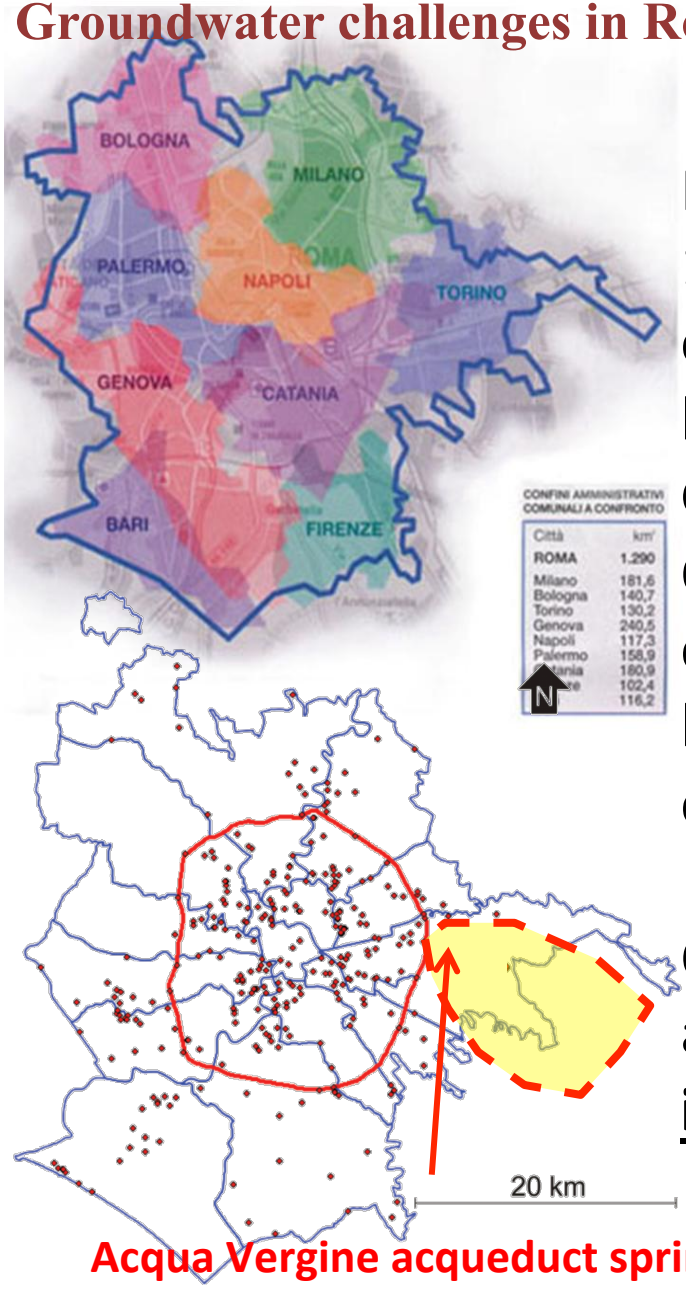
The benefits to Rome to have a new Hydrogeological Map

5) **The most updated and detailed knowledge of the subsurface highlighted by the new hydrogeological map, together with the newly established groundwater monitoring network, provide a solid base of knowledge supporting the administration to develop policies of sustainable use of resources in urban areas ; the same can be considered as basic element of information for the development of future projects such as:**
   - **The natural background levels of contaminant in groundwater**
   - **The development of Managed Aquifer Recharge pilot projects to prevent storm flooding**
   - **The land characterization and planning in order to promote the low enthalpy geothermal energy use for building cooling and heating due to very favorable groundwater temperature**

6) **Under the resilience strategy of the city, an entire thematic strand is related to water considered in all its manifestations, as surface-water and groundwater. The Hydrogeological Map is an important base informative element for this purpose.**

Groundwater challenges in Rome

Polluted sites



Rome is a very large city, of about 1284 km^2 , and the major 9 italian cities could be inserted in its boundaries.

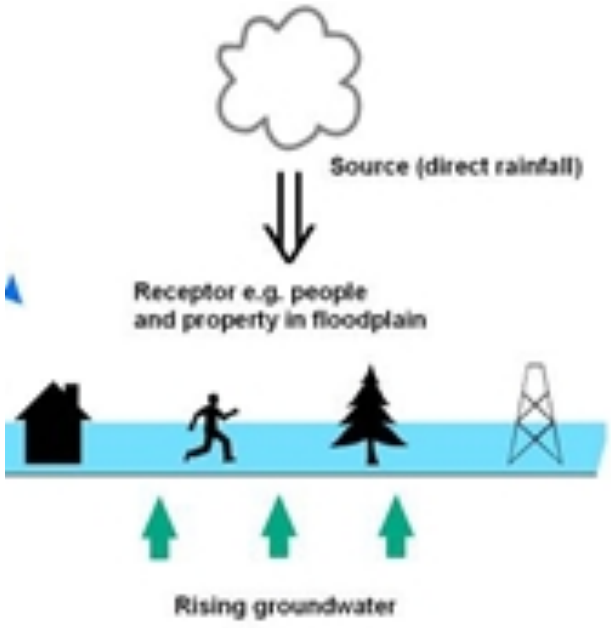
Groundwater of Rome, as in every big City, is dayly threatened by potential contamination due as to «classic» hydrocarbon compounds as to clorinated solvents.

Currently the potential polluted sites are more than 350 (**obviously not all involving groundwater**)

Acqua Vergine acqueduct spring's protection area

Groundwater challenges in Rome

Groundwater flooding



In some areas of the City, specially those close to the coastal sector where reclamation has been performed in the past, can be interested by flooding not due to «simple» rain and storms, but to groundwater rising.

Volcanic gas pockets

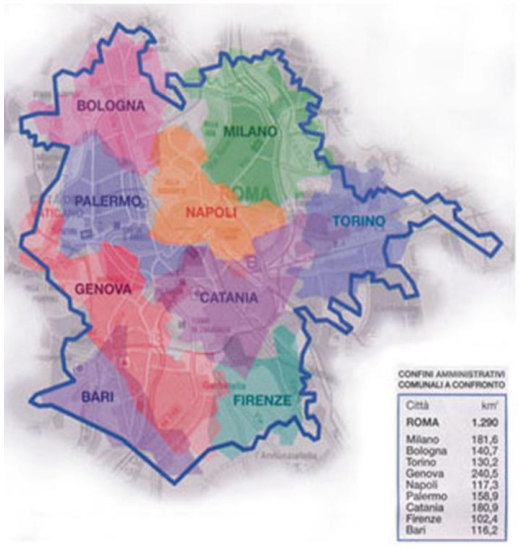
In occasion of water well drilling activities in the Colli Albani Volcano sector, which is still active, some gas pocket (CO_2 and H_2S) can be intercepted, and this could be very dangerous for public safeness.

Groundwater, from challages to resource, playing a role in the city resilience

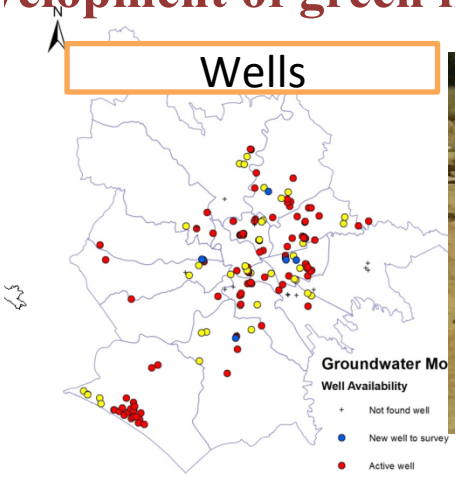
The greater knowledge and monitoring of groundwater, a reality prevalently "invisible" to most, can help to face certain challenges with greater awareness.

At the same time some sustainable uses of this resource can constitute measures that can contribute to greater urban resilience and adaptation to climate change ...

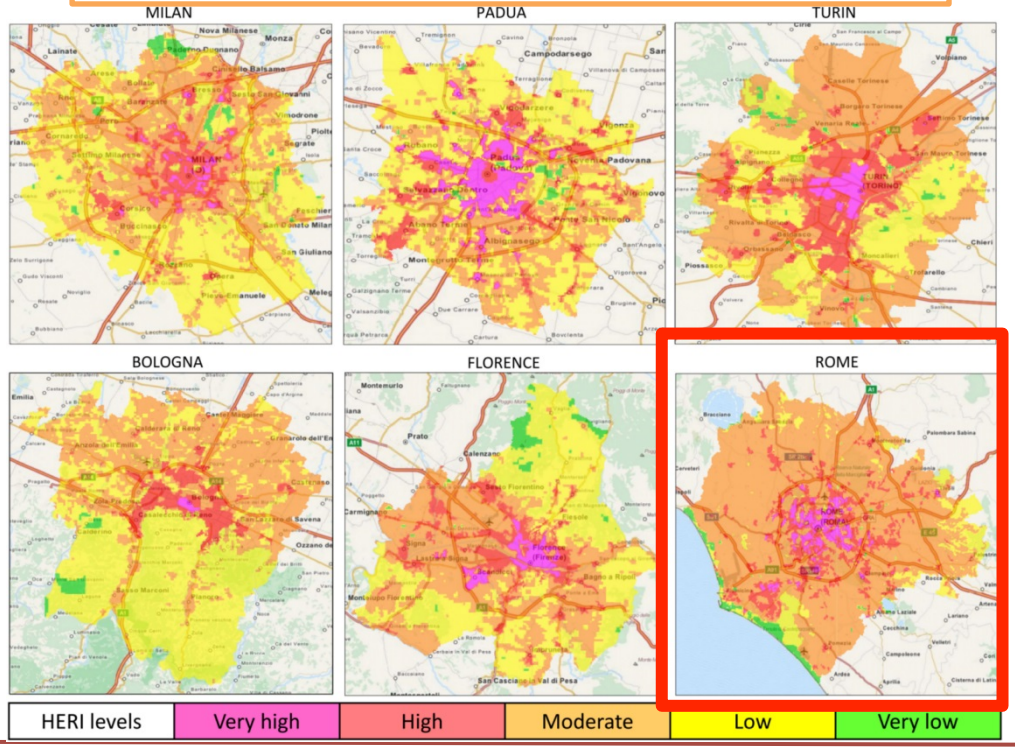
velopment of green infrastructures



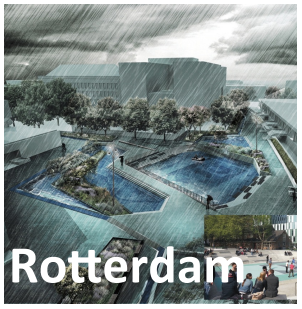
Wells



hazard in some cities

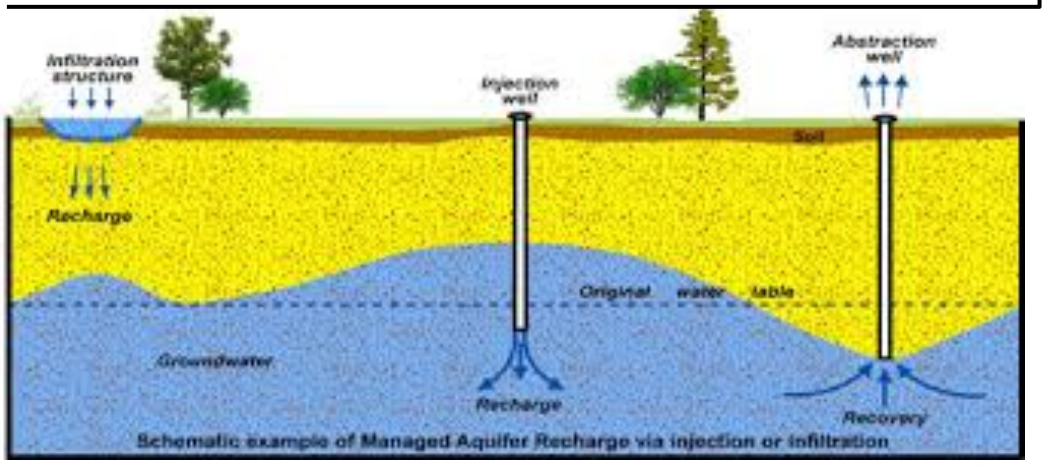


Stormwater harvesting and Managed Aquifer Recharge (MAR)



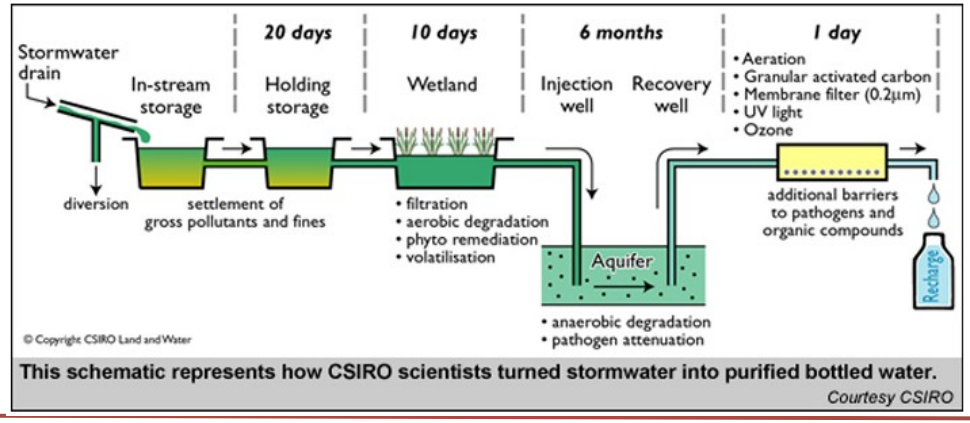
Stormwater harvesting to avoid urban flooding is already a reality in many cities.

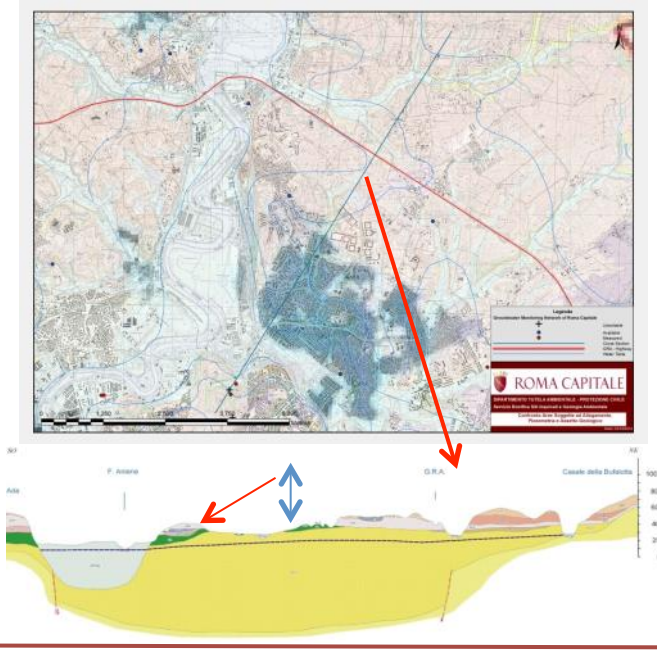
<u>This «harvesting» could be performed also using the «natural tanks» we have in the underground (aquifers)</u>



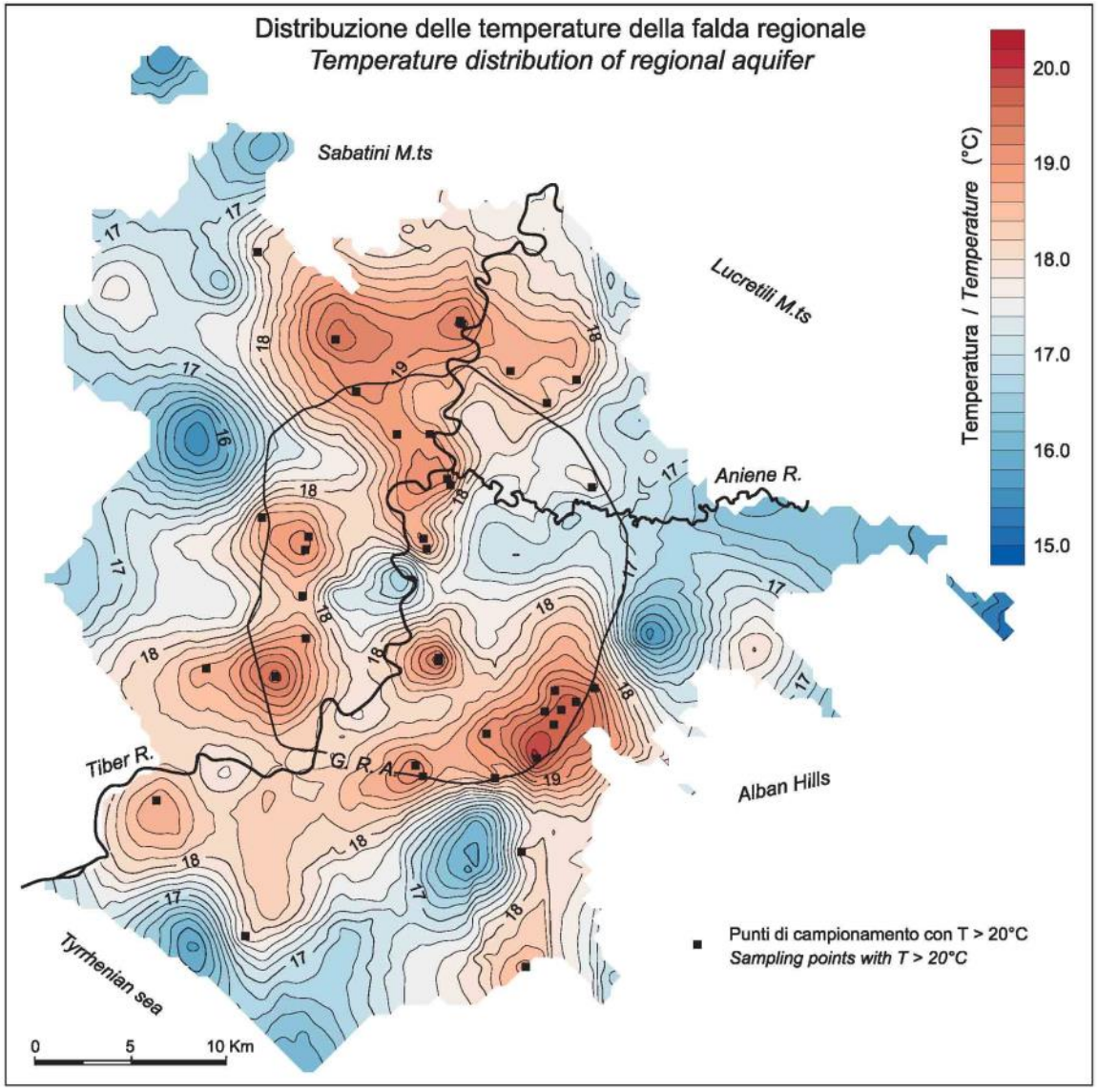
D.M. 100/2016 (M.A.T.T.M.)

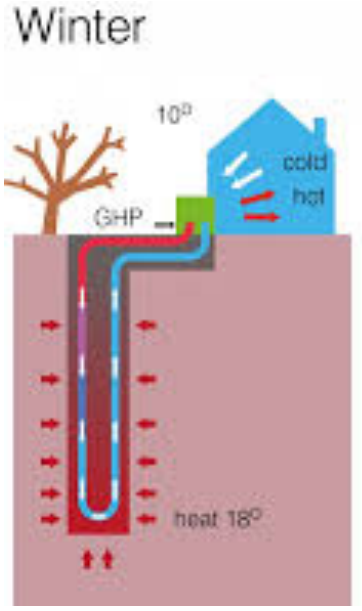
Italian regulation about managed aquifer recharge activities

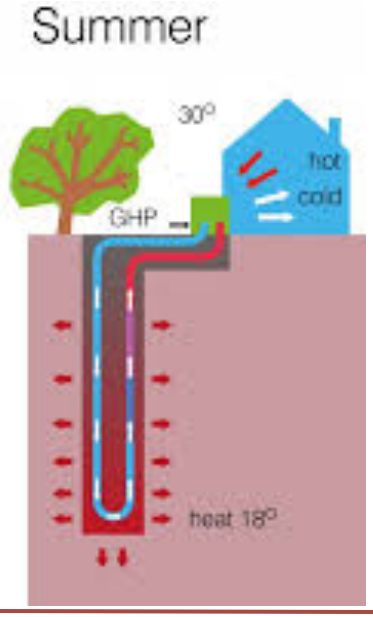




Low enthalpy geothermal energy







***L.R. n.3 del 21/4/2016** regional law of Latium Region about small geothermal plants*

Is groundwater playing some roles in the resilience of cities?

Direct role	What happens in case of stop or crisis	And thus…
1) Drinking water supply	Ealth and social problems	lack of hygiene, dehydration, epidemics, popular upset
2) Green areas irrigation water supply	Soil, grass and plants go to be dry and death	more heat waves effects, more fire hazard, less permeability and less water ritention effect
3) Agriculture and industry water supply	Production stop	Economic losses, loss of jobs, loss of well-being , popular upset
4) Urban surface infiltration	High runoff	Crisis of drainage network, urban floods, local blackouts, taffic jams, landslides
5) Discharge drainage in reclamation areas	Water table rising	Groundwater flooding, urban flood, local blackouts, taffic jams
6) Urban GDE survival	Ecosystem damage	Loss of Environmental value
Value	**Shock**	**Cascading effects**

What happens in a groundwater resilient city 1/2

Probable shock involving goundwater	What happens	And thus…
Drought and heat waves	**Aware** people and managers make a responsible use and distribution of water	Water demand is lower
	Groundwater recharge has been managed and **monitored**	Green areas irrigation water supply is possible, the city is cooler, the soil is alive and the natural GW recharge is guaranteed
		Agriculture and industry water supply is possible and the well-being is mantained
Heavy rain	The urban surface has been made more permeable	The runoff is less, the groundwater is recharged, the urban drainage network is less stressed, urban floods are less important or more fastly recovered
	Water tables are **monitored** and harvesting tanks or basins have been build	Lowlands and reclamation areas are less interested by flooding
Shock	Value	Resilience dividend

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What happens in a groundwater resilient city 2/2

Probable shock involving goundwater	What happens	And thus…
Pollution	Goundwater **monitoring** allow to evaluate pollution migration and distribution	Is possible to better understand where remediation is to be performed and where groundwater need to be treated
		Contaminated site remediation activities management, and also existing GDE protection activities are easier
	Aware people and groundwater users have a better behaviour towards the groundwater resources protection	Comunication between government and citizens about existing pollution phenomena is easier, and cohoperation is greater
Energy demand	The groundwater system **knowledge** is good and the aquifers are **monitored**	The groundwater system low enthelpy geothermal potential can be disfruted for heating and cooling systems, and GHG emissions are lower
Shock	Value	Resilience dividend

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Conclusions

Groundwater is an "invisible" reality but it is a very important resource for many uses (from drinking water supply, to irrigation, to fire-fighting, to geothermal, etc.)
The hydrogeology of Rome presents a complex setting, but today it is better known and monitored.

It has been seen how some of the problems strictly connected with groundwater have to be treated, but at the same time it has also been seen how this resource can represent a great opportunity for development, also in terms of adapting to climate change.


Thank you!
(Stalctites and stalgmites in a urban cave of Rome due to acqueduct losses)