

potenzialità della geotermia a bassa entalpia nella provincia di Ravenna

dr. Dimitra Rapti-Caputo

LABeLAB Ravenna, 25-27 settembre 2013

dr. Dimitra Rapti-Caputo
Università di Ferrara, Dipartimento di Fisica e Scienze della
Terra, via Saragat, 1 blocco B, stanza 314, 44121 Ferrara
e-mail: cpr@unife.it



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DEVELOPMENT FUND

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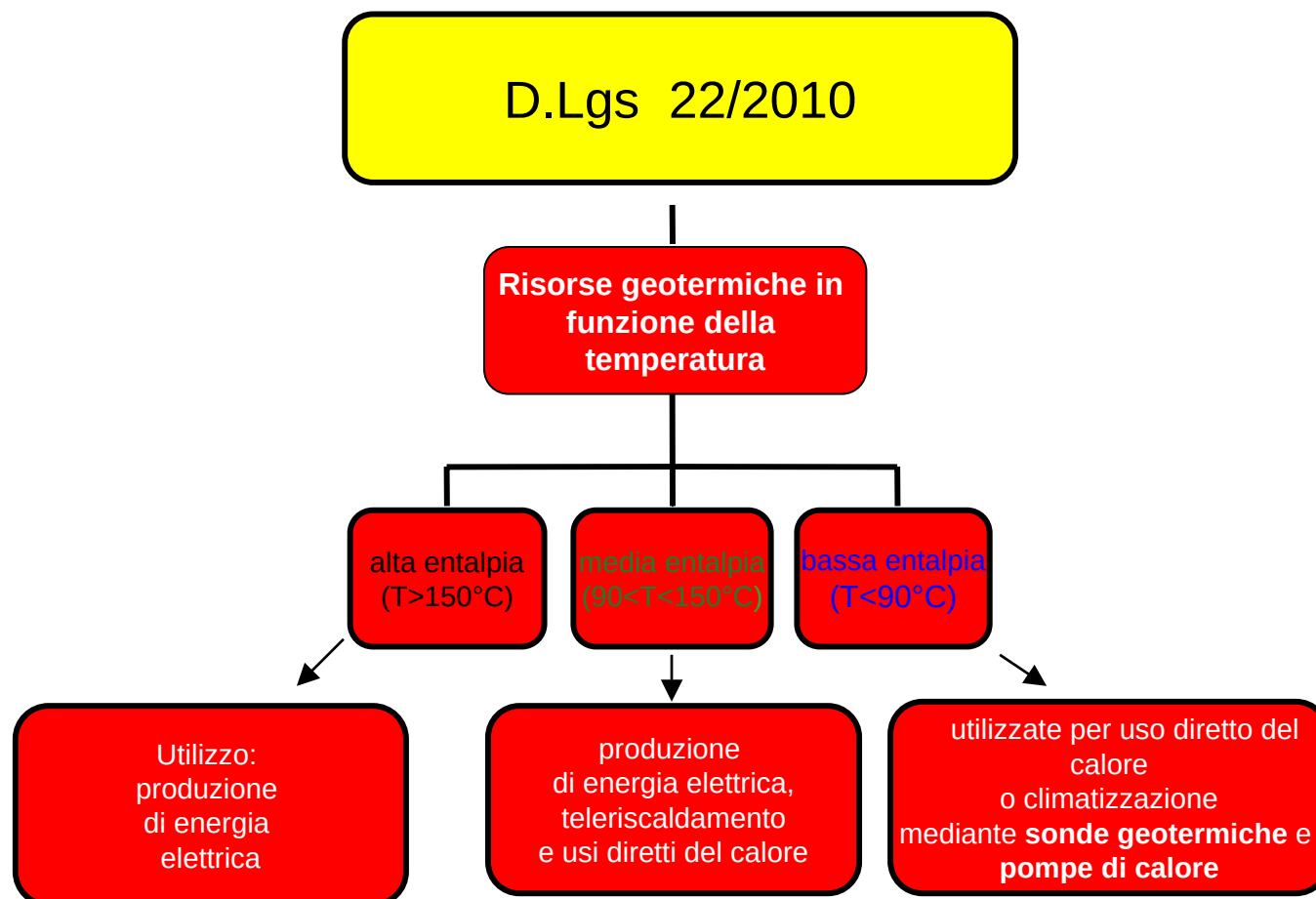
definizione concetti base

geotermia a bassa entalpia

Geotermia: scienza che si occupa dello studio e dello sfruttamento del calore esistente all'interno della Terra.

Entalpia: è una funzione di stato che esprime la quantità di energia che un sistema termodinamico può scambiare con l'ambiente.

L'entalpia di un fluido che circola ed è contenuto nel serbatoio geotermico **esprime il “valore” energetico sia del fluido che del serbatoio.**

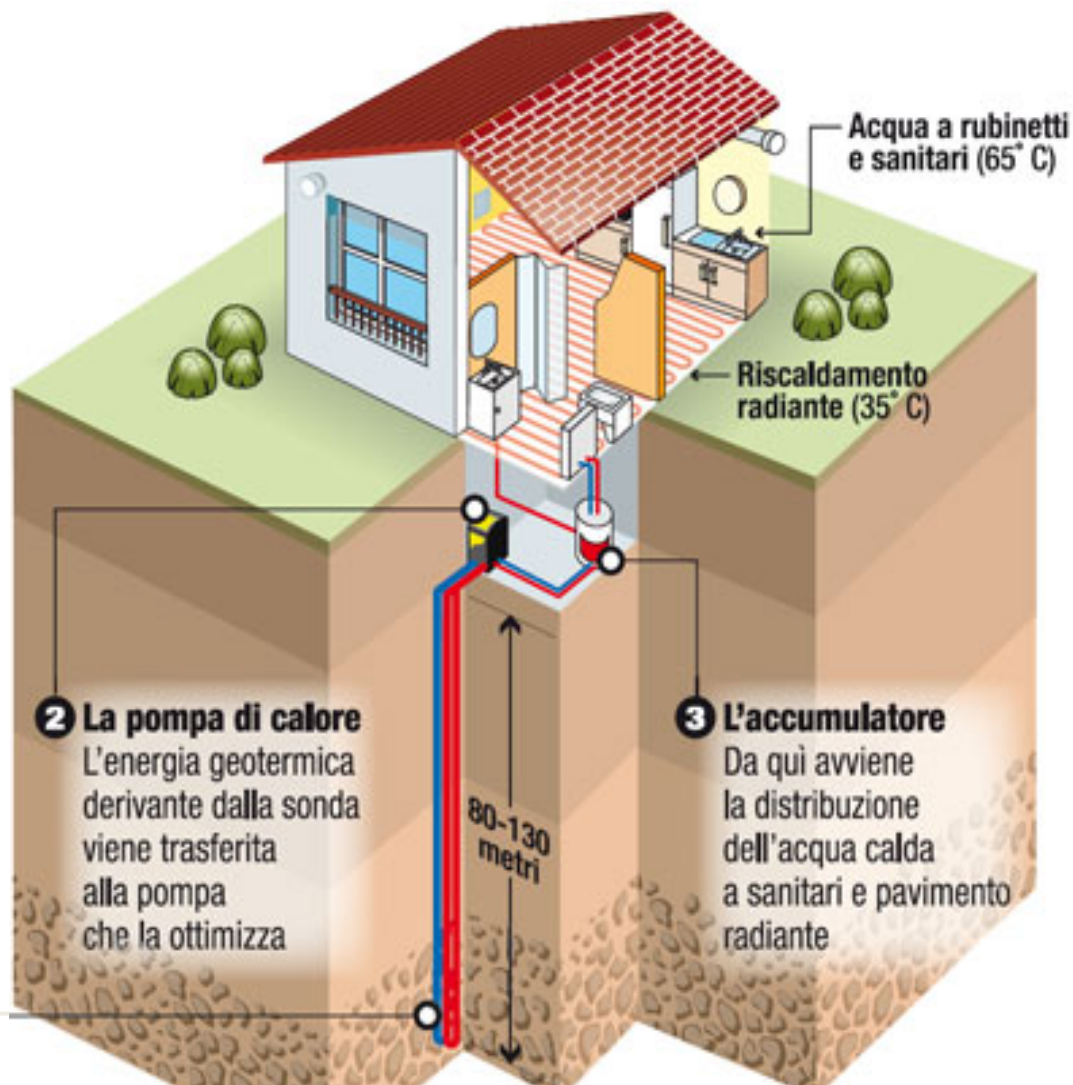


Impianto geotermico a bassa entalpia

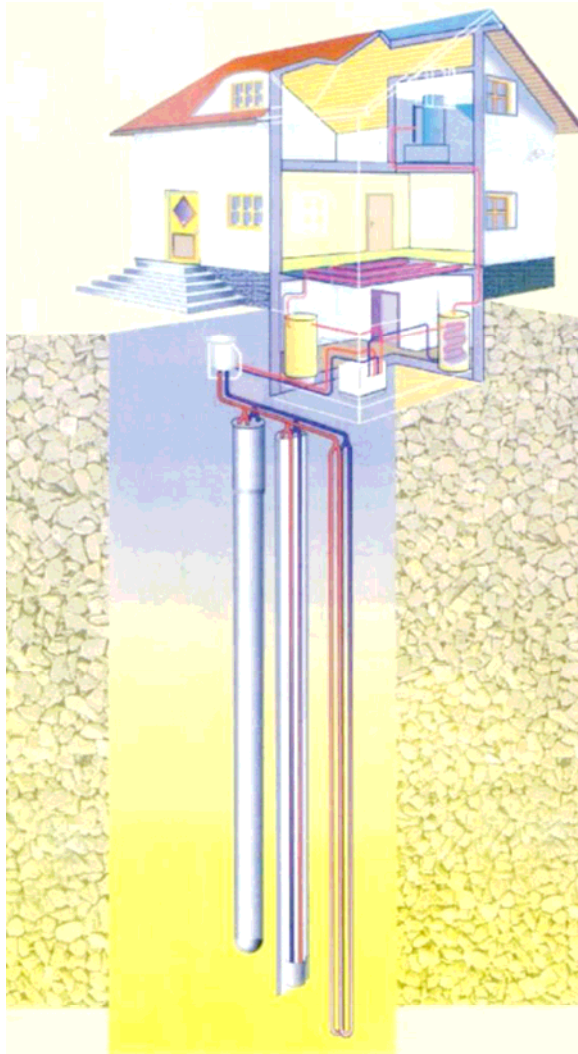
1 Le sonde geotermiche

Calate all'interno di perforazioni verticali hanno un doppio compito:

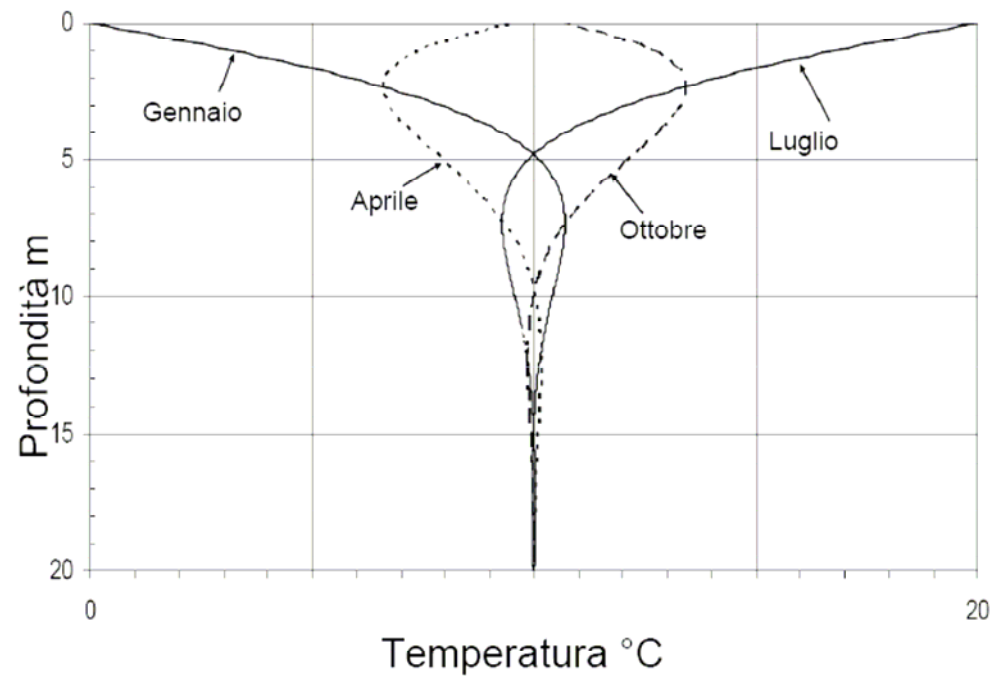
- in inverno prelevano calore latente dal sottosuolo riscaldando l'immobile
- in estate cedono calore al sottosuolo rinfrescando l'immobile



Principi di funzionamento delle sonde geotermiche



Italia: da 10 a 100 m di profondità, temperatura del sottosuolo costante **fra 12 e 14°C**



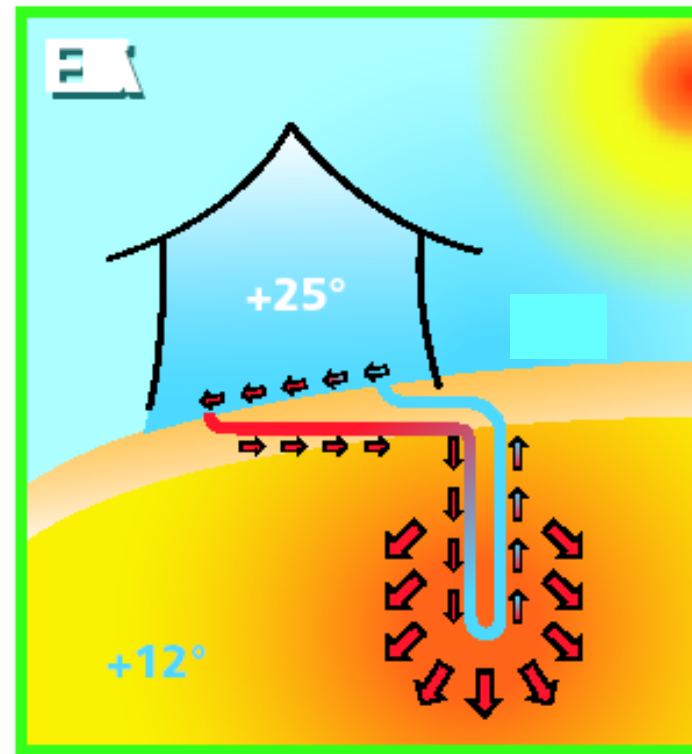
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Principi di funzionamento delle sonde geotermiche



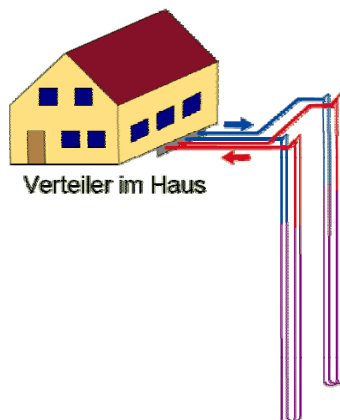
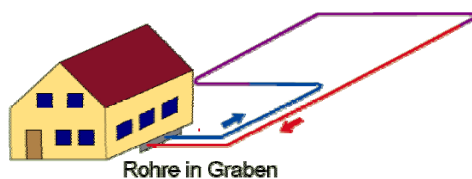
Sistemi di sfruttamento della energia geotermica a bassa entalpia

Sistemi a circuito chiuso

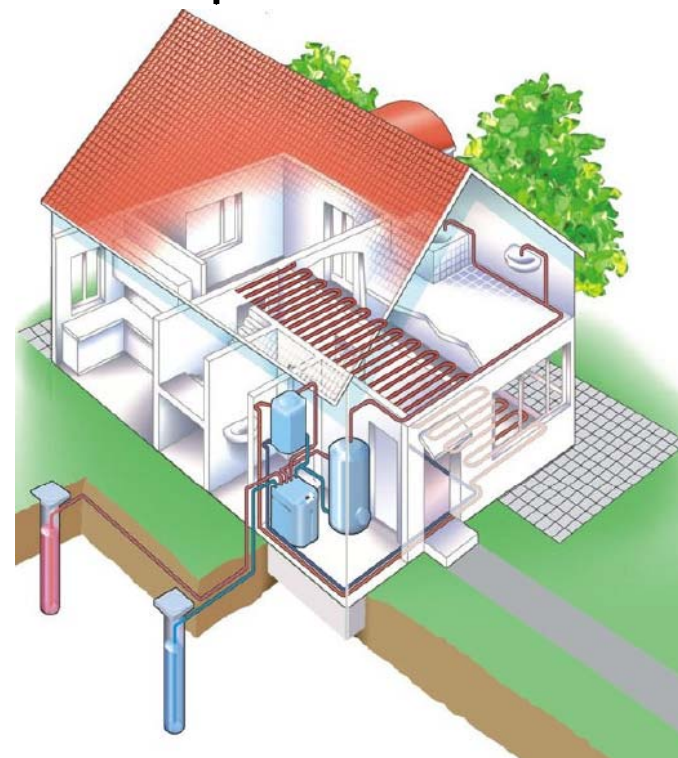
Sonde orizzontali
(1.2-3.0)

Sonde verticali
(10-250m)

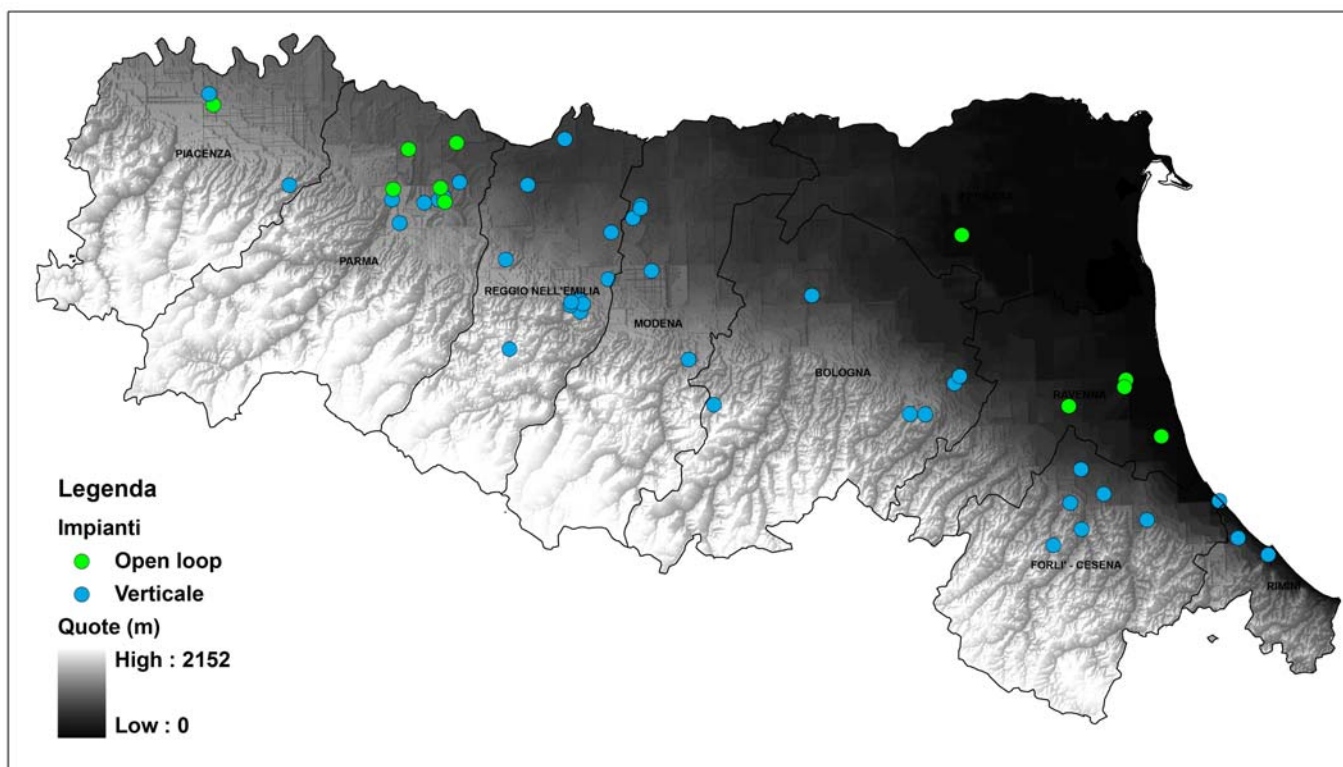
Pali energetici
(8-45m)



Sistemi a circuito aperto



Stato dell'arte degli impianti installati in RER



from Geological Survey of Emilia Romagna region

Censiti 57 impianti (verticali)

- ✓ 42 closed loop
- ✓ 15 open loop

**Quanto calore trasmettere un terreno e
come viene misurato?**



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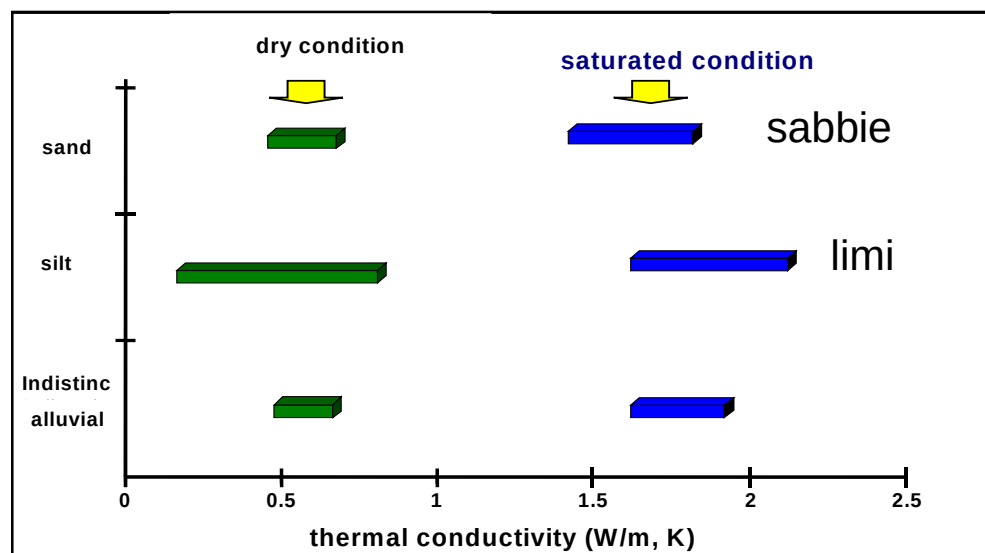
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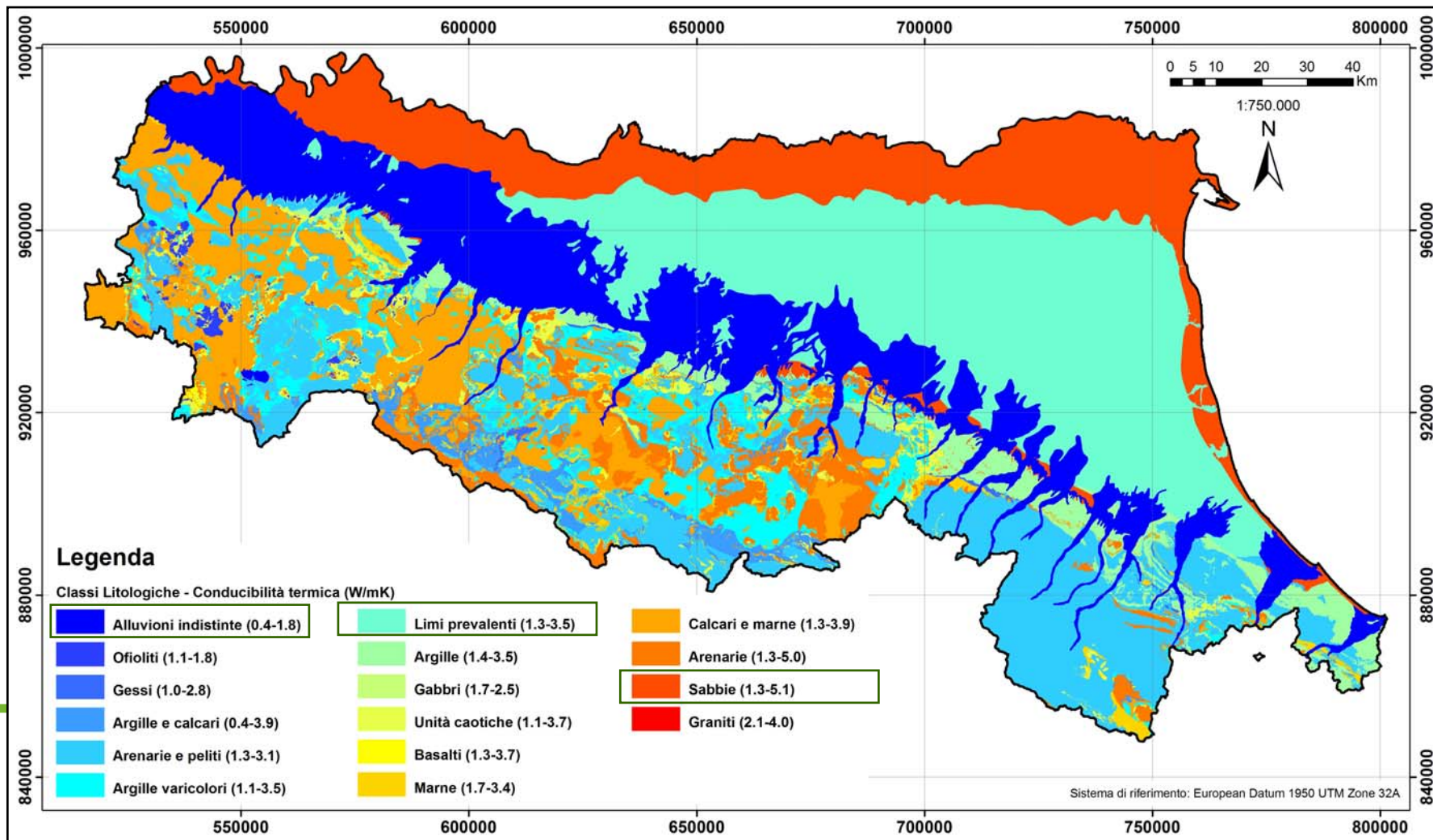
Classi litologiche	Conducibilità termica (W / m, K)
Alluvioni indistinte	0.46-0.65
Sabbie	0.47
Gessi	0.50
Limi prevalenti	0.55
Argille – argille varicolori	0.65
Argille e calcari	0.65-1.93
Arenarie e peliti	0.65-2.13
Ofiolite	1.86-3.00
Calcari e marne	1.93-2.12
Basalti	2.06
Gabbri	2.07
Marne	2.12
Arenarie	2.13
Unità caotiche	2.23
Graniti	3.27

from Geological Survey of Emilia Romagna region

La conducibilità termica dei terreni dipende: dalle condizioni **geologiche** ed **idrogeologiche** del sito



la conducibilità termica è una misura dell'attitudine di un terreno a trasmettere il calore



from Geological Survey of Emilia Romagna region

**Qual è la potenza termica estraibile da
un terreno?**

Capacità termica specifica dei terreni

	underground	specific heat extraction	
		for 1800 h (W/m)	for 2400 h (W/m)
general guideline values	poor underground (dry sediment) with $\lambda < 1,5$ W/m K	25	20
	normal rocky underground and water saturated sediment with $\lambda = 1,5 - 3,0$ W/m K	60	50
	consolidated rock with high thermal conductivity, with $\lambda > 3,0$ W/m/K	84	70
Individual rocks	gravel, sand, dry	<25	<20
	gravel, sand, saturated water	65 – 80	55 – 65
	for strong groundwater flow in gravel and sand, for individual systems	80-100	80 - 100
	clay, loam, damp	35 – 50	45 – 60
	limestone (massive)	55 – 70	55 – 65
	sandstone	65 – 80	55 – 70
	siliceous magmatites (e.g. granite)	65 – 85	35 – 55
	basic magmatites (e.g. basalt)	40 – 65	60 – 70
	gneiss	70 – 85	80 – 100
From VDI 4640 (German guideline for ground heat pumps and direct thermal use of the underground)			

Le norme VDI 4060 Tedesche forniscono una tabella delle **potenze termiche estraibili** in funzione delle proprietà del terreno e l'ore di funzionamento dell'impianto

Capacità termica specifica Considerazioni

	underground	specific heat extraction	
		for 1800 h (W/m)	for 2400 h (W/m)
Individual rocks	gravel, sand, dry	<25	<20
	gravel, sand, saturated water	65 – 80	55 – 65
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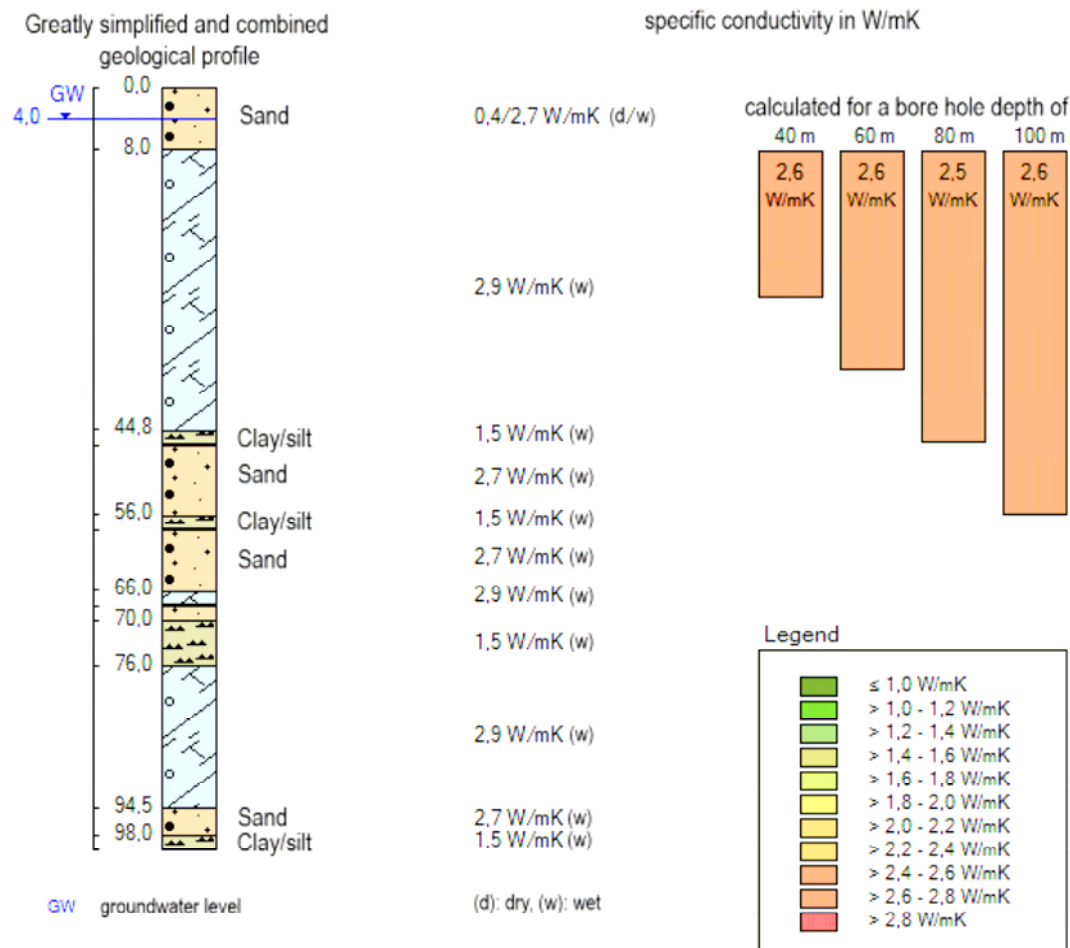
Le norme VDI 4060 Tedesche forniscono una tabella delle potenze termiche estraibili in funzione delle proprietà del terreno

capacità termica specifica considerazioni

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Le norme VDI 4060 Tedesche forniscono una tabella delle potenze termiche estraibili in funzione delle proprietà del terreno

esempio: calcolo conducibilità termica

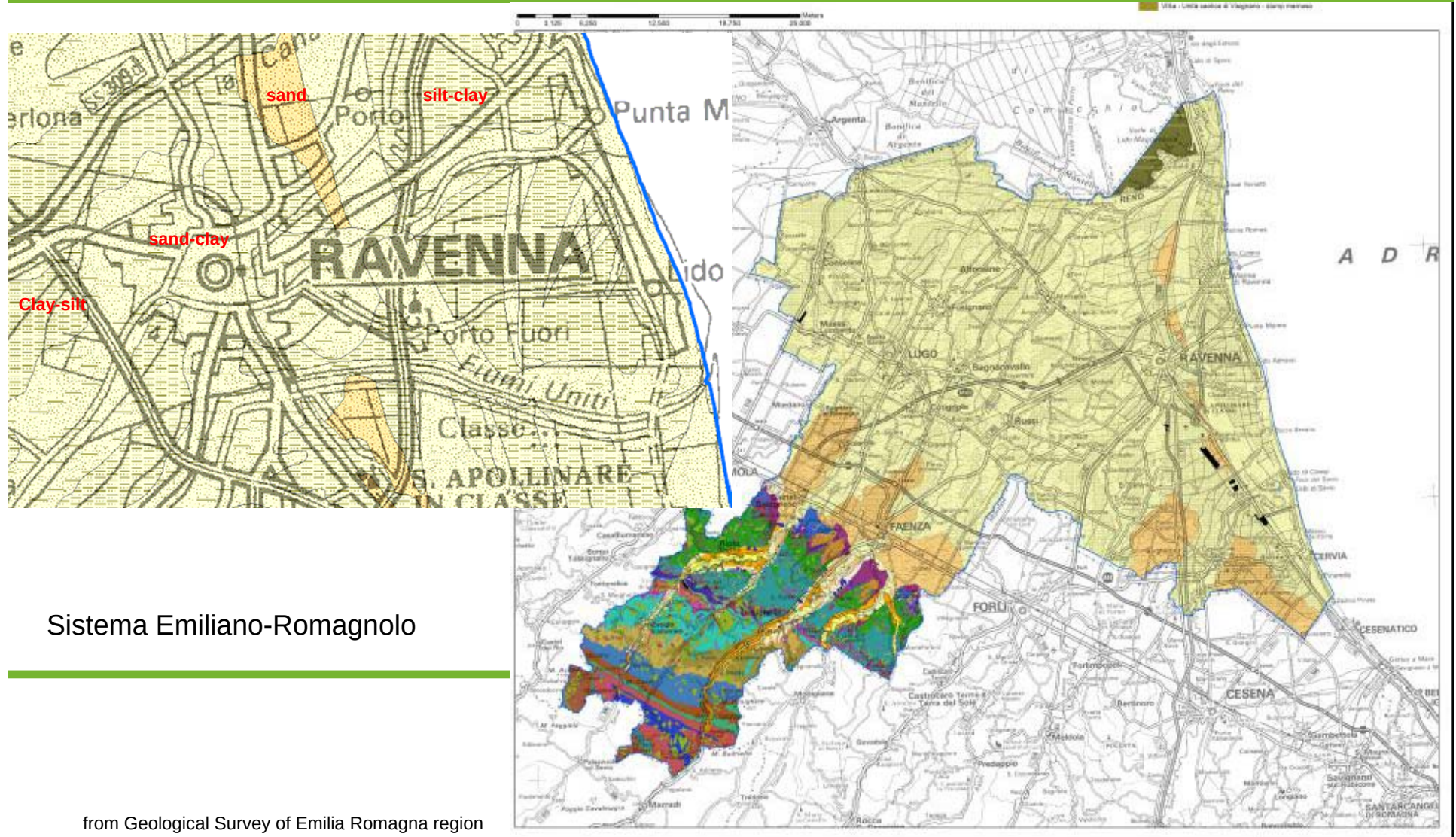


**Calcolo della
conducibilità termica
pesata per lo spessore
degli strati**

*The values on specific conductivity of rock are from VDI 4640 (2010), or were ascertained by laboratory or on-site measurements of loose rock in Berlin

applicazione

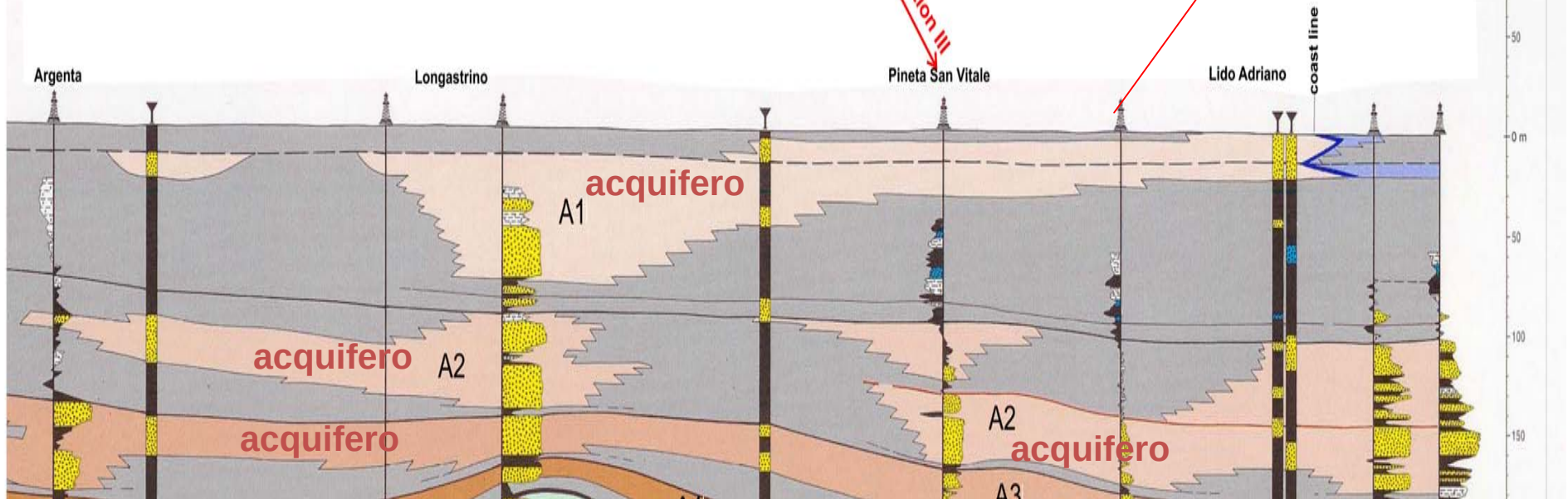
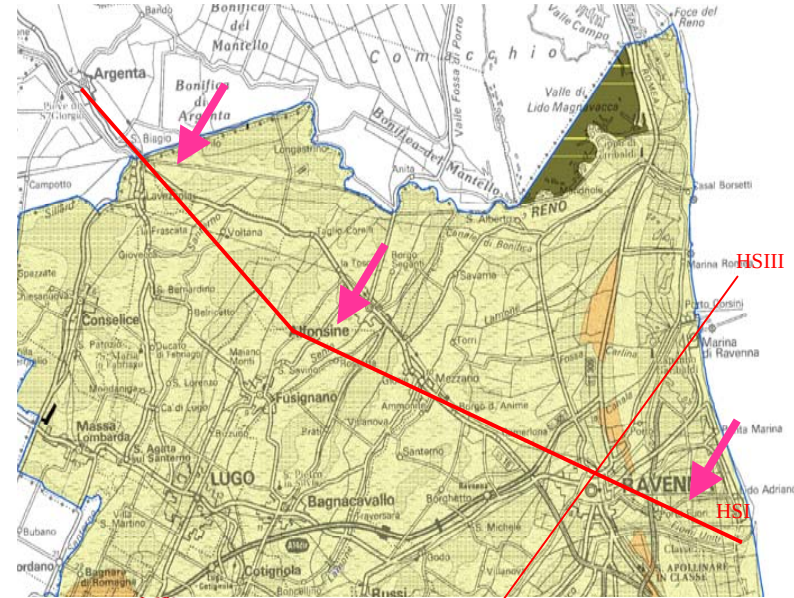
0 13.832 Meters



Sistema Emiliano-Romagnolo

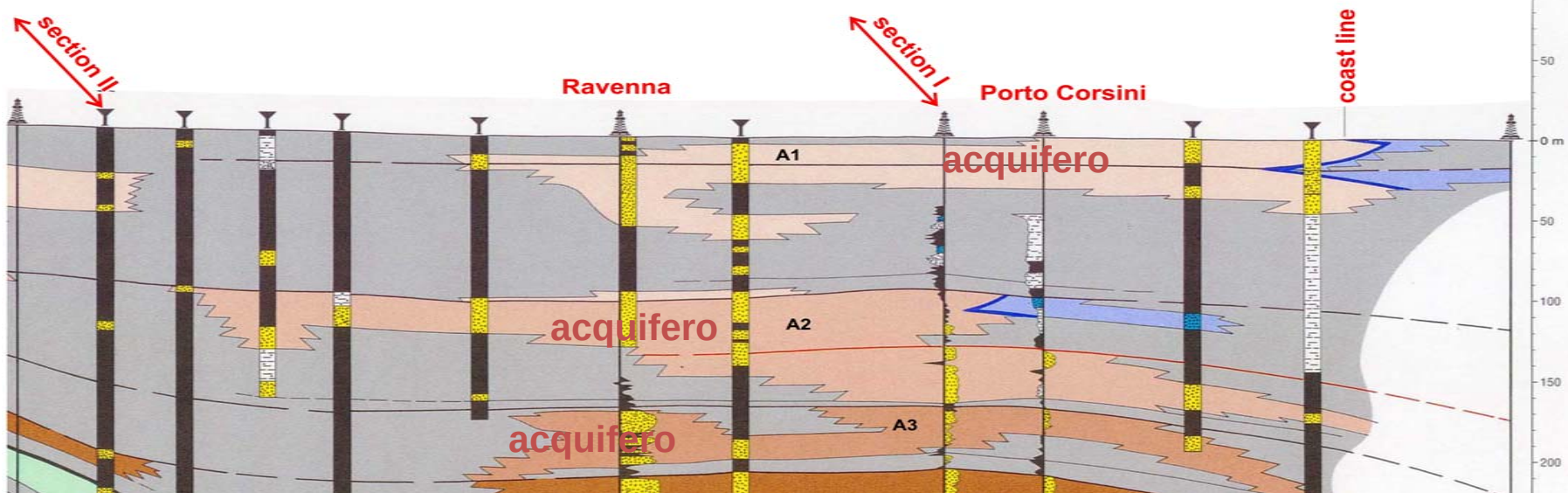
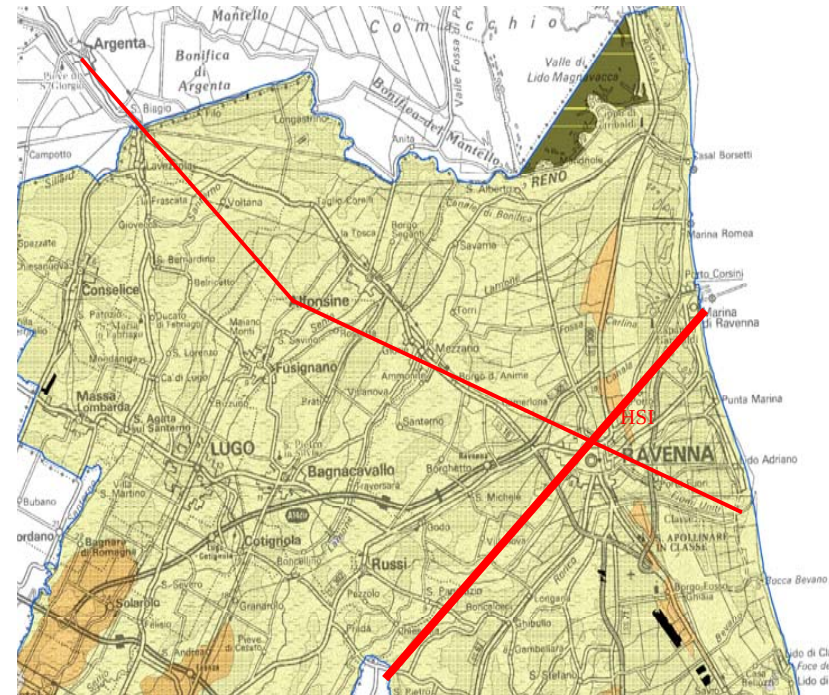
from Geological Survey of Emilia Romagna region

Sistemi acquiferi



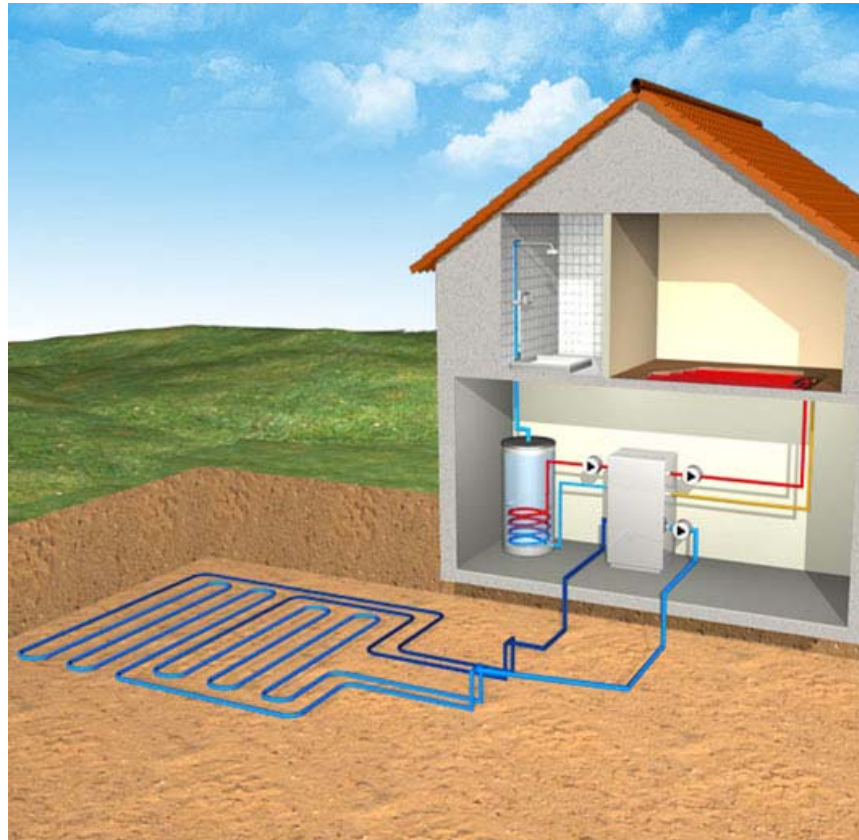
from Geological Survey of Emilia Romagna region

Sistemi acquiferi

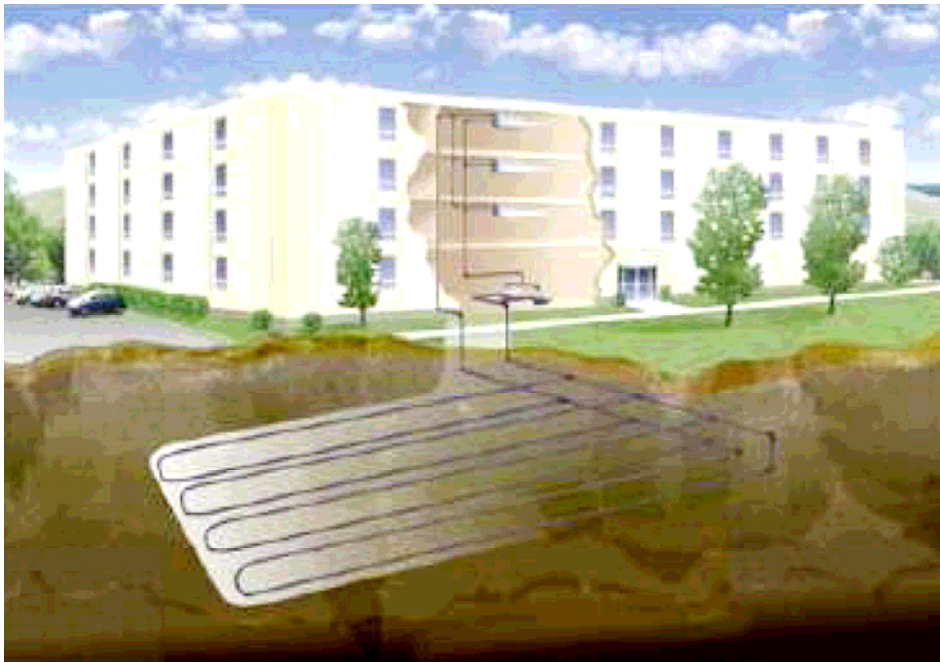


from Geological Survey of Emilia Romagna region

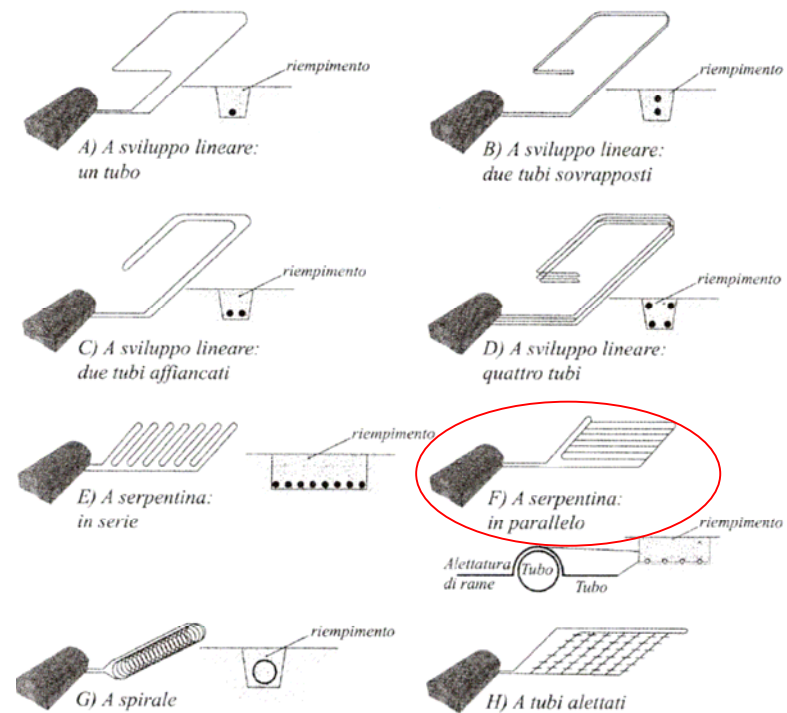
Sonde geotermiche orizzontali



Sonde geotermiche orizzontali



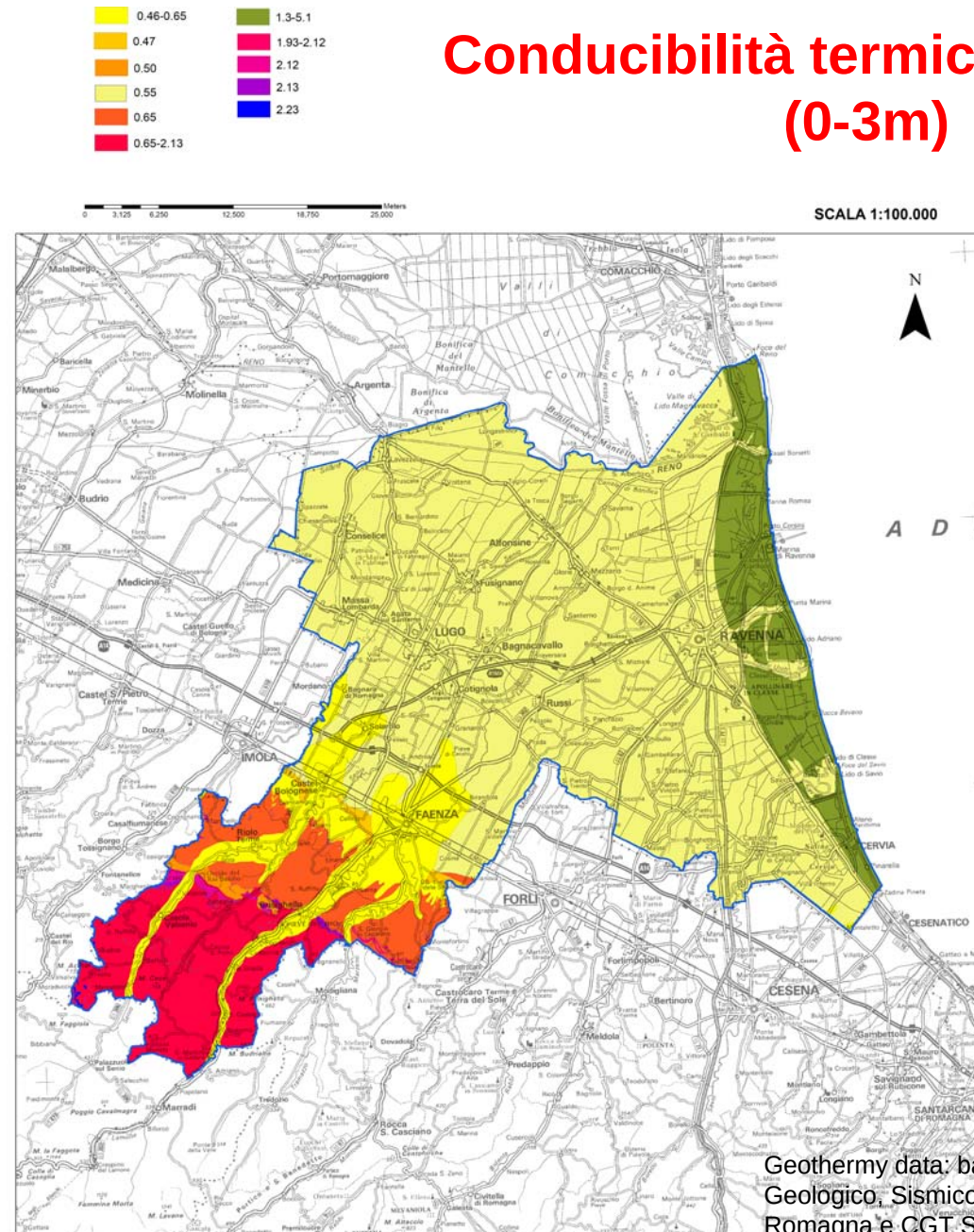
profondità: **1.2 - 3.0** metri dal piano campagna



sonde geotermiche orizzontali: configurazioni

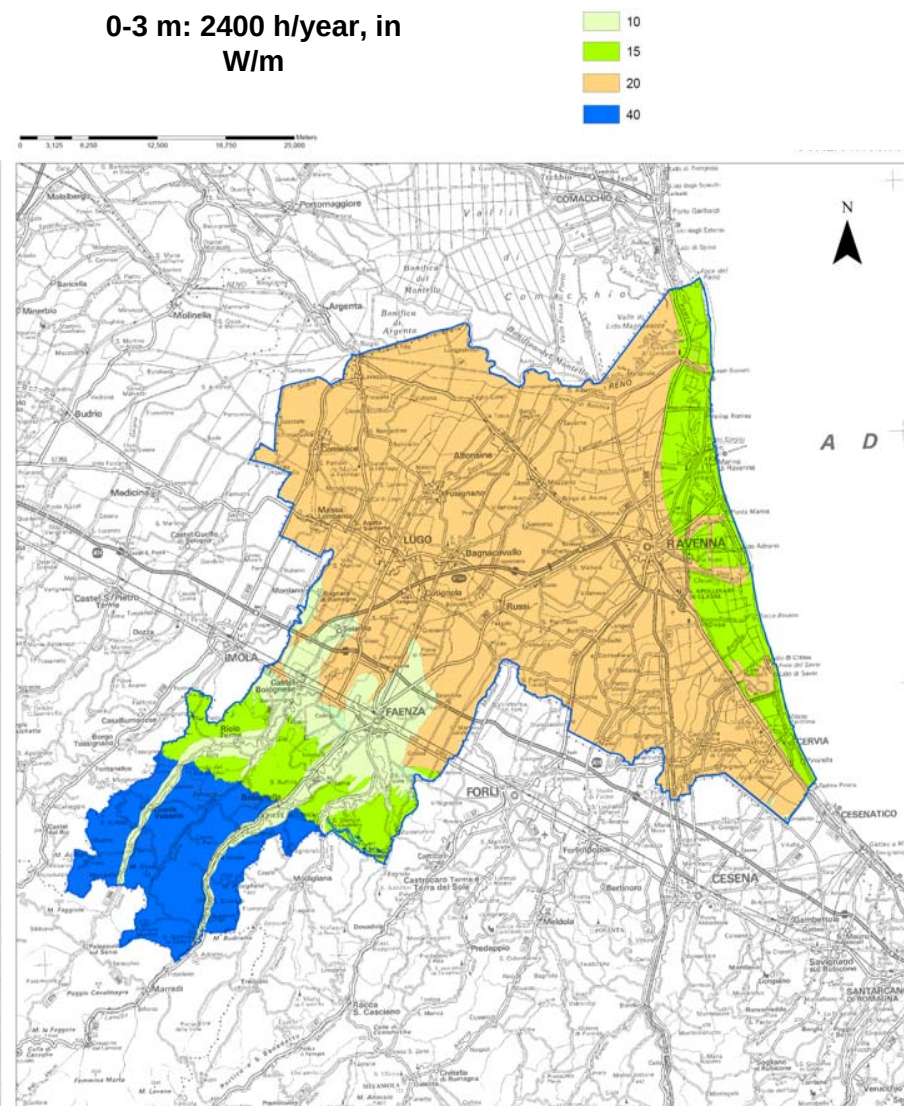
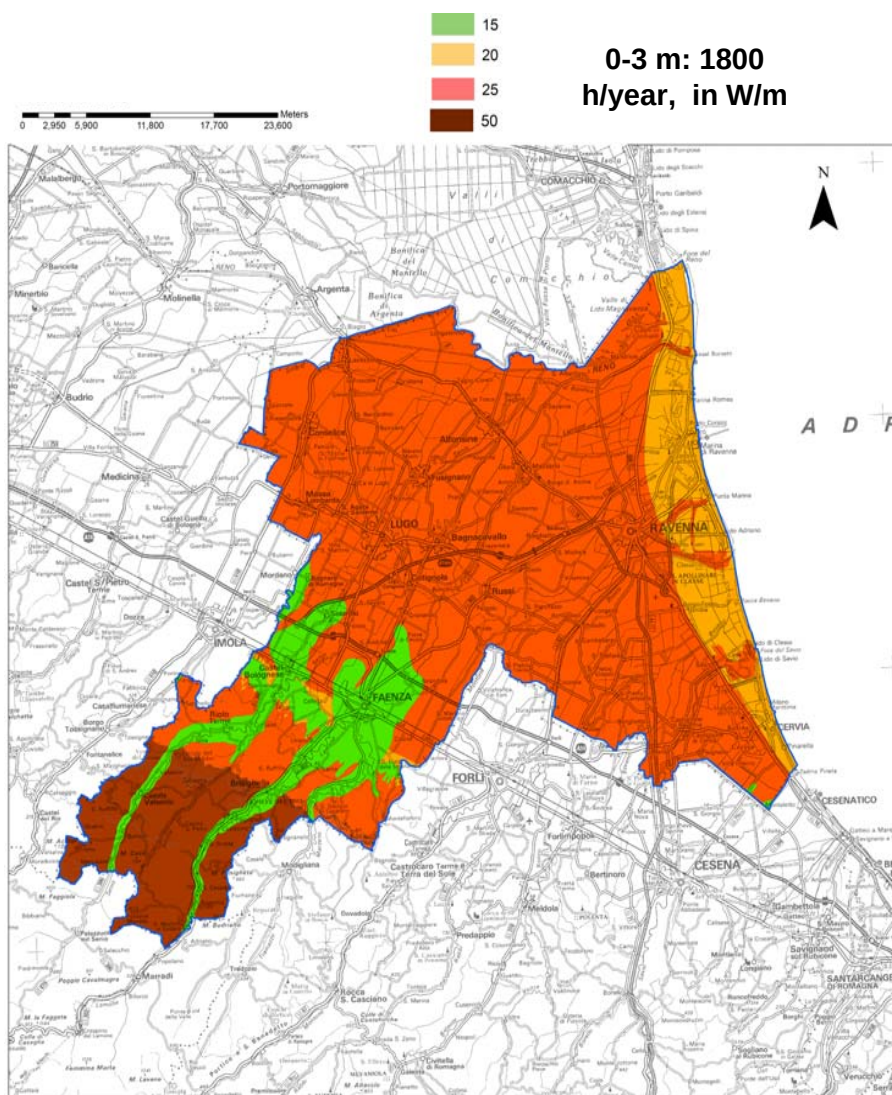
DRCT2

Conducibilità termica dei terreni (0-3m)

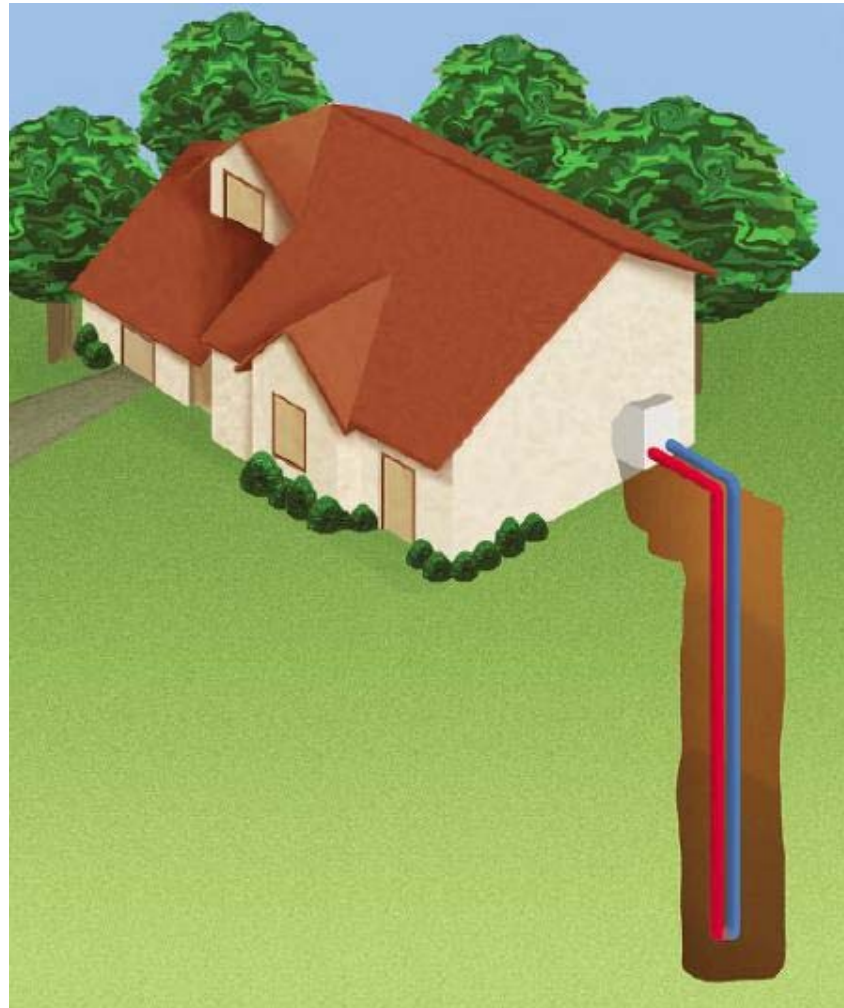


Geothermy data: based on database of Servizio Geologico, Sismico e dei suoli della Regione Emilia Romagna e CGT SpinOff s.r.l. dell'Università degli Studi di Siena, permission: PG.2013.0042957 del 15/02/2013

Capacità termica specifica dei terreni 0-3 m



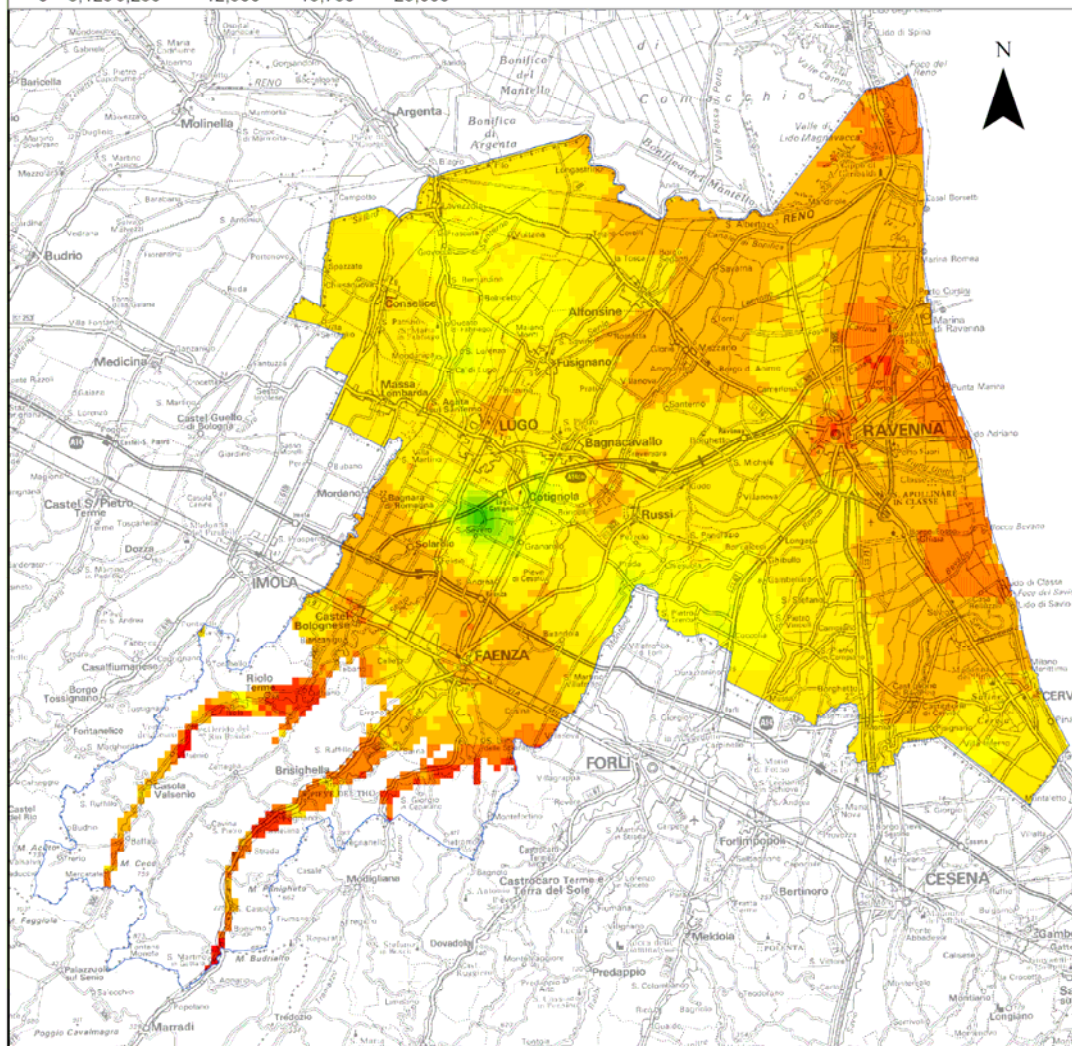
Sonde geotermiche verticali



λ_{0-30} (W/m,K)

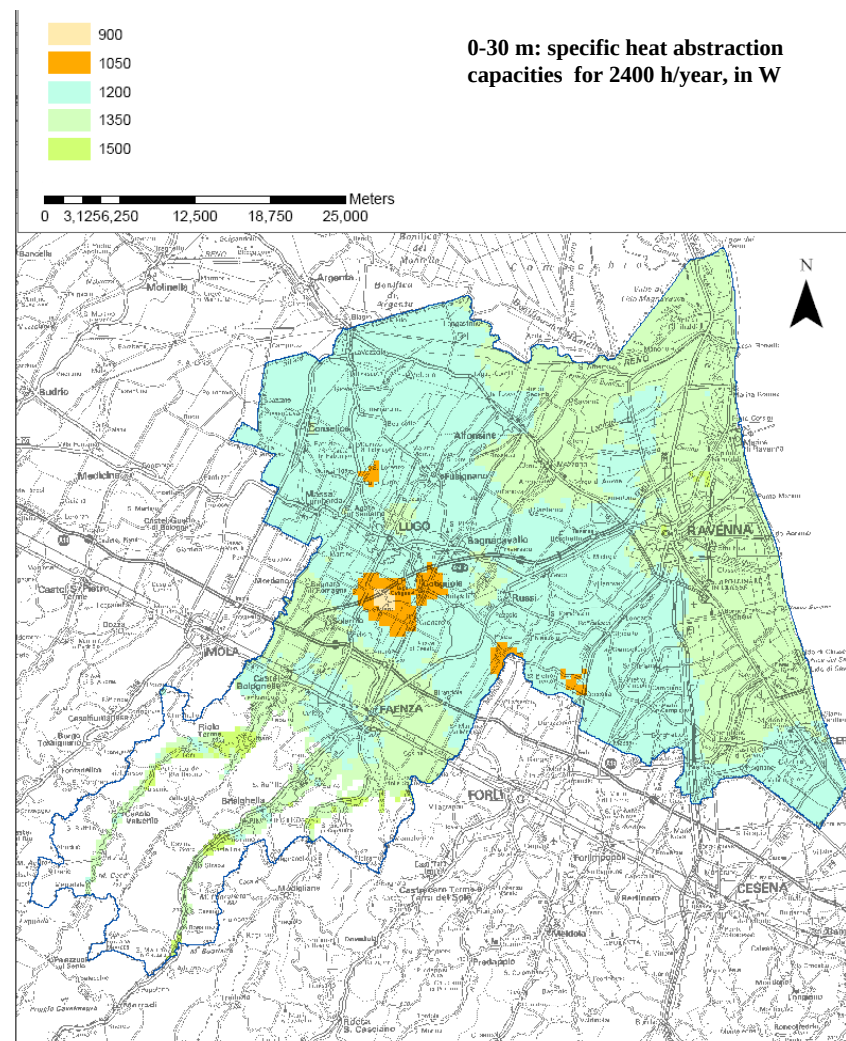
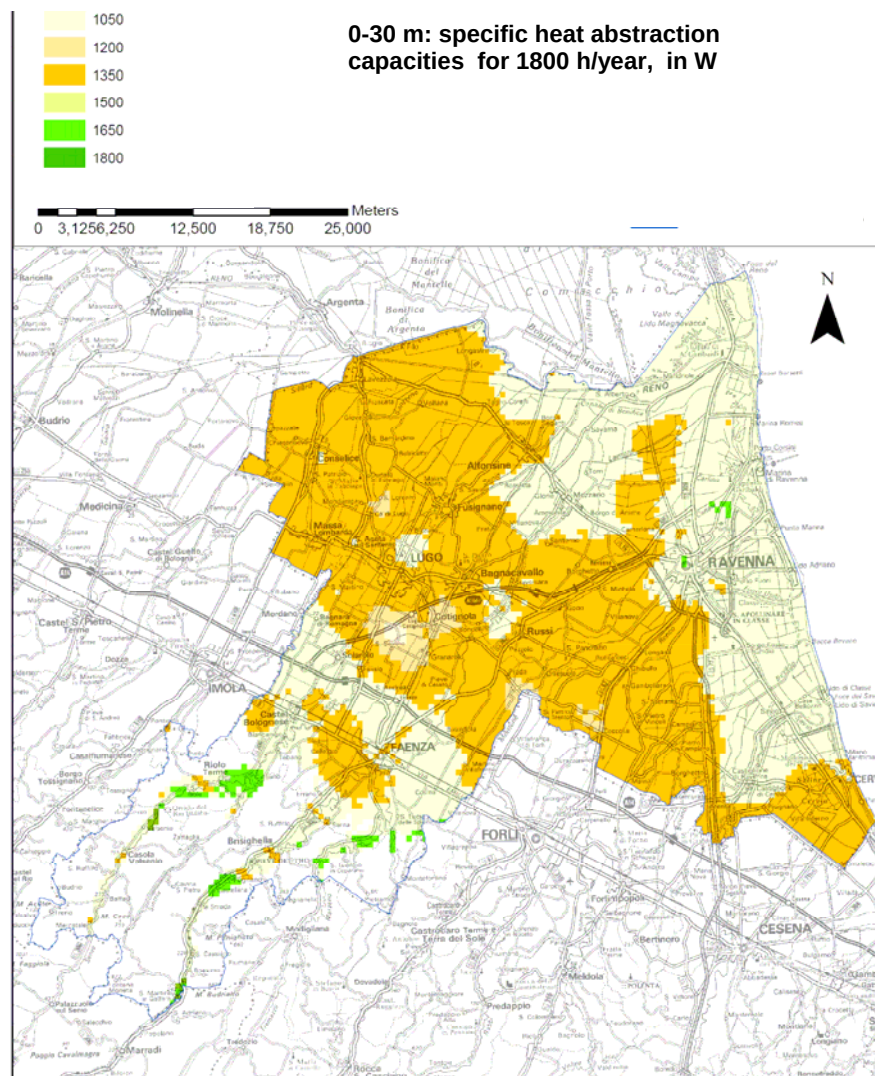


0 3,125 6,250 12,500 18,750 25,000 Meters

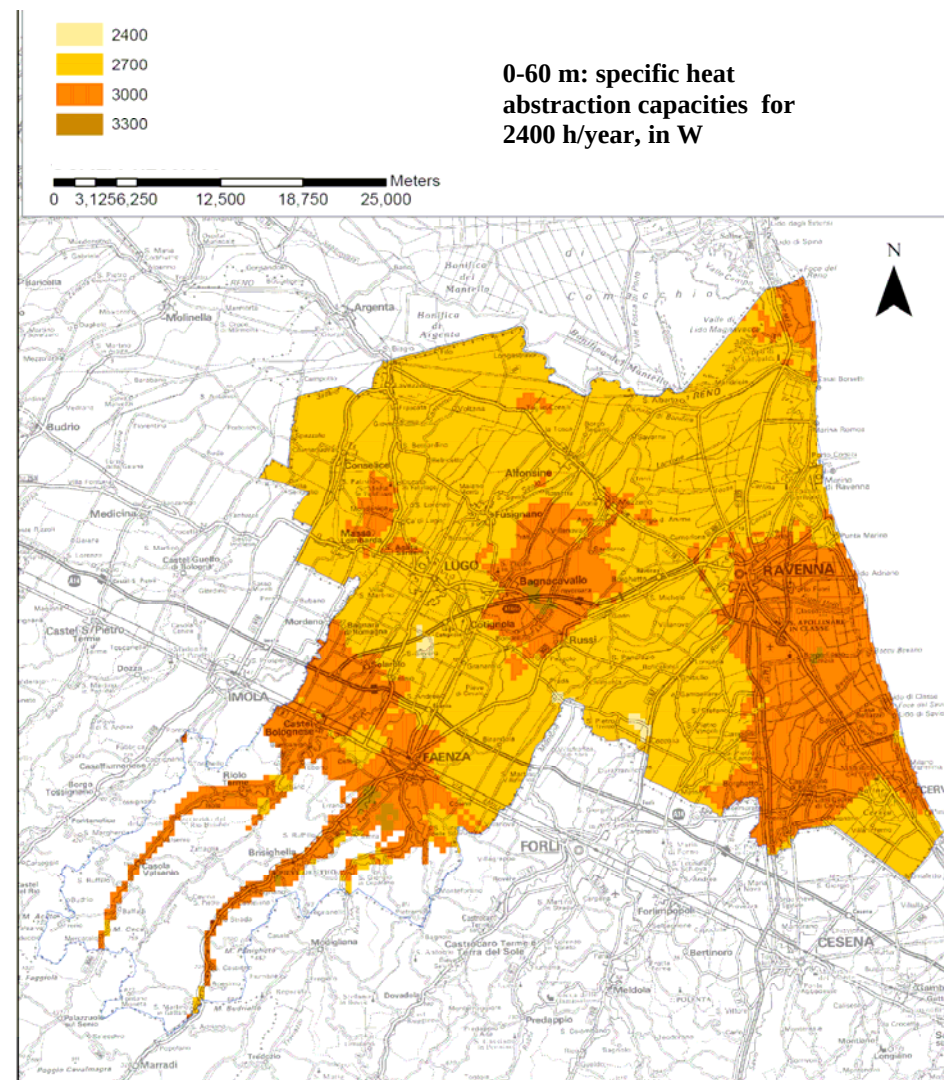
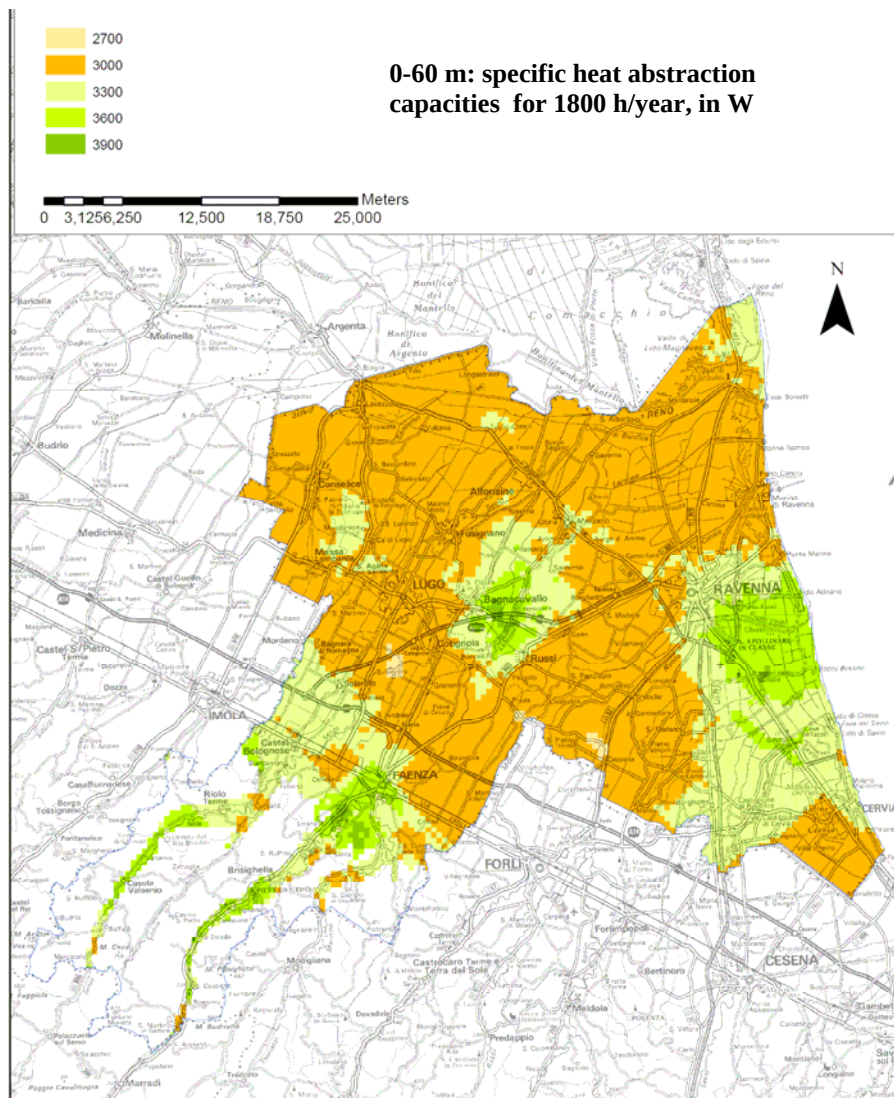


**Conducibilità
termica
profondità 0-30m**

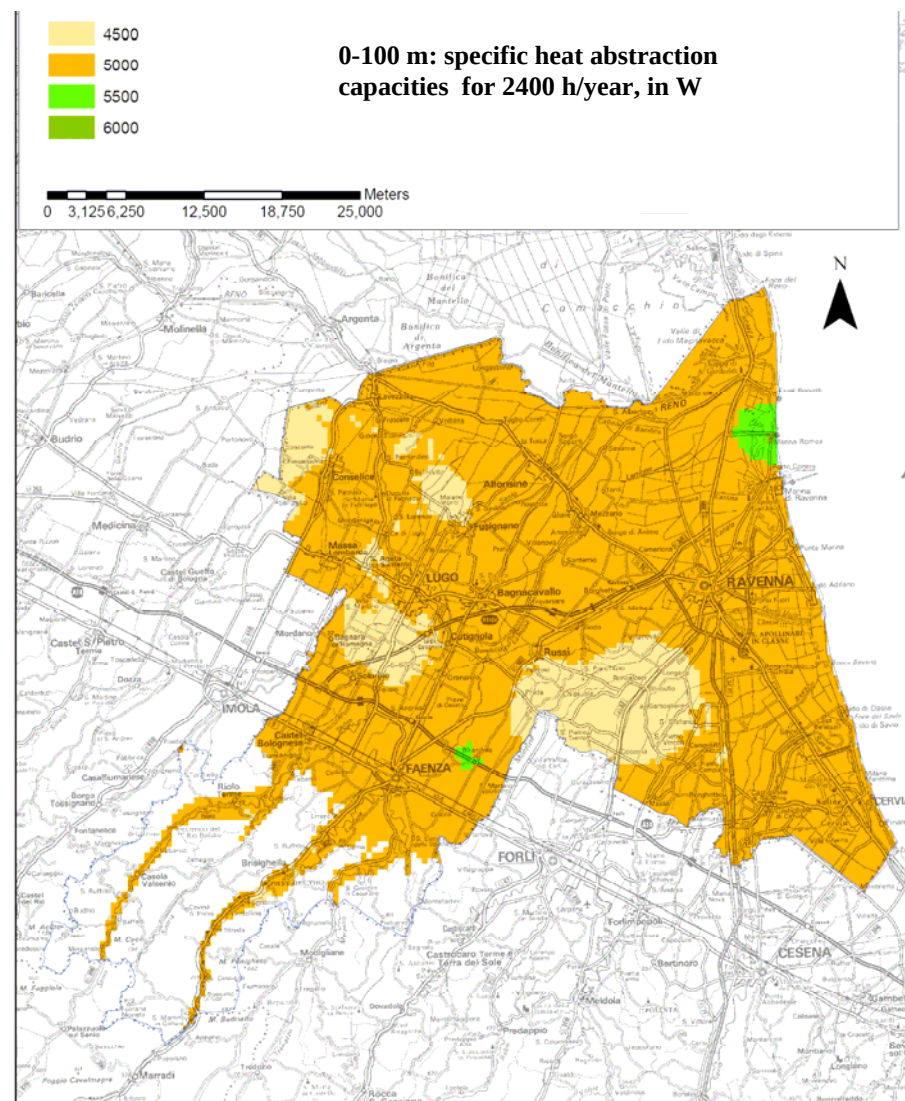
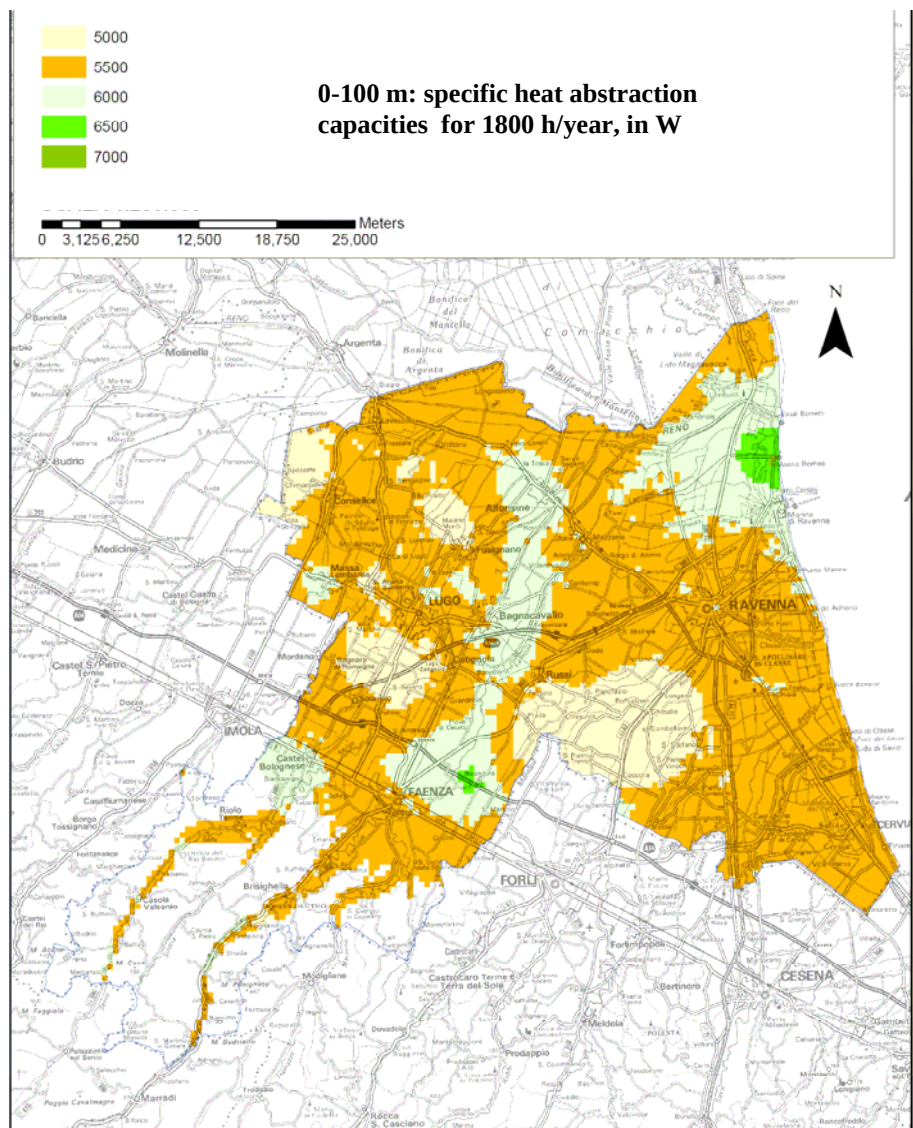
Capacità termica specifica dei terreni 30m



Capacità termica specifica dei terreni 60 m



Capacità termica specifica dei terreni 100 m

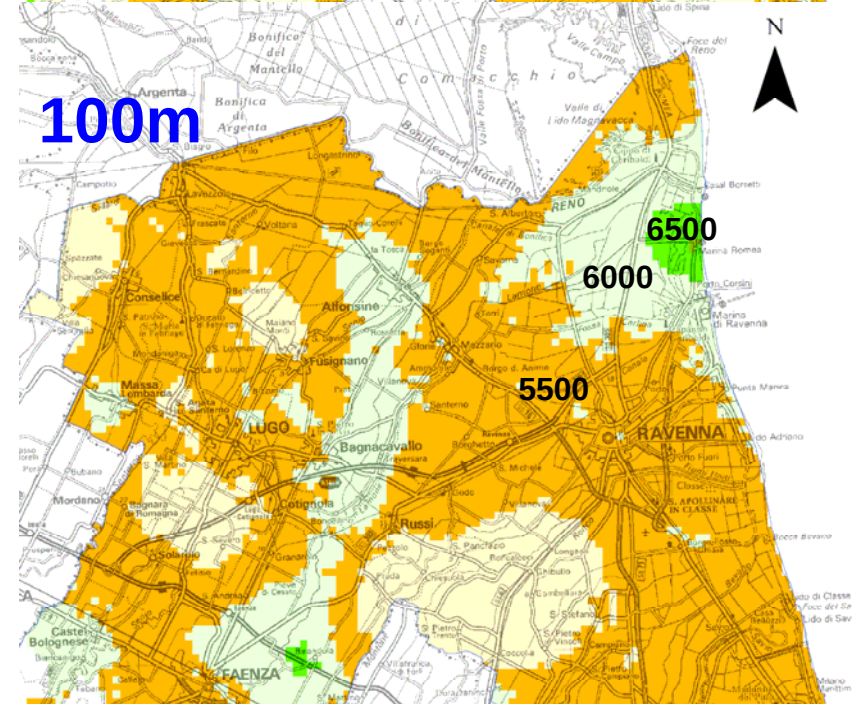
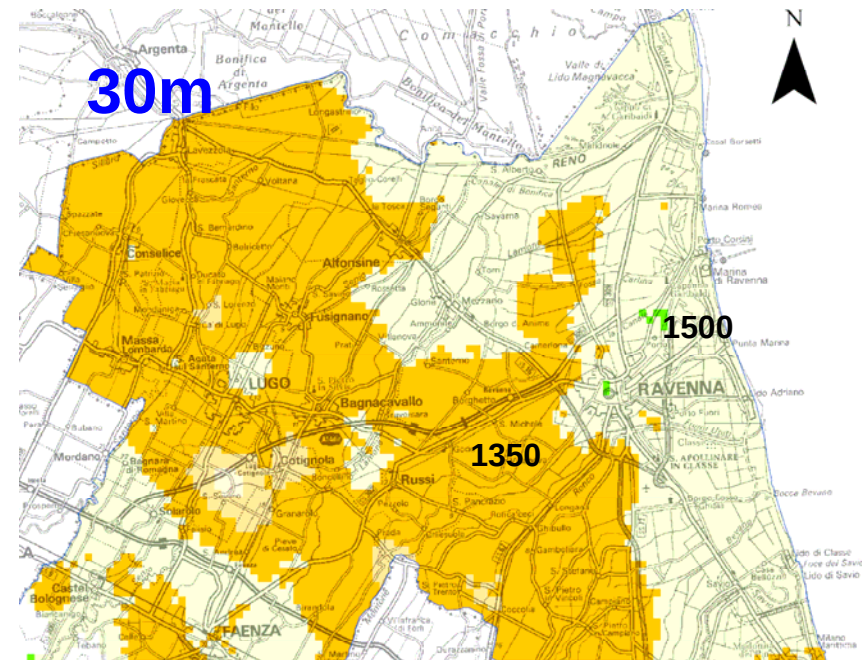
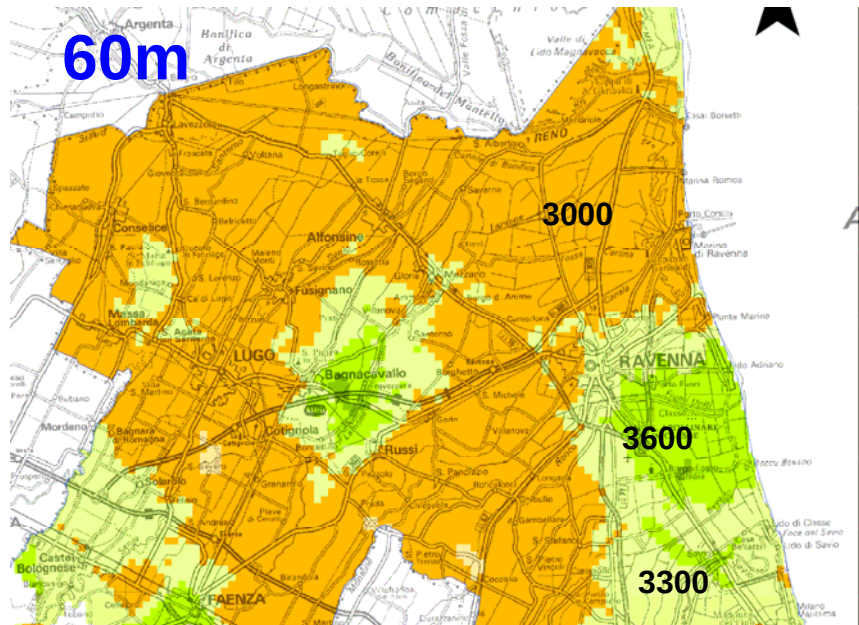


Mappe capacità termica specifica: confronto



Maggiori profondità

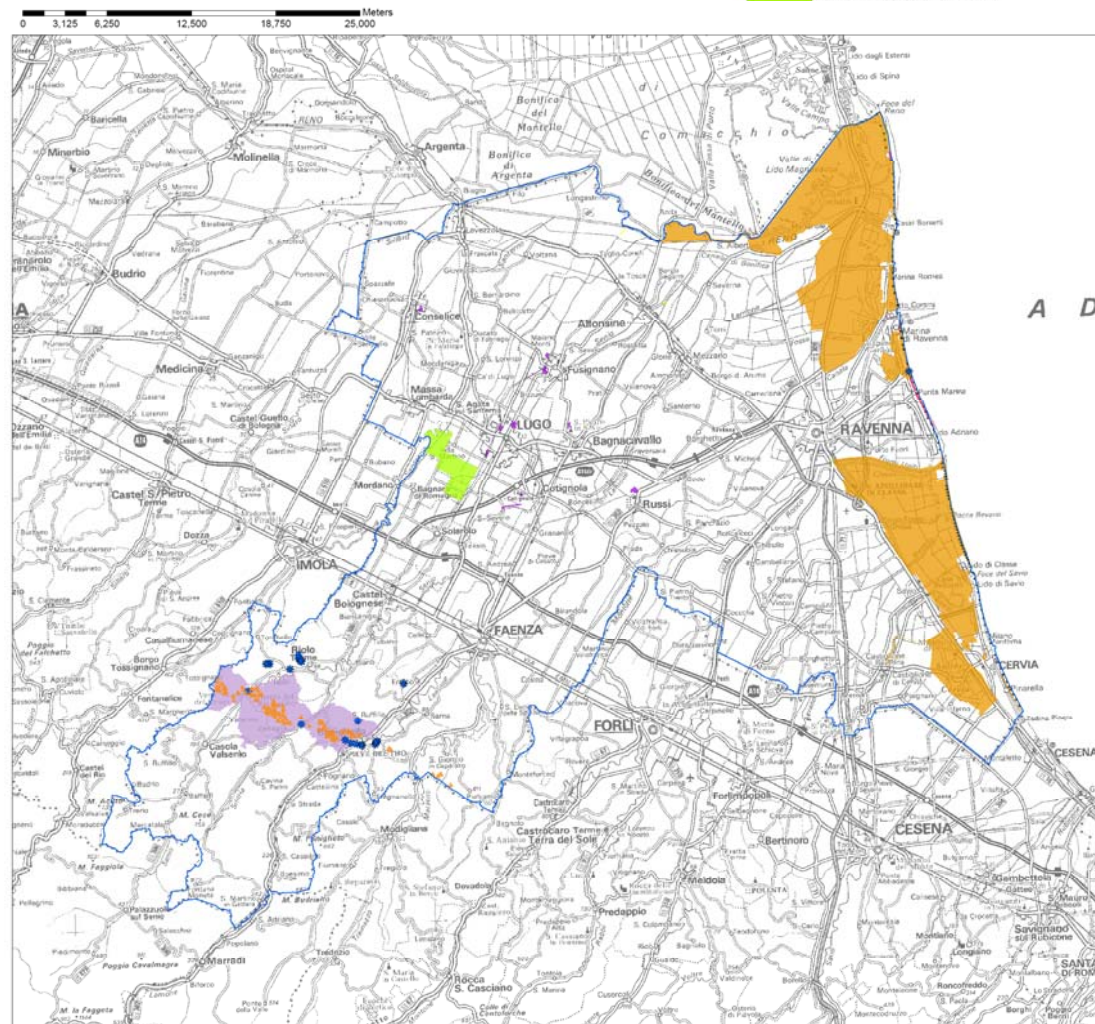
Aumento capacità termica



**aree
escluse**

Natural parks and protected areas

- ★ spring
- ▲ Natural cativities
- Areas vulnerable to sea storm $R_r=1$ year
- Areas vulnerable to sea storm $T_r=10$ years
- Areas vulnerable to sea storm $T_r=100$ years
- Alfonsine
- Delta del Po
- Pineta di Ravenna
- Sacca di Bellocchio
- Vena del Gesso Romagnola
- Aree di riequilibrio ecologico
- Paesaggi Protetti



**aree d'interesse
archeologico**



Ringraziamenti:

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del Servizio Geologico della Regione Emilia Romagna

Dott. Cesari, GEO-NET Srl

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City of Klagenfurt
(AT)



Province of Ravenna
(IT)



Province of Turin (IT)



Expert institutions:

Energy conservation
foundation (PL)



Ecopower Stock Exchange
Salzburg (AT)

Research Studios Austria
(AT)



Local Agenda 21 for Dresden
(DE)



Environment Park Turin (IT)

