



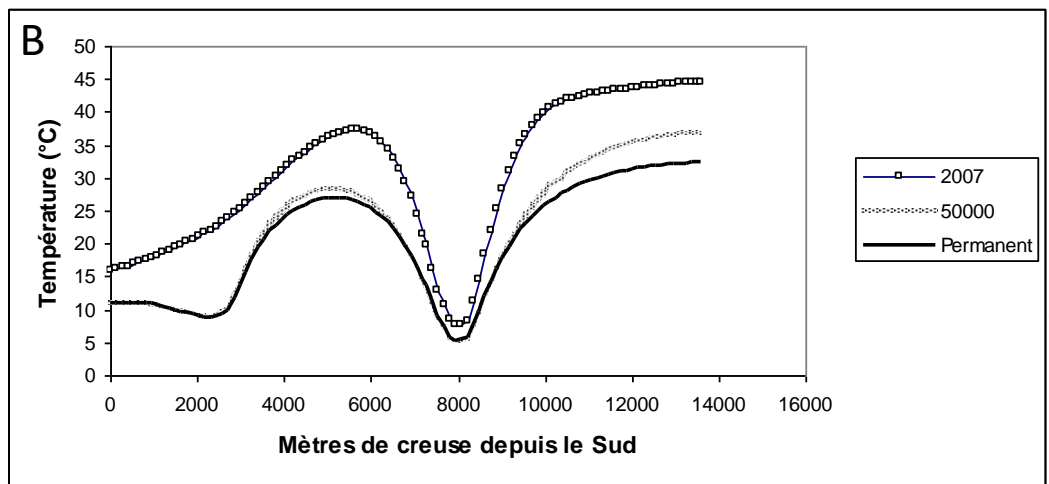
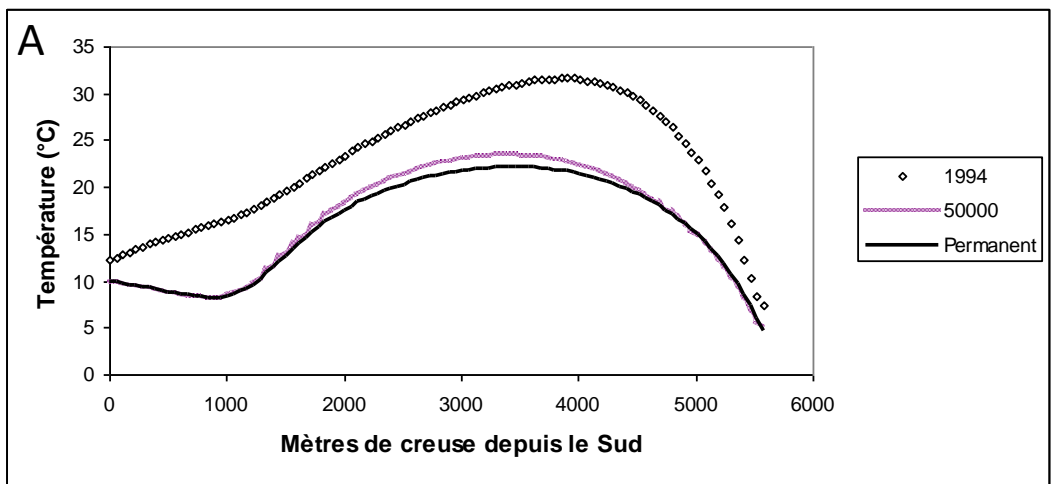
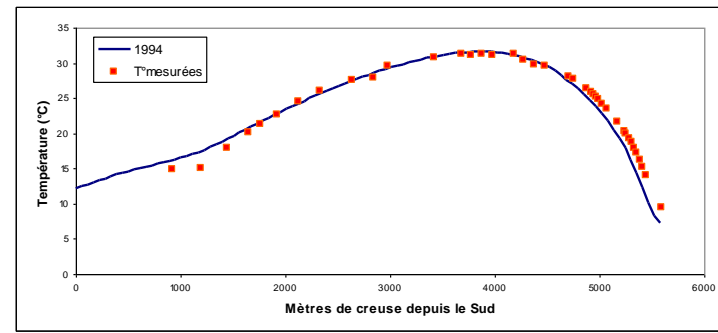
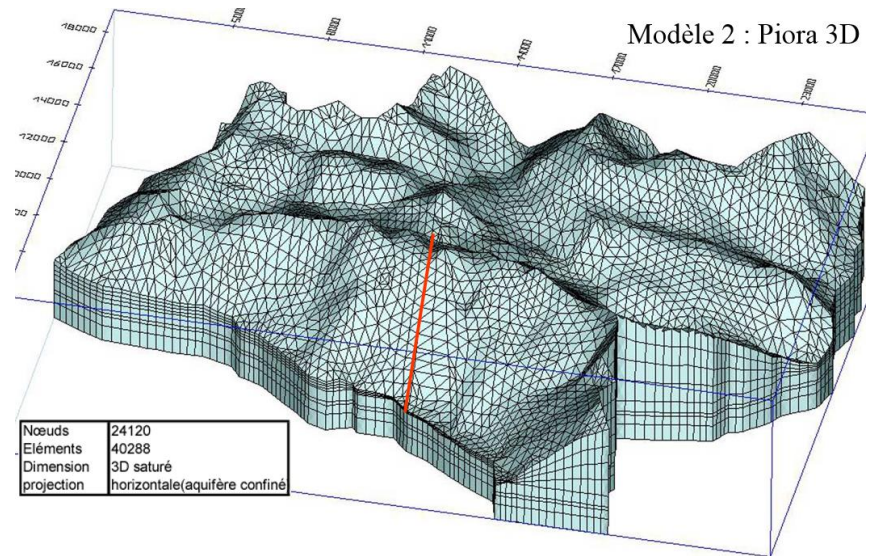
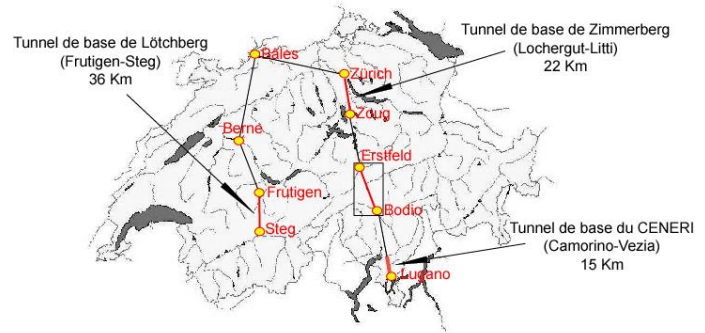
NUMERICAL SIMULATIONS OF GROUNDWATER AND SURFACE WATER THERMAL SYSTEMS

Dr Boris Matti, March 2023

*2022 - 20 years of
experience*

CASE 1 PIORA – ALPTRANSIT (TI, CH) – 3D HYDRO-THERMAL (2001-2002)

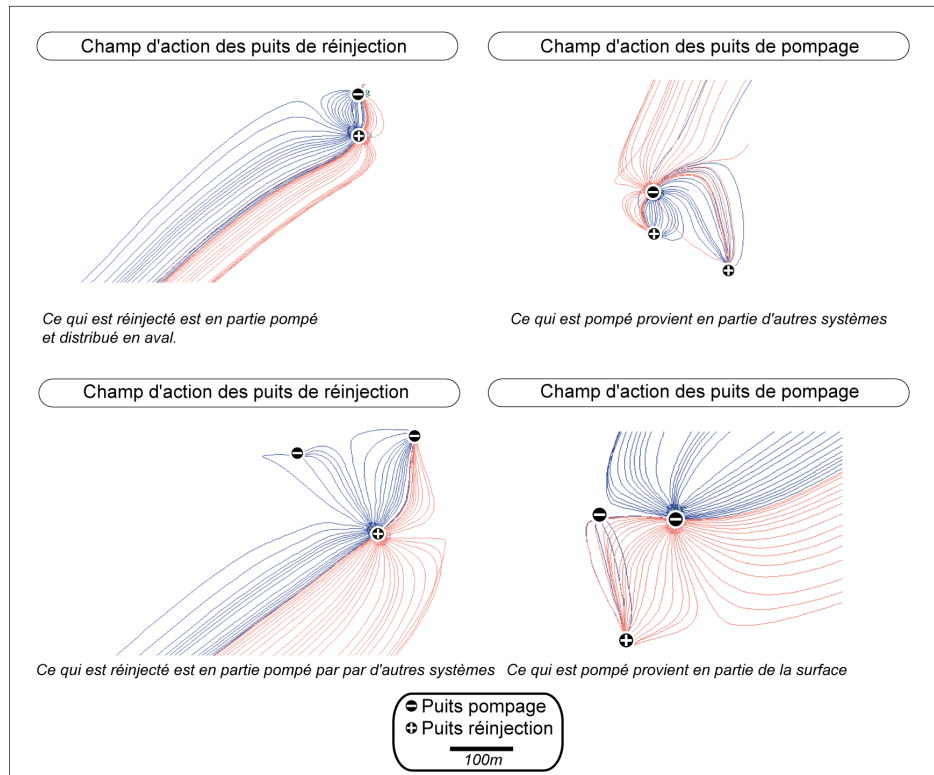
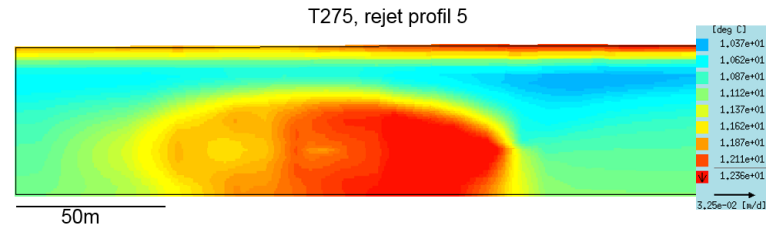
Objectives: To calibrate a 3D hydro-thermal model of the Gotthard massif and to estimate the temperatures during the drilling of the Alptransit base tunnel. Approach point: La Piora gallery.



CASE 3 SION HOSPITAL AND SUVA (VS, CH) – 3D HYDRO-THERMAL (2007)

Objectives: To calibrate a 3D hydro-thermal model of the Rhone aquifer to assess the thermal potential of the aquifer and to study the feasibility of additional heat pump systems. Study of thermal interferences and thermal plume path.

Modélisation thermique - PAC – rayon d'action - SUVA



Bilan thermique en automne

Flux entrant par la face amont	2.87E+11 [J.j ⁻¹]
Flux entrant avec les précipitations	3.20E+11 [J.j ⁻¹]
Flux entrant par le Rhône	2.70E+10 [J.j ⁻¹]
Flux géothermique à la base	4.61E+10 [J.j ⁻¹]
Flux sortant par la face aval	-4.81E+11 [J.j ⁻¹]
Flux sortant par le sommet	-2.95E+11 [J.j ⁻¹]
Flux sortant par exfiltration vers le Rhône	-9.19E+11 [J.j ⁻¹]
Puits de prélèvement ICHV PAC	-8.20E+09 [J.j ⁻¹]
Puits de réinjection ICHV PAC	8.39E+09 [J.j ⁻¹]
Puits de prélèvement SUVA PAC	-5.85E+10 [J.j ⁻¹]
Puits de réinjection SUVA PAC	4.58E+10 [J.j ⁻¹]
Total	-1.14E+12 [J.j⁻¹]

Bilan thermique en été

Flux entrant par la face amont	5.77E+11 [J.j ⁻¹]
Flux entrant avec les précipitations	7.60E+11 [J.j ⁻¹]
Flux entrant par le Rhône	9.14E+11 [J.j ⁻¹]
Flux géothermique à la base	6.58E+10 [J.j ⁻¹]
Flux sortant par la face aval	-4.85E+11 [J.j ⁻¹]
Flux sortant par le sommet	-1.26E+12 [J.j ⁻¹]
Flux sortant par exfiltration vers le Rhône	-2.21E+10 [J.j ⁻¹]
Puits de prélèvement ICHV PAC	-8.51E+10 [J.j ⁻¹]
Puits de réinjection ICHV PAC	9.66E+10 [J.j ⁻¹]
Puits de prélèvement SUVA PAC	-1.82E+11 [J.j ⁻¹]
Puits de réinjection SUVA PAC	1.75E+11 [J.j ⁻¹]
Total	3.55E+11 [J.j⁻¹]

Bilan thermique en hiver

Flux entrant par la face amont	3.42E+11 [J.j ⁻¹]
Flux entrant avec les précipitations	4.73E+11 [J.j ⁻¹]
Flux entrant par le Rhône	1.73E+10 [J.j ⁻¹]
Flux géothermique à la base	4.64E+10 [J.j ⁻¹]
Flux sortant par la face aval	-4.59E+11 [J.j ⁻¹]
Flux sortant par le sommet	-2.47E+11 [J.j ⁻¹]
Flux sortant par exfiltration vers le Rhône	-9.11E+11 [J.j ⁻¹]
<i>Puits de prélèvement ICHV PAC</i>	
<i>Puits de réinjection ICHV PAC</i>	
Puits de prélèvement SUVA PAC	-4.61E+10 [J.j ⁻¹]
Puits de réinjection SUVA PAC	4.00E+10 [J.j ⁻¹]
Total	-7.44E+11 [J.j⁻¹]

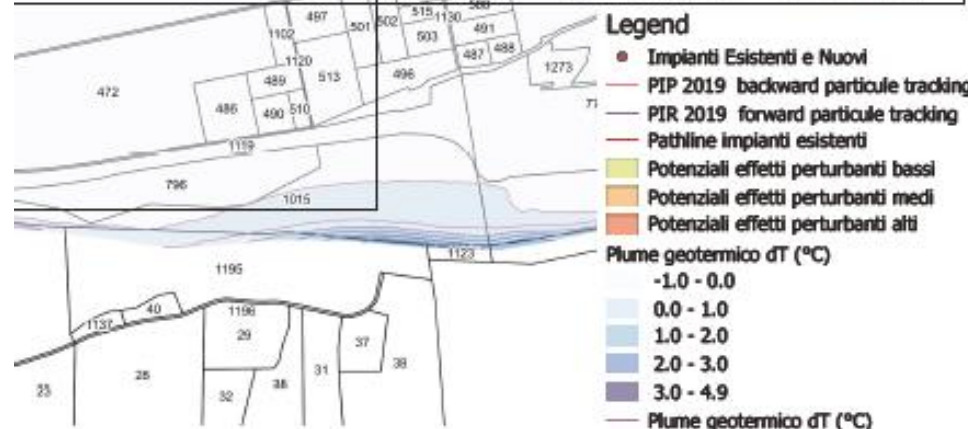
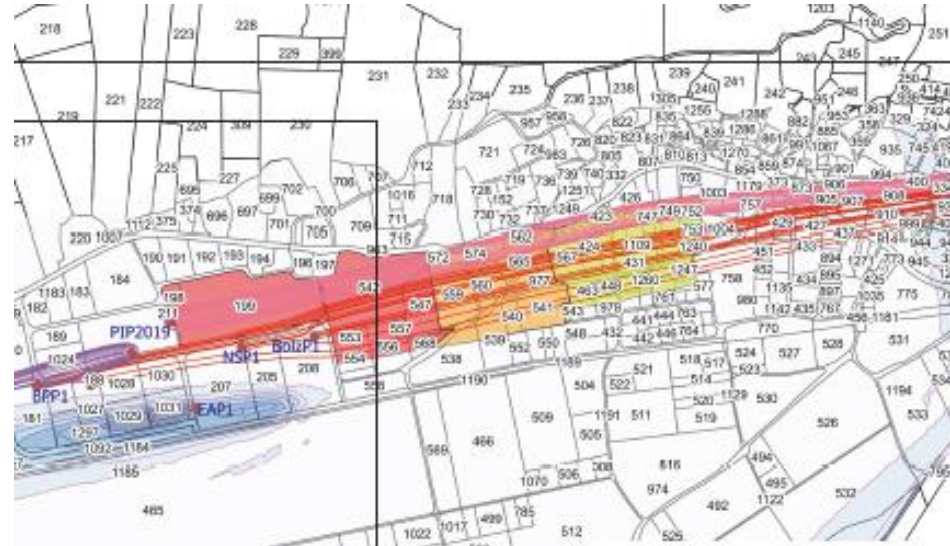
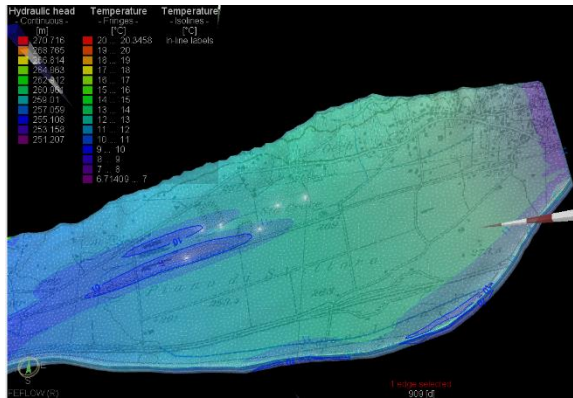
Bilan thermique au printemps

Flux entrant par la face amont	7.72E+11 [J.j ⁻¹]
Flux entrant avec les précipitations	6.06E+11 [J.j ⁻¹]
Flux entrant par le Rhône	1.11E+12 [J.j ⁻¹]
Flux géothermique à la base	6.56E+10 [J.j ⁻¹]
Flux sortant par la face aval	-3.93E+11 [J.j ⁻¹]
Flux sortant par le sommet	-1.24E+12 [J.j ⁻¹]
Flux sortant par exfiltration vers le Rhône	-2.94E+10 [J.j ⁻¹]
Puits de prélèvement ICHV PAC	-4.68E+10 [J.j ⁻¹]
Puits de réinjection ICHV PAC	5.97E+10 [J.j ⁻¹]
Puits de prélèvement SUVA PAC	-1.23E+11 [J.j ⁻¹]
Puits de réinjection SUVA PAC	1.25E+11 [J.j ⁻¹]
Total	9.06E+11 [J.j⁻¹]

CASE 17 SAN VITTORE (GR, CH) HEAT PUMPS – 3D HYDRO-THERMAL

(2017-2019)

Objectives: To calibrate a 3D hydro-thermal model of the San Vittore (GR) aquifer for the assessment of the thermal seasonal effect of heat pumps, and the study of the sustainable use of the thermal resources.

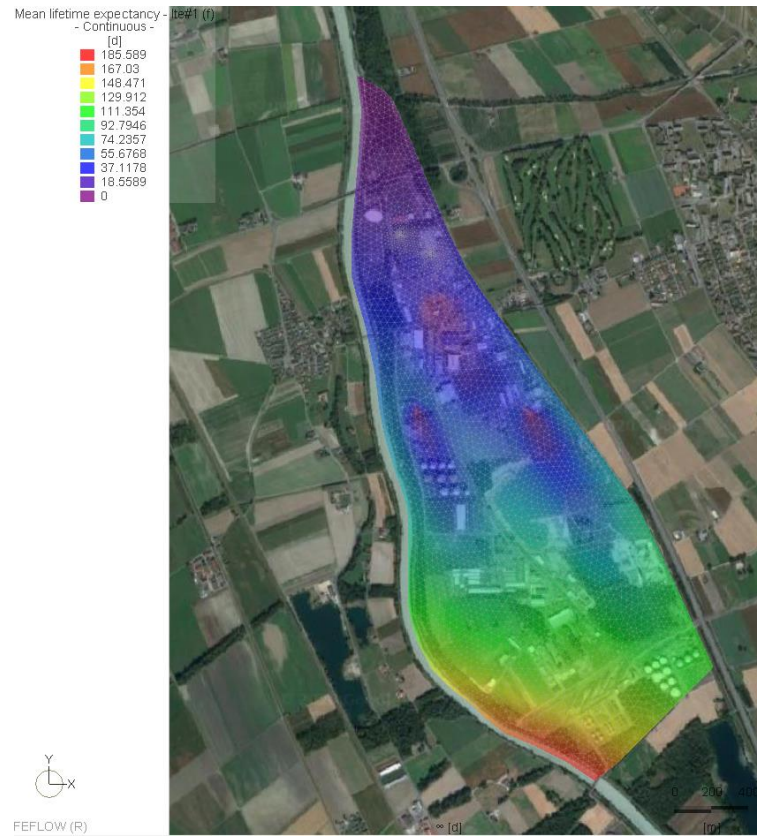
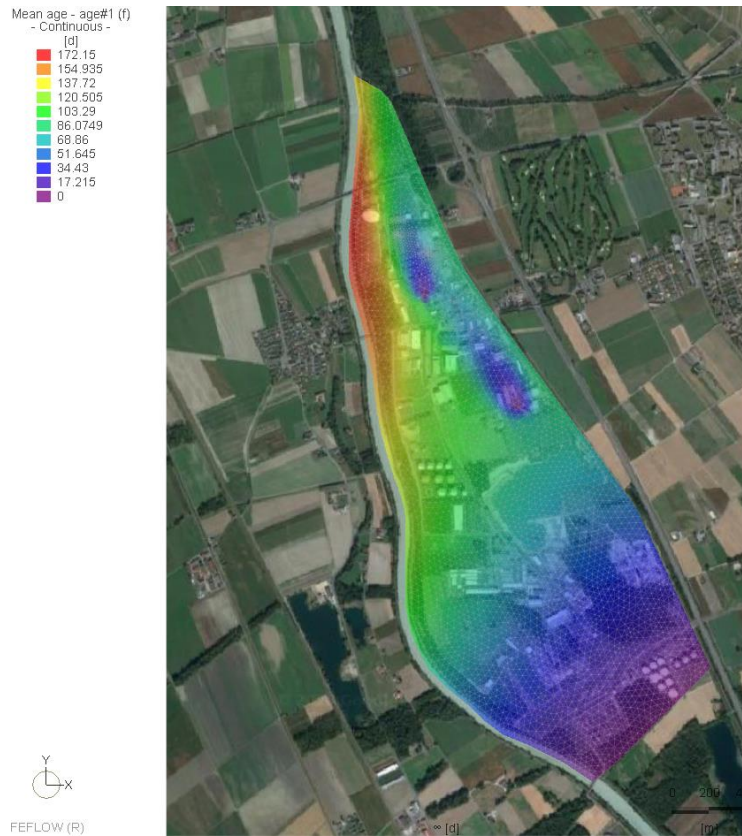
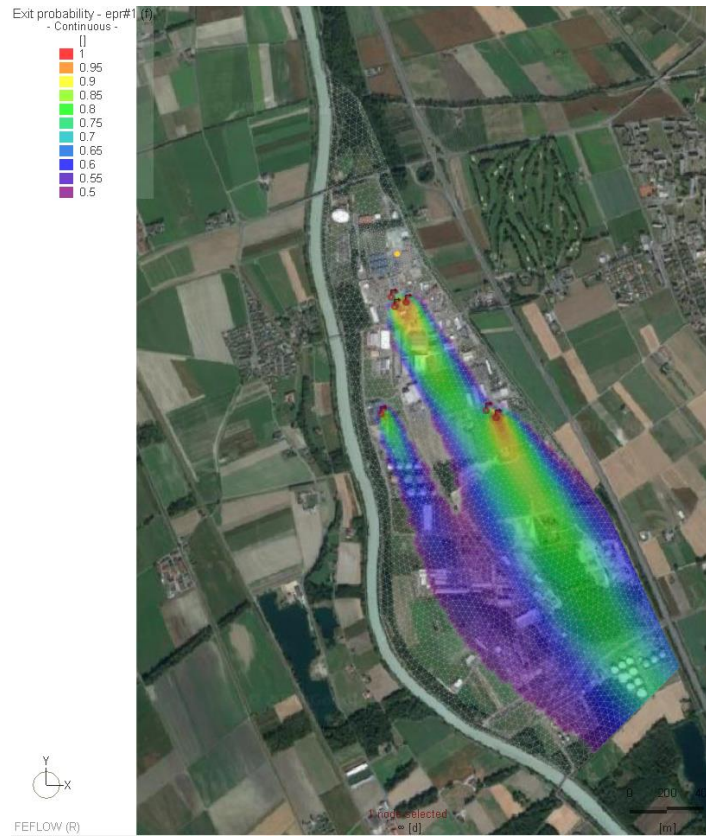


Settore 1	Settore 2	Settore 3	Settore 4
Nessuna controindicazione. <i>Nuovi impianti di pozzi termici fattibili.</i>	Nessuna controindicazione, però. <i>Nuovi impianti di pozzi termici fattibili. Richiede una breve valutazione e uno studio complementare principalmente sul posizionamento</i>	Nuovi impianti di pozzi termici generalmente controindicati. <i>Richiede una valutazione e uno studio complementare approfondito sul posizionamento, dati termico-tecnici e sulle portate di esercizio</i>	Nuovi impianti di pozzi termici controindicati.
146, 153, 181, 346, 470, 471, 473, 474, 475, 477, 478, 482, 483, 484, 485, 578, 584, 585, 586, 587, 588, 589, 685, 687, 688, 690, 691, 692, 693, 694, 793, 794, 971, 972, 973, 1025, 1028, 1030, 1125, 1126, 1127, 1182, 1185, 1283, 1284	08, 177, 184, 212, 465, 592, 794, 1091, 1175, 1184, 1257	81, 178, 179, 182, 183, 205, 207, 1026, 1027, 1089, 1092, 1183, 1295, 1297	180, 189, 1024, 1029, 1031, 1307

Settore 1: zona verde	Settore 2: zona arancione	Settore 3: zona rossa
Nessuna controindicazione. <i>Nuovi impianti di pozzi termici sono fattibili. Nell'ambito del rilascio della concessione è necessaria una valutazione sul miglior posizionamento degli impianti.</i>	Nuovi impianti di pozzi termici fattibili, con riserve. <i>Necessario uno studio di fattibilità approfondito con simulazioni numeriche volte a valutare ogni richiesta di concessione.</i>	Nuovi impianti di pozzi termici presso i quali non è possibile una re-iniezione delle acque direttamente nell'aquifero. Vanno valutate assieme all'autorità cantonale eventuali altre possibilità di scarico verso ricettori superficiali. E quindi necessario uno studio di fattibilità approfondito.
423, 424, 426, 431, 448, 463, 543, 544, 545, 564, 567, 747, 749, 752, 753, 759, 760, 762, 803, 978, 985, 1105, 1106, 1107, 1108, 1109, 1177, 1240, 1247, 1252, 1260, 1267, 1290, 1291,	538, 539, 540, 541, 559, 560, 561, 562, 563, 564, 565, 570, 571, 572, 573, 575, 977, 1177	198, 199, 211, 542, 547, 553, 554, 556, 557, 568

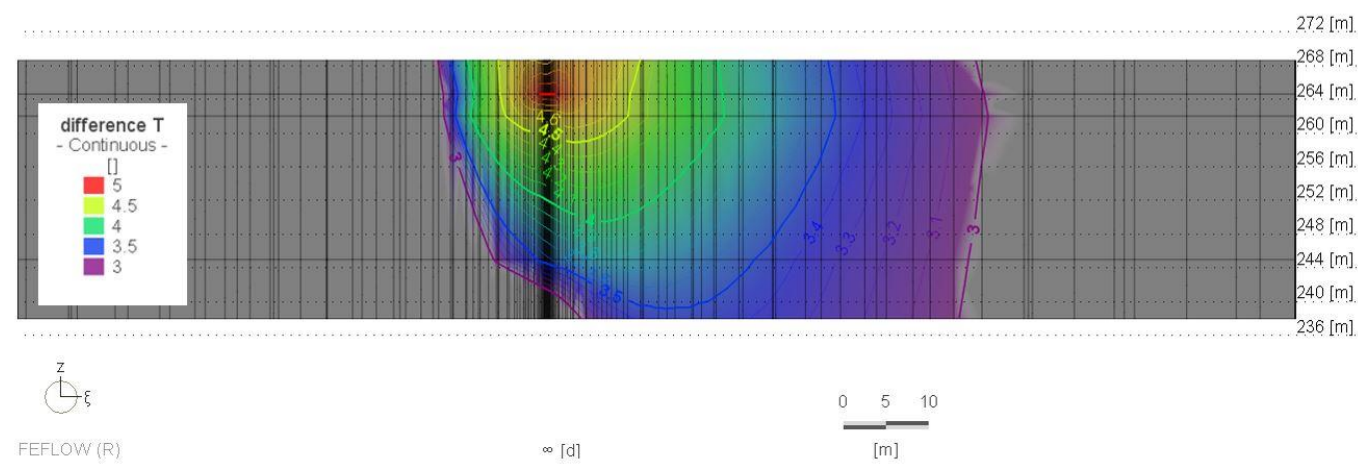
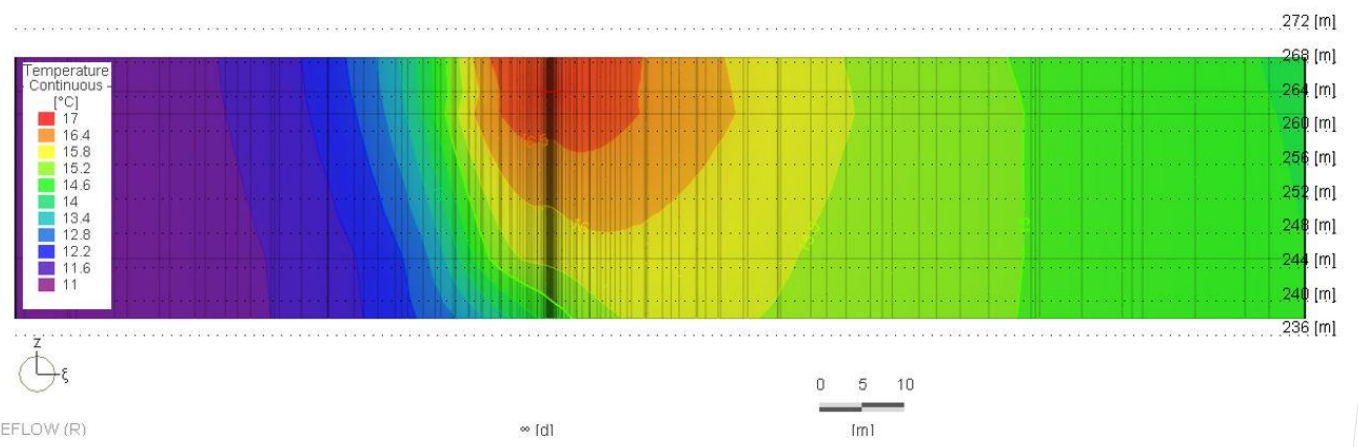
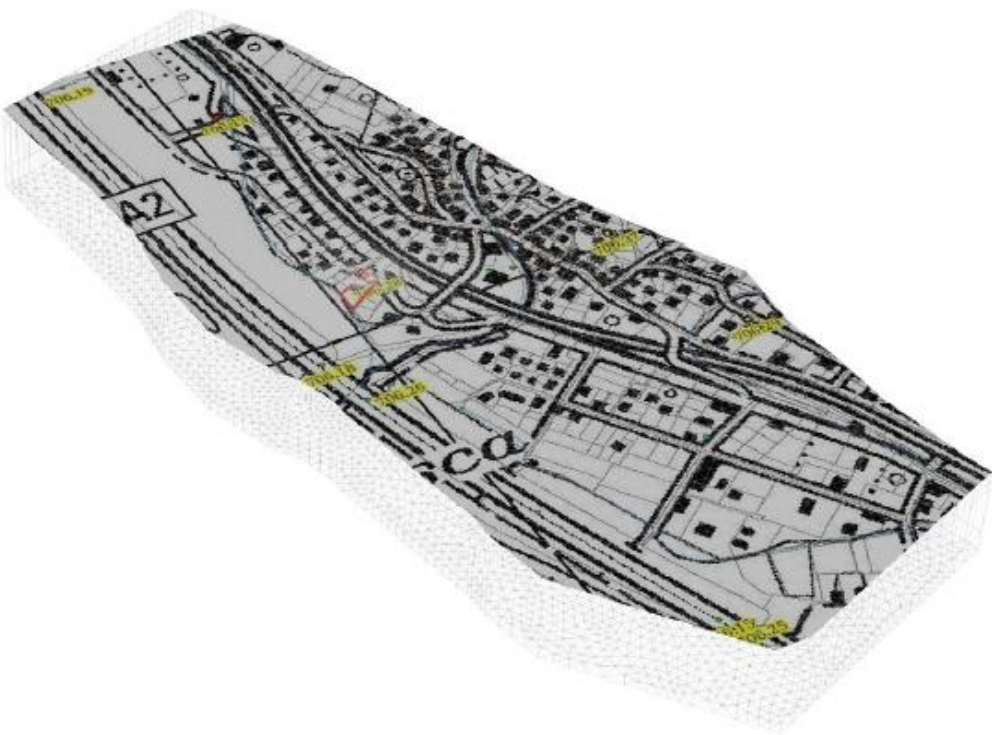
CASE 22 HEAT PUMPS – MIGROS, CH – 3D HYDRO-THERMAL (2020)

Objectives: To calibrate a 3D hydro-thermal model for the feasibility study of thermal exploitation by pumping the water table of the Rhône within the framework of the CC CHABLAIS CENTER 2020 project. The system must allow the production of heat and cold. In addition to the flow steady-state solutions towards a well described by Dupuit's analytical solution, the statistical distribution of the random variable 'age' of the groundwater has been modeled using the classical advection-dispersion equation for the transport of a conservative and non-reactive tracer.



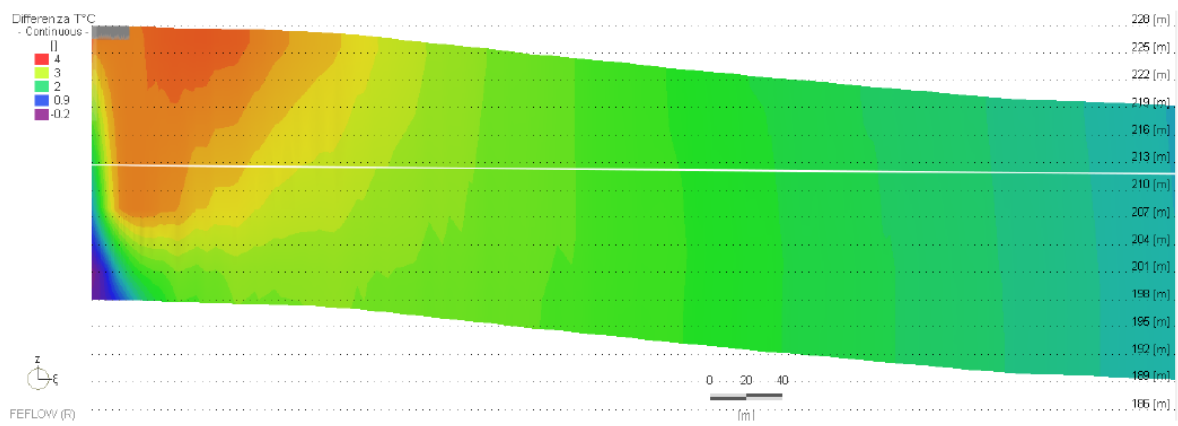
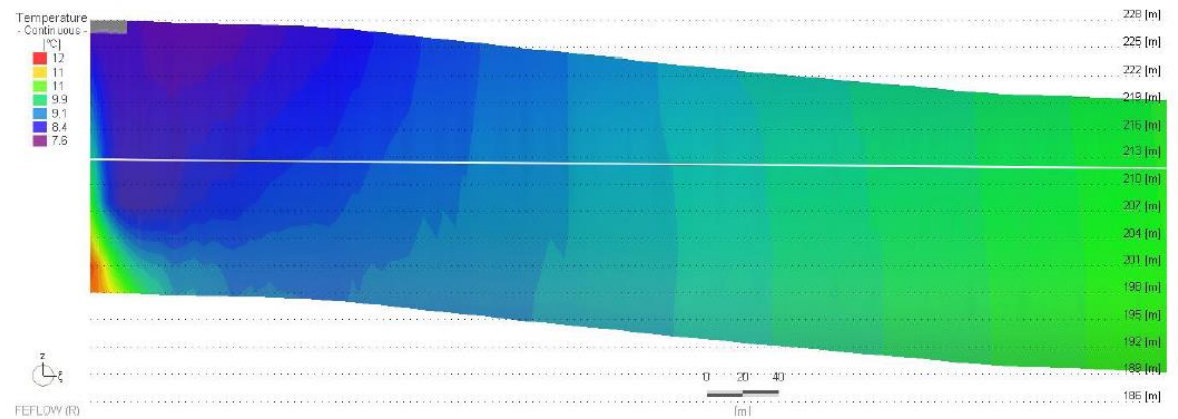
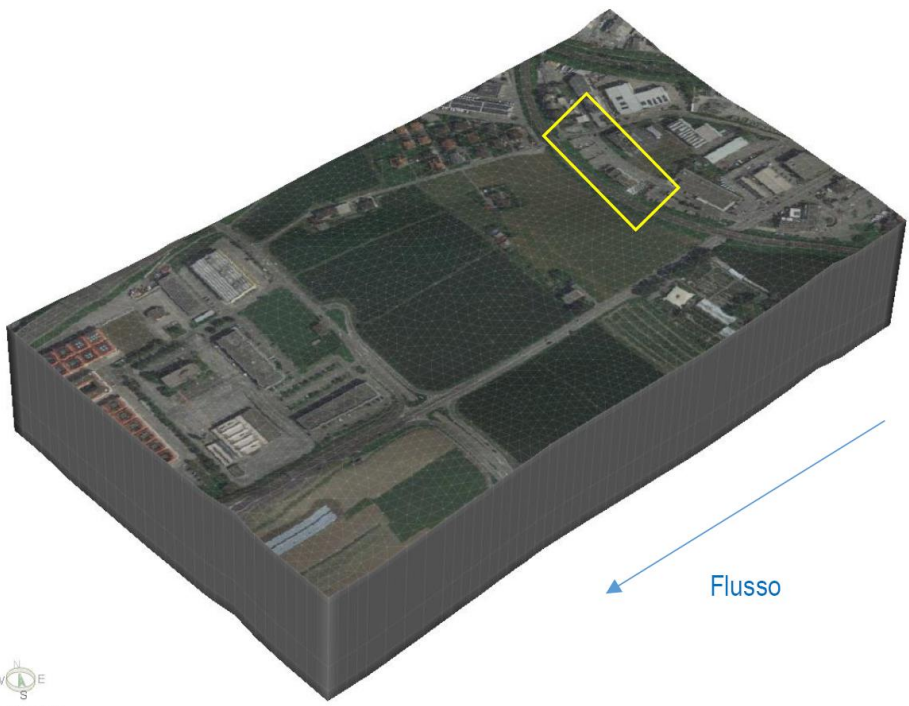
CASE 28 OSOGNA HEAT PUMP (TI, CH) – 3D HYDRO-THERMAL (2017-2019)

Objectives: TO calibrate a 3D hydro-thermal model to evaluate the extension (impact) of the thermal plume with time.



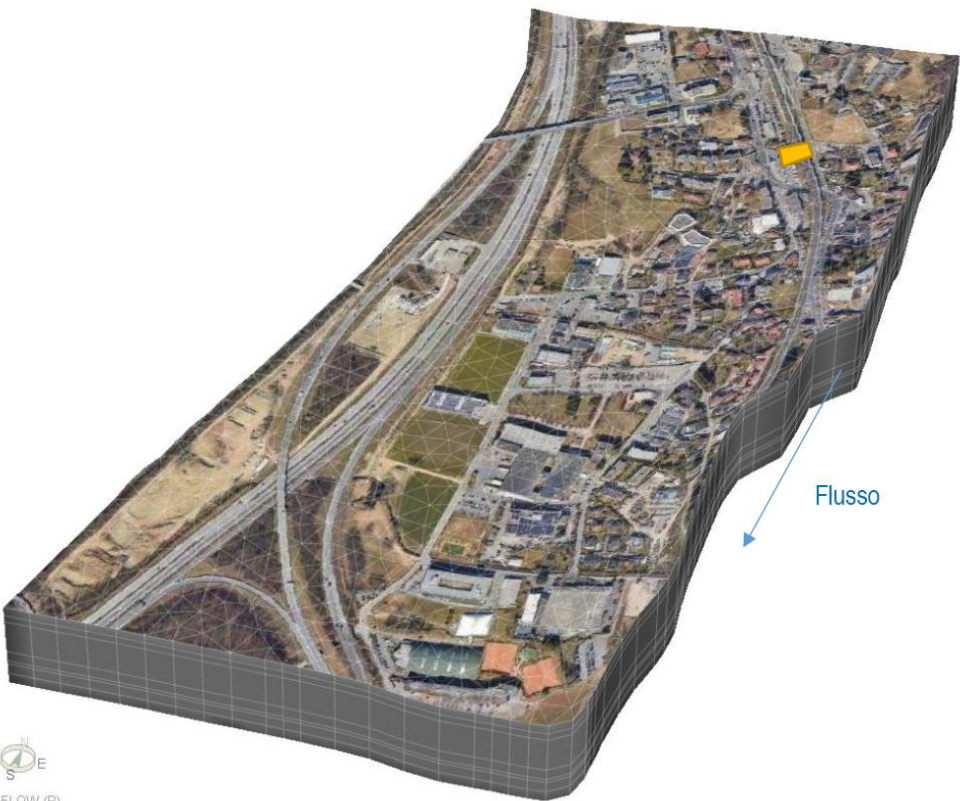
CASE 31 GIUBIASCO HEAT PUMP (TI, CH) – 3D HYDRO-THERMAL (2022)

Objectives: To calibrate a 3D hydro-thermal model to evaluate the extension (impact) of the thermal plume with time.

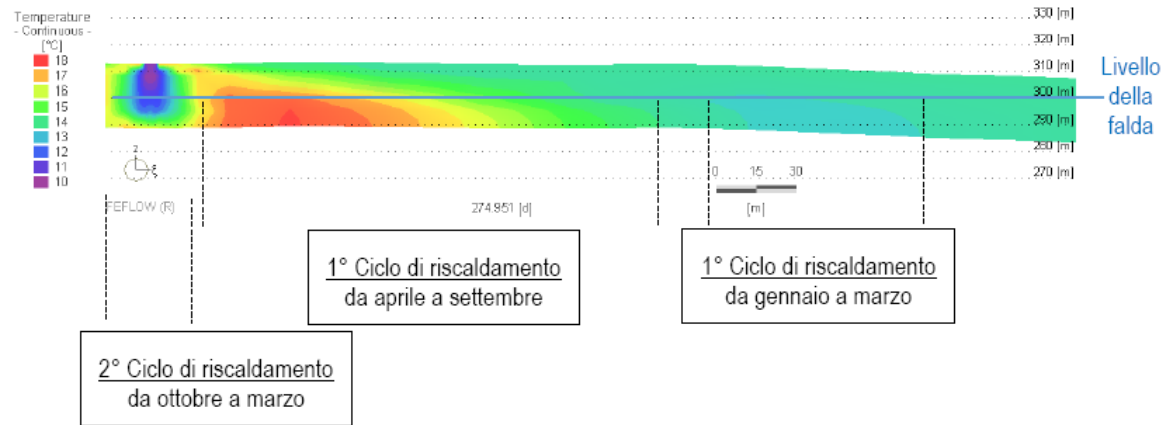


CASE 32 CADEMPINO HEAT PUMP (TI, CH) – 3D HYDRO-THERMAL (2023)

Objectives: To calibrate a 3D hydro-thermal model to evaluate the extension (impact) of the thermal plume with time.



A _ Temperatura °C.



B _ Differenza di temperatura °C.

