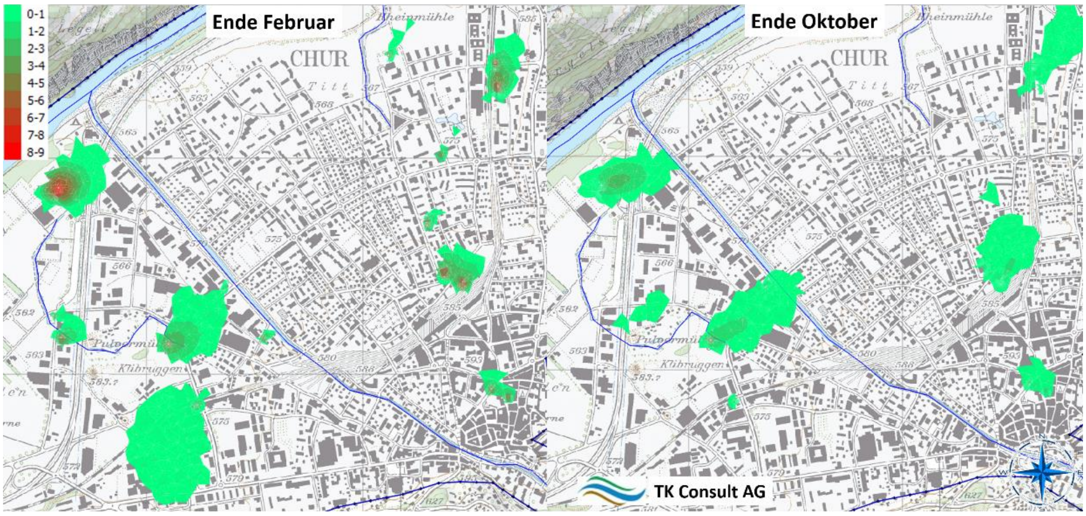
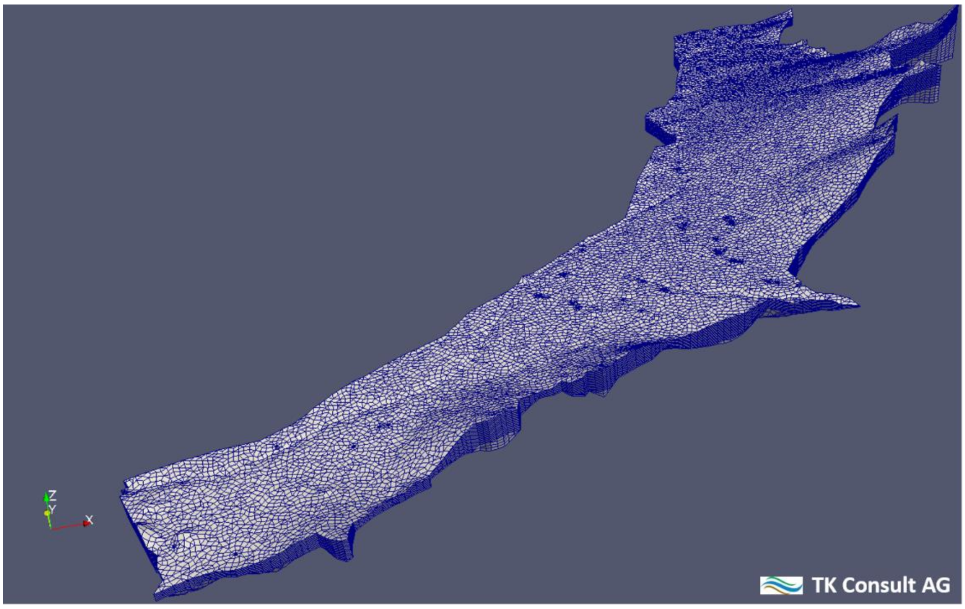
Project: Thermal use of groundwater (Chur, CH)



Thermal drawdown after at different time steps: (left) after a period of intensive heat pumping, (right) after a few months of recovery.

Employer:	SC+H Siber Cassina + Handke AG
Task:	3D Hydrothermal model. Evaluation of present status of the aquifer, both in terms of hydraulic and thermal drawdown. 10 years forecast of thermal impacts. Vulnerability map.
Model:	3D density-driven finite element model, transient flow and thermal boundary conditions
Software:	SPRING



Finite element mesh. Vertical exaggeration factor = 2.5

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Summary

The city of Chur, in Switzerland, wants to evaluate the potential of the aquifer for heating and cooling purposes. Nowadays, 14 open systems (i.e., groundwater-source heat pumps) and 125 closed systems (ground-source heat pumps) operate in the area. Overall, 5.7 MW are extracted. Main questions are: “What’s the current status of the aquifer?”, “How vulnerable to new concessions is it?” and “Is the use of groundwater for heating and cooling purposes sustainable?”

To answer these questions, TK Consult AG has developed a transient, density-driven 3D hydrothermal model (see figure above). We have evaluated the current status by simulating first the “natural state” of the aquifer, i.e., in the absence of heat pumping and, second, the “forced state”, in the presence of heat pumps. The difference between the corresponding outputs is the thermal drawdown caused by the thermal use of groundwater. Salient features of this model are:

- The fine discretization near heat pumps to alleviate numerical instabilities while solving the heat transport equation.

- The density dependent features of the model

- The transient calculation of water tables at rivers and of groundwater recharge on the basis of existing data.

- The fine temporal discretization of the heat transport equation. The groundwater flow equation is solved with a time step of 1 day. Instead, the heat transport equation uses a time step of 5 minutes.

Main results of this work are:

- The impact of the closed systems is negligible (**Figure 1**).

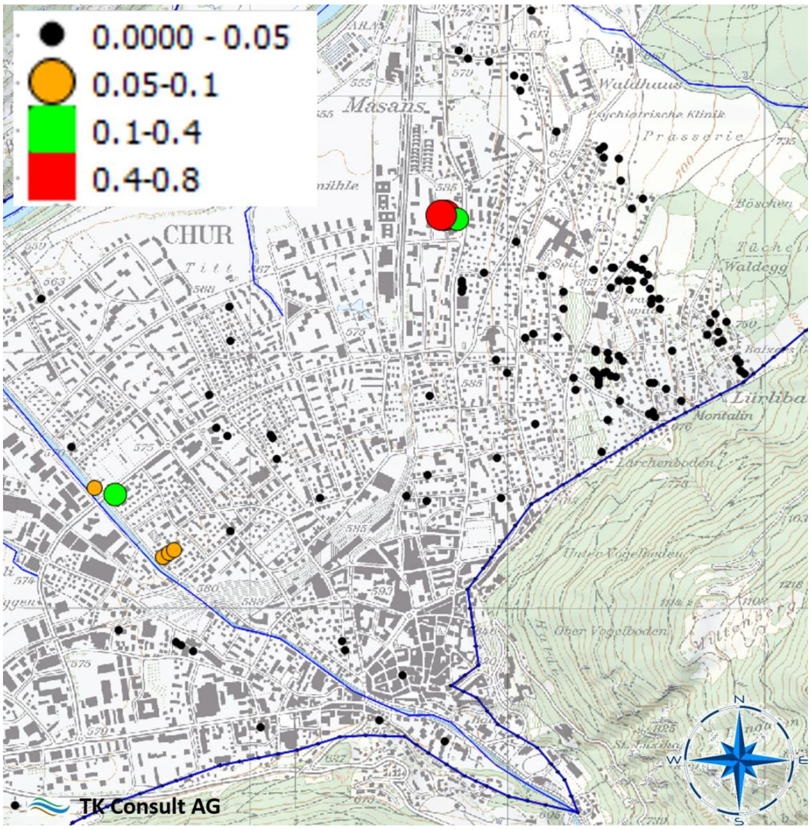

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__Figure 1.__ Maximum thermal drawdown at the location of the closed systems.

- The impact of the open systems is large, but at a small scale of some hundreds of meters (**Figures 2 and 3**).

- The use of groundwater for heating and cooling purposes is by all means sustainable at the global scale. There are large and permanent thermal drawdowns in the closest vicinity of the open systems only (**Figure 3**).

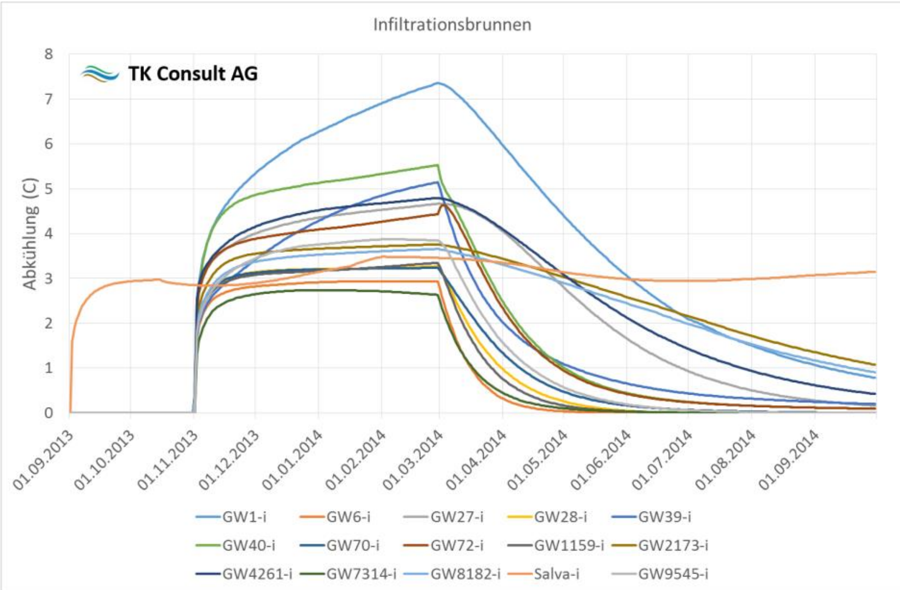

Figure 2. *Temporal evolution of thermal drawdown at the reinjection wells of open systems*

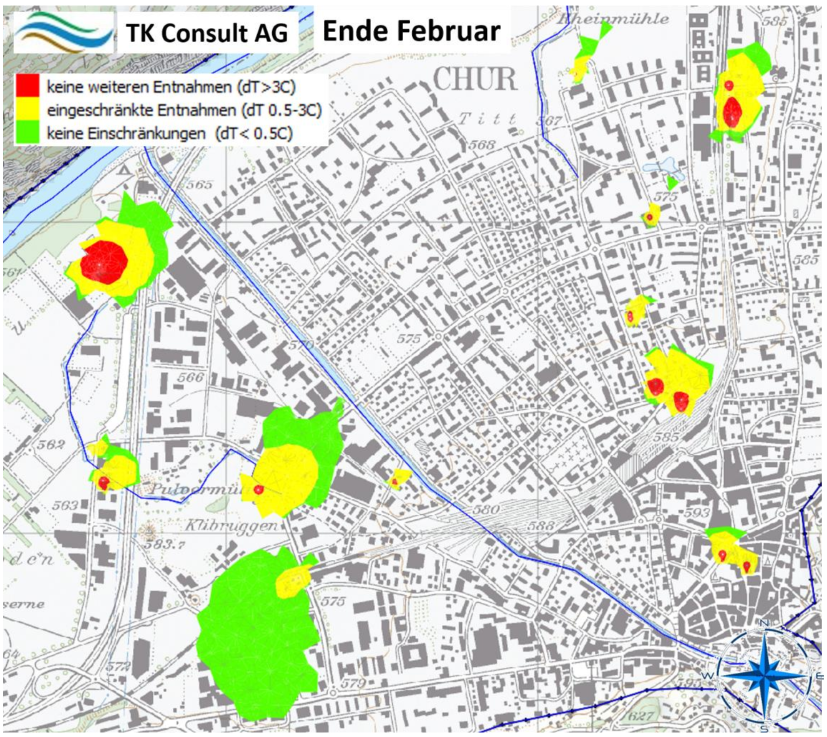

Figure 3. *Vulnerability map / traffic light system. Red color depicts the areas where new concessions for heat pumping should not be given. Yellow areas are those where small concession could be given. New concessions at green areas (and the remaining ones) do not pose at risk the sustainability of the system.*

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The model could also be used to:

- design an optimum monitoring network that maximizes the quantity and quality of newly achieved information.

- design an optimum heat pumping network that maximizes the extracted energy while keeping the impact of pumping on the aquifer under tolerable levels.

Shall you need further information, please contact us:
http://tkconsult.ch/kontakt.php?lang_list=en

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