Investigating the Impacts of Hydrogeological Parameters on DSI Efficiency through Numerical Simulation

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Introduction: Düsensauginfiltration (DSI), 'nozzle-suction-infiltration', is a new method for dewatering that avoids groundwater abstraction from the aquifer [1]. Drawdown is achieved via pumping of groundwater at upper abstraction section, meanwhile, all the pumped water is injected through the same borehole, but in greater depth (Fig. 1).

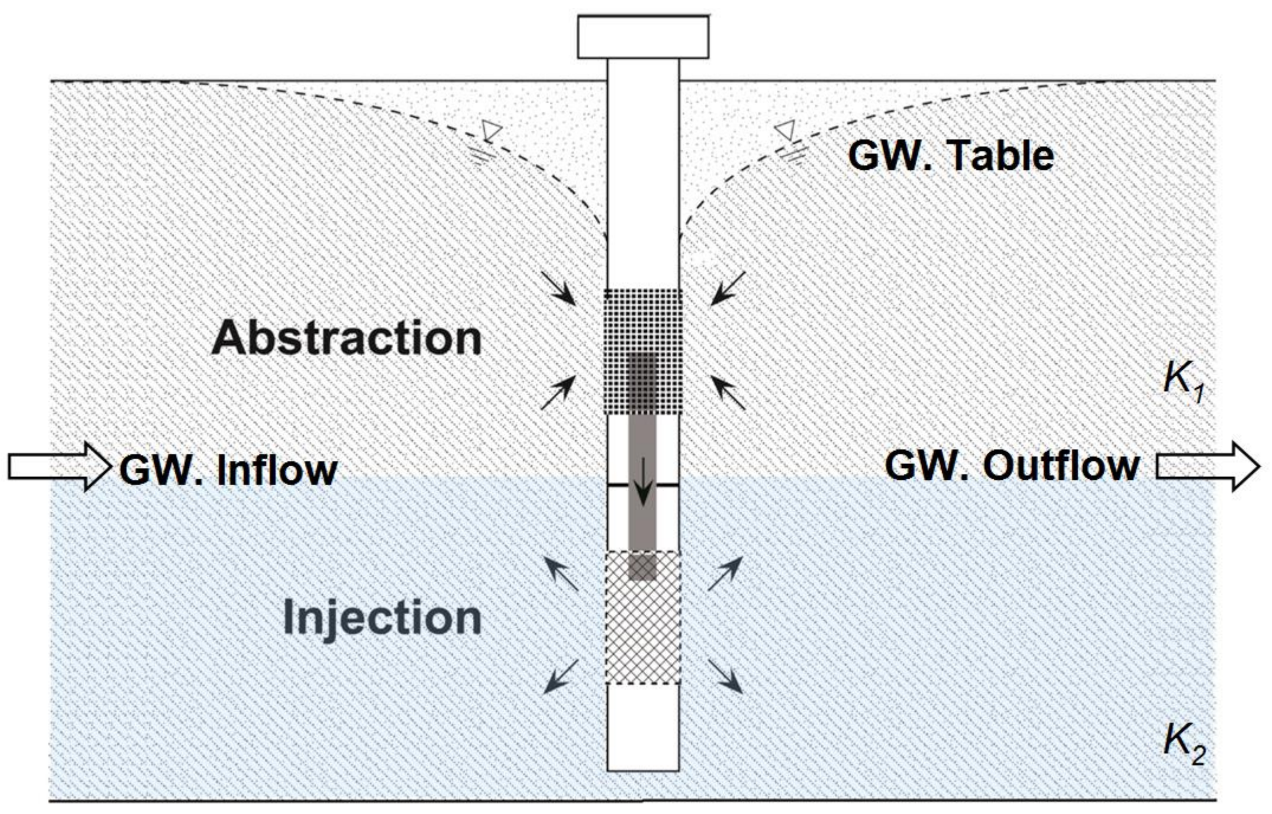

Figure 1. Conceptual model sketch of DSI method.

Computational Method:

- Darcy's Law $\nabla \mathbf{k} \nabla p = 0$
- Arbitrary Lagrangian-Eulerian method

The simulation method was validated by comparison against the results obtained from respective analytical solutions and the field observations [1, 2].

Hydrogeological Parameter Evaluation:

- DSI-well setting
- Hydraulic conductivity
- Anisotropy
- Heterogeneity
- Multi DSI-wells

Table 1. Parameter set-up

Variable	Value	Units
Pumping Depth	5	m
Injection Depth	8	m
Pumping Rate	20	m^3/h
Hydraulic Conductivity	1×10^{-3}	m/s

Conclusions: DSI is a promising novel dewatering method that provides efficient dewatering and improves eco-compatibility. The successful application of DSI requires good pre-investigation of the site and its corresponding well-settings.

Results:

- Deeper injection section and higher pumping/injection rate yield in larger and deeper drawdown.
- Lower hydraulic conductivity and anisotropy ratio contribute to larger and deeper drawdown.
- More conductive injection layer results in smaller dewatered area.
- The conventional dewatering results in larger influenced area than DSI method.

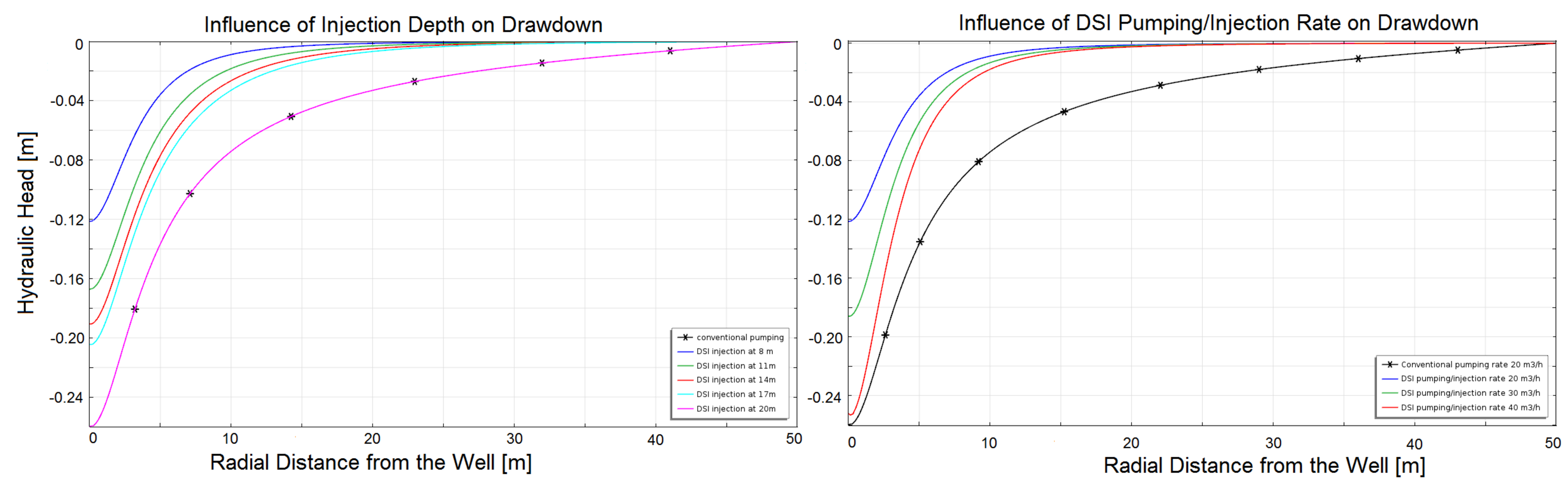

Figure 2. Influence of DSI-well settings on drawdown compared with conventional dewatering (pumping only), Injection depth (left); Pumping and injection rate (right).

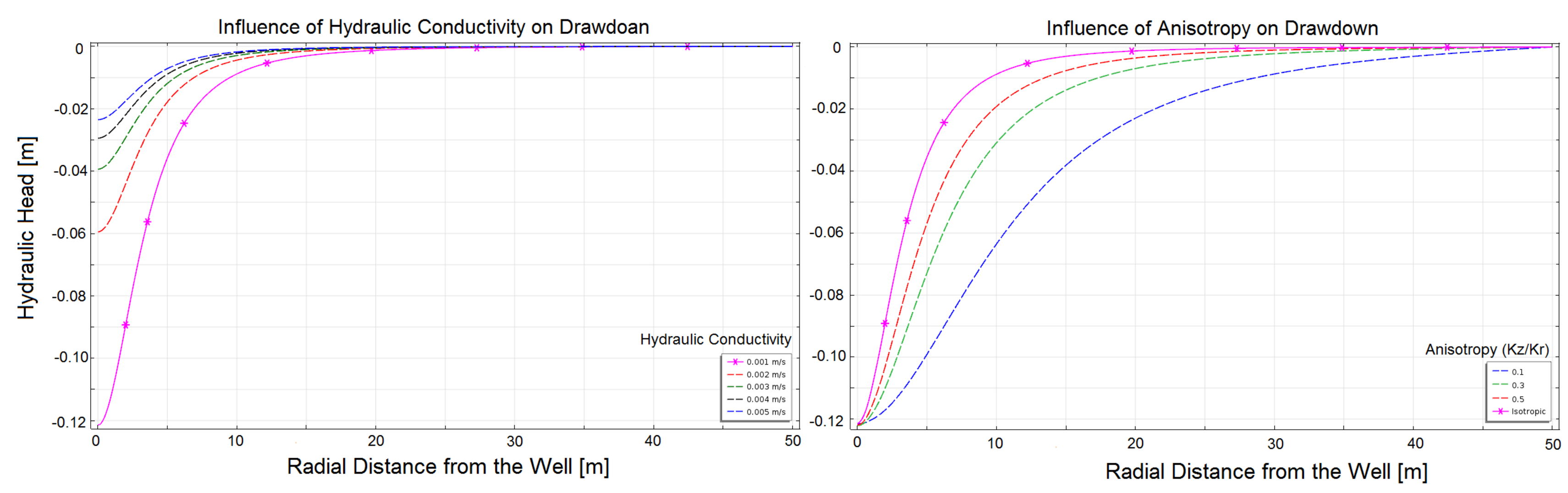

Figure 3. Influence of hydrogeological parameters on drawdown, Hydraulic conductivity (left); Anisotropy (right).

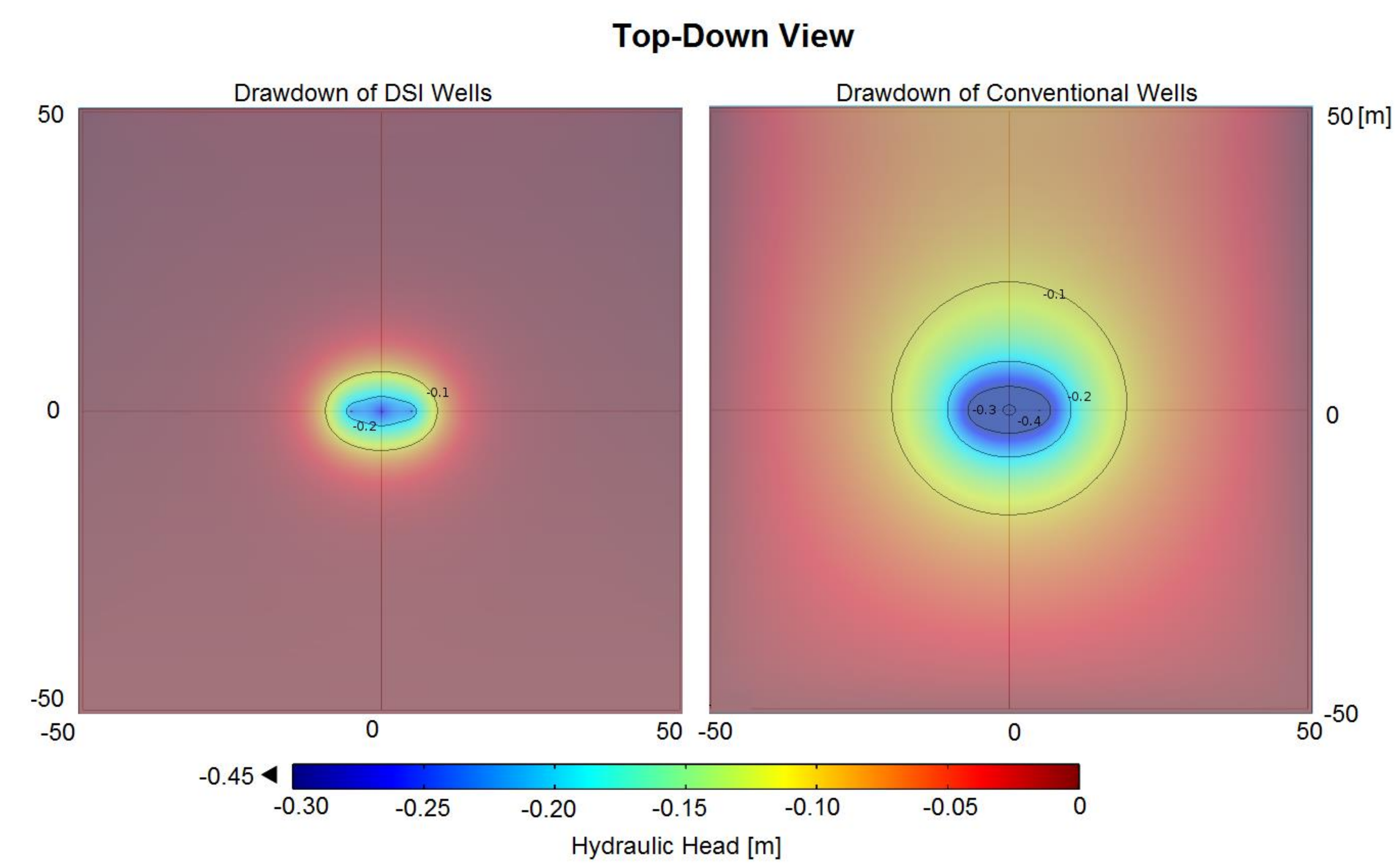

Figure 4. Comparison of drawdown influenced area of DSI wells and conventional wells (3 wells, Layered $K_2=3*K_1$).

References:
[1] Jin, Y., Holzbecher, E. Oberdorfer, P., Simulation of a novel groundwater lowering technique using arbitrary Lagrangian-Eulerian method, COMSOL Conference, Stuttgart (Germany), 2011.
[2] Jin Y., Holzbecher E., Ebneth S.,Simulation of pumping induced groundwater flow in unconfined aquifer using arbitrary Lagrangian-Eulerian method, COMSOL Conference, Milan (Italy), 2012.

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