Numerical study of the Martelange mine to be used as lower reservoir for constructing an Underground Pumped Storage Hydropower plant

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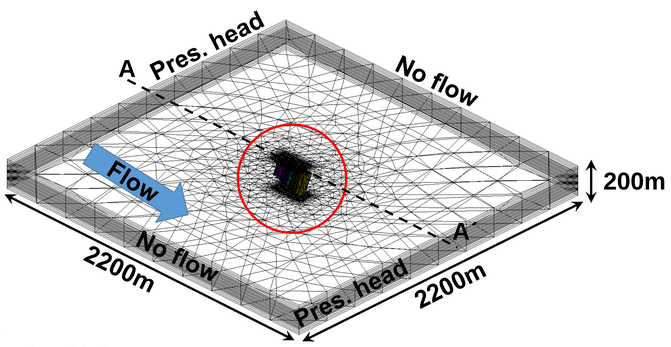
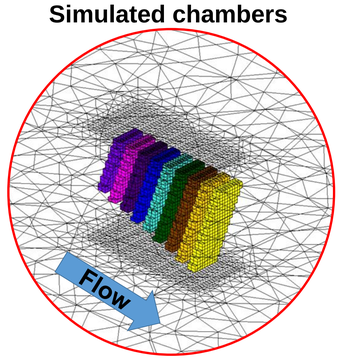
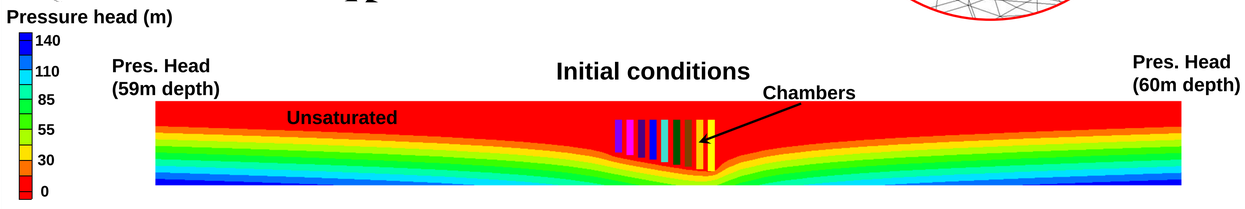
Introduction

Underground Pumped Storage Hydropower (UPSH) using abandoned mines is an alternative to manage the energy production in flat regions. UPSH plants store energy pumping water from an underground reservoir (abandoned mine) to a surface reservoir, and produce electricity discharging the water from the surface into the underground reservoir. The main concerns arise from the water exchanges between the underground reservoir and the surrounding medium, which may impact on the efficiency and the environment. To date, this problem has not been studied in real cases. The Martelange old slates mine (Belgium) is considered to be used as underground reservoir for an UPSH plant. This mine was exploited using the 'room and pillar' mining technique and the remaining volume to be used as underground reservoir consists in 9 underground adjacent chambers. Environmental impacts and efficiency related issues are studied under different realistic scenarios concerning three solutions to rehabilitate the site.

Materials and methods







Dirichlet BCs were prescribed inside each chamber according to the considered rehabilitation option considered. Head evolution inside each chamber was computed using a distributed hydraulic model and assuming a random electricity demand evolution. The considered scenarios were:

- **Sce1: Two galleries connecting the chambers and under atmospheric pressure.**
- **Sce2: Ten galleries connecting the chambers and under atmospheric pressure.**
- **Sce3: Two galleries connecting tightness chambers. Thus, pressure inside increases when they are filled.**

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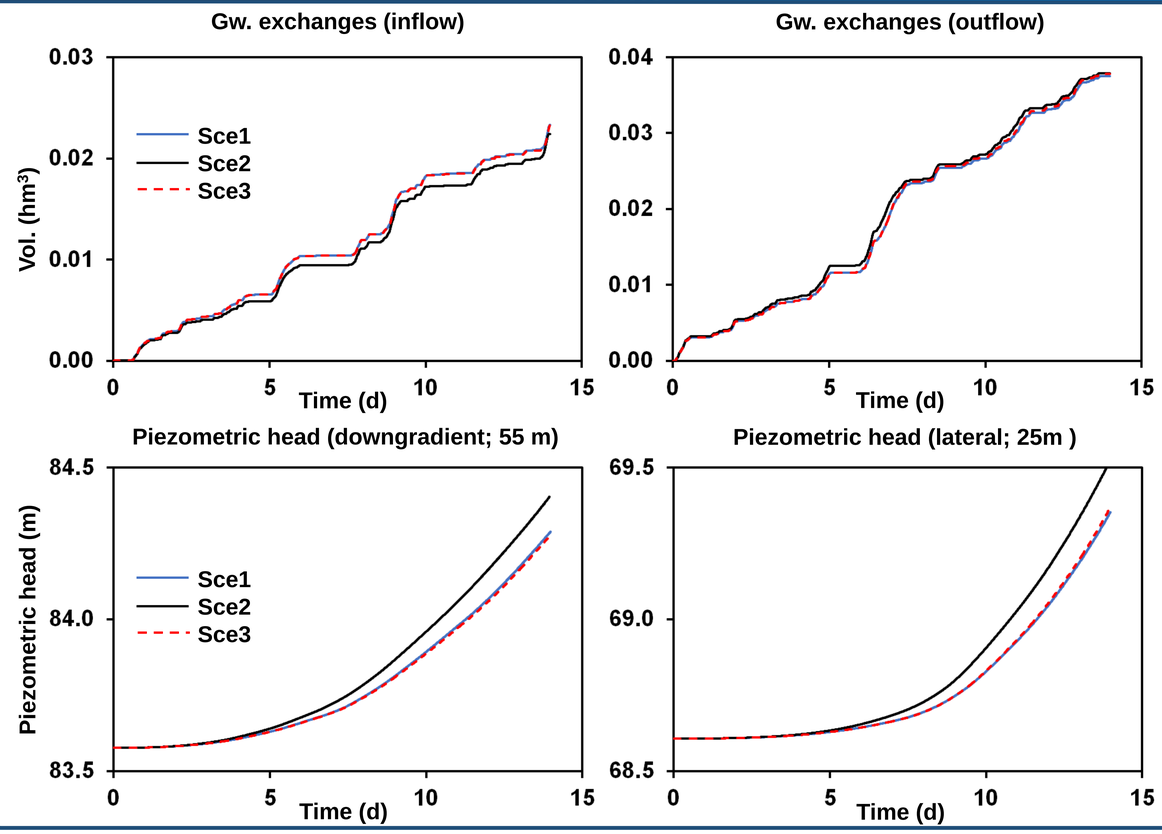
Results



Conclusions

- **Connectivity between chambers modify the interaction between the underground reservoir and the surrounding porous medium. Thus, connectivity is relevant in terms of environmental impacts and efficiency.**
- **The increase of pressure inside the chambers does not affect noticeably the results.**
- **Groundwater exchanges, and therefore the impact on the groundwater flow, are lower when the number of galleries is increased.**
- **More time would be needed to fill completely the chambers when ten galleries connecting the chambers are considered. Thus, the efficiency would be improve by increasing the number of galleries.**

References

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