Modelling sustainable borehole yields

Managing an aquifer as a water resource requires a socially and environmentally acceptable balance to be maintained between supply and demand. This will only be achieved if the total amount of water that can be extracted from an aquifer without causing any detrimental effects to the basin is known. The total amount of water available from a water resource zone can be determined from the sustainable yield of each supply borehole within that zone. The sustainable yield of a borehole is the product of the groundwater level in the aquifer. Water resource managers must apply management practices to determine optimum management strategies for any individual borehole or group of boreholes.

The issue of scale

The sustainable yield of a borehole is a function of a number of variables that operate at different scales. These should be represented in a groundwater model to provide a reliable estimate of the borehole yield.

Factors influencing sustainable yield at the local scale:
- Depth of borehole, pump and screen.
- Vertical heterogeneity around the borehole.
- Development of turbulent non-linear flow, particularly in fractured aquifers.
- Development of a seepage face.

Factors influencing sustainable yield at the regional scale:
- Spatial and temporal variations in recharge.
- Vertical and lateral heterogeneity.
- Discharge from river or streams.
- Interference from other abstraction boreholes.

The coupled SPIDERR-ZOOMQ3D model is applied to a supply borehole located in the River Thames catchment. The abstraction borehole is situated in the Chalk aquifer of the Thames Basin in southern England. The Chalk is the principal aquifer in the UK, providing around 40% of the total public water supply in the Thames region.

Model application

The coupled SPIDERR-ZOOMQ3D model is applied to a supply borehole located in the River Thames catchment. The abstraction borehole is situated in the Chalk aquifer of the Thames Basin in southern England. The Chalk is the principal aquifer in the UK, providing around 40% of the total public water supply in the Thames region.

Conclusions

- A methodology is presented for simulating abstraction boreholes in regional groundwater models.
- The SPIDERR model represents large scale heterogeneity and processes around an abstraction borehole.
- The SPIDERR model is linked with the ZOOMQ3D groundwater modelling code through OpenMI.
- The coupled methodology allows a multi-scale borehole model to be linked easily and precisely in existing regional groundwater models.
- The model application to an abstraction borehole in the River Thames catchment demonstrates the potential for use of the model for assessing the sustainable yield of supply boreholes, which is essential for effective groundwater management.
- Climate scenarios can also be applied to the coupled model to investigate the potential impact of climate change on the sustainable yield of supply boreholes.

References

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