Relative influence of changes in hydraulic conductivity with depth and climate change on estimations of borehole yields

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Understanding the impact of climate change on borehole yields from fractured aquifers is essential for future management of groundwater resources. Although the impact of changes in hydraulic conductivity with depth (VKD) on groundwater levels is well established, the relative significance of climate change and VKD on borehole yield estimates is poorly understood. We hypothesize that VKD exerts a significant additional control on borehole yields under climate change which has not been considered in yield assessments to date. We developed a radial groundwater flow model of an idealised pumping borehole in the fractured Chalk aquifer of south-east England, and applied 11 VKD profiles based on a simple conceptual representation of variability in hydraulic conductivity with depth in the Chalk. For each VKD profile, we applied 20 climate scenarios and six constant pumping rates for the period 1962 – 2014. We then estimated borehole yields based on the derived lowest pumping water levels during key drought years (e.g. 1976). We show that VKD is more significant ($p < 0.0001$) than changes in climate ($p > 0.1$) in controlling lowest pumping groundwater levels. Hydraulic conductivity is as significant a control as climate on borehole yields, although responses are highly non-linear associated with pumping water level-pumping rate curves intersecting key yield constraints (e.g. pump intake depth, major inflow horizons). It is recommended that variations in hydraulic conductivity with depth are taken into consideration in future assessments of borehole yields under climate change when developing integrated water resources management plans. The approach presented is generic and can be applied across different aquifers where vertical heterogeneity is present.