Microbial impact assessment of the 2018 European drought on groundwater quality in the Republic of Ireland: An opportunistic field study

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Global climate change models predict an increase in both the frequency and severity of extreme weather events, including prolonged drought conditions, thus posing a unique set of challenges for regions traditionally unaccustomed to severe climate phenomena. This is particularly significant for the occurrence of severe drought events in areas characterised by temperate maritime climates, such as the Republic of Ireland (ROI). While numerous studies have explored the impacts of drought on groundwater levels and chemical contamination, few studies have sought to investigate the impacts of sporadic drought events on the microbial quality of groundwater for human consumption. Accordingly, the 2018 (June-August) European drought event represented a unique opportunity to investigate the effects of prolonged low rainfall and elevated temperature (relative to seasonal means) on the incidence of faecal indicator organisms (FIOs) among unregulated domestic groundwater supplies in the ROI.

A dual-sampling fieldwork regime (during and post-event) of private wells (n=74) and subsequent risk factor (logistic regression) and bivariate analyses were used to evaluate the potential role of meteorological and site specific (hydrogeology, contaminant sources etc.) conditions on the incidence of microbial contamination. During absolute drought conditions (≥15 days characterised by no measureable precipitation, June 2018), the sampled cohort exhibited a significantly decreased risk of microbial contamination (OR: 0.356, p = 0.024) with 12.2% (n = 9/74) of supplies contaminated with Escherichia coli (E. coli), increasing to 28.4% (n = 21/74) upon abatement of drought conditions (October 2018). No analysed risk factors were associated with E. coli presence at the 95% confidence level, although, the presence of onsite domestic wastewater treatment systems (U = 1.03 p = 0.057) approached statistical significance during the drought. Findings suggest that the 2018 European drought served to decrease background levels of FIO within private wells in the ROI, likely due to reduced hydraulic loading from the surface, soil moisture deficits and consequently, significantly decreased bacterial survival. Results would seem to reiterate the significance of onsite domestic wastewater treatment systems as a source of subsurface contaminants in Ireland. The presented opportunistic field study provides a critical
characterization of the impacts of unprecedented drought events on microbiological water quality in domestic groundwater supplies in temperate regions, and may be used by sanitary/environmental engineers, hydrologists, hydrogeologists, policy-makers, planners and healthcare practitioners to safeguard against the future human health effects of climate change and extreme weather events.