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Gateway to the Earth

Controls on temporal variation of the occurrence of micro-organics including emerging contaminants in a lowland chalk catchment

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Aim

Over the past decades there has been a growing interest in micro-organic (MO) contaminants, their occurrence, fate in the environment and toxicity. This study explored the temporal variation of a broad suite of MOs within different linked hydrologic compartments of a lowland Chalk catchment in southeast England, the most important aquifer for drinking water in the UK. This study set out to focus on characterising temporal variation of both mixtures and concentrations of MOs including emerging contaminants within a well characterised lowland chalk site.

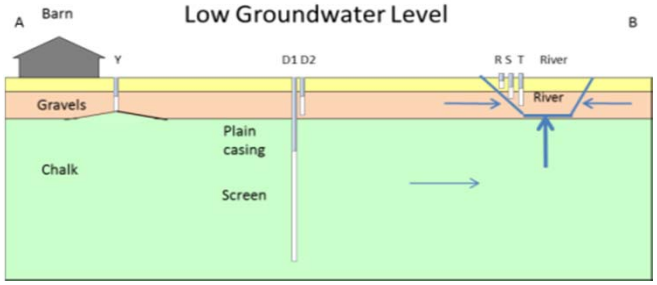

Figure 2. Conceptual models of groundwater movement at the study site across section AB at Low groundwater level conditions showing the presence of a Chalk mound in the vicinity of piezometer Y.

Study Site

The study was conducted at the Boxford research site in Berkshire, UK. The site was instrumented with piezometers as part of the Lowland Catchment Research Programme (LOCAR) for characterisation of the interaction between groundwater, surface water and hyporheic zone in a lowland Chalk catchment . The site is in a rural setting with a farm to the north which undertakes both arable and dairy activities, while to the south lies the River Lambourn and an associated wetland, both designated as a Site of Special Scientific Interest (SSSI). The Geological setting is shown in Figure1 and conceptual model of the site is presented in Figure2.

Method

Sampling was carried out using 6 piezometers and the River Lambourn (Figure1 &2). The piezometers included 1 into Chalk, 2 into gravel and 3 into hyporheic zone, which access groundwater from 0.5m to 25 m depth and offer insight into different hydrological compartments within the site .

Monthly sampling was carried out between August 2013 and August 2014 capturing a full hydrological cycle including a period of extremely high groundwater levels in February 2014 and recovery. Samples were collected in 1-litre glass bottles and kept refrigerated in the dark before analysis where possible (Figure 3 shows sampling set up). Samples were analysed by the Environment Agency National Laboratory Service using the GCMS screening methods developed for their organic micropollutant monitoring programme.

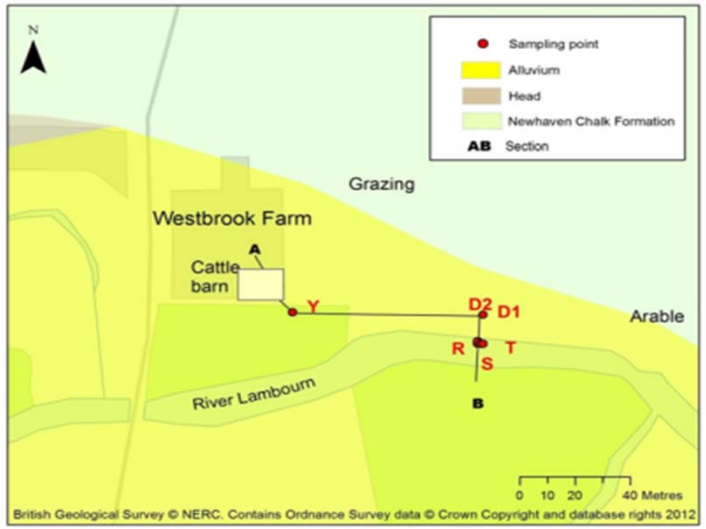

Figure 1 Map of site area showing geological setting, sample locations and section AB of conceptual schematic given in Figure 2.

Figure 3 Sampling of a borehole.

Results

Frequency of detection for different environments is presented in Figure 5. It is clear that chalk groundwater has higher frequency of detection of compounds than other compartments. Figure 4 summarises the differences of the concentrations of compounds detected within different compartments. Chalk has the higher median concentrations . Figure 4 highlights that greater numbers of compounds are found at higher concentration within the Chalk.

- Overall 303 detections of 39 different compounds
- 19 compounds detected more than once
- Chalk – 26 different compounds with a maximum of 12
- Alluvium – 11/10 with a maximum of 7 compounds
- Surface water – 17 compounds with a maximum of 9 different compounds
- Hyporheic – 6-9 compounds with a maximum of 6 different compounds per visit
- Fewer compounds during high water levels
- Trichloroethene and Atrazine most frequently detected
- Highest concentration is for Bisphenol A
- TCE has a relationship with water level
- Atrazine is not controlled by groundwater level as it is present within saturated zone

Conclusions

- There is temporal variation in both the number and concentration of compounds detected with fewer compounds detected during high groundwater level conditions.
- Both point and diffuse sources have shown to be controls on the TCE concentrations observed.
- There is no correlation between groundwater level and Atrazine concentration as it is present within saturated zone.
- This high-frequency study is one of the first to provide evidence to suggest that Chalk can have a greater diversity of MOs compared to surface waters.

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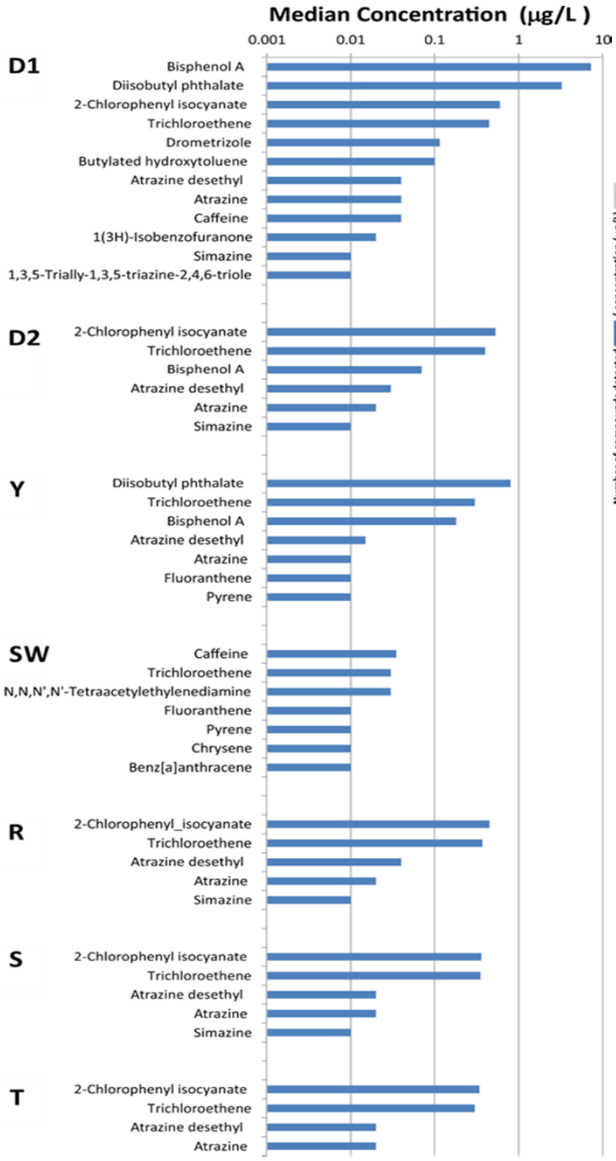

Figure 4 Median concentrations of contaminant concentrations in different compartments that have been detected more than once .

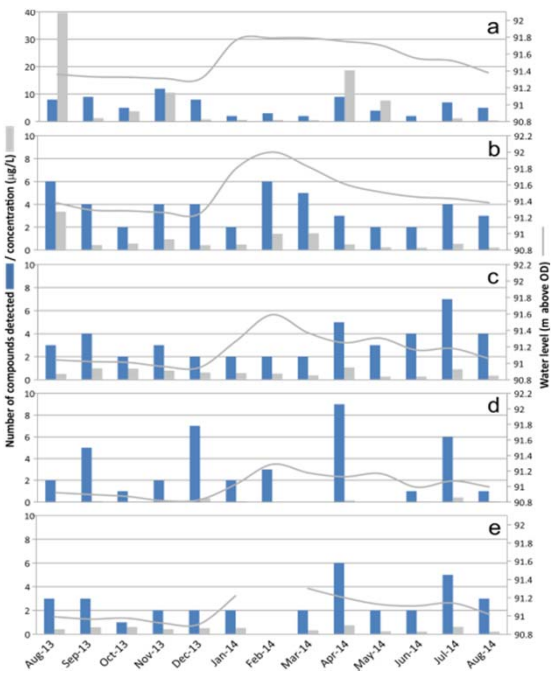

Figure 5. Frequency of detection of MOs and total concentration in water compartments: a) chalk groundwater D1, b) alluvial groundwater represented by gravel D2 and c) Y , d) R. Lambourn, e) hyporheic zone represented by site T. Note that y-axis scale is different for Figure 5a.