Microplastic contamination from fibres in the River Witham

Introduction:

Microplastics are a form of emerging anthropogenic environmental pollution. They are small pieces of plastic debris of less than 5mm in size often formed from the breakdown of larger plastics, but they may also be created in their own right (for example microbeads and glitter). These can find their way into the food chain being consumed by zooplankton which in turn are consumed by fish and then birds and finally mammals (Nara, 2019).

Microplastics have been found in rivers across the UK. A recent study of the highly urban River Mersey (North West England) and its tributaries which drains from the Pennine and Peak District hills, found that this system had the highest concentrations of microplastics of any river in the world so far sampled (Hurley et al., 2018). The region contains some of the highest rainfall in England with average annual rainfall between 1981 and 2010 great than 1500 mm (Met Office Press Office, 2014). This high level of rain appears to flush microplastics quickly through the catchment (Hurley et al., 2018).

By contrast, there is comparatively little research on East Midlands rivers, a region with approximately half the annual rainfall of the North West, and a catchment with shallower gradients. Thus, there is a lack of understanding of how microplastics are transported in dry, flat and agricultural catchments.

The River Witham (Lincolnshire) is an example of such a catchment. This 132km long river has a basin size of 3,817 km^2 and travels from its source in South Witham to the Wash where it discharges. The Wash is important because this is a Nature reserve described by the RSPB as "the UK's most important inter-tidal wetland site" due to the huge biodiversity of birds present over winter; between 400,000 and 450,000 visiting birds per season (Scott. 2017). Thus, a large deposition of microplastics from the Witham could pollute one of the UK's most important nature reserves.

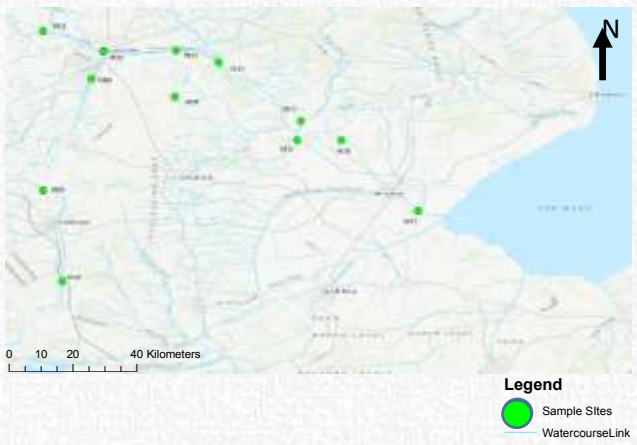


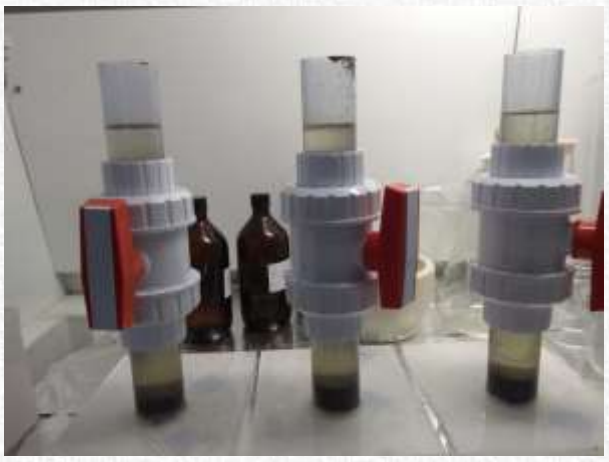
Figure 1: GIS map of the sample sites along the River Witham

Aim:

The aims of this study are to: 1) quantify the level of microplastics in an agricultural catchment; 2) understand the distribution of microplastics across a low lying and dry UK catchment.

Methods:

Microplastics were extracted from bulk sediment using flotation extraction, quantified using microscopic analysis. The method uses a 1.5 g/cm^3 density Zinc Chloride-deionised water solution to extract microplastics by flotation, from sediment of known mass, in a sediment microplastic extraction unit (SMI, Fig. 2). Each separation is filtered through stainless steel meshes and the quantity of microplastics counted manually under a microscope.



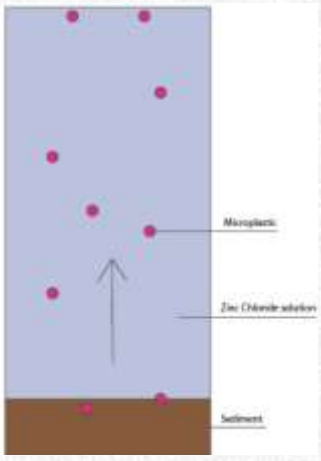


Figure 2: Sediment-Microplastic Isolation Unit (SMI) uses the principle of density floatation by adding sediment to Zinc Chloride solution of 1.5g/ml density. This density allows for fine and heavy sediment to settle while both heavy and light plastics can float up.

Results:

Table 1:

This table shows the total microplastics and type as well as the shell count

Site	Latitude	Longitude	Total	Threads	Beads	Solid	Foil	Shells
WI02	52.81139	-0.62355	40	20	0	20	0	1620
WI05	52.97688	-0.65833	1500	460	40	780	220	280
WI08	53.17939	-0.57036	120	20	0	100	0	300
WI10	53.26564	-0.65875	460	100	0	360	0	280
WI12	53.229761	-0.548708	720	0	0	720	0	100
WI13	53.23018	-0.4161	1680	1100	0	520	60	1260
WI14	53.20936	-0.33801	940	200	0	420	320	1120
WI19	53.06802	-0.19526	860	100	20	640	100	960
WI20	53.06802	-0.11561	120	60	0	60	0	180
WI21	52.93936	0.024728	5960	1120	0	3180	1660	2080
WI24	53.102953	-0.188803	160	20	0	140	0	100
WI26	53.14695	-0.41815	900	520	0	380	0	0

Figure 2: GIS Proportionate (left) and pie charts (right) to represent the microplastic count and type respectively

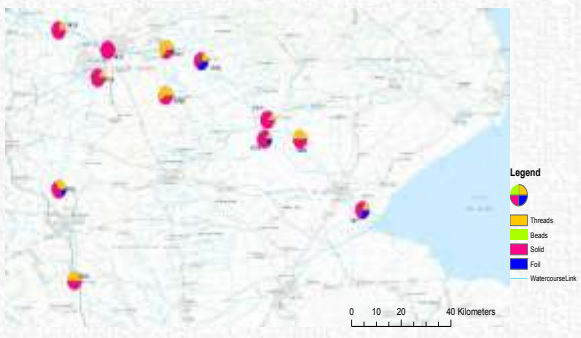
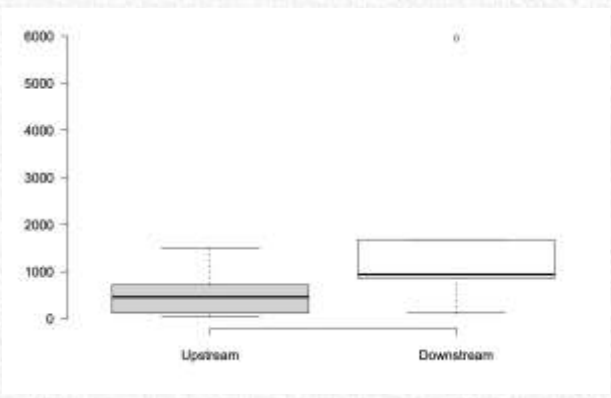
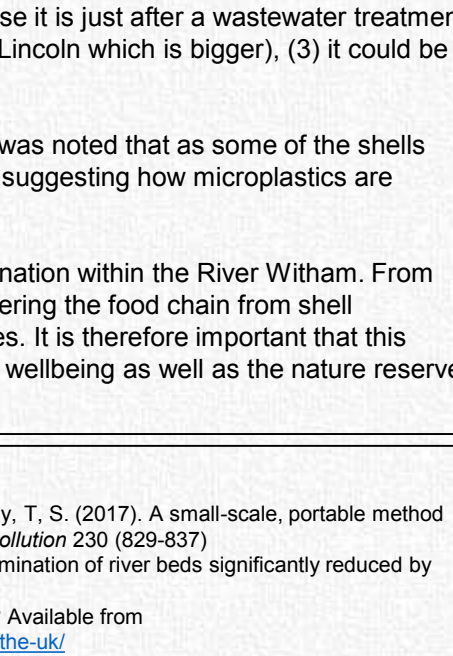


Figure 4: GIS map of thread counts along the catchment of the River Witham

Figure 3: Box and Whisker plot of the Microplastic count upstream and downstream of the River Witham





Discussions and Conclusions:

The results show there is clear evidence of the extent of microplastic contamination within the River Witham. The River was found to contain microplastic concentrations of up to 5960 parts per kg (Table 1). This is lower than the urbanised catchment of the River Mersey, however it is still very important due to the Wash.

It is notable that microplastics increase downstream (Figure 3) but the tributaries do not have high levels of microplastics thus indicating that accumulation is from the main channel from point sources. Microplastics also increase after towns with threads being a particular problem as shown by Table 1 and Figure 4. It is worth noting that the Haven site is very different from the rest of the catchment and is an outlier, having the highest concentrations of anywhere on the catchment (Table 1) however, there are many potential reasons for this; (1) it could be due to all the river microplastics ending up there, (2) because it is just after a wastewater treatment plant for Boston (however we do not see the same for Lincoln which is bigger), (3) it could be due to the tidal influence and high salinity.

When inspecting the samples under the microscope it was noted that as some of the shells were moved, small pieces of shiny foil fell out of them, suggesting how microplastics are entering the food chain for consumption.

In conclusion it is evident there is microplastic contamination within the River Witham. From investigating the shells, it is clear microplastics are entering the food chain from shell consumption and as such being consumed by ourselves. It is therefore important that this research is looked at in response to human health and wellbeing as well as the nature reserve at the Wash.

References:

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