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This submission highlights some key findings on microplastic pollution in UK rivers so that they can be considered by the EAC as part of the Inquiry into *Water Quality in Rivers.*

Executive Summary

River habitats across the UK are being degraded by the widespread practice of 'spilling' untreated wastewater and sewage. This submission highlights recent research at The University of Manchester that has **demonstrated a direct link between poor wastewater management and high levels of microplastic pollution in UK rivers**. Our work points to untreated wastewater as the main supplier of microplastics to river ecosystems. **The microplastic problem can be tackled by treating wastewater – existing treatment methods are highly effective at removing microplastics from wastewater.** The key recommendation is straightforward – treating wastewater will reduce microplastic pollution of river habitats and reduce the transport of microplastics to the oceans. Reducing plastic waste must be part of this solution, but that is a longer-term goal. **Our key findings are in good agreement with Professor Peter Hammond's work on untreated sewage discharges to watercourses.**

This submission makes the following recommendations:

- Tighten regulation around the discharge of untreated wastewater to rivers so that volumes are minimised. This will improve river water quality and reduce microplastic transfer to river bed habitats. It will also reduce microplastic transport to the marine environment.
- Make wider use of bed sediment sampling (in, for example, Environment Agency surveys) to monitor the extent of microplastic contamination and thereby assess the quality of river bed habitats (and any threats) and police water industry practice.
- Since we have shown that plastic microbeads are still a major component of riverine microplastic contamination, regulation around the use and disposal of plastic microbeads (that are used in blast cleaning and related industrial processes) needs to be introduced/strengthened.
- Commission a UK-wide survey of microplastic pollution of river beds utilising the sampling methodology employed at Manchester. Existing datasets, such as that generated by the Greenpeace Survey of 2018, do not provide an accurate picture of riverine microplastic contamination and threats to river habitats across the UK.

Introduction

I am Professor of Physical Geography at The University of Manchester, where I lead the research into microplastics in rivers. I have worked on river catchment processes for over 30 years and published widely on river science and floodplain environments. I have extensive field experience in the UK and internationally and I am an elected Fellow of the British Society for Geomorphology. Much of my recent research has focussed on understanding microplastic pollution in UK rivers, particularly in urban and sub-urban settings. The recommendations in this submission are based on work that has been rigorously peer reviewed and published in prestigious journals including *Nature Geoscience* and *Nature Sustainability*. Our most recent work published in May 2021 in *Nature Sustainability* was covered in the press by Politics Home, The Guardian and BBC News, among others.

I discussed this microplastics research and its implications with members of the Environmental Audit Committee in May 2021 including a meeting with Rt Hon Philip Dunne and EAC advisors on 25 May. I gave an invited presentation to members of the Environmental Audit Committee on 8 July 2021 as part of their field visit to the River Windrush. I have also met with the *APPG on Microplastics* and contributed to their Policy Report that is due to be published in September 2021.

1. Background

1.1. Microplastic contamination poses a threat to freshwater habitats, marine life and human health. Microplastics are now ubiquitous in the environment and rivers are the main transporter of microplastics to the oceans. While it is not feasible to remove the microplastics already present in our waterways, we can manage the volume entering rivers because the vast bulk of microplastics enter via distinct point sources: these are primarily combined sewer overflows and wastewater treatment works outfalls. Existing wastewater treatment processes can remove most (up to 99%) of the microplastics in wastewater. **Until we reduce our use of plastics, effective wastewater treatment is the best tool presently available to minimise microplastic inputs to rivers.**

1.2. Microplastic hotspots in rivers can act as a vector for sewage-borne toxins, amplifying their effects to degrade riverine ecosystems. There are also significant concerns that concentrated sewage deposits provide a breeding ground for genetic mutation and antibiotic resistance. The discharge of sewage to rivers is a controversial practice and forms a key part of the Water Quality in Rivers Inquiry. **Our work has now linked this practice (and the wider practice of discharging untreated wastewater to rivers) to very high levels of microplastic contamination of ecologically important river habitats – namely river channel beds.** The quality of these habitats underpins the entire riverine ecosystem.

2. Recent research

2.1. We first recorded widespread microplastic contamination of river channel beds in ten rivers around the city of Manchester in samples collected in 2015 and 2016 (Figure 1). These rivers are typical of urban, semi-urban and rural river catchments across the UK. **Our findings are therefore of relevance to most of the UK.**

2.2. As well as revealing much higher-than-expected levels of microplastic pollution in river channel beds, our study was the first to recognize the effectiveness of flood events to scour river beds of microplastics and flush them downstream. These flushing events show that **rivers have the capacity to self-clean, provided the input of microplastics is reduced.**

2.3. Following a large flood in July 2019, we carried out a detailed programme of field sampling and laboratory analyses on the River Tame in the upper Mersey basin of Northwest England to establish microplastic *sources*. **We found very high levels of microplastic contamination in the urban and sub-urban river beds.** The rural headwaters showed much lower microplastic loadings. Urbanised zones in particular showed alarming microplastic concentrations – the highest recorded anywhere in the world. The microplastic assemblages showed wide variation, with each reach having a different mix of microplastic types (microbeads, microfibres, fragments and others).

2.4. Our work has shown that microplastics can only accumulate on river beds at high concentrations if untreated wastewater laced with microplastics is discharged into river flows that are too low to disperse the microplastics downstream.

2.5. We still see very high concentrations of microbeads on river channel beds. **These microbeads come from trade effluents via discharges from CSOs and from the discharge of untreated wastewater from WWTWs.** We do not see microbeads from personal care products. These were banned in the UK in January 2018, but most companies phased them out earlier. **The microbead problem has not gone away, the 2018 ban did not address industrial sources.** We need to address this.

2.6. Environment Agency (EA) monitoring typically focuses on water samples and there is limited EA expertise on sediment properties and microplastics. Most surveys in UK rivers have focused on sampling microplastics suspended in river water. **However, concentrating solely on buoyant microplastics in the water column can yield a very limited picture of microplastic contamination**. We have observed that microplastics of all types accumulate on river beds in very high concentrations and often reside there for weeks or months, until a significant flood event disturbs the bed and washes them downstream.

3. Implications

3.1. Microplastic hotspots on river beds have implications for the ecological health of our rivers. **Many aquatic fauna live, feed and reproduce in the channel bed environment; they face prolonged exposure to microplastics as a result of wastewater/sewage spills.** The channel bed is the worst place for microplastic accumulation because it maximises their bioavailability. Allowing microplastics to accumulate on the river bed maximises opportunities for primary and secondary ingestion by aquatic fauna.

3.2. Many microplastics are highly buoyant and easily transported by flood flows. **Our research shows that hotspots of channel bed microplastic contamination *cannot***

form during high river flows because these flows flush microplastics downstream. The only way such microplastic hotspots can form is via the discharge of untreated wastewater into river flows that are too sluggish to transport them downstream. Our research shows that these hotpots can form in dry weather and in low flows when rainfall conditions are far from exceptional. **In short, the presence of these microplastic hotspots offers very clear evidence that untreated wastewater is routinely discharged outside of the conditions allowed by EA permits**. This form of microplastic contamination is a consequence of wastewater and sewage disposal into low flowing streams. **This conclusion is in good agreement with the work of Professor Peter Hammond.** We have arrived at the same conclusion from very different approaches.

3.3. **Conventional wastewater treatment is capable of removing up to 99% of the microplastics entering rivers**, with most being removed in the tertiary treatment stage. Treated wastewater is dominated by low concentrations of synthetic fibres – these microplastics can evade all stages of treatment but they do so in very low concentrations (Figure 2). Treated wastewater *cannot* account for the varied microplastic assemblages of microbeads, fragments, fibres and so on that form the heavily contaminated channel bed hotspots (Figure 2). Rather, these bed assemblages share many similarities with the mix of microplastic types *entering* water treatment plants. **Where microplastics are found in high concentrations on river beds, it forms one of the clearest indicators of poor wastewater management.**

3.4. **The geography and composition of the most heavily microplastic hotspots often allows them to be traced to specific point sources**: CSO and wastewater outfalls from WWTWs. Both are water company assets. The microplastic problem described here should form part of the Storm Overflows Taskforce. Reducing urban runoff through green infrastructure will help to reduce microplastic inputs to rivers.

3.5. In the recent River Tame study about half of the microplastics are microbeads. **The presence of microbeads on the river bed in high concentrations provides a very clear link with the urban wastewater system because these are *primary* microplastic particles used in specific industrial processes.** Their presence within mixed microplastic assemblages links the full assemblage to the wastewater system. Microbead use in personal care products was banned in the UK in January 2018 when Michael Gove was Environment Minister, but several industries (mainly in urban settings) still use plastic microbeads in very large quantities – specifically as blast media for industrial cleaning and for stripping rust and paint from metalwork.

4. Recommendations

4.1. **Tighten regulation around the discharge of untreated wastewater to rivers so that volumes are minimised.** This will improve river water quality and reduce microplastic transfer to river bed habitats. It will also reduce microplastic transport to the marine environment. These is a strong case to be made for making flow data publicly available in real time. Water company practice is key part of the solution.

4.2. **Utilise sediment monitoring to police water industry practice:** The microplastic load on a river channel bed represents a cumulative history of all contamination events since the last significant flood. **It is possible to use the microplastic assemblage to track and trace the point sources of wastewater.** The monitoring of microplastics on river channel beds can help the EA to identify permit breaches.

4.3. **Strengthen regulation on industrial microbeads:** The presence of significant volumes of microbeads in channel bed microplastic hotspots demonstrates that they are still used by industry in very large amounts and that these microbeads are finding their way into the urban drainage system and wastewater treatment plants. **We need improved regulation on microbead disposal on industrial premises to keep them out of our rivers.** We need new regulations to ensure that these materials are disposed of appropriately on site and not simply washed into the urban drainage system. The use of alternative materials to plastic microbeads should also be explored.

4.4. **A UK-wide survey of the extent of microplastic contamination is needed.** This should focus on the contamination of river bed habitats and assess the bioavailability of the microplastic load in a given setting. We also need further research to identify ecologically-relevant upper limits for microplastics in river systems. We do not have any legal targets or limits for microplastic pollution despite a growing literature pointing to multiple harmful impacts on freshwater and marine ecosystems.

References

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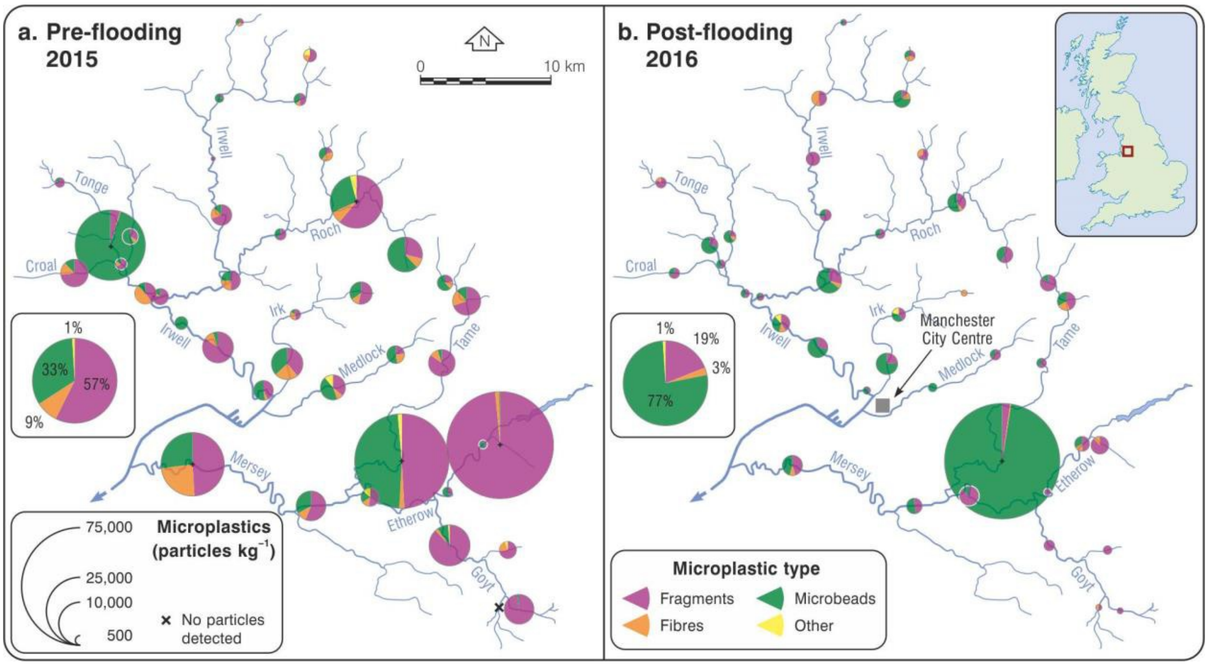

Figure 1. Microplastic concentrations in river bed sediments at 40 sites across 10 rivers around Manchester in 2015 and 2016. Microplastic concentrations decreased at most sites after the winter flooding of 2015/2016. Rivers will clean themselves if we limit the volume of microplastics entering the system.

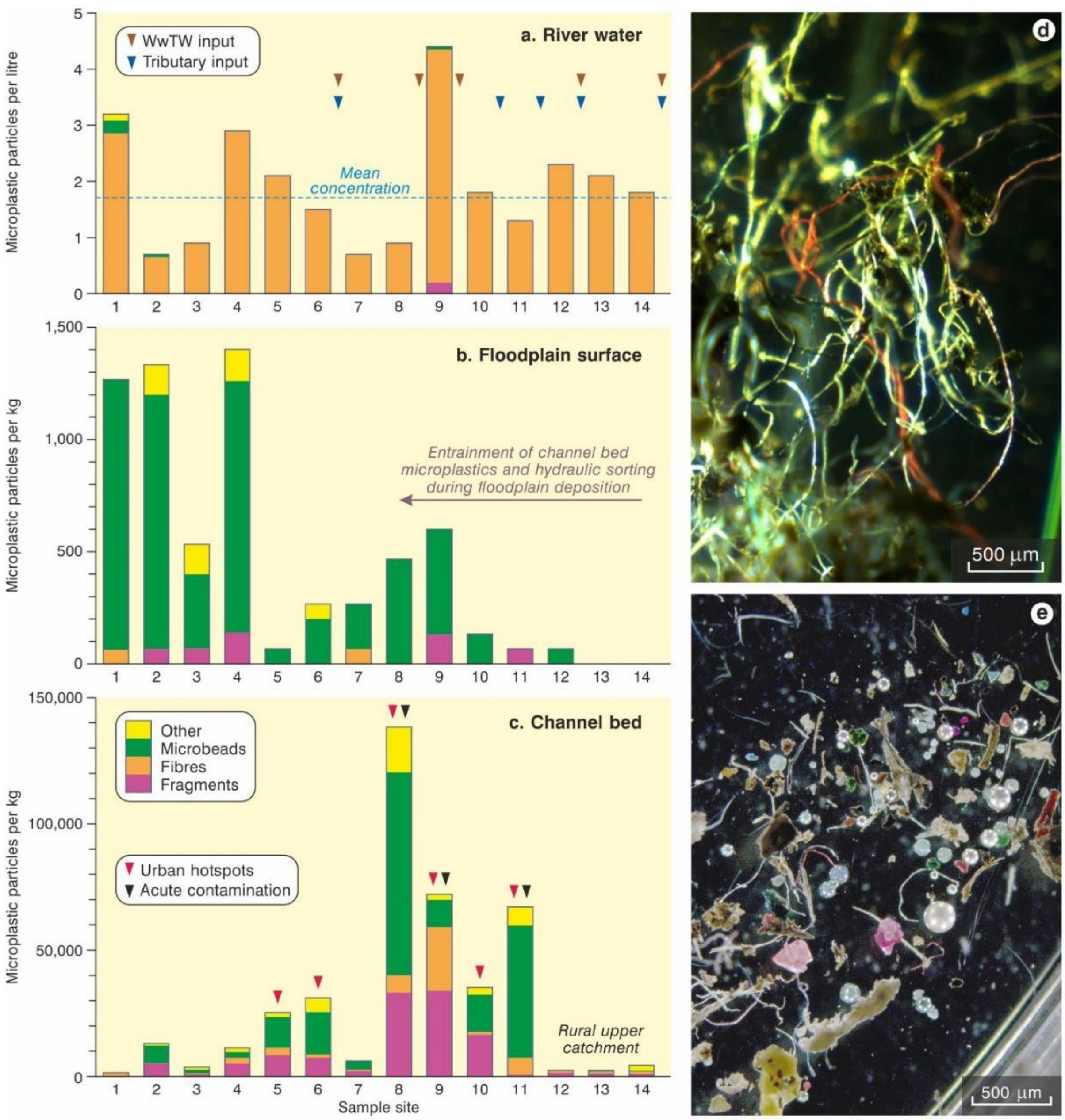

Figure 2. Microplastic concentrations in river water, in floodplain sediments, and in river channel bed sediments in the River Tame (Upper Mersey) catchment in summer 2019. The top photograph shows microplastic fibres recovered from river water fed by wastewater discharges that have been treated. The bottom photograph shows the full mix of microplastic types found on river channel beds. These bed assemblages are typical of the microplastic loads found in *untreated* wastewater.