River diversions may cause microplastics to remain longer on land and in streams before reaching oceans

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Diverting streams and rivers to irrigate crops or provide drinking water may significantly extend the time microplastics spend in river catchments before they flow into our oceans, a new study reveals.

Publishing their findings in Water Research, an international group of scientists led by the University of Birmingham, highlight the impact of water management in terms of river diversions for irrigation purposes on
microplastic transport.

These diversions can have significant impact on the estimates of the pollutant's flow towards our oceans, with the diverted water from rivers dispersing the tiny plastic particles across farmland from where they may be flushed back into other watercourses or neighboring catchments.

The research team studied two paired rivers in Colorado, United States—the Boulder Creek and its less urbanized tributary South Boulder Creek—evaluating the effects of urbanization and flow diversions on the up-to-downstream profiles of local microplastic concentrations as well as microplastic loads, indicating the flow-weighted downstream transport of particles.

The researchers found that microplastic concentration patterns in both rivers were related to the degree of catchment urbanization: Data from both streams suggests a link between microplastic concentration and urbanization, as microplastic concentrations in Boulder Creek with a more urbanized catchment were higher in both surface water and sediment than in South Boulder Creek, and microplastic concentration increased in downstream direction when passing more urbanized areas.

Lead author Anna Kukkola, from the University of Birmingham, commented, "We discovered strong links between the degree of urbanization in the river catchment and observed river microplastic concentrations, highlighting how human activities resulted in immediate increase in microplastics in this mountainous catchment.

"A key novelty of this study is the application of the loading approach which is used here for the first time for the quantification of microplastics fluxes and enabled us to not only identify microplastic sources but also determine the downstream evolution of microplastic transport patterns and in this case also the diversion of microplastics out
of the river catchment."

Co-author Rob Runkel, from the United States Geological Survey, added, "These results for microplastics are consistent with our results for other urban-derived elements such as chloride, where we are seeing 3 to 9 times more loading in the more urbanized Boulder Creek watershed."

The international team furthermore discovered that the magnitude of flow diversions from both streams resulted in large quantities of microplastic being removed from each stream and being transported out of their actual catchment. They measured microplastic removal through flow diversions of over 500 microplastic particles per second (or 1,800,000 per hour) from the two rivers studied.

To put this into perspective: In 2012, 241 km$^3$ of water were diverted for agricultural purposes in North America alone with 2,670 km$^3$ having been diverted globally. By using conservative estimates based on the >63 µm particle threshold of their study, the researchers estimated that this could result in around 41 trillion microplastic particles being redistributed out of river networks into the terrestrial environment in North America every year, with as many as 459 trillion particles being redistributed globally.

Co-author and Principal Investigator Professor Stefan Krause, from the University of Birmingham, commented, "How we manage our streams and rivers can have a substantial impact on the transport of microplastics, yet these effects have not been incorporated into global models that assume downstream convergence of microplastic fluxes along river networks. Our current models may, therefore, underestimate the quantities and residence times of plastics held in river catchments and overestimate the speed with which microplastics are transported into our oceans."
While toxicity assessment was not a focus of the current study, co-author Professor Iseult Lynch from the University of Birmingham noted, "The results of this study are highly relevant for estimating ecotoxicological impacts on aquatic and terrestrial environments and ecosystems, with enhanced terrestrial residence times resulting in extended (chronic) exposures."


Provided by University of Birmingham

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