

Date of Submission (month day, year) : July 06 2026

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Abstract (Doctor)

Title of Thesis	Fate and Transport of Microplastic in an Agricultural River 農耕地河川におけるマイクロプラスチックの動態評価
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Approx. 800 words

Microplastic (MP) pollution in agricultural river systems remains far less understood than in urban basins, despite the intensive use of agricultural plastics and the role of rivers in transferring land-based plastics to coastal and marine environments. This dissertation investigated the sources, distribution, transport dynamics, ageing and ecological risk of MPs in agricultural rivers draining into Mikawa Bay, Japan, integrating field data across four environmental compartments — surface water, river sediment, farmland soil and atmospheric deposition — under contrasting hydrological conditions, with intensive monitoring of the Umeda River catchment and its principal agricultural tributary, the Hamada River.

A methodological comparison first showed that, at a standardised volume of 1,000 L in low-flow rivers, plankton-net, bucket and pump methods produced statistically indistinguishable MP abundances (1.8 vs 1.5 particles/m³; Kruskal-Wallis $p > 0.05$), although they differed in particle morphology and reproducibility; method choice should therefore be guided by site hydraulics, with the bucket method offering the greatest field versatility. Baseline characterisation established that polyethylene (PE), polypropylene (PP) and film-shaped particles dominated all compartments; that river sediment (75 ± 87 particles/kg) and farmland soil (790 ± 55 particles/kg) act as major sinks relative to surface water; and that PE-coated controlled-release fertiliser microcapsules in soil and sediment provide direct diagnostic evidence of an agricultural source. The agricultural Umeda River carried roughly three times more MPs than neighbouring urban rivers.

Rainfall was the dominant control on MP dynamics: concentrations rose from a baseline mean of 20 particles/m³ to 3,253 particles/m³ during heavy rain, and although wet days represented only 34% of the year, they accounted for more than 98% of annual MP emissions (heavy rainfall alone 80–83%). MP flux followed a power-law load–discharge relationship ($n = 1.49\text{--}1.61$), a strong total-suspended-solids–MP correlation ($R^2 = 0.846$) validated turbidity as a real-time proxy, and first-flush behaviour concentrated most MP mass within the early phase of events. A mass-balance and L–Q framework quantified the annual emission under four scenarios, ranging from 0.29 tonnes/year (dry season only) and 7.48 tonnes/year (combined 242 dry and 123 wet days), and 22 tonnes/year (wet season only). The combined estimate of approximately 3.28 tonnes/year exported to Mikawa Bay (≈ 0.41 tonnes/km²/year) was

dominated by wet-weather flow (7.48 vs 0.29 tonnes/year) and exceeded European agricultural sites of comparable waste-management standard, indicating that agricultural plastic-use intensity and rainfall-driven transport govern loads in this farmland river. Carbonyl-index analysis indicated that most particles were already moderately-to-highly oxidised, implying long-residence-time sources such as weathered mulch films rather than freshly discarded material. Ecological risk was strongly rainfall-dependent, escalating from moderate under baseflow to extremely high during storms (PRI = 5,400; PHI = 363.5), driven by the episodic mobilisation of high-toxicity polymers including polyvinyl chloride (PVC) and polyurethane (PU).

Overall, the study demonstrates three central conclusions: rainfall is the disproportionate driver of MP transport in small agricultural rivers; agricultural plastic use is the primary identifiable source of MP contamination in such catchments; and MP ecological risk is fundamentally episodic rather than chronic, with storm periods constituting critical windows that must be prioritised in monitoring and management to reduce MP export from agricultural catchments to downstream coastal and marine environments.