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Abstract (Doctor)

Title of Thesis	Quantification, spatial distribution and characterization of macroplastics in agricultural river (農業河川におけるマクロプラスチックの定量、空間分布および特性評価)
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Approx. 800 words

Plastics encompass a broad category of polymer-based synthetic or semi-synthetic macromolecules. Although previous macroplastic (plastics larger than 5 cm) research has established frameworks for field methodologies, debris characterization, and land-use impacts, significant data gaps persist regarding agricultural contributions to riverine macroplastic pollution. To address this blind spot, this study quantified agricultural plastic contributions, identified influx drivers, and characterized macroplastic sources, their physical traits, chemical characteristics and deposition dynamics near farmland aquatic systems. The primary methodological strategy relied on spatial and temporal comparative analyses centered on the Hamada River in Toyohashi city, Aichi prefecture, Japan-- an ideal study location due to its warm climate, easy access, and high proportion of agricultural land cover (> 80%). Between 2021 and 2023, two core field approaches were executed along the Hamada River: after-rain riverbank samplings and river net samplings. The after-rain riverbank samplings evaluated bank accumulation at upstream and downstream transects to test the hypothesis that surface runoff flushes terrestrial debris into river systems during major rainfall events. Accumulated items within designated zones were quantified, dried, weighed, and subjected to polymer and visual characterization. Conversely, river net samplings utilized manual nets to capture floating debris directly from the water column. To establish a broader regional and environmental baseline, comparative samples were collected from the Umeda River, Toyo River, Mlese River in Indonesia, and Long Beach along the Pacific Coast. Spatial distribution along the downstream transect of the Hamada River demonstrated a pronounced accumulation hotspot, with 46% of all retrieved samples (205 out of 448) concentrated within the 7-10 m zone. This pattern was largely driven by dense riparian vegetation, such as weeds and thorny bushes, which acted as natural debris traps. The upstream section lacked similar vegetation and consequently displayed no such retention zone. Spatial and temporal monitoring revealed that sample abundance was governed by short-term hydrological pulses and localized micro-topographic trapping rather than continuous, steady-state transport. Baseline sample abundance remained low (typically ≤ 2 items/m²) across most dates, but episodic events triggered substantial localized surges, reaching up to 13.6 items/m² in the 9-10 m segment. Rainfall emerged as the dominant mechanism mobilizing land-based macroplastics into the aquatic environment, while wind speed and direction acted as secondary distribution drivers along the riverbanks. Average sample density during after-rain riverbank samplings reached 5.33 g/m² downstream and 11.14 g/m² upstream, representing a two to five-fold increase compared to river net sampling 2.04 g/m². Furthermore, the macroplastic flux
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rate following rainfall events (1.39 samples/hour/m²) was nearly double that of river net samplings (0.87 samples/hour/m²) reinforcing the role of rainfall and subsequent surface runoff in washing terrestrial waste ashore. Compositional analysis revealed that polyethylene agricultural mulch film, derived from adjacent tobacco farms constituted 31-59% of all recovered items, establishing it as the dominant contaminant in the Hamada River. Polyethylene averaged 70% of the total polymer composition, with an average recovery of 92 macroplastic pieces per sampling event. While food packaging typically dominates riverine plastic waste globally, it accounted for only 1-3.6% of debris in the Hamada River. Morphologically, 39% of net-sampled items exhibited an aspect ratio between 2 and 5, whereas after-rainfall riverbank samples predominantly displayed aspect ratios of 1 to 2 (38-46%) alongside broader color diversity. White was the single most prevalent color among net samples (53.6%), followed by transparent items (25%). Comparative sampling across contrast environments highlighted the strong influence of local land-use on plastic signatures. The Umeda River closely mirrored the Hamada River, with polyethylene mulch film comprising nearly half of the total samples and white being the dominant color. In contrast, the Toyo River contained a higher proportion of polypropylene derived from abundant food packaging, despite white remaining the dominant color (48.6%). The Mlese River in Indonesia was dominated by consumer packaging, plastic cups, straws, and styrofoam, with polypropylene accounting for nearly 40% of retrieved items. Finally, the Long Beach marine site yielded over 45 kg of macroplastics and exhibited substantially greater color and polymer diversity than any riverine site, with polyethylene terephthalate (PET) representing ~30% of samples. Collectively, these findings delineate the magnitude of agricultural macroplastic runoff, elucidate the meteorological and structural factors governing field-to-river transport, and underscore how agricultural plastic pollution profiles diverge from urban riverine and marine environments.