Appendix II

Report for the Project Progress Meeting and 2^{nd} Stakeholder Consultation

Project Annual Progress Meeting and 2nd Stakeholder Consultation Report

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Progress Meeting

Enhancing the Science-Policy Interface to Manage Microplastic Influx from Major Cities into the Oceans in Southeast Asia

Venue: Ho Chi Minh City University of Technology | Date: 11–12 September 2025 |

Agenda: See Attached I

Meeting summary

The objective of this meeting was to review progress to date and to discuss the delivery of project outcomes in line with its three core goals: the development of Source–Pathway–Receptor (SPR) frameworks, the generation of primary and secondary datasets, and the enhancement of stakeholder engagement to strengthen the science–policy interface. During the first year, significant progress has been achieved in the following areas. Preliminary findings from the project team, based on a comprehensive review of the current status of microplastic research in the region, confirm that there is a growing body of work investigating microplastics in different water environments. Studies highlight increasing concerns about contamination levels in wastewater (both domestic and industrial), groundwater, and drinking water. These findings point to emerging evidence of ecosystem risks and potential health impacts of microplastics across ASEAN countries.

Extensive field sampling campaigns have been conducted across all three cities, covering wastewater, industrial estates, agriculture, livestock, and atmospheric deposition. Country-specific SPR frameworks are being refined with dry and wet season data, with Bangkok's framework serving as a baseline. The project noted that Jakarta's framework is distinct due to its unique sewer coverage and urban planning, while Ho Chi Minh City's is similar to Bangkok's due to comparable urban layouts.

The consultation concluded that Vietnam is at an early stage in addressing microplastic pollution. Stakeholders expressed strong interest in receiving clear, evidence-based guidance that aligns with government priorities. By fostering collaboration between researchers, utilities, industries, and policymakers, the project can play a key role in advancing MP management in Vietnam and across Southeast Asia.

Field visits further illustrated the partial effectiveness of centralized industrial wastewater treatment plants and highlighted the potential of nature-based solutions, such as Floating Treatment Wetlands, in improving water quality in urban systems. These visits provided important insights into current practices and innovative options for addressing urban water pollution.

Moving forward, each country will continue its field sampling efforts. The project will also deliver regional knowledge products, including a March 2026 webinar and a coordinated multi-paper publication plan, to ensure robust outputs that can inform wastewater management and environmental policy in Southeast Asia.

1. Opening and Introduction

The meeting started at 9:00 AM at the designated meeting room in Ho Chi Minh City. Participants included project members from Vietnam, Indonesia, and Thailand. The session was chaired by ***Dr. Wenchao Xue***, Project Proponent from the Asian Institute of Technology (AIT), Thailand. Dr. Xue presented the overall project overview, its objectives, current status, and deliverables, as well as the planned outputs and upcoming activities. She emphasized that the project needs to fulfill the agreed objectives and deliverables. During the first year, three major activities have been conducted. First is updating knowledge on microplastic research in Southeast Asia through literature summary and review, which is progressing and still requires additional updates. The second activity involves major engagement from the three teams in field sampling, data collection, and analysis. Progress updates on these components are expected during the meeting. The third activity involves initiating dialogue with stakeholders, which is part of the objective to enhance stakeholder engagement and support policy spaces. In 2024, the team already met stakeholders in Jakarta, and in 2025 there will be consultations in Vietnamese cities, with further activities planned in the second year.

2. Project Objectives

Dr. Xue explained that the project is built around three major objectives. The first is the development of a Source–Pathway–Receptor (SPR) framework for three study cities. This framework will help identify and quantify microplastic pathways from urban sources into the marine environment. The second objective is to generate primary and secondary datasets. Primary datasets are obtained from field investigation and laboratory analysis, while secondary data comes from literature review and national statistics. These data will then be used to quantify the material flow of microplastics. The third objective is to enhance engagement with stakeholders and support science–policy interaction in Southeast Asia. This includes dialogue with policymakers, environmental agencies, and relevant stakeholders.

3. Progress Review (Year 1 Activities)

In terms of progress, Dr. Xue explained that overall the project is on track, with some activities experiencing slight delays or taking longer than initially planned. A major stakeholder meeting was organized in October 2024, and the development of the project website is ongoing. The draft version of the website is expected to be available soon, no later than next month (October 2025), after which the project members will review and provide input. The website will also host project information, announcements, newsletters, and reports of project-related conference presentations. She requested project members to also inform the secretariat whenever they participate in relevant conferences and present project-related research so that it can be recorded and disseminated.

Another important component of progress in Year 1 is the literature review. The team has completed a comprehensive literature collection and screening, resulting in around 700 publications relevant to microplastic research in Southeast Asia. The screening excluded review articles, non-English papers, publications with no access, studies without geographic features, and purely laboratory experiments. The literature was then analyzed and classified into major research directions: environmental baseline, fate and influencing factors, impact assessments, and countermeasures. Initial results show that more than 60% of the research in the region focuses on establishing an environmental baseline, such as concentrations of microplastics in water, sediments, and biota. The remaining publications cover studies on fate and factors, impact assessment, and management strategies. This structure reflects the current status of regional research.

She also noted that publications in Southeast Asia have increased significantly, especially after 2020. Indonesia leads with more than 300 publications, followed by Thailand with about 200, and Vietnam with nearly 180–200. Other countries like Malaysia and the Philippines are also active but are not part of the current research team.

The topic-wise distribution up to February 2025 shows that the majority of studies (60–70%) across ASEAN countries focus on establishing an environmental baseline. Smaller shares of studies investigate fate and factors, health and ecosystem impacts, and management strategies or technological solutions. Research in Thailand, Vietnam, and Indonesia follows a similar distribution.

The MPs report in ASEAN waters indicates that 723 research papers report the presence of microplastics in the environment. Of these, surface waters account for 36% of studies, biota 33%, soil/sediment/sludge 28%, wastewater 5%, air 3%, and groundwater 2%. This suggests that surface water and coastal/marine waters are the major focus, with increasing concern also given to wastewater, groundwater, and drinking water (including both tap and bottled water).

When comparing MP levels in ASEAN waters versus global benchmarks, the data show that contamination levels in Southeast Asia are broadly comparable to global averages. However, MPs in wastewater and drinking water are significantly higher than in surface freshwater or seawater, while groundwater levels are intermediate. This indicates that urban water systems are of particular concern.

Country-level comparisons show that in surface freshwater, Indonesia exhibits higher microplastic levels than Thailand and Vietnam, possibly linked to wastewater management challenges. In coastal seawater, microplastic levels fluctuate widely across all ASEAN countries, with Malaysia recording the highest values, potentially linked to marine-based activities such as fishing or plastic transport.

Regarding ecosystem risks and health impacts, studies report evidence of exposure through drinking water and surface water. Risk assessments include Estimated Daily Intake (EDI), Polymer Hazard Index (PHI), Pollution Load Index (PLI), and Ecological Risk Index (RI). Microplastics are also found to act as carriers of toxic chemicals including heavy metals, PAHs, additives, and organic pollutants. Several studies report the co-existence of MPs and toxic chemicals in environmental samples, though the precise role of MPs as vectors requires more study. Emerging evidence also points to MPs facilitating antibiotic resistance gene transfer.

Environmental pathways identified include wastewater discharge, stormwater runoff, and atmospheric deposition. A few studies attempt mass flux estimation but no systematic source–sink analysis has been conducted. Spatial and seasonal patterns show MPs are linked with population density, urbanization level, and land use. Levels are higher in drainage canals and rivers than in coastal and marine waters. Seasonal trends indicate higher concentrations in rainy seasons, often linked with the Southeast Asian monsoon. Driving factors include climatic and meteorological variables, hydrodynamics, socioeconomic parameters, and biodegradation processes. Methodologically, many researchers still rely on qualitative analysis, with statistical and modeling studies slowly emerging. Future directions point to incorporating hydraulic models and AI/ML approaches for complex data.

Dr. Xue will initiate work on a review publication focusing on microplastics in water, with particular attention to air deposition and drinking water, as several studies have already addressed these topics. Project team members who are interested will be invited to collaborate in preparing this review paper.

4. Progress Update from Bangkok, Thailand

The project team in Bangkok, Thailand provided a detailed update on the planned and ongoing field sampling events. According to the sampling design, a total of 21 sites were identified across different pollution sources, with 42 events and 324 samples planned. Sampling points are categorized into domestic wastewater treatment plants (DW), industrial estate wastewater (IW), agricultural runoff (AW), livestock and poultry breeding wastewater (LPBW), and atmospheric fallout (AF). For each sub-category, samples are collected during both dry and wet seasons, using appropriate sampling methods such as composite sampling, point sampling, and 24-hour continuous samplers. This systematic design ensures representation of different environmental pathways of microplastic contamination in the Bangkok Metropolitan Region.

For domestic wastewater treatment plants (DW), six sites were targeted: three centralized WWTPs (urban) and three decentralized WWTPs (suburban). Sampling progress shows that the centralized WWTPs at Nong Khaem, Din Daeng, and Chatuchak have been completed successfully with 100% progress. For the decentralized WWTPs, progress varied: Thasai DWTP is at 50%, Ramintra DWTP at 80%, and Romklao DWTP at 70%.

In the case of industrial wastewater treatment plants (IW), four sites were chosen: Ladkrabang Industrial Estate, Bangpoo Industrial Estate, Bangplee Industrial Estate, and Samut Sakhon Industrial Estate. The Bangpoo site has achieved 100% progress, while Bangplee has reached 90%. Ladkrabang and Samut Sakhon are at 50% and 70%, respectively.

For agricultural runoff (AR), sampling is conducted at Khlong Luang Research Center Paddy Field and Pathumthani Research Center Paddy Field. The progress stands at 70% and 80%, respectively. This involves collection of irrigation runoff in the dry season and surface runoff in the wet season. Parallel to this, livestock and poultry breeding wastewater (LPBW) sites include two chicken farms (Narong Farm 1 and 2) and one pig farm (Sanong Farm). The Narong chicken farms are at 90% progress, while Sanong pig farm has reached 70% progress. Sampling from effluent discharge at these farms is being conducted systematically in both dry and wet seasons.

For atmospheric fallout (SR), six sites have been installed, including Nonsi Witthaya School, Public Relations Department, Chokchai Metropolitan Police Station, South Bangkok Power Plant, Department of Disease Control, and Bangkok University. Except for the South Bangkok

Power Plant, which is at 90% completion, all other sites have reached 100% progress. These sites are equipped with fallout samplers to capture deposition during both dry and wet seasons. Photographs from the field show the fallout devices installed in different urban contexts, including during both dry and wet season operations.

The Bangkok team will continue laboratory analysis and characterization of collected samples to produce quantitative datasets. To ensure consistency across countries, the team will prepare and share a common data-entry template with Vietnam and Indonesia so that all project teams can input results in a standardized format. This harmonized approach will support the delivery of comparable outcomes for the project and strengthen the integration of datasets into the Source–Pathway–Receptor (SPR) frameworks. *More details as shown in Attached II*

5. Progress Update from Ho Chi Minh City, Vietnam

The project team in Ho Chi Minh City reported that sampling during the dry season has been completed successfully in May 2025, with a total of 20 samples collected. The sampling design included domestic wastewater, industrial wastewater, crop farming wastewater, livestock and poultry breeding wastewater, as well as atmospheric deposition in both urban and suburban areas. For domestic wastewater at the centralized WWTP, inlet samples of 3 liters were collected using composite sampling divided across the morning, afternoon, and late afternoon (1 L each), with duplicates resulting in two samples. Outlet samples were 30 liters, also collected as composites at three time intervals of 10 L each, with duplicates generating two samples. Similarly, for industrial wastewater at Le Minh Xuan centralized WWTP, inlet samples (3 L, composites of 1 L across three times of day, with duplicates) and outlet samples (30 L, composites of 10 L across three times of day, with duplicates) were collected, providing four samples in total. Crop farming wastewater was sampled by irrigation runoff at 5 L using point sampling, with duplicates collected. Livestock and poultry wastewater was sampled from effluent of WWTP storage ponds at 3 L, point sampling with duplicates. For atmospheric deposition, urban and suburban areas (open spaces in residential, commercial, and traffic-related land uses) were sampled continuously for 24 hours with a volume of 3–5 L each, resulting in two additional samples. A total of six field blanks were also included, bringing the total number of dry season samples to 20.

For the upcoming wet season in September 2025, the team has planned to collect 14 samples following a similar structured approach. This round will include domestic wastewater sampling at Binh Hung centralized WWTP with both inlet (3 L composites across three times of day with duplicates) and outlet (30 L composites across three times of day with duplicates). Industrial wastewater sampling will again be conducted at Le Minh Xuan centralized WWTP, using the same inlet and outlet scheme. Crop farming wastewater will be captured through surface runoff (5 L, point sampling with duplicates), while livestock and poultry wastewater will be taken from WWTP effluent or storage ponds (3 L, point sampling with duplicates). Air samples in urban and suburban open areas will be collected using 24-hour continuous samplers (3–5 L each). The total planned sample size for the wet season is 14.

The Vietnam team also reported some laboratory challenges. At present, they are relying on optical microscopes to identify suspected microplastics. However, there are difficulties in confirming whether observed particles are indeed plastic. Therefore, the team is discussing the need to verify if the Ho Chi Minh laboratory has access to a stereo microscope, which would allow clearer identification of microplastics and help improve analytical confidence. Additionally, the use of fluorescence microscopy is being considered, particularly to analyze samples from atmospheric deposition, which often include fine and ambiguous particles.

Dr. Quyen and Ho Chi Minh team will follow up on the availability of stereo microscopes and fluorescence equipment at local laboratories, as these tools are critical for improving the accuracy of microplastic identification and quantification, particularly for the counting process required in mass flow calculations within the Source–Pathway–Receptor (SPR) framework. In parallel, the Vietnam team will continue with the wet-season sampling campaign, comprising 14 samples, which is scheduled for completion by 30 September 2025. *More details as shown in attached III*

6. Progress Update from Jakarta, Indonesia

The project team in Jakarta reported that the planned dry season sampling has been completed successfully across selected sites. The sampling design in Jakarta reflects the unique urban wastewater management situation, where only around 2% of the city's wastewater is connected to a centralized sewage system. Therefore, the majority of wastewater discharge comes from septic tanks and is directly released into canals and receiving waters, as well as greywater discharged through drainage pipes. These represent the major sources and pathways of microplastic pollution in the Jakarta urban environment, and they were incorporated into the field sampling strategy.

The designated sampling sites cover multiple pollution sources across Jakarta, including domestic wastewater (DW) at IPAL Krukut (centralized WWTP), industrial wastewater (IW) at Kawasan Industri Pulogadung, agricultural runoff (Agri) at Pertanian Cilincing, livestock wastewater (Lives) at Cikoko Bio Farm Education, and atmospheric fallout (AF) at Universitas Pertamina (AF-1) and Masjid Istiqlal (AF-2). These sites are distributed across the metropolitan region and represent different urban, industrial, and peri-urban land use conditions, as shown in the mapped presentation provided as detial IV.

For domestic wastewater, samples were collected from influent and effluent points of IPAL Krukut WWTP, using composite sampling over three time periods (morning, afternoon, late afternoon). Since only a very small proportion of the city is connected to WWTPs, the team also included septic tank effluents discharging directly into canals as part of the dry season sampling design. In addition, drainage pipes carrying greywater from households were sampled using point sampling and composite grab methods to capture likely microplastic sources from untreated discharges.

For industrial wastewater, the target site is Pulogadung Industrial Estate. However, the team reported that sampling here has been delayed because permissions are still being processed. Industrial sites present significant bureaucratic challenges, but once approval is granted, inlet and outlet samples will be collected following the same composite method as in domestic WWTPs.

For agricultural runoff, samples were collected from the Pertanian Cilincing site, including irrigation water and runoff during the dry season, using point sampling methods. For livestock wastewater, effluent from the Cikoko Bio Farm (pig and poultry production systems) was sampled using point sampling with duplicates, representing another important non-sewered discharge pathway.

For atmospheric fallout, two sites were included in Jakarta: Universitas Pertamina (AF-1) and Masjid Istiqlal (AF-2). These were equipped with fallout samplers to collect dry deposition and wet deposition through 24-hour continuous sampling events. These sites are representative of both suburban campus areas and dense urban religious centers.

In addition to fieldwork, the Jakarta team presented their laboratory analysis results for the first batches of collected samples. They have been working to identify microplastic particles under microscopy, characterize polymer types, and begin counting particle numbers to support quantification of mass flows. While methodological challenges remain similar to those reported in Vietnam, the team is gradually improving their protocols for reliable identification.

Furthermore, the Jakarta team also shared progress on the Source–Pathway–Receptor (SPR) framework for Indonesia. Their framework integrates the different pollution sources identified in Jakarta: centralized WWTPs, septic tanks and greywater drains, industrial effluents, agricultural runoff, livestock wastewater, and atmospheric fallout. Each source is linked to its environmental pathways and receptors, including canals, rivers, surface water, and marine receiving waters. This SPR diagram is being refined as laboratory results are incorporated.

Overall, the Indonesia team emphasized that their dry season campaign is progressing well, laboratory analysis is underway, and the SPR framework is in place. They will continue to pursue industrial sampling permissions and will prepare for the upcoming wet season sampling campaign, which is expected to capture higher runoff and discharge loads typical of Jakarta's monsoon climate. *More details as shown in detial IV.*

7. Afternoon Session – Discussion on SPR Frameworks

In the afternoon session, the project team continued with in-depth discussions on the Source–Pathway–Receptor (SPR) frameworks for each study city, focusing on refining system flows and incorporating country-specific practices. The discussion began with the framework from Thailand, which served as a reference model for other countries. The Thailand SPR framework captures multiple sources of microplastics, including domestic sewage, industrial wastewater, agricultural runoff, livestock wastewater, atmospheric fallout, and surface runoff. These are linked through pathways such as sewer systems, stormwater drainage, and wastewater treatment plants (WWTPs), leading to receptors including surface waters, land retention, and sludge deposits. This model illustrates how wastewater is partially collected, treated in centralized WWTPs, or discharged directly to receiving waters, while stormwater and surface runoff often bypass treatment infrastructure.

For Jakarta (Indonesia), the SPR framework will be revised because the system structure differs significantly from Thailand. While domestic sewage flows are conceptually similar, Jakarta's sewer collection rate is only about 2%, which is a major difference. This means that both greywater and blackwater are largely uncollected and discharged untreated. To reflect this, the Jakarta framework will explicitly include septic tanks as a separate source, with effluent often discharged directly into canals or receiving waters, as well as greywater drains that flow untreated to the environment. Unlike Thailand and Ho Chi Minh City, Jakarta does not have widespread centralized WWTPs, and therefore most industrial estates release wastewater directly to receiving waters without treatment. This creates a distinct industrial wastewater flow that bypasses the WWTP route seen in the Thai framework. Air deposition flows remain consistent with Thailand's model, linking directly to surface waters and land retention.

For agricultural runoff, the Jakarta team noted similarities with Thailand but emphasized the need to confirm local land-use types, distinguishing between upland crop fields and paddy fields. In dry weather, paddy fields may not discharge water, but in wet weather, surface runoff from paddy systems will contribute directly to receiving waters. The team agreed to verify these assumptions with practical field evidence and local agricultural data. Livestock wastewater flows were considered similar to Thailand's framework, entering the environment through effluent from ponds or small-scale WWTPs, with minimal centralized collection.

Regarding surface runoff, Jakarta's drainage system operates very differently from Thailand. The city lacks an integrated sewer system with pumping stations; instead, rainfall and urban runoff are discharged directly to receiving waters via gravity-fed drains. The team discussed the need to check what proportion of Jakarta is served by gravity drainage versus areas without drainage infrastructure, and how to incorporate this into flow calculations. They also agreed to examine surface runoff coefficients more carefully, potentially consulting data from the national Land Development Department or equivalent sources in Indonesia to refine the estimates of surface runoff contributions to microplastic transport.

For Ho Chi Minh City (Vietnam), the framework shares broad similarities with Thailand, since both domestic and industrial wastewater are connected through centralized WWTPs. However, specific adjustments are required. First, collection efficiency needs to be more accurately represented, and land-use categorization must be clarified, particularly in distinguishing how much of the country's agricultural land is crop land versus paddy fields, and which type dominates in Vietnam. During the discussion, the Ho Chi Minh team raised a concern about the datasets being used, noting that some data are from 2023, while land-use area figures come from 2024. The team agreed that these can still be used, but it must be clearly documented which year's data are applied for calculations to maintain transparency. The drainage system in Ho Chi Minh City also requires verification, specifically whether the city operates a combined system (where wastewater and stormwater are managed together) or a separate system. Like Jakarta, Ho Chi Minh also requires refinement of surface runoff coefficients and seasonal discharge patterns, especially under monsoon conditions, to ensure calculations accurately reflect wet- and dry-season variability.

Overall, the SPR frameworks are progressing well, with Thailand's model providing the baseline structure, Jakarta showing the most divergent conditions due to limited sewerage coverage and reliance on septic tanks and greywater discharges, and Ho Chi Minh requiring refinements in land-use classification, drainage system characterization, and temporal data consistency. The teams agreed on the importance of validating framework assumptions with practical evidence from each country, particularly concerning wastewater management practices, drainage systems, and agricultural land types. These refinements are critical to ensuring that the frameworks realistically capture national contexts and provide a solid foundation for quantifying microplastic material flows into Southeast Asia's aquatic environments.

The country teams agreed to refine and validate their Source–Pathway–Receptor (SPR) frameworks using local datasets and field evidence. For Jakarta, revisions will focus on explicitly incorporating septic tanks, greywater discharges, and the predominance of untreated flows. The Ho Chi Minh City team will improve accuracy in land-use categorization, collection efficiency, and drainage system characterization.

Bangkok, Thailand will maintain its role as the baseline framework, serving as a reference model. All teams will work toward harmonizing framework structures, with particular attention to surface runoff coefficients and seasonal variability, to enable robust cross-country comparisons and reliable quantification of microplastic flows.

8. Webinar & Publications (2026)

- **Webinar (March 2026):** ~50 participants, 15–20 speakers. Two strategies:
    1. Open call for Master's/PhD speakers (4 sessions, abstract book).
    2. Link to special issue publication.
- **Planned publications:**
    1. 1–2 national papers per country using primary data.
    2. Comparative wastewater management paper across cities.
    3. Review paper on microplastics in water in Southeast Asia.

The project team will organize the regional webinar in March 2026, targeting approximately 50 participants and 15–20 speakers, with outputs linked to a special-issue publication. Each country team will prepare 1–2 national papers using primary datasets, alongside a comparative wastewater management paper and a regional review paper on microplastics in water. In addition, team members are encouraged to consider co-authoring an additional review paper focusing on air deposition or drinking water, as these topics are receiving growing research attention in the region.

Dr. Xue provided an overview of the project’s overall progress, highlighting achievements to date and outlining upcoming priorities for all three country teams.

Vietnam and Jakarta teams sharing updates on field sampling and laboratory analysis activities.

Field Trip Activities

As part of Progress meeting in Ho Chi Minh City, the project team conducted field visits to sites directly relevant to the project's objectives of understanding microplastic (MP) sources, pathways, and treatment systems in urban Southeast Asia. These visits provided valuable opportunities for the team to observe wastewater treatment operations and innovative technologies for water pollution control, thereby deepening the practical understanding necessary to support the development of Source–Pathway–Receptor (SPR) frameworks and policy recommendations.

❖ Le Minh Xuan central wastewater treatment plant

On 12 September 2025, the project team visited the Le Minh Xuan central wastewater treatment plant (WWTP), which plays an important role in the management of industrial wastewater in Ho Chi Minh City. The facility treats wastewater generated from 124 factories, spanning industries such as mechanical manufacturing, textiles, garment production, fertilizers and pesticides, and food processing. The treatment system combines both biological and physicochemical processes. Wastewater first passes through coarse and fine screens (1000 μm pore size) to remove debris, before entering an equalization tank. Primary treatment includes coagulation and flocculation, followed by settling in Clarifier 1. Secondary treatment uses the conventional activated sludge (CAS) process in aeration tanks, followed by secondary settling in Clarifier 2. A second coagulation-flocculation step (Physicochemical Process 2) and Clarifier 3 provide further separation. The treated effluent then undergoes disinfection in a chlorine contactor before being discharged to the C6 Canal, which eventually flows into the Saigon River.

This visit was directly related to the project's work, as it provided insights into the current practices of industrial wastewater treatment in Ho Chi Minh City and how such systems contribute to reducing—but not eliminating—microplastic discharge. The team was able to link the observed treatment stages to project data collection and SPR modeling, particularly in terms of evaluating the effectiveness of treatment in removing MPs and identifying potential release points into the aquatic environment. The visit also highlighted the importance of monitoring effluent quality and considering the diversity of industrial inputs that can influence MP loads.

Sitte visit to the Le Minh Xuan central wastewater treatment plant, focusing on industrial wastewater management and microplastic challenges.

❖ Visit to Pilot Floating Treatment Wetlands by KEYLAB at Hang Bang Hotel

The second site visit was to the Pilot Floating Treatment Wetlands (FTWs) established by KEYLAB, located at the Hang Bang Hotel. Floating treatment wetlands are an emerging nature-based solution (NbS) for improving water quality, which use floating platforms planted with wetland vegetation to absorb, filter, and break down pollutants from water bodies. These systems harness both plant uptake and microbial activity on plant root biofilms to capture organic matter, nutrients, and potentially microplastics from the water column.

During the visit, the project team observed the installation of the pilot FTW units and discussed the design, operational principles, and monitoring techniques applied in this system. The FTWs were demonstrated to function as a decentralized treatment option, particularly suitable for urban canals, lakes, and small water bodies, where conventional centralized wastewater treatment systems are not feasible. The field trip allowed participants to explore how FTWs can complement existing infrastructure in cities like Ho Chi Minh, where a mix of centralized WWTPs, septic tanks, and untreated discharges all contribute to microplastic pollution.

For the project, this site visit was highly relevant because it showcased an innovative approach that could serve as a potential countermeasure within the SPR framework. By capturing microplastics and reducing contaminant loads before water enters major rivers, FTWs could play a role in mitigating pollution at local hotspots. The team also gained insights into practical considerations such as plant species selection, maintenance requirements, and scaling potential. These lessons are valuable for both the technical dimension of microplastic flow analysis and for the policy engagement component, as they demonstrate feasible, community-based solutions that can be proposed to urban stakeholders.

Learning from KEYLAB's pilot Floating Treatment Wetlands at Hang Bang Hotel, a nature-based solution to capture pollutants including microplastics

Stakeholder Consultation – Vietnam

The stakeholder consultation in Vietnam was attended by representatives from both academia and water utilities. The participants included Dr. Tra Van Tung and Dr. Vo Thi Dieu Hien from Nguyen Tat Thanh University, Dr. Phan Nhu Nguyet from Vietnam National University – Ho Chi Minh City (University of Science), Dr. Thai Van Anh from the Institute of Applied Science, and Mr. Doan Hung from the Saigon Water Supply Corporation (SAWACO). This participants reflected both research expertise and practical responsibility for urban water supply and management.

Project Introduction by Dr. Wenchao Xue

Dr. Xue opened the session with an introduction to the regional project *Enhancing the Science-Policy Interface to Manage Microplastic Influx from Major Cities into the Oceans in Southeast Asia*. She explained that the project is designed to address critical quantitative questions: how much microplastic is generated each year from domestic wastewater, industrial effluent, livestock waste, and agricultural runoff; how much is captured by sewer systems and wastewater treatment plants; how much is discharged directly into rivers; and how much remains in soils and land environments. She emphasized that although definitive answers are not yet available, the ongoing research is structured to provide these numbers and to translate them into practical management recommendations. Dr. Xue stressed that these findings will be highly relevant for those involved in urban water management and invited the stakeholders to reflect on their awareness, perceptions, and suggestions.

Concerns and Awareness of Stakeholders

The first response came from **Mr. Doan Hung of SAWACO**, who noted that his agency currently focuses on monitoring water quality indicators such as organic matter, which directly impact public health. At present, MPs are not included in their monitoring system, but in the future MPs will likely become an important focus. He viewed the project as important because it puts an emerging issue onto the agenda of utilities that are responsible for protecting public health.

Dr. Xue then asked whether the participants had heard about MP pollution and whether they observed increasing concern or awareness about the issue. Participants collectively acknowledged that in Vietnam, awareness and knowledge of MPs are still in the early stages. There are currently no specific regulations, standards, or management strategies for MPs, although policies do exist for plastic waste and single-use plastics. They advised that public communication should avoid blaming industries that lack the technology to address MPs. Instead, communication should focus on capacity building, knowledge sharing, and feasible solutions. **Mr. Doan Hung** added that SAWACO, as a state-owned utility, is under government responsibility to supply water to the entire city, making this issue particularly significant. For him, the project provides a platform that can bridge science with SAWACO's public service mission.

Dr. Xue explained that many people are surprised to learn that MP levels in drinking water can be comparable to those in wastewater. She stressed that this does not mean panic is necessary but rather shows the importance of recognizing MPs as an emerging pollutant that needs better monitoring and management. She emphasized that the project team's findings, showing MPs in both tap and bottled water, highlight the urgency of improved action. Stakeholders reflected that this evidence is vital because it demonstrates why Vietnam needs to act before the issue becomes unmanageable.

Comparative Regional Perspectives

Following this, **Dr. Bob Adyari**, another member of the project team, raised a question about research and knowledge sharing in Vietnam. He noted that because MP levels in urban systems are relatively high, he wanted to know how researchers in Vietnam share their results and how they compare with Thailand and Indonesia.

Dr. Phan Nhu Nguyet from Vietnam National University – Ho Chi Minh City (University of Science) explained that Vietnam already has some research outcomes, but the knowledge remains fragmented and awareness is uneven. She asked about the situations in Thailand and Indonesia. For her, the project is important because it connects Vietnam's fragmented work with regional comparisons, making it easier to advocate for more coherent national strategies.

Dr. Xue replied that the region faces similar challenges: there are no specific regulations on MPs. Policies exist to reduce plastic usage overall, but no concrete strategies or standards address MP discharges into wastewater and the urban environment. She added that in Vietnam there is growing public awareness that MPs affect human health and ecosystems. People are concerned and increasingly informed about MPs.

In Indonesia, the government is trying to educate the public, but researchers admit that the effects of MPs are still uncertain. Ordinary people receive information through media, which sometimes leads to concern but also to confusion. The Indonesian stakeholders noted that communication should avoid blaming factories because industries currently do not have the technology to address MPs. Similarly, in Thailand, there is no dedicated technology to manage MPs, but public awareness is increasing.

Similar to Vietnam, awareness is increasing in Thailand, but panic is not yet observed. **Dr. Adyari** added that researchers should simplify communication to the public, focusing on explaining available technologies for MP management, so that people can understand without being overwhelmed. Stakeholders agreed that this shows the project is not only producing data but also helping design communication strategies that are realistic for the region.

Dr. Phan Nhu Nguyet asked whether it is easy to access industries for research. Dr. Xue responded that industries are often difficult to approach because they fear reputational damage and may reject sampling requests. By contrast, government agencies are generally more open if procedures are followed. Protecting industry reputation while conducting research remains a challenge. Stakeholders noted that the project's neutral academic framing helps open dialogue that might otherwise be blocked.

Mr. Doan Hung of SAWACO asked whether there are existing technologies to remove MPs that could be applied to Vietnam's water supply. **Dr. Xue** responded that most large-scale water treatment plants still rely on conventional technologies that are not specifically designed to remove MPs. She added that in Thailand, for example, people often drink bottled water that is marketed as clean, but researchers have reported high MP levels in bottled water. This shows that there is no quality control specific to MPs at present.

In Vietnam, many families do not rely on tap water for drinking. Instead, they boil water or use filtration systems at home, while wealthier families purchase bottled water. **Dr. Phan Nhu Nguyet** shared her personal experience, saying that because she is aware of many pollutants in the water, she chooses to buy bottled water for safety. In Jakarta, bottled water is also common because tap water is often contaminated with bacteria. Stakeholders reflected that the project validates everyday experiences with scientific evidence, giving people clearer reasons to adopt safe practices.

Dr. Adyari asked whether government agencies in Vietnam had initiated surveys of MPs beyond tap water—for example, in rivers or the wider environment. Stakeholders explained that only researchers are currently studying MPs, and government agencies have not yet launched systematic surveys. The government acknowledges MPs as an issue but does not yet regulate or monitor them comprehensively. They saw the project as filling this monitoring gap while also motivating agencies to act in the future.

Challenges in Research and Technology

Dr. Tra Van Tung asked whether the project considers nanoplastics. He explained that detecting particles at the micrometer or nanometer scale requires advanced microscopy and specialized equipment, which Vietnam currently does not have. This lack of capacity is a major challenge. He considered the project important because it raises this limitation at the regional level, helping Vietnam make the case for external technical and financial support.

They also discussed international regulations. While the European Union has introduced bans on certain plastic products and economic measures such as charges or penalties, no country in Southeast Asia has regulations specific to MPs or nanoplastics. Most policies in the region focus only on plastic products or waste, not on small plastic particles. Stakeholders valued the project's ability to bring global policy lessons into the Southeast Asian context, making it easier for Vietnam to anticipate future trends.

Stakeholder Needs and Project Contributions

Stakeholders expressed clear needs and interests. They want comparative data that shows how Vietnam's situation relates to Thailand and Indonesia. They also want evidence-based recommendations that can be used in national policy discussions, particularly those related to sludge reuse, circular economy approaches, and sustainability.

Dr. Xue explained that the project's ultimate goal is to provide recommendations useful to managers and policymakers. The project can help identify the most important pathways of MPs and highlight which management strategies could reduce pollution most effectively. By comparing three cities across the region, the project can demonstrate how different management patterns result in different levels of MP discharge, thereby offering best practices for future improvement. She added that while no single project can solve every problem, this project can contribute useful knowledge and recommendations. For example, it can highlight risks of MPs accumulating in sludge that is reused in agriculture or deposited in landfills. Stakeholders regarded this as highly valuable because sludge reuse is already a government priority in Vietnam.

Finally, the discussion turned to how knowledge could be transferred to policymakers. Participants admitted that in Vietnam this is not yet easy. Government agencies are aware of MPs but have not yet developed specific regulations. Communication currently relies on academic publications, media, and NGOs. **Dr. Tra Van Tung** from Nguyen Tat Thanh University suggested that engaging organizations such as WWF, which already have research on water and agriculture, could help raise government interest. He also pointed out that government attention is currently focused on topics such as sludge reuse and circular economy. Therefore, if the project frames its findings in relation to these themes, it will be easier to attract policy attention. Stakeholders concluded that this policy linkage is one of the strongest values of the project.

Conclusion

The consultation concluded that Vietnam is at an early stage in addressing microplastic pollution. Stakeholders are aware of the problem and concerned about its implications for drinking water and wastewater, but there are no regulations or dedicated technologies in place. They emphasized that the project fills urgent gaps—providing quantitative data that utilities like SAWACO can use, comparative regional knowledge that strengthens Vietnam's scientific standing, capacity building that researchers such as Dr. Tra Van Tung see as essential, and policy-relevant recommendations that connect directly with themes highlighted by Dr. Thai Van Anh and others.

Stakeholders expressed strong interest in receiving clear, evidence-based guidance that aligns with government priorities and avoids creating unnecessary panic. They recognized that the project provides not only numbers but also a framework for communication, capacity development, and policy dialogue. By fostering collaboration between researchers, utilities, industries, and policymakers, the project was seen as a practical enabler that can play a key role in advancing MP management in Vietnam and across Southeast Asia.


Mr. Doan Hung
Saigon Water Supply Corporation (SAWACO)

Dr. Phan Nhu Nguyet
Dr. Evi Siti Sofiy

National and local stakeholders engaging in dialogue on challenges, needs, and pathways to translate science into policy.

I Program of 2nd Progress Meeting

Program of Progress Meeting

Enhancing the Science-Policy Interface to Manage Microplastic Influx from Major Cities into the Oceans in Southeast Asia

Ho Chi Minh City, Vietnam

Background

The research project titled "Enhancing the Science-Policy Interface to Manage Microplastic Influx from Major Cities into the Oceans in Southeast Asia" is a collaborative effort aimed at addressing the critical environmental threat posed by plastic debris and microplastics (MPs) in Southeast Asia (SEA). Funded by the Asia-Pacific Network (APN) for Global Change Research under its Collaborative Regional Research Programme (CRRP) scheme, this project brings together three institutions: the Asian Institute of Technology (AIT) in Thailand, Ho Chi Minh City University of Industry and Trade (HUIT) in Vietnam, and Universitas Pertamina (UP) in Indonesia. SEA is considered a global hotspot for plastic waste discharge into the oceans, yet there remains a significant knowledge gap in understanding the complex interactions between land-based sources, aquatic pathways, and environmental sinks of MPs in urban coastal areas. This project aims to develop a comprehensive system model to quantify the influx of microplastics in urban aquatic systems across selected cities in SEA. It will address critical questions surrounding the sources, pathways, and receptors of MPs, as well as how this knowledge can be used to improve management and policymaking. Key activities of the project include reviewing existing research, formulating a source-pathway-receptor (SPR) framework, collecting field data, and engaging stakeholders to ensure that the findings are relevant to policy development. The project is expected to generate evidence-based strategies for preventing marine plastic pollution and to support sustainable management efforts across SEA. Funded for a two-year period starting October 1st, 2024, the project will focus on three major cities in the partner countries, with the goal of providing actionable insights for mitigating the growing challenge of microplastic pollution in the region

Expected Outputs of the Meeting

The annual meeting aims to achieve the following:

1. **Progress Reports**: Presentation and discussion of progress from each of the three partner countries.
2. **Stakeholder Consultation**: Engaging with key stakeholders for input on microplastic management strategies.
3. **Field Visits**: Observing real-world applications and the current situation regarding microplastic management.

Program

Date: 10th – 13th September 2025

Date	Time	Agenda
10th Sep	**Departure: Travel to Ho Chi Minh City, Vietnam**	
11th Sep	**Progress Meeting**	
	9.00 – 9.30	**Overall progress summary by Dr. Wenchao Xue**
	9.30 – 10.00	**Progress of field and laboratory activities from Vietnam and Jakarta teams**
	10.00 – 11.00	- Discussion on SPR framework development - Addressing gaps in secondary data
	11.00 – 12.00	**Planning for Year 2 activities** - Seminar preparation - Primary data collection and discussion - Stakeholder consultation planning - Publication plan
	12.00	**Lunch**
	Key Stakeholders Roundtable Discussion	
	13:00 – 14:30	Brief introduction on stakeholders' roles and engagement related to microplastic pollution and management (~10 minutes per speaker).
	14:30 – 15:00	Coffee Break
	15:00 – 16:00	Open discussion: Actionable Solutions and Collaborative Efforts for Microplastic Management in Southeast Asian Region • Understand the knowledge & research gaps • Identify the policy and management concern & needs • Enhance regional collaboration & networking • Roles of young talent capacity building & stakeholder engagement
12th Sep	**Field Visite**	
9.00-12.00	9.00-12.00	- Pick up at Hotel Visit to Le Minh Xuan central wastewater treatment plant (for industrial wastewater)
	12.00-13.30	Lunch
	13.30-14.30	Visit to **Pilot Floating Treatment Wetlands** by KEYLAB in Hang Bang Hotel
	15.00	Return Hotel

Date	Time	Agenda
13th Sep	**Return trip**	

Participants

No	Name	Affiliation
Project members		
1	Dr. Wenchao Xue, Project Proponent	Asian Institute of Technology (AIT), Thailand
2	Dr. Thi Kim Quyen Vo, Collaborator	Ho Chi Minh City University of Industry and Trade (HUIT), Vietnam
3	Dr. Bob Adyari	Universitas Pertamina (UP), Indonesia
4	Dr. Betanti Ridhosari	Universitas Pertamina (UP), Indonesia
5	Dr. Nurulbaiti Listyendah Zahra	Universitas Pertamina (UP), Indonesia
6	Dr. Evi Siti Sofiyah	Universitas Pertamina (UP), Indonesia
7	Ms. Mutita Wattanasuk	Asian Institute of Technology (AIT), Thailand
Invited Participants		
1	Dr. Tra Van Tung	Nguyen Tat Thanh University
2	Dr. Vo Thi Dieu Hien	Nguyen Tat Thanh University
3	Dr. Phan Nhu Nguyet	Vietnam National University – Ho Chi Minh City University of Science
4	Dr. Thai Van Anh	Institute of Applied Science
5	Mr. Doan Hung	Saigon Water Supply Corporation (SAWACO)

II Progress Updated – Bangkok, Thailand

III Progress Updated – Ho Chi Minh City, Vietnam

IV Progress Updated – Jakarta, Indonesia

Asia-Pacific Network for Global Change Research (APN):

2nd Progress Meeting

11 September 2025

Outline:

✓ Overview of the project objectives and deliverables

✓ Progress update on microplastics knowledge status review in SEA

✓ Progress update on field sampling and MP analysis

✓ Discussion on MPs mass flow frameworks in three cities and data gaps

✓ Update of project financial figure

✓ Discussion on future work plan

Objectives:

Overall :

The project including three objectives aiming at gaining a systematic understanding of MPs entering the oceans through urban aquatic systems in the SEA Region The specific objectives of this study are:

- To develop a suitable source-pathway-receptor (SPR) framework for a holistic understanding of MP transmission from Southeast Asian urbans through critical literature review.
- To quantitatively assess MP influx into marine ecosystems in selected urban areas based on the SPR framework and mass balance analysis.
- To strengthen the capacity of policymakers to understand the impact of urban MP pollution and formulate evidence-based policy frameworks.

Project Timeline:

Asian Institute of Technology

Project Activities	Year 1 (2024/2025) (from 1 October 2024 – 30 September 2025)											
	1	2	3	4	5	6	7	8	9	10	11	12
Project planning & kick off meeting @ Indonesia	√											
Development of Project Website	√	√	√									
Critical Review & Data collection		√	√	√	√							
SPR framework formulation		√	√	√	√	√						
1st Online Progress Meeting						√						
Detailed field sampling design							√					
Stakeholder/Expert interview and consultation					√	√	√					
Field Survey and Sampling Events								√	√	√	√	√
Laboratory analysis									√	√	√	√
1st publication preparation							√	√	√	√	√	√
2nd Progress Meeting @ Viet Nam												√

Project Activities	Year 2 (2025/2026) (from 1 October 2025 – 30 September 2026)											
	1	2	3	4	5	6	7	8	9	10	11	12
Field Survey and Sampling Events	√	√	√	√	√							
Laboratory analysis	√	√	√	√	√	√						
Quantitative Mass Flow Analysis		√	√	√	√	√	√					
3rd Progress Meeting online							√					
Regional Webinar						√						
Policy brief and recommendation development							√	√				
Science-policy dialogues								√	√			
2nd publication preparation							√	√	√	√	√	
Stakeholder Workshop Preparation and Delivery										√	√	
Final report and project recommendations/dissemination											√	
APN project & financial reporting												√

Expected Outputs:

- **Objective 1- outputs:** 1) Critical review on the state-of-the-art knowledge and information of marine MP pollution originating from urban sources in the study countries (review report); 2) SPR frameworks designed for three study coastal urbans (Framework diagrams for each study city with documentary description).

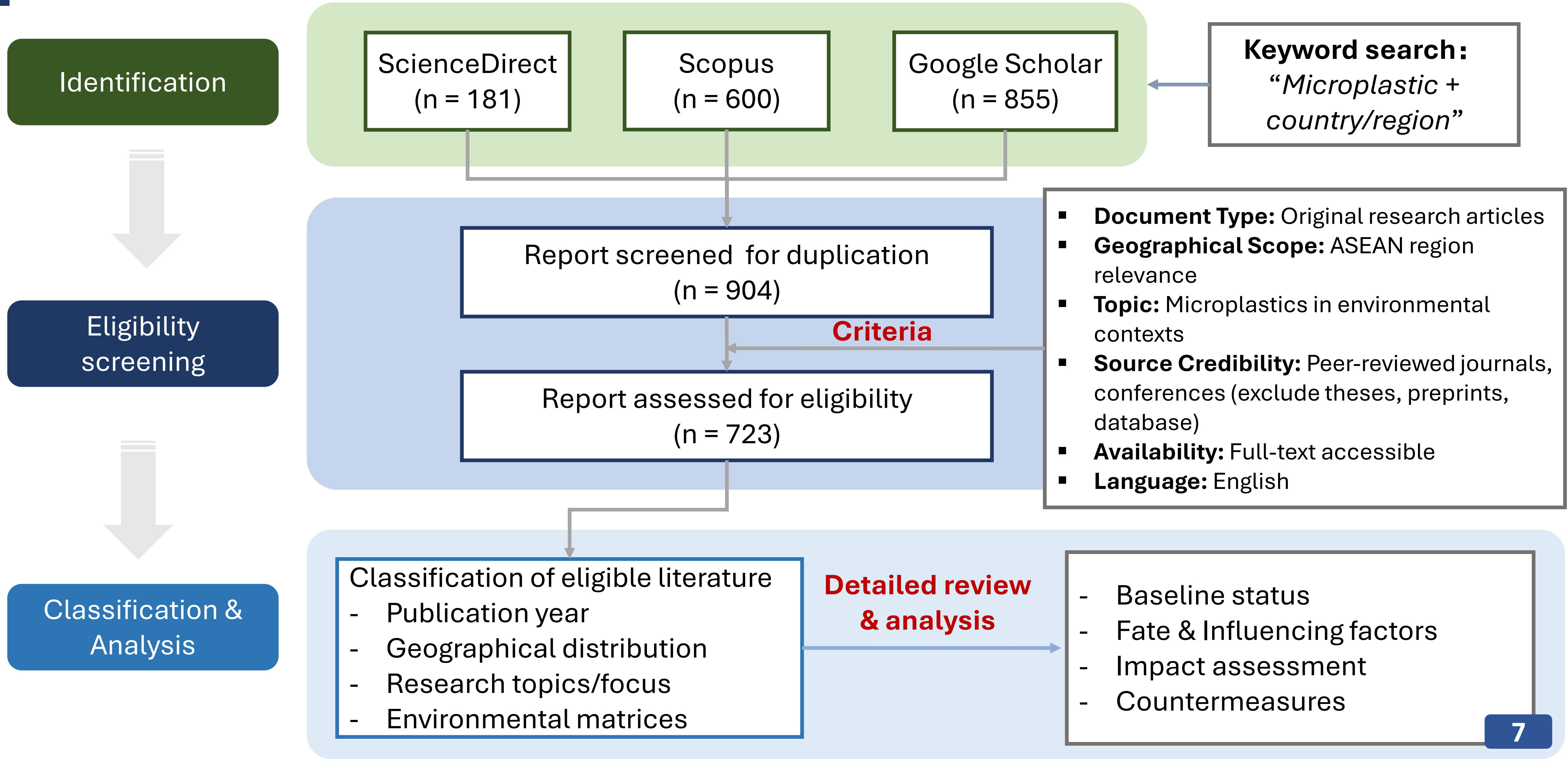
- **Objective 2 – outputs:** 1) Quantity and characterizations of urban-derived MPs based on field investigation (Datasets); 2) Quantitative assessment of MP influx in three study cities (report); 3) Interim report; 4) Peer reviewed publications

- **Objective 3 – outputs:** 1) Regional webinar (report); 2) Science-policy brief (leaflets, brochure, reports); 3) Science-policy dialogue/meeting (report); 4) Regional workshop proceeding (report); 5) Project website, social media content (videos, posts, announcement, newsletter, etc.); 6) Project final report

Progress Update on

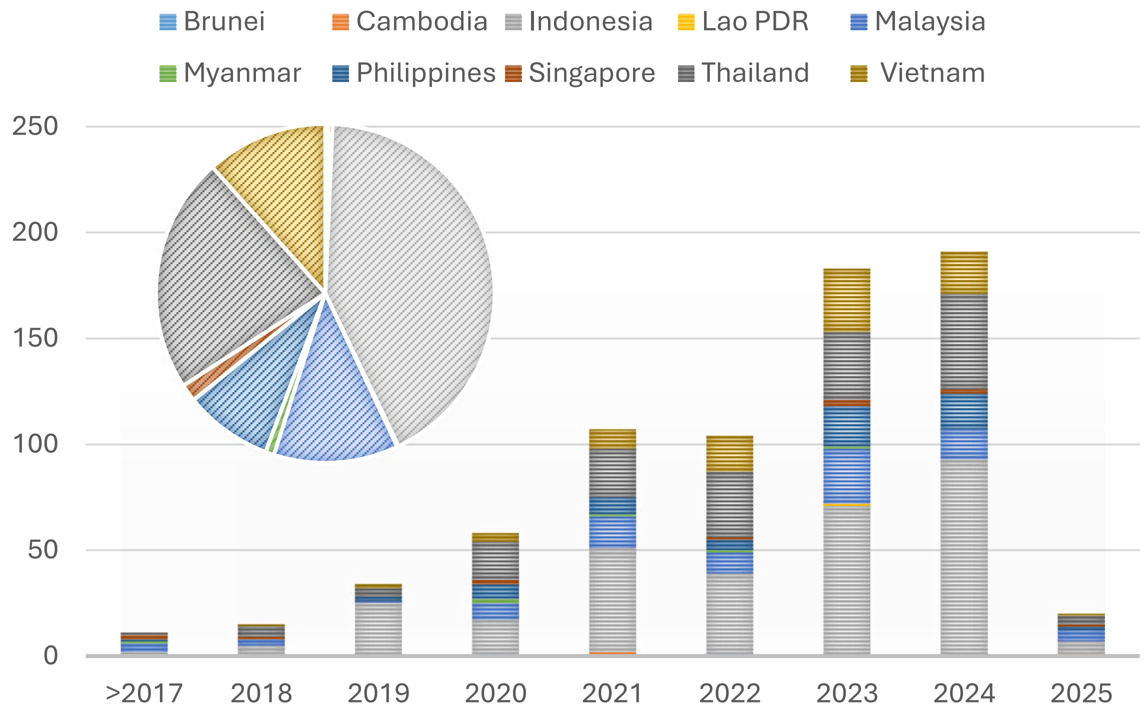
- Literature review (report)
- Field Sampling & Laboratory Analysis (dataset)
- Framework Development (report & diagram)

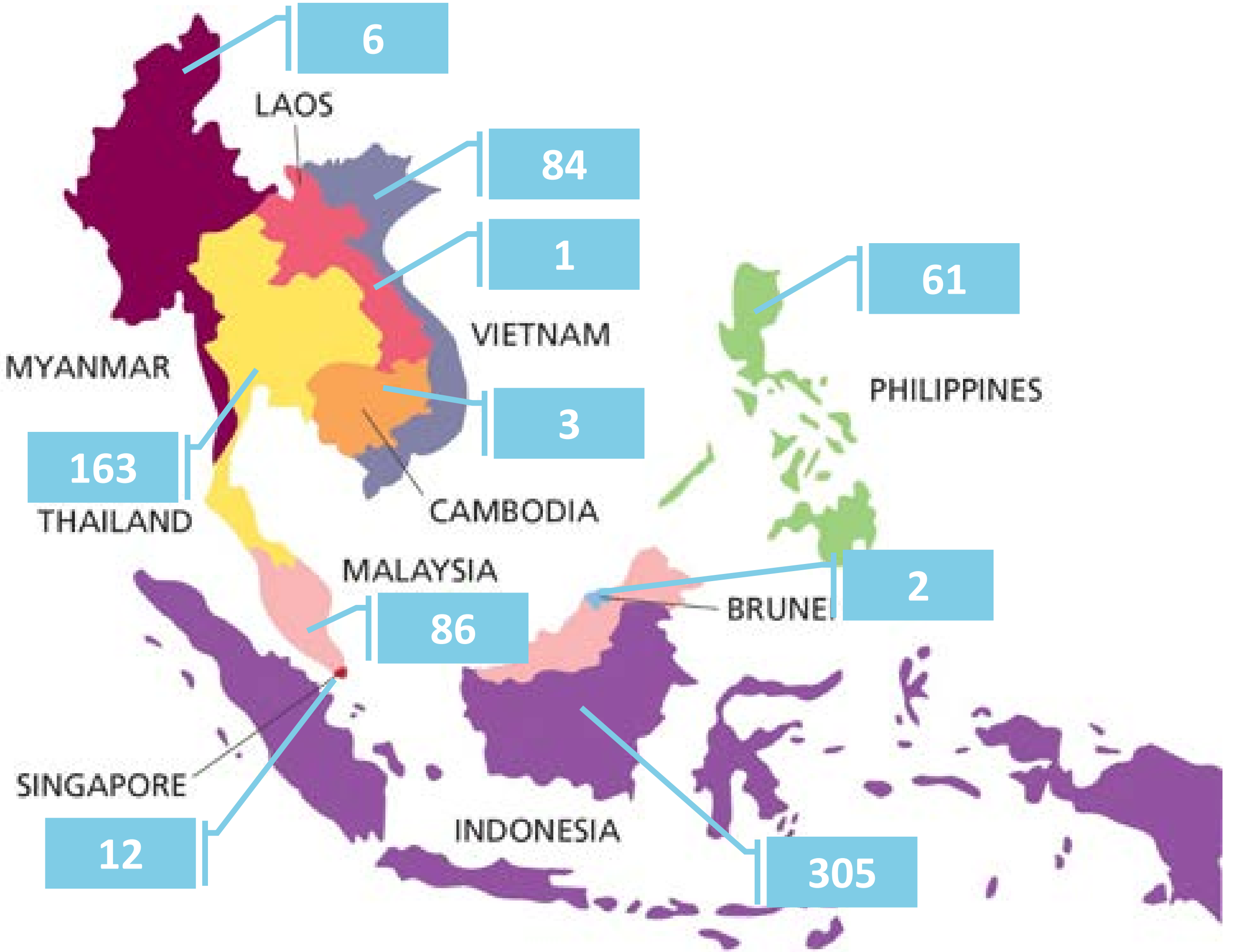
Literature Review Method



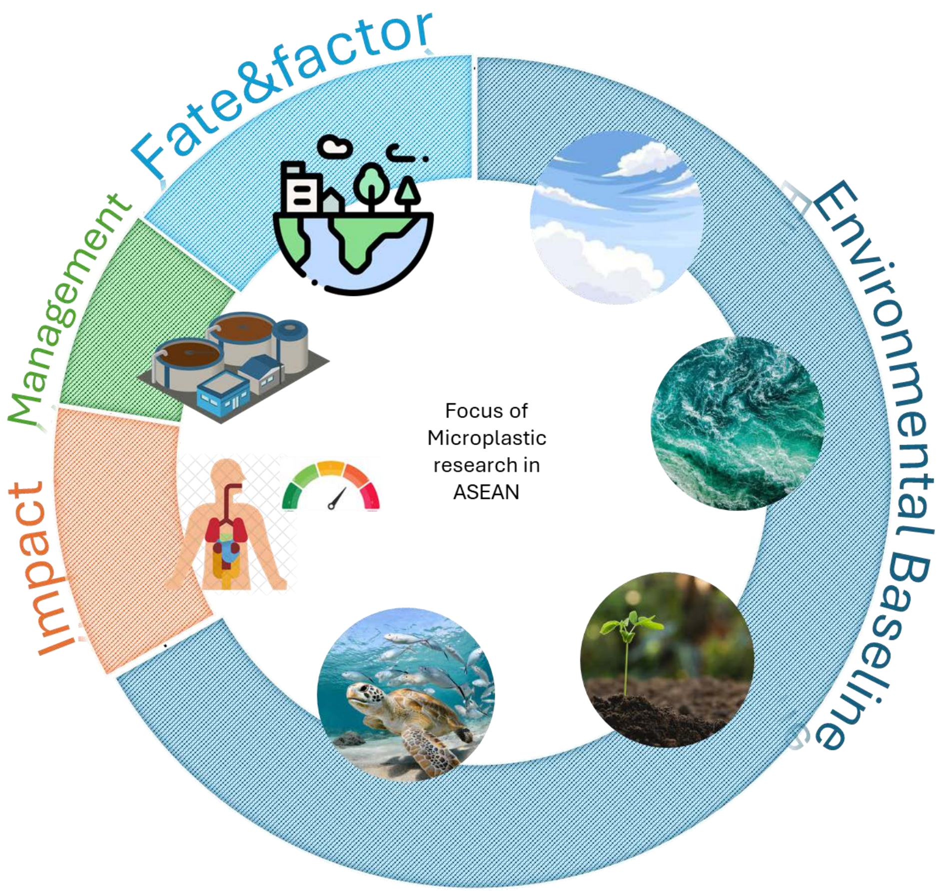
Current Research Status in Southeast Asia (up to Feb 2025)

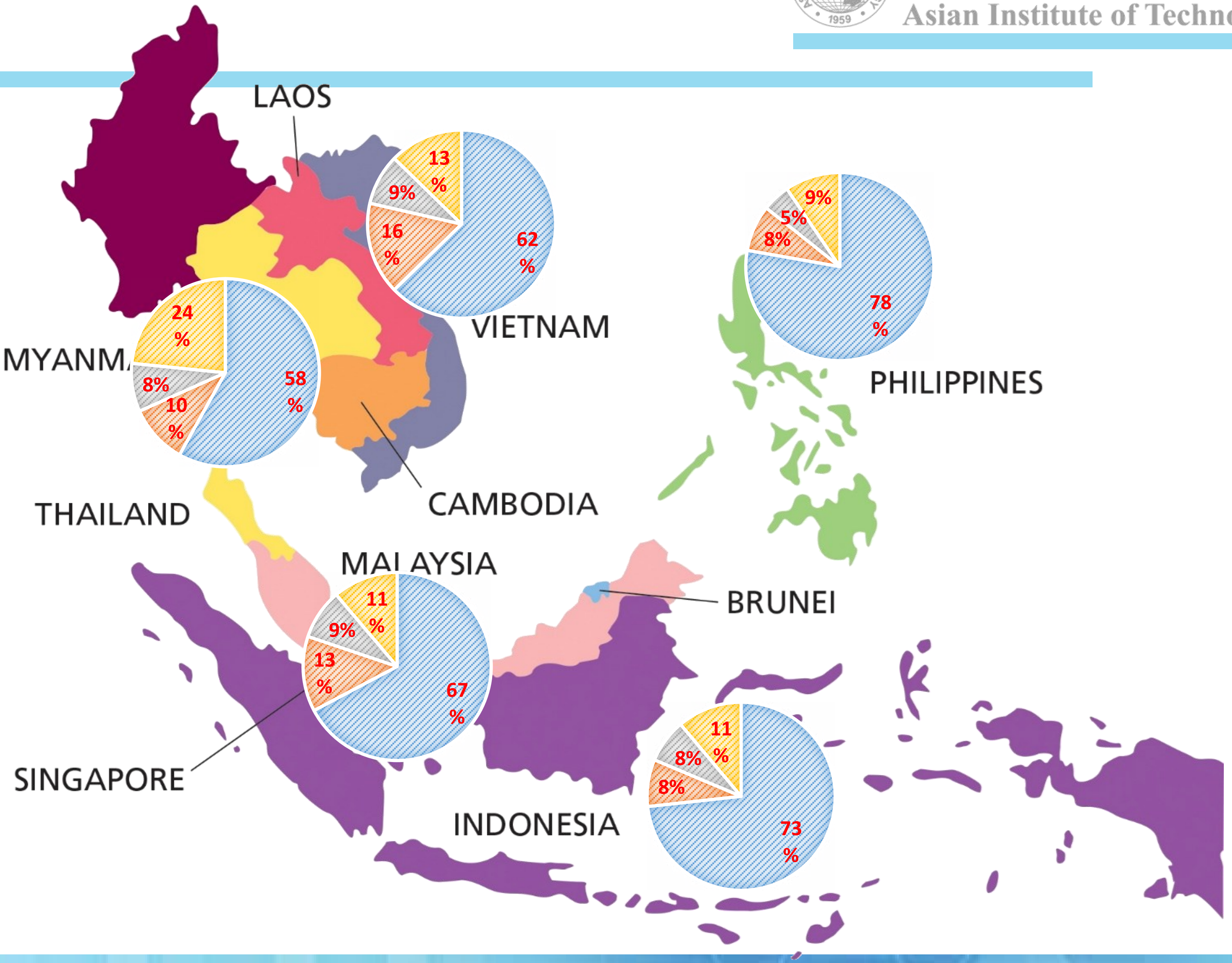
- **Indonesia, Philippines, Viet Nam, Thailand, and Malaysia** are considered among the biggest MP dischargers globally, showing rapidly growth in research concern
- **Increasing reports on MPs in SEA since 2019**
- Limited knowledge and information comparing with other regior





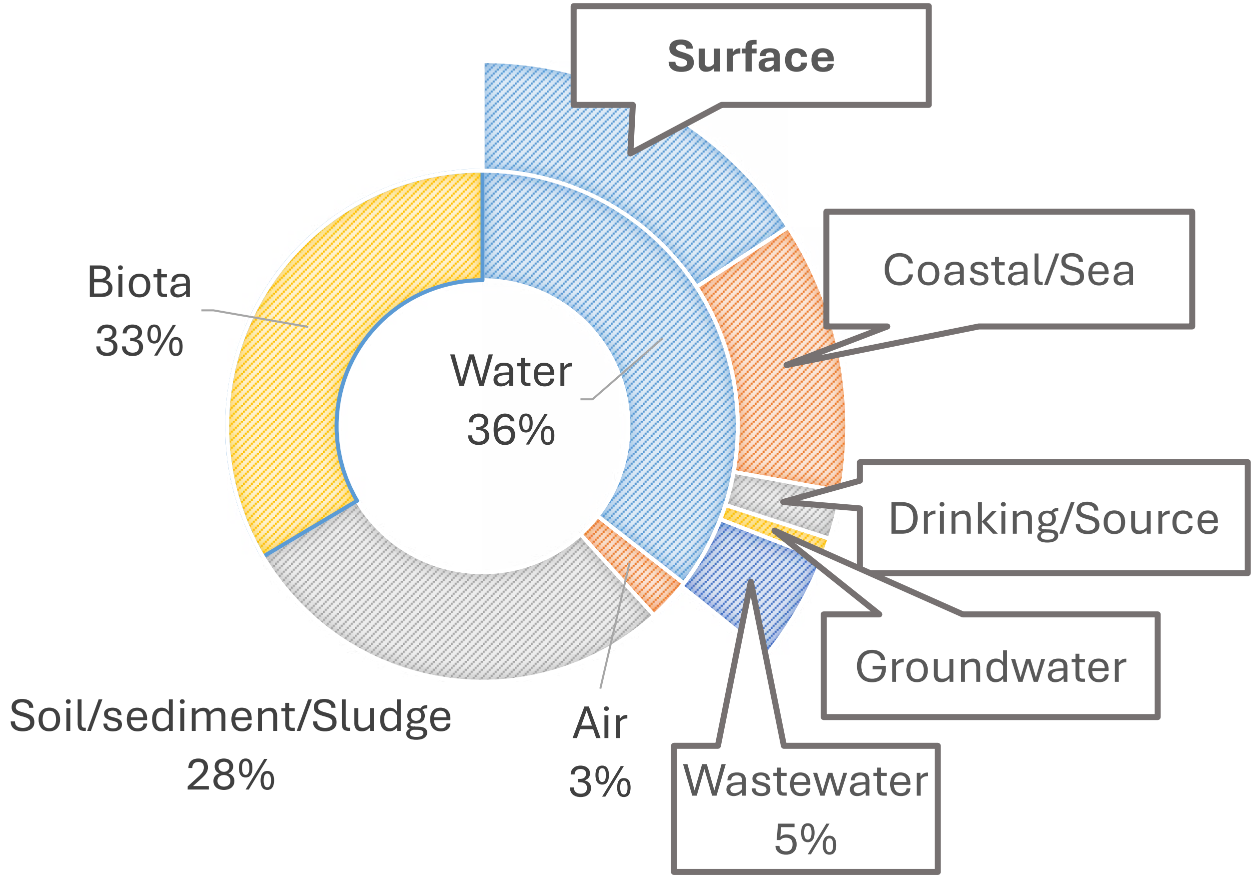
Topic-Wise distribution (up to Feb 2025)





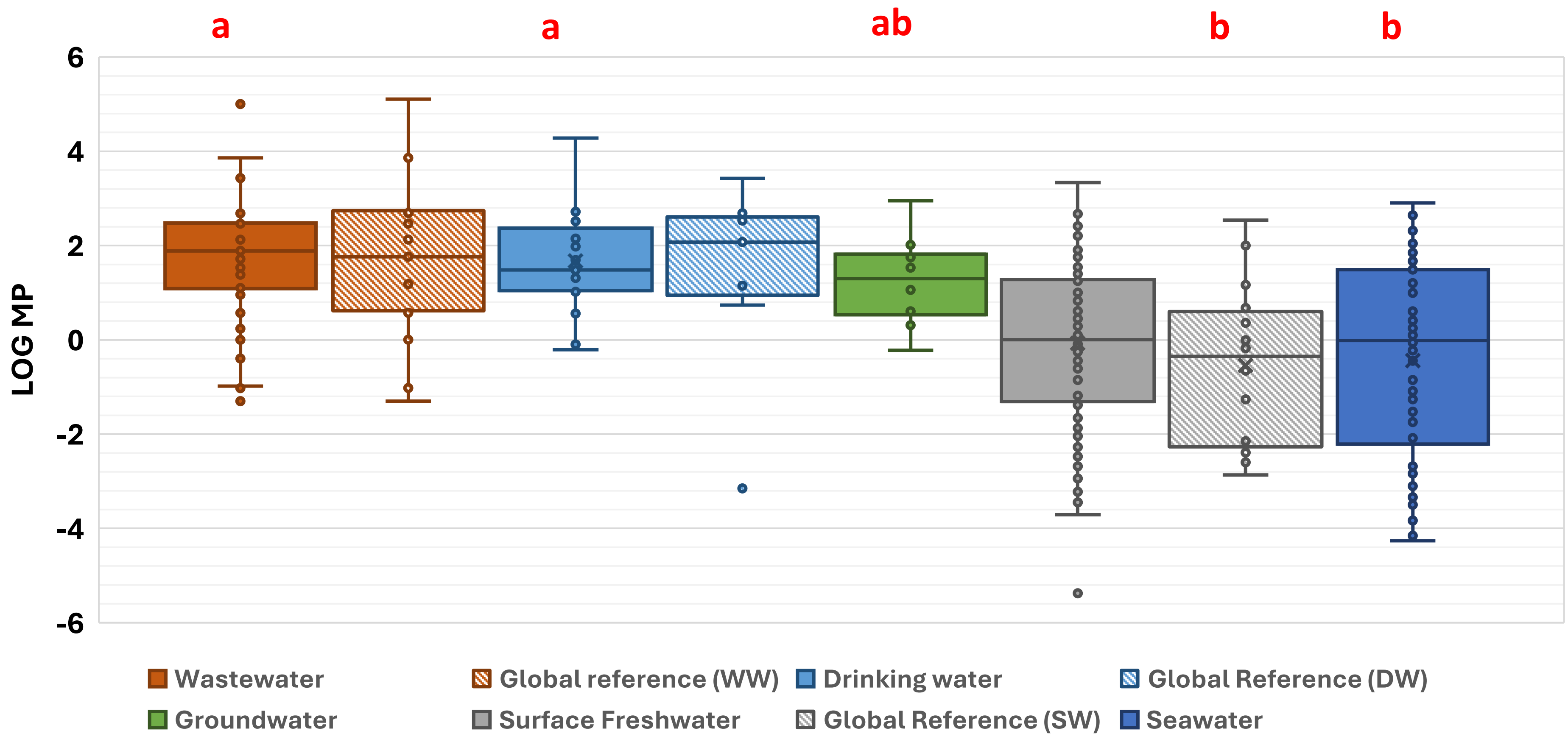
MPs report in ASEAN Waters:

In **723 research paper** reporting the environmental presence of MPs.



- Investigation on different water environment
- Surface water and coastal/marine water are the major concerns for baseline investigation in SEA.
- Increasing concerns on the contamination level in wastewater (domestic and industrial wastewaters), groundwater (especially associated with landfill impact), and drinking water (including tap water and bottle water)

MPs in ASEAN Waters Vs. Global Benchmarks



- MP contamination levels in SEA waters are comparable with global benchmarks.
- MPs in Wastewater and drinking water are significantly higher than those in surface freshwater and seawater
- MPs level in groundwater is between wastewater and surface water level

Koelmans et al., 2019

MPs in ASEAN Waters

- Comparable levels of MPs are found in wastewater (inf), drinking water (tap & bottle water), and groundwater
- One explanation on the high MPs detected in drinking water is the smaller filter size used in relevant research.
- This needs to be further verified for the studies in ASEAN.
- Rare reports are available for groundwater investigation. Most of the current reports are investigations at landfill sites.

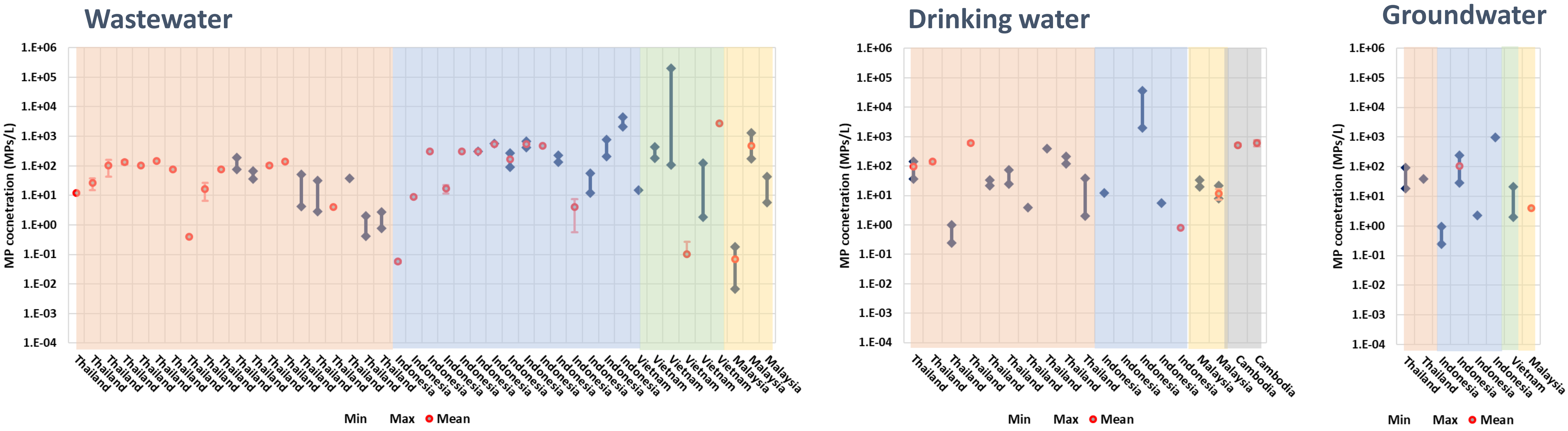
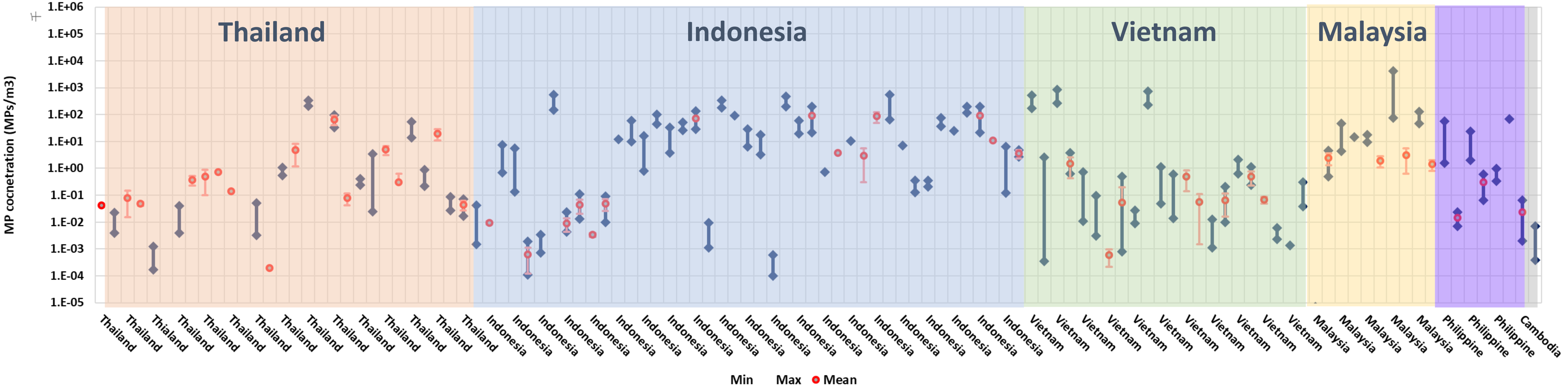


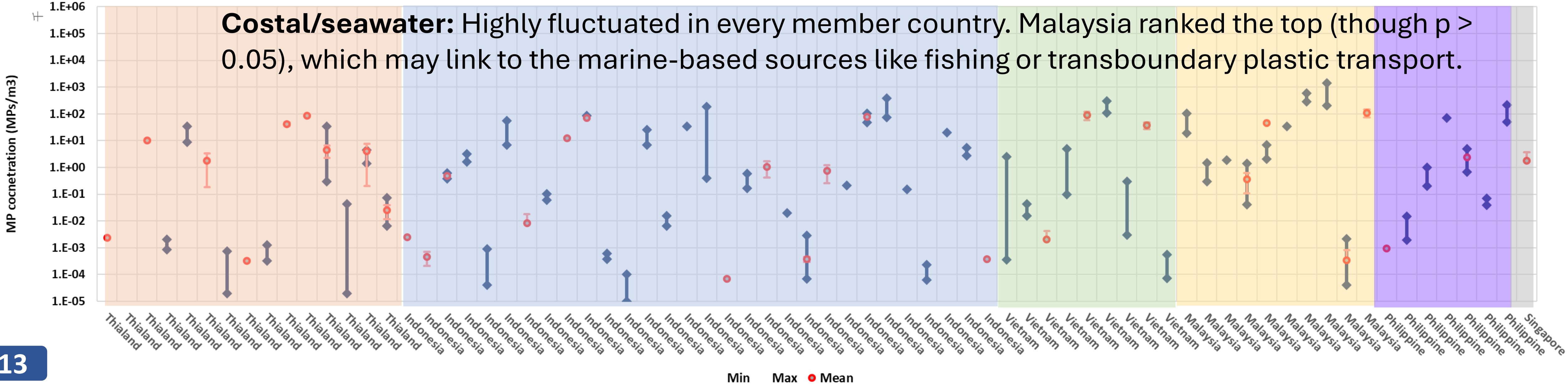
Figure. MPs concentration levels reported in wastewater, drinking water, and groundwater in ASEAN countries

MPs in ASEAN Waters

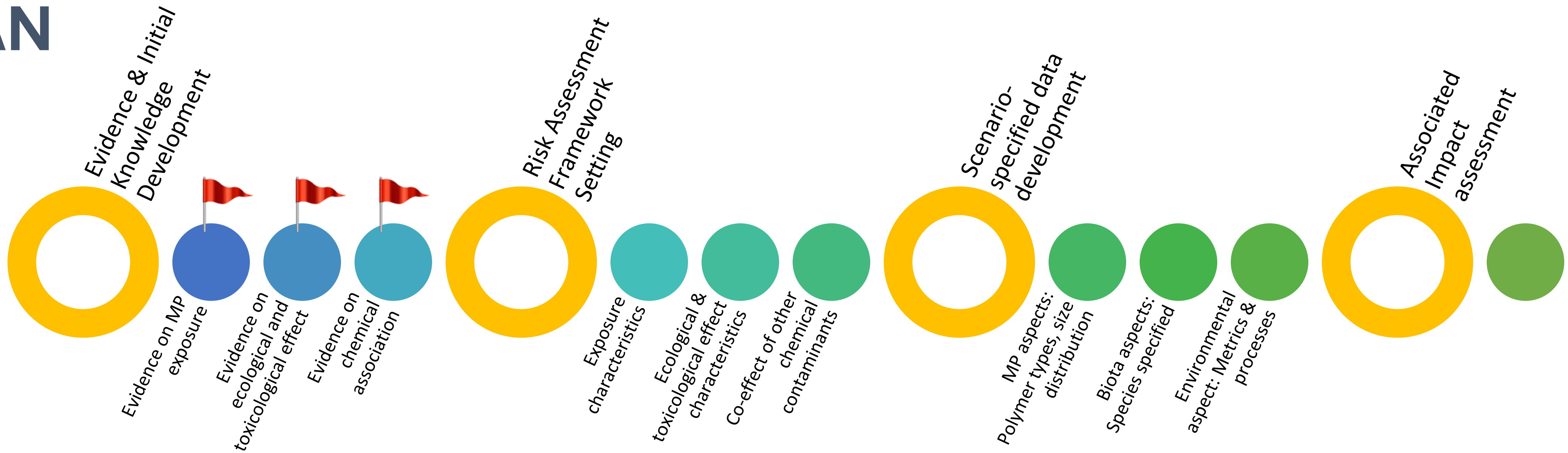
Surface freshwater: Indonesia shows higher levels than Vietnam and Thailand, and other counties in ASEAN, which may link with the wastewater management situations



Costal/seawater: Highly fluctuated in every member country. Malaysia ranked the top (though $p > 0.05$), which may link to the marine-based sources like fishing or transboundary plastic transport.



Ecosystem risks & health impact assessment of MPs in ASEAN



Research focus	Summary	References
Evidence of MP exposure	Estimated Dietary Intake (EDI) through drinking water & surface water	Adji et al., 2022
Evidence on ecological and toxicological effect	Polymer hazard index (PHI); pollution load index (PLI); ecological risk index (RI); risk quotient (RQ)	Nguyen et al., 2024; Do et al., 2024
Evidence on chemical association	✓ A number of researchers have investigated the co-existence of various toxic chemicals (such as heavy metals, VOCs, PAHs&PCB, PAEs and plastic additives) with MPs in water, soils, and sediment. ✓ However, several of the research only reported that MPs and toxic chemicals are detected in the same environmental samples, while their research didn't indicate the tole of MP as a "convector" of toxic chemicals. ✓ Investigations on adsorption/carriage of toxic chemicals such as heavy metals (Cr, Cu, Ni, Pb, Cd, and Zn, Ti etc.), organics including PAHs and PCBs, and antibiotic-resistant bacteria/ gene (ARB/ARG) by MPs have been reported in surface water and/or seawater.	Ta and Babel, 2020 a&b; 2023 a&b; Eamrat et al., 2023; Bouhroum et al.. 2019; Purwiyanto et al., 2020; Rahmayanti et al., 2022; Lestari et al., 2025; Thao et al., 2024

Environmental Pattens/Pathways and Factors Affecting MP Fate

Environmental pathways

- Key sources & paths investigated: wastewater discharge, runoffs, atmospheric deposition
- A few mass flux estimation: discharge from WWTP or river discharge
- A few reports on understanding the interlinkages between different environmental metrics (air-water, water-sediment, air, water & sediment – biota)
- No systematic source-path-sink analysis

Spatial & seasonal pattern

- Spatial pattern: within the same watershed, MPs level is usually found linked with the types and density anthropogenic activity (link with population density, urbanization level, or land use types); among different water bodies, WWs > drainage canals > rivers > costal & sea
- Seasonal pattern: most of the reports find that rainy season > dry season; sometimes this seasonal variation is not significant; link with the monsoon season in SEA

Driving factors of MP transportation & transformation

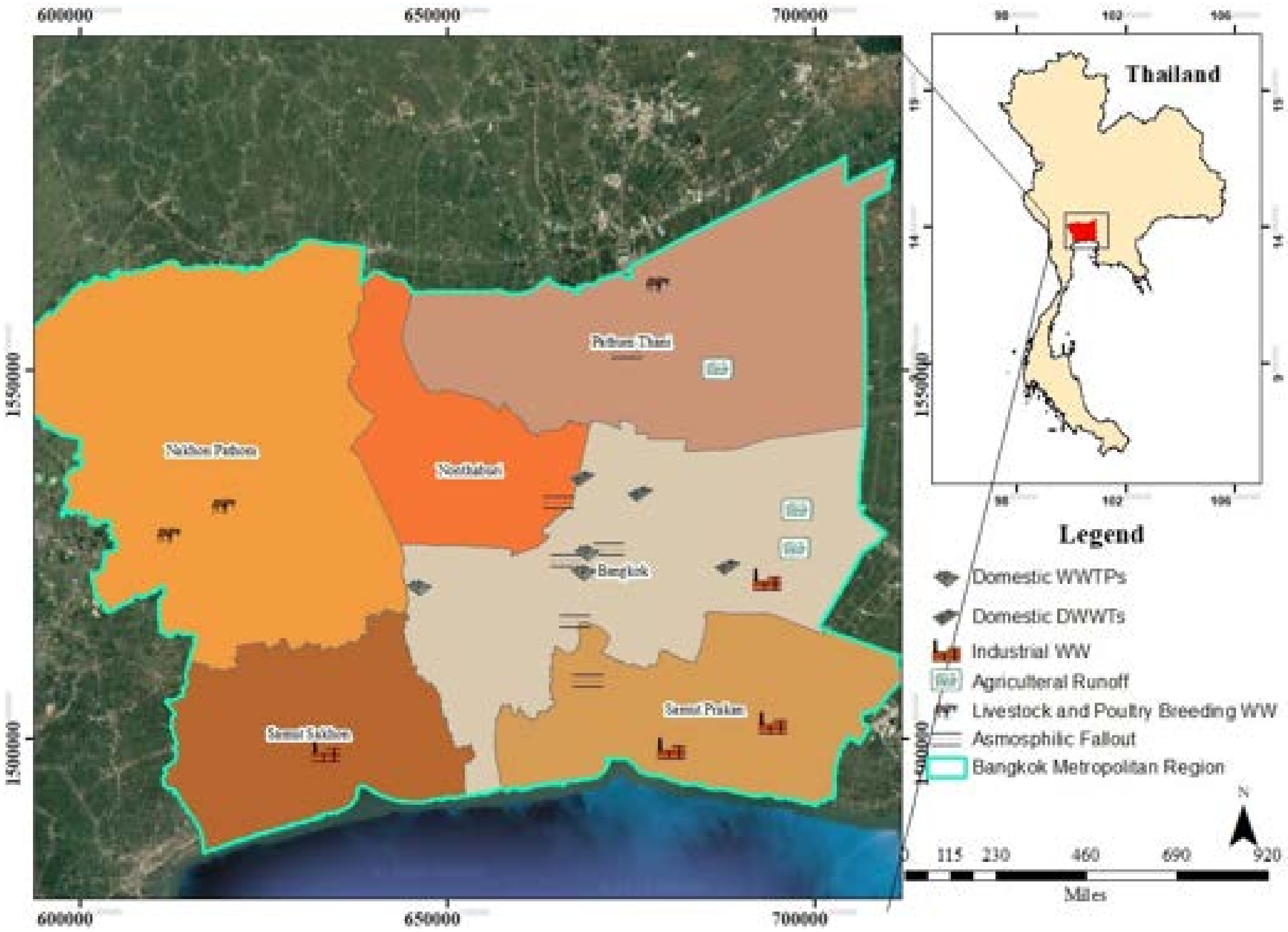
- Climatic & meteorological drivers
- Hydrodynamic drivers (including in territorial and ocean water)
- Development factors (land use types, population dentistry, social-economic parameters)
- Biological factors (biodegradation process of MPs)

Study methodology

- Many researchers still use qualitative analysis & discussion
- Statistical analysis is the key method to indicate the potential relationships between MPs and various driving factors
- Hydraulic models & currency models are attempted to incorporate with MPs study
- ML & AI can be future direction with big volume and complex composition of data

Microplastic Management in ASEAN (To be added)

Sampling Sites (BMR)



Site ID	Location	Treatment System	Coordinate X	Coordinate Y	Capacity (m^3/day)	Sewage Destination	Type of Wastewater
Domestic Wastewater Wastewater Treatment Plant							
WWTP-1	Nong Khaem Water Quality Control Plant	Activated Sludge	646651	1517240	157,000	Rat Charoen Sok Canal	Domestic
WWTP-2	Din Daeng Water Quality Control Plant	Biological Activated Sludge Process with Nutrient Removal	668427	1523871	350,000	Makkasan Swamp and Samsen Canal	Domestic
WWTP-3	Chatuchak Water Quality Control Plant	Cyclic Activated Sludge System	669057	1521545	150,000	Bang Sue Canal	Domestic
Decentralized Treatment System							
DWWT - 1	Thaan DWWTPs	Activated Sludge	668442.1	1531867	1,000	Bang Talat Canal	Domestic
DWWT - 2	Ramintra DWWTPs	Activated Sludge	676100.2	1533699	800	Lam Phak Chi Canal	Domestic
DWWT - 3	Romklao DWWTPs	Activated Sludge	688202.3	1523799	3,800	Ton Nun Canal	Domestic
Industrial Wastewater							
IW-1	Ladkrabang Industrial Estate	Activated sludge	693421	1521702	18,400	Prawet Burirom Canal	Key Industries: Electronics, automotive parts, and textiles.
IW-2	Bangpoo Industrial Estate	AS1: Activated Sludge, AS2: Activated Sludge, RBC: Rotating Biological Contactor	680480	1498708	AS1: 30,200 AS2: 3,600 RBC: 2,300	Sukhumvit Canal	Key Industries: Automotive, electronics, and petrochemicals.
IW-3	Bangplee Industrial Estate	Activated sludge	694208	1503467	8,000	Chorakhe Noi Canal	Key Industries: Textiles Packaging materials, and food processing.
IW-4	Samut Sakhon Industrial Estate	Activated sludge	633422	1497634	18,000	Sewa Canal	Key Industries: Food processing, textiles, and consumer goods.
Agricultural Runoff							
ARI-1	Nongchok Paddy field	-	698335	1547398	-		Paddy field
ARI-2	Khlong Luang Research Center Paddy Field	-	686844	1534122	-		Paddy field
ARI-3	Pathumtani Researchcenter Paddy Field	-	700227	1518215	-		Paddy field
Livestock and Poultry Breeding Wastewater							
LPBW-1	Narong Farm (Chicken 1)	-	684536	1519241	-	-	Poultry Breeding
LPBW-2	Narong Farm (Chicken 2)		693521	1531668	-	-	Poultry Breeding
LPBW-3	Narong Farm (Pig Farm)	-	678660.2	1561793	-	-	Livestock
Atmospheric Fallout							
SR-1	Nonsi Witthaya School	-	667420.7	1513969	-	-	-
SR -2	Public Relations Department	-	666179.8	1524225	-	-	-
SR -3	Chokchai Metropolitan Police Station	-	672109.6	1525739	-	-	-
SR -4	South Bangkok Power Plant	-	669215.6	1507861	-	-	-
SR -5	Department of Disease Control	-	665238	1532186	-	-	-
SR -6	Bangkok University	-	674474.2	1553689	-	-	-

Sampling Events

Type of pollution source	Sub-category	Sampling point	Site No	Sampling frequency	Sampling method	Planned Sampling	
						No of events	No of samples
DW	**Centralized WWTP (urban)**	Influent, effluent outlet	3	3 times in Dry & wet weather	Composite sampling (3 composites) *duplicate	18	72
	Decentralized WWTP (suburban)	Influent, effluent outlet	3	3 times in Dry & wet weather	Composite sampling (3 composites) *duplicate	18	72
IW	**Industrial estate wastewater**	Inspection well of central WWTP influent, effluent outlet	4	3 times in Dry & wet weather	Composite sampling (3 composites) *duplicate	24	72
AW	**Crop farming wastewater (paddy land & upland agriculture)**	Irrigation runoff in dry weather & surface runoff in wet weather	2	3 times in Dry & wet weather	Point sampling *duplicate	12	36
	Livestock & poultry breeding wastewater	Effluent of WWTP of commercial livestock & pig farms	3	3 times in Dry & wet weather	Point sampling *duplicate	18	36
AF	**Urban area**	Open areas in residential, commercial & traffic land uses	3	3 times in Dry & wet weather	24-hour continuous sampling	18	18
	Suburban area	Open areas in residential, commercial & traffic land uses	3	3 times in Dry & wet weather	24-hour continuous sampling	18	18
Total			21			42	324

Update on Field Sampling

Domestic Wastewater Treatment Plants

Site ID	Location	Progress
WWTP-1	Nong Khaem Water Quality Control Plant	100%
WWTP-2	Din Daeng Water Quality Control Plant	100%
WWTP-3	Chatuchak Water Quality Control Plant	100%
DWWT - 1	Thasai DWWTPs	50%
DWWT – 2	Ramintra DWWTPs	80%
DWWT - 3	Romklao DWWTPs	70%

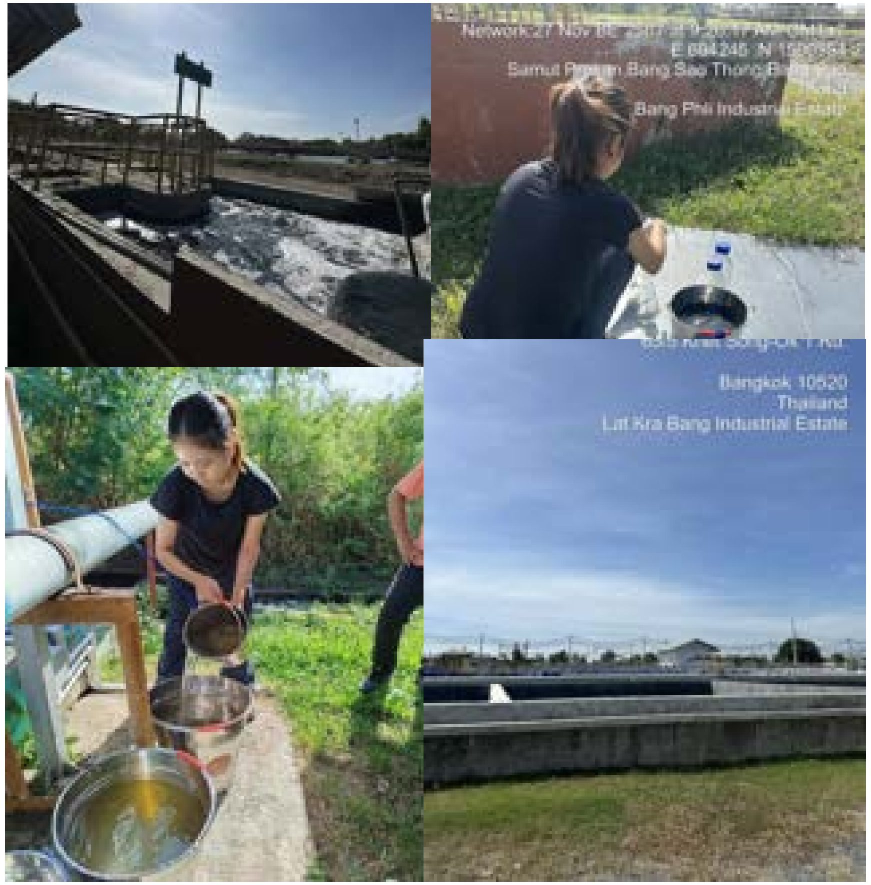
During Dry Season

During Wet Season

Update on Field Sampling

Industrial Wastewater Treatment Plants

Site ID	Location	Progress
IW-1	Ladkrabang Industrial Estate	50%
IW-2	Bangpoo Industrial Estate	100%
IW-3	Bangplee Industrial Estate	90%
IW-4	Samut Sakhon Industrial Estate	70%



Update on Field Sampling

Site ID	Location	Progress
Agricultural Runoff		
ARI-2	Khlong Luang Research Center Paddy Field	70%
ARI-3	Pathumtani Research center Paddy Field	80%
Livestock and Poultry Breeding Wastewater		
LPBW-1	Narong Farm (Chicken 1)	90%
LPBW-2	Narong Farm (Chicken 2)	90%
LPBW-2	Sanong Farm (Pig Farm)	70%

Agricultural Runoff

Livestock and Poultry Breeding Wastewater

Update on Field Sampling

Atmospheric Fallout

Site ID	Location	Progress
SR-1	Nonsi Witthaya School	100% ✓
SR -2	Public Relations Department	100% ✓
SR -3	Chokchai Metropolitan Police Station	100% ✓
SR -4	South Bangkok Power Plant	90% 🔄
SR -5	Department of Disease Control	100% ✓
SR -6	Bangkok University	100% ✓

During Dry Season

Wet Season

Update on Laboratory Analysis

Asian Institute of Technology

	Pretreatment						Identification	
	Dry	Dry	Dry	Wet	Wet	Wet	Microscope	FTIR
Domestic Wastewater (DW)								
Wastewater Treatment plant (WWTPs)								
1. Chatuchak Water Quality Control Plant	✅	✅	✅	☐	☐	☐	✅	☐
2. Nong Khaem Water Quality Control Plant	✅	✅	✅	☐	☐	☐	✅	☐
3. Din Daeng Water Quality Control Plant	✅	✅	✅	☐	☐	☐	✅	☐
Decentralized Treatment System DWWTPs)								
1. Thasai DWWTPs	☐	☐	☐	☐	☐	☐	☐	☐
2. Ramintra DWWTPs	☐	☐	☐	☐	☐	☐	☐	☐
3. Romklao DWWTPs	☐	☐	☐	☐	☐	☐	☐	☐
1. Bangpoo Industrial Estate	✅	✅	✅	☐	☐	☐	✅	☐
2. Ladkrabang Industrial Estate	✅	✅	✅	☐	☐	☐	✅	☐
3. Smuthsakorn Industrial Estate	✅	✅	✅	☐	☐	☐	✅	☐
4. Bangplee Industrial Estate	✅	✅	✅	☐	☐	☐	✅	☐

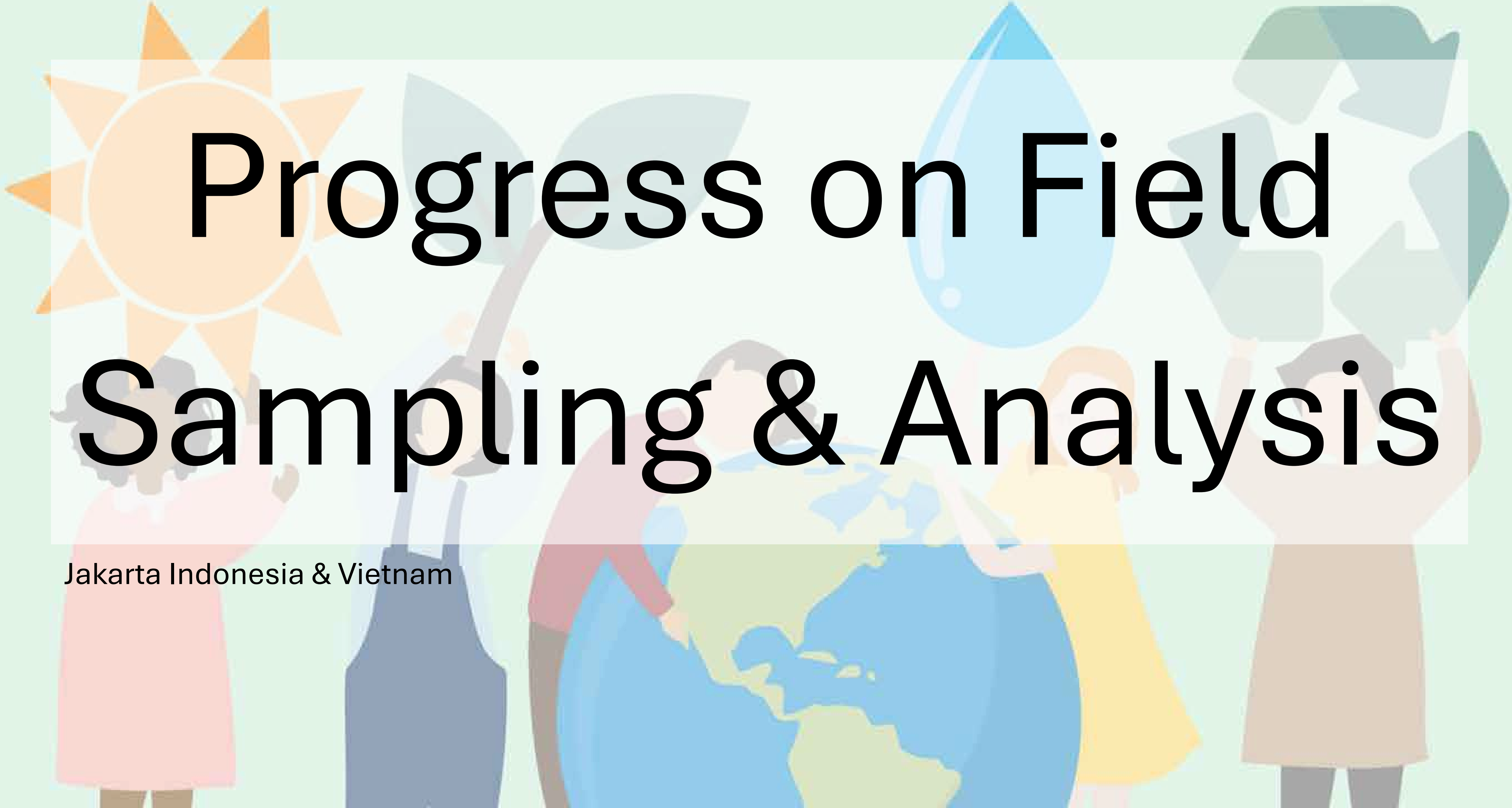
Update on Laboratory Analysis

Asian Institute of Technology

	Pretreatment						Identification	
	Dry	Dry	Dry	Wet	Wet	Wet	Microscope/ Florescent	FTIR
Asmosphilic Fallout								
1. Nonsi Witthaya School	✓	✓	✓	☐	☐	☐	✓	☐
2. Public Relations Department	✓	✓	✓	☐	☐	☐	✓	☐
3. Chokchai Metropolitan Police Station	✓	✓	✓	☐	☐	☐	✓	☐
4. South Bangkok Power Plant	✓	✓	✓	☐	☐	☐	✓	☐
5. Department of Disease Control	✓	✓	✓	☐	☐	☐	✓	☐
6. Bangkok University (Rangsit Campus)	✓	✓	✓	☐	☐	☐	✓	☐
Agricultural Wastewater								
Khlong Luang Research Center Paddy Field	☐	☐	☐	☐	☐	☐	☐	☐
Pathumtani Research center Paddy Field	☐	☐	☐	☐	☐	☐	☐	☐
Livestock Wastewater								
Narong Farm (Chicken 1)	☐	☐	☐	☐	☐	☐	☐	☐
Narong Farm (Chicken 2)	☐	☐	☐	☐	☐	☐	☐	☐
Sanong Farm (Pig Farm)	☐	☐	☐	☐	☐	☐	☐	☐

Progress on Field Sampling & Analysis

Jakarta Indonesia & Vietnam



Detailed Field Sampling Design

Sampling site selection

Thailand, Indonesia, and Vietnam: Based on (information sources), the major pollution sources identified are ***domestic wastewater (DW), industrial wastewater (IW), and agricultural wastewater (AW), and atmospheric fallout (AF).*** Each environmental samples should be collected as composite samples with **duplications**.

Season in 3 countries

- Thailand: Dry season (October-May), Wet Season (Mid of May – Mid of October)
- **Jakarta:** Dry Season (May - September) and Wet Season (October to April).
- **Ho chi minh:** Dry season (December – April) Wet season (May – November).

Detailed Field Sampling Design

Asian Institute of Technology

Type of pollution source	Sub-category	Sampling point	Site No.	Sampling frequency	Sampling method	No. of event	Total Sample No.
Indonesia and Vietnam							
DW	Centralized WWTP (urban)	Inspection well of sewage influent, effluent outlet	1	1 time in Dry & Wet weather	Composite sampling (3 composites), duplication	2	8
IW	Industrial estate wastewater	influent, effluent outlet	1	1 time in Dry & Wet weather	Composite sampling (3 composites), duplication	2	8
AW	Crop farming wastewater (paddy land & upland agriculture)	Irrigation runoff in dry weather & surface runoff in wet weather	1	1 time in Dry & Wet weather	Point sampling, duplication	2	4
	Livestock & poultry breeding wastewater	Effluent of WWTP of commercial livestock & pig farms	1	1 time in Dry & Wet weather	Point sampling, duplication	2	4
AF	Urban area	Open areas in residential, commercial & traffic land uses	2	1 time in Dry & Wet weather	24-hour continuous sampling	2	4
	Suburban area	Open areas in residential, commercial & traffic land uses	2	1 time in Dry & Wet weather	24-hour continuous sampling	2	4
Sub-total			8			12	32

Detailed Field Sampling in Jakarta

Asian Institute of Technology

Dry Season (May - September) and Wet Season (October to April).

	Year 2025										Year 2026	
Month	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**
	Dry		**Dry**		**Dry**		**Wet**		**Wet**		**Wet**	
Field Survey and Sampling Events		⟷	⟷				⟷	⟷				
Lab analysis				⟷	⟷							
Sample Shipment									⟷	⟷		
Quantitative Mass Flow Analysis									⟷	⟷	⟷	⟷

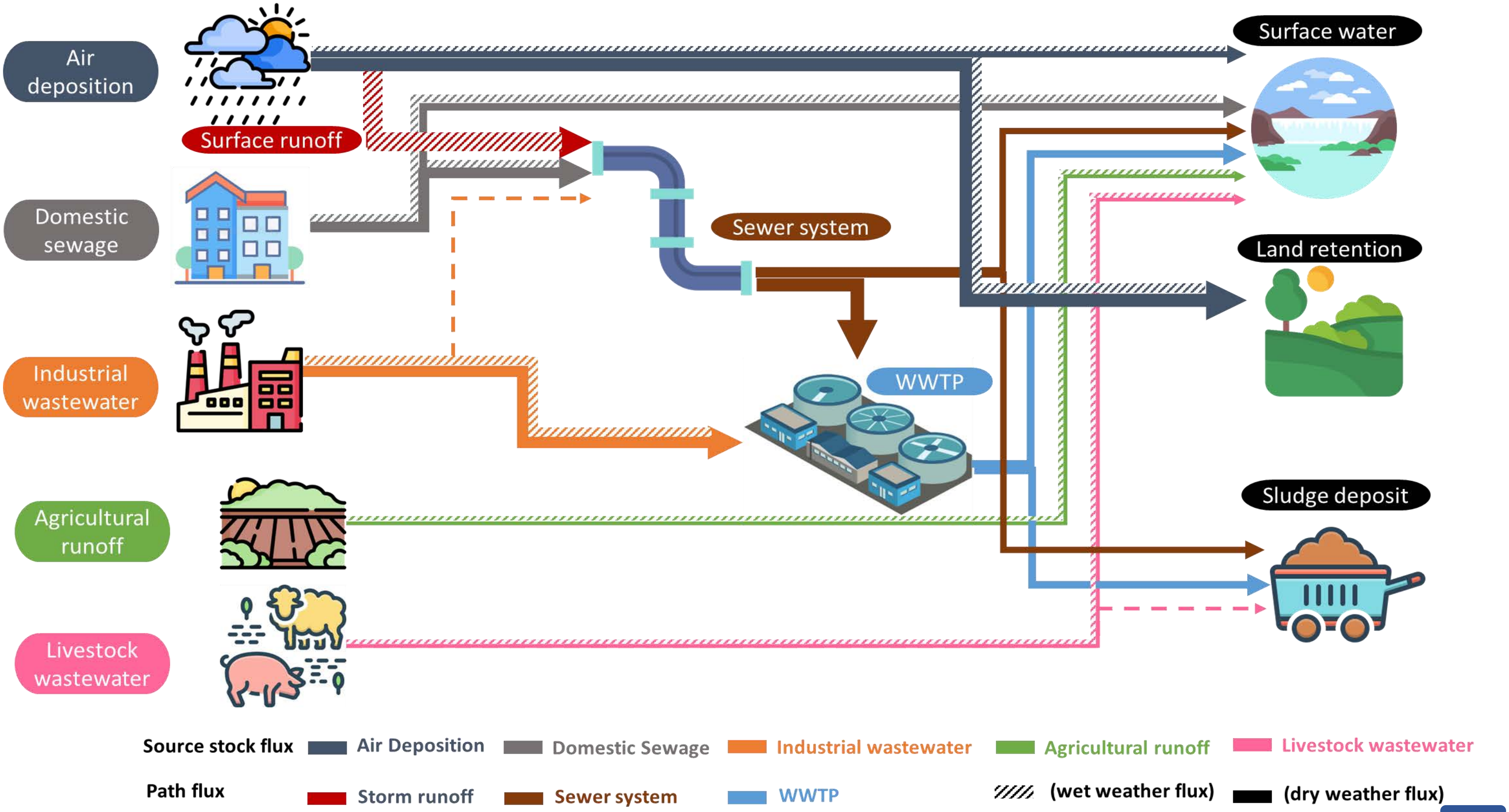
Detailed Field Sampling in Ho Chimin

Asian Institute of Technology

Dry season (December – April) Wet season (May – November).

	Year 2025										Year 2026	
Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Dry		Wet		Wet		Wet		Dry		Dry	
Field Survey and Sampling Events		↔	↔			↔	↔					
Lab analysis				↔	↔							
Sample Shipment									↔	↔		
Quantitative Mass Flow Analysis									↔	↔	↔	↔

MPs SPR Framework Development


Air deposition
Surface runoff
Domestic sewage
Industrial wastewater
Agricultural runoff
Livestock wastewater
Sewer system
WWTP
Surface water
Land retention
Sludge deposit
Source stock flux
Air Deposition
Domestic Sewage
Industrial wastewater
Agricultural runoff
Livestock wastewater
Path flux
Storm runoff
Sewer system
WWTP
(wet weather flux)
(dry weather flux)

Thank You

Enhancing the Science-Policy Interface to Manage Microplastic Influx from Major Cities into the Oceans in Southeast Asia

SAMPLING AND ANALYSIS OF MICROPLASTICS IN WATER SAMPLES

(VIETNAM'S TEAM)

Vietnam's team:

- Dr. Vo Thi Kim Quyen
- Pham Phuoc An
- Nguyen Thi Hong Nhung
- Luu Lan Huong
- Tran Cong Sac

Ho Chi Minh City, 2025 Sep. 11

Sampling

Domestic wastewater treatment plant

- Position: Influent
- Total volume: 1 L (morning) + 1 L (afternoon) + 1 L (Late afternoon) → **3 L**
- Sampling depth: 1 – 5 cm of the top water layer
- Number of samples: 2

Sampling

Domestic wastewater treatment plant

- Position: Effluent
- Total volume: 10 L (morning) + 10 L (afternoon) + 10 L (Late afternoon) → **30 L**
- Sampling depth: 1 – 5 cm of the top water layer
- Number of samples: 2

Sampling

Industrial wastewater treatment plant

- Position: Influent
- Total volume: 1 L (morning) + 1 L (afternoon) + 1 L (Late afternoon) → **3 L**
- Sampling depth: 1 – 5 cm of the top water layer
- Number of samples: 2

Sampling

Industrial wastewater treatment plant

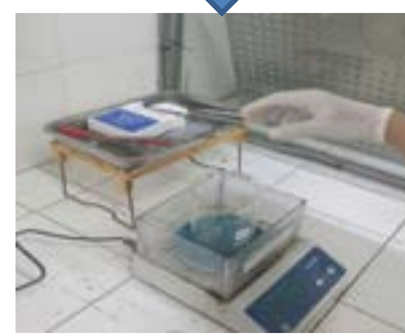
- Position: Effluent
- Total volume: 10 L (morning) + 10 L (afternoon) + 10 L (Late afternoon) → **30 L**
- Sampling depth: 1 – 5 cm of the top water layer
- Number of samples: 2

Analysis

Weigh a clean, dry 500 mL beaker

Pour the sample through a stacked arrangement of 5.6-mm, 12 μm stainless steel mesh sieves. Discard material retained on 5.6-mm sieve

Transfer solids collected in the 12 μm sieve into the tared beaker → Place beaker in 90 °C drying oven for 24 hours or longer to sample dryness



Determine the mass of the beaker with dried solids

Wet Peroxide Oxidation (WPO); Fenton's reaction

Analysis

Transfer the WPO solution to the density separator

Rinse the WPO beaker with distilled water several times to transfer all remaining solids to the density separator → and allow solids to settle overnight (24 hour)

Collect floating solids in a clean 12 µm sieve

- Weigh a clean and dry Petri Dish
- Transfer solids collected in the 12 µm into the tared petri dish
- Place Petri dish in 90 °C drying oven for 24 hours or longer to sample dryness
- Determine the mass of Petri Dish with microplastics

Microscopic examination of the microplastics

Analysis

Transfer the WPO solution to the density separator

Rinse the WPO beaker with distilled water several times to transfer all remaining solids to the density separator → and allow solids to settle overnight (24 hour)

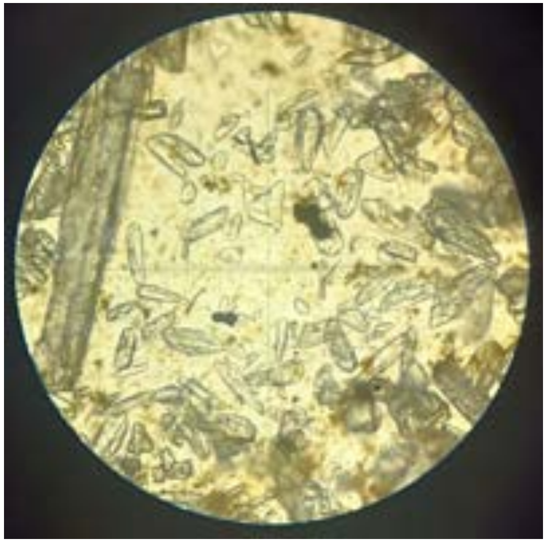
Collect floating solids in a clean 12 µm sieve

- Weigh a clean and dry Petri Dish
- Transfer solids collected in the 12 µm into the tared petri dish
- Place Petri dish in 90 °C drying oven for 24 hours or longer to sample dryness
- Determine the mass of Petri Dish with microplastics

Microscopic examination of the microplastics

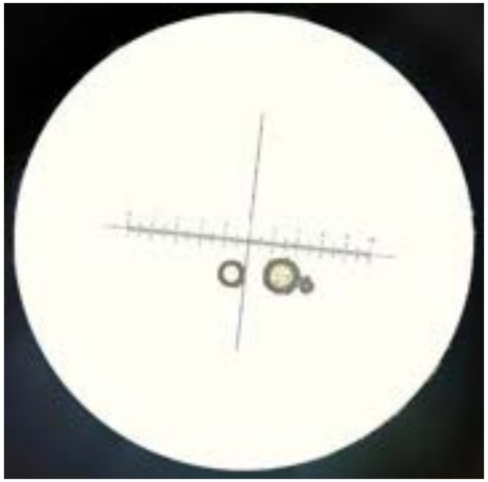
Results

Domestic wastewater treatment plant



Influent samples

Effluent samples



Results

Industrial wastewater treatment plant

Influent samples

Effluent samples

Future plan

Wet weather sampling: 14 samples → finish at 30th Sep.

Type of pollution source	Sampling point	Volume	Duplication	Total Sample
Domestic wastewater (Binh Hung centralized WWTP)	Inlet	3 L	2	2
	Outlet	30 L	2	2
Industrial wastewater (Le Minh Xuan centralized WWTP)	Inlet	3 L	2	2
	Outlet	30 L	2	2
Crop farming wastewater	Surface runoff	5 L	2	2
Livestock & poultry breeding wastewater	Effluent of WWTP/storage pond	3 L	2	2
Air sample	Urban area: Open areas in residential, commercial & traffic land uses	3 – 5 L	1	1
	Suburban area: Open areas in residential, commercial & traffic land uses	3 – 5 L	1	1

Future plan

Dry weather sampling: 20 samples→ finish at 30th Nov.

Type of pollution source	**Sampling point**	**Volume**	**Duplication**	**Total Sample**
Domestic wastewater (centralized WWTP)	Inlet	3 L	2	2
	Outlet	30 L	2	2
Industrial wastewater (Le Minh Xuan centralized WWTP)	Inlet	3 L	2	2
	Outlet	30 L	2	2
Crop farming wastewater	Irrigation runoff	5 L	2	2
Livestock & poultry breeding wastewater	Effluent of WWTP/storage pond	3 L	2	2
Air sample	Urban area: Open areas in residential, commercial & traffic land uses	3 – 5 L	1	1
	Suburban area: Open areas in residential, commercial & traffic land uses	3 – 5 L	1	1
Field Blank				6

PROGRESS REPORT: MICROPLASTIC INFLUX INTO AQUATIC SYSTEMS FROM MAJOR POLLUTION SOURCES IN SOUTHEAST ASIAN URBAN AREAS – A CASE STUDY IN THE JAKARTA METROPOLITAN AREA

Universitas Pertamina

Bob Adyari, Ph.D
Evi Siti Sofiyah, Ph.D
Betanti Ridhosari, M.T
Ir. Nurulbaiti Listyendah Zahra, M.T

11st September 2025

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Universitas Pertamina

INTRODUCTION
Research Background

National plastic generation **6.76 million tons/year**

Jakarta plastic waste **205 kg/day, Approximately 9.9 g/person/day of plastic**

Microplastics are plastic particles measuring < 5 mm.

MP Degradation

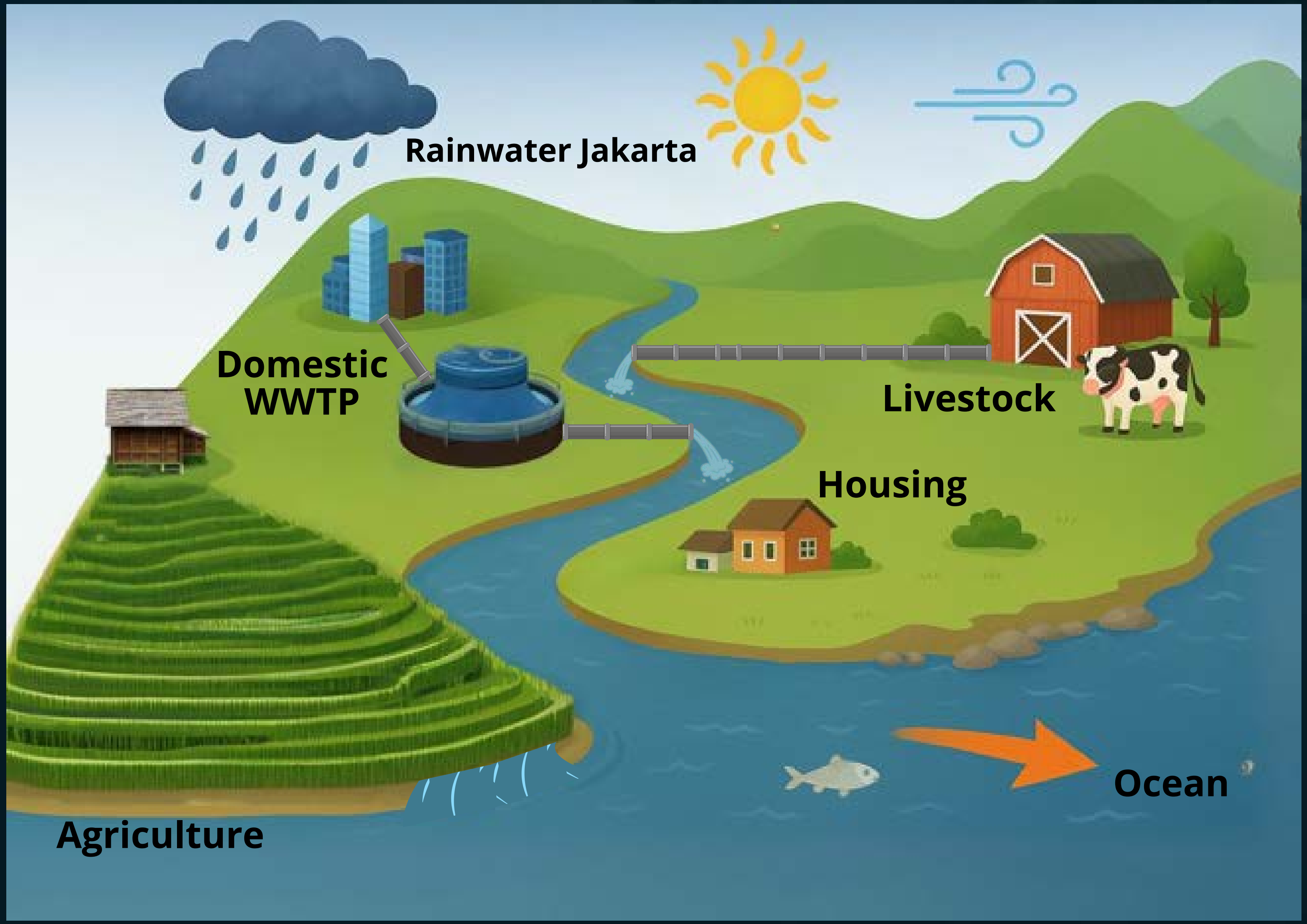
Decomposed by UV, friction, and microorganisms → into smaller particles, known as Microplastics.

(GGGI, 2025; van Emmerik et al., 2022; Zha et al., 2022)

INTRODUCTION

Research Background

Reasons for Sampling Microplastic Distribution in Jakarta



- **Domestic WWTP → Selected because it collects urban wastewater, representing potential microplastic release from daily human activities.**
- **Agriculture → Chosen to assess possible accumulation of microplastics in soil due to plastic mulch and other agricultural inputs.**
- **Livestock → Sampled to examine potential contamination from feed, drinking water, and livestock waste as microplastic pathways.**
- **Residential Areas → Included because densely populated settlements generate large amounts of plastic waste that may degrade into microplastics.**
- **Urban Rainwater → Collected to investigate the role of atmospheric deposition in transporting microplastics into the urban environment.**

METHODOLOGY

Sampling Location

Location: Cilincing Farm

Coordinates: 6°07'40.6"S, 106°57'41.0"E

Location: WWTP Pertamina Simprug Complex

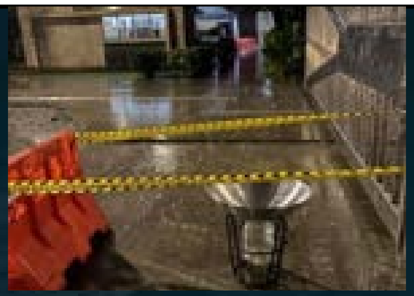
Coordinates: 6°13'37.8"S, 106°47'21.1"E

Location: Graha Raya Bintaro Housing Complex

Coordinates: 6° 15′ 10.02″ LS, 106° 40′ 58.75″ BT

Location: Istiqlal Mosque

Coordinates: 6°10'10.3"S, 106°49'52.0"E



Location: Cikoko Bio Farm Education

Coordinates: 6° 14′ 20.70″ LS, 106° 51′ 44.12″ BT

Location: Pertamina University

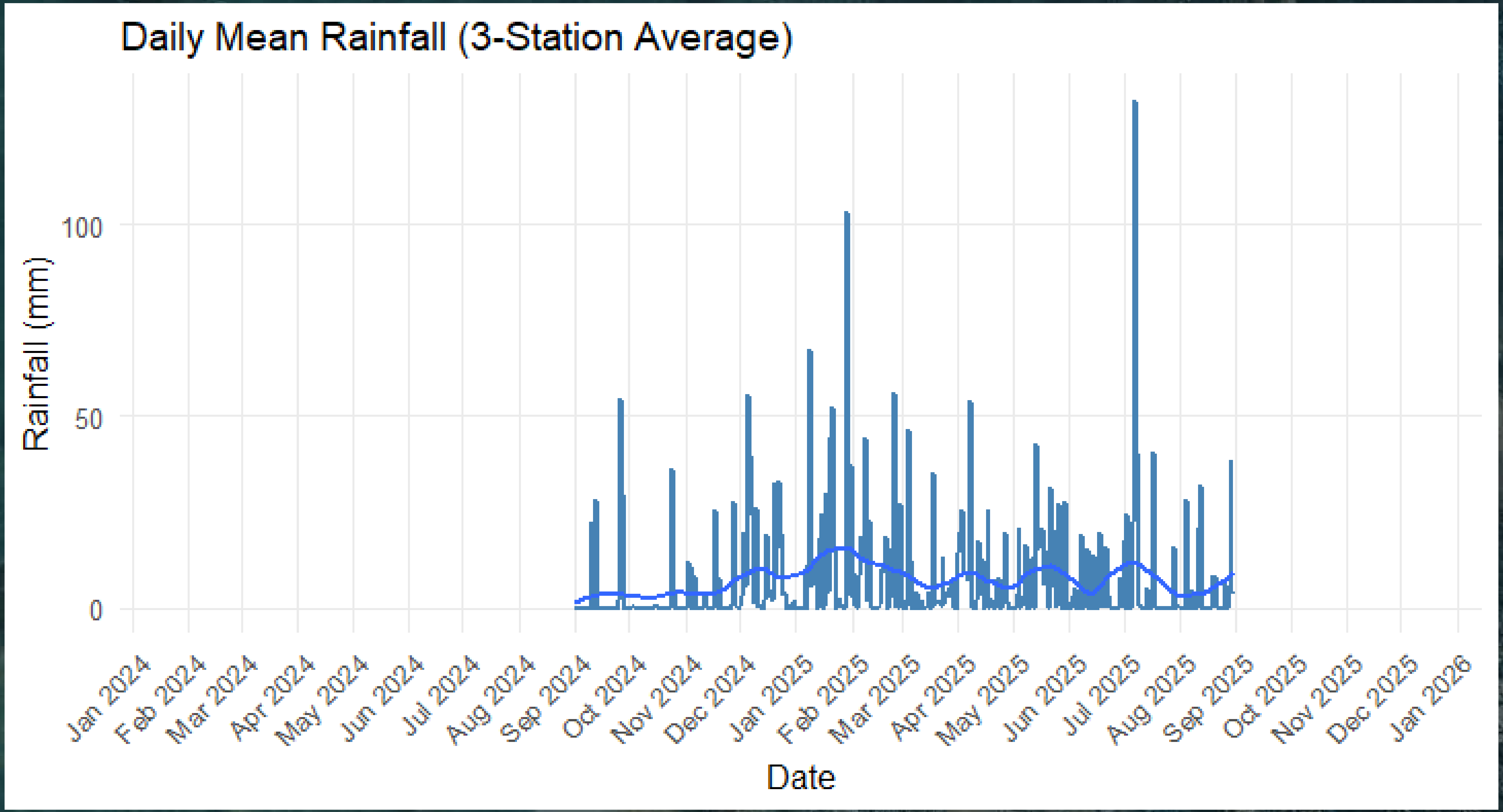
Coordinates: 6° 13′ 40.64″ LS, 106° 47′ 21.35″ BT

Legend

- : Agriculture
- : Livestock
- : House
- : Domestic WWTP
- : Rainwater

N
W E
S

RAINFALL (2024-2025)



METHODOLOGY

Domestic Wastewater Treatment Plant Sampling Location

AQUABIDES FILTRATION

SAMPLING PREPARATION

SAMPLING OF WWTP INFLUENT AND EFFLUENT

WET SCREENING OF SAMPLES

SIEVED SOLIDS TRANSFER

MICROPLASTIC + ORGANIC

WET PEROXIDE OXIDATION (WPO)

DENSITY SEPARATION

SEPARATION OF SOLIDS IN DENSITY SEPARATOR

SIEVED SOLIDS TRANSFER

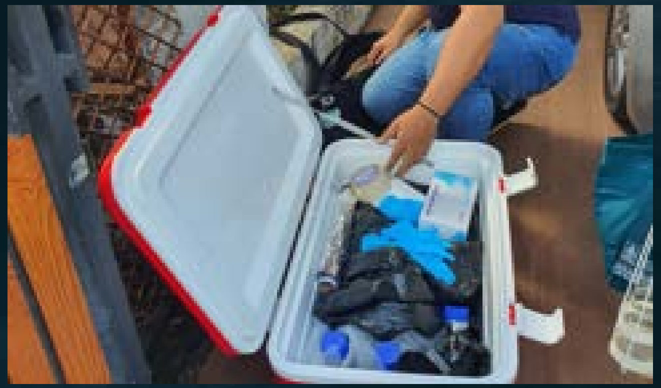
MICROPLASTICS

MICROSCOPIC EXAMINATION MICROPLASTICS

METHODOLOGY

Housing Sampling Locations

AQUABIDES FILTRATION



SAMPLING PREPARATION

SAMPLING OF HOUSING EFFLUENT

WET SCREENING OF SAMPLES

SIEVED SOLIDS TRANSFER

MICROPLASTIC + ORGANIC

WET PEROXIDE OXIDATION (WPO)

DENSITY SEPARATION

SEPARATION OF SOLIDS IN DENSITY SEPARATOR

SIEVED SOLIDS TRANSFER

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MICROSCOPIC EXAMINATION MICROPLASTICS

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AQUABIDES FILTRATION


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SAMPLING OF IRRIGATION EFFLUENT


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SIEVED SOLIDS TRANSFER


MICROPLASTIC + ORGANIC


WET PEROXIDE OXIDATION (WPO)


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SEPARATION OF SOLIDS IN DENSITY SEPARATOR


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AQUABIDES FILTRATION

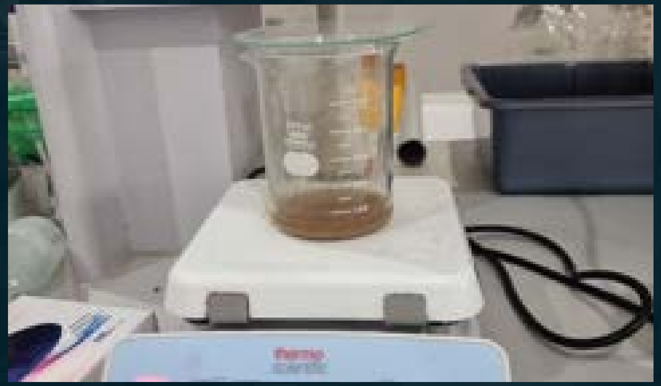

SAMPLING PREPARATION


SAMPLING OF LIVESTOCK EFFLUENT


WET SCREENING OF SAMPLES


SIEVED SOLIDS TRANSFER


MICROPLASTIC + ORGANIC


WET PEROXIDE OXIDATION (WPO)


DENSITY SEPARATION


SEPARATION OF SOLIDS IN DENSITY SEPARATOR


SIEVED SOLIDS TRANSFER


MICROPLASTICS


MICROSCOPIC EXAMINATION MICROPLASTICS

METHODOLOGY

Rainwater Sampling Location

AQUABIDES FILTRATION

SAMPLING PREPARATION

RAINWATER SAMPLING

RAINWATER SAMPLING STORAGE

WEIGHING THE INITIAL WEIGHT OF FILTER PAPER & PETRI DISHES

RAINWATER SAMPLE FILTRATION

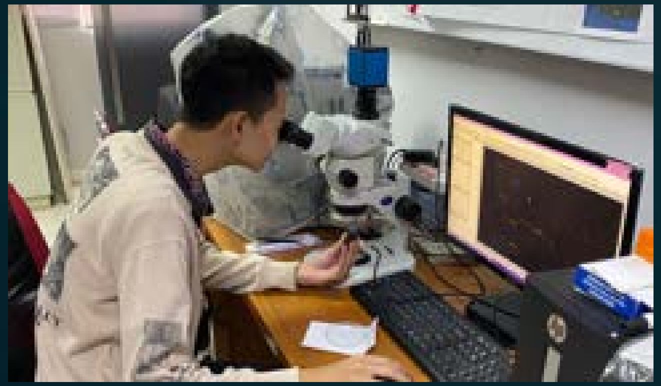
DRYING OF RAINWATER SAMPLES

FINAL WEIGHING OF FILTER PAPER AND PETRI DISHES

PREPARATION OF NILE RED SOLUTION

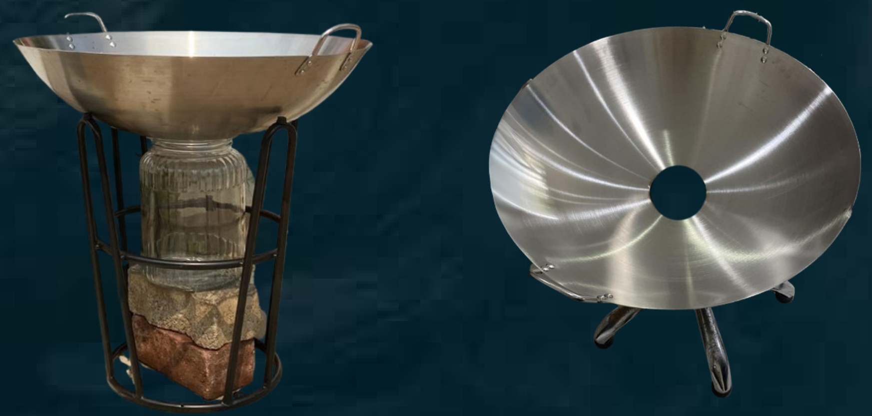
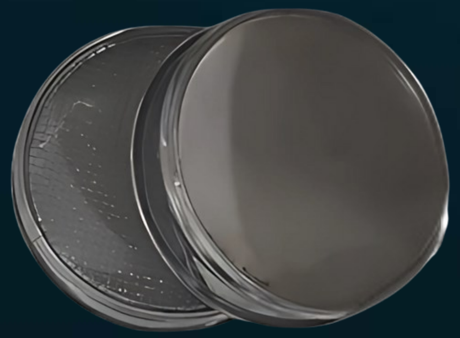
ADDITION OF NILE RED SOLUTION TO FILTER PAPER

DRYING OF RAINWATER SAMPLES AFTER NILE RED SOLUTION



MICROSCOPIC EXAMINATION MICROPLASTICS

METHODOLOGY
Sampling Methods

Environmental Compartment	Water Sample Processing	air sample processing
Sampling Size	1 L Discharge Point 1 L Influent 10 L Effluent	Collect samples after 24 hours
Sampling Device	 Stainless-steel bucket	 Stainless-steel pan +glass bottle
Sieving Tool	 Sieve 5 mm & 0.012 mm	 Filter sample with glass fiber filters (GF/C, Whatman®, 1.2 µm porosity)

METHODOLOGY
Sampling Methods

Environmental Compartment

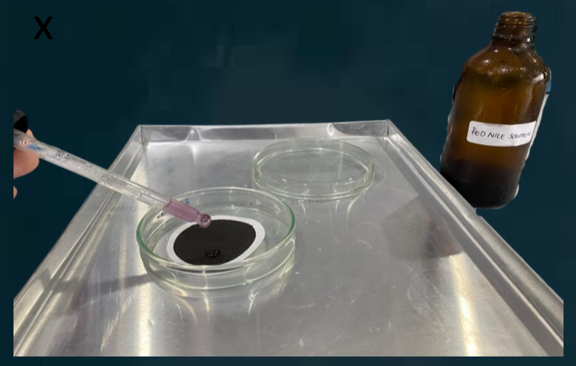
Water Sample Processing

air sample processing

Digestion

Add 20 ml Iron (II) And 20 ml H_2O_2

Place the beaker on the hotplate for 30 min heat at 75℃



Fill filter with Nile Red staining

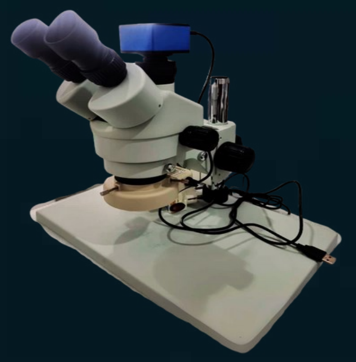
Density Separation

Add 14 g $ZnCl_2$
Transfer the solution to funnel separation Leave it separate for 24 hours

Filtration

Sieve Size 5 mm & 0.012 mm

Identification



Trinocular Stereo Microscope (ZS7050) Physical characteristics of MPs Shape, size, color, and number

Olympus SZX7 Microscopy Physical characteristics of MPs Shape, size, and number

METHODOLOGY
Domestik WWTP

MPS FLUX FROM DOMESTIC WASTEWATER:

- **Water Consumption**

  $$Q_{water} = N \times K$$

- **Wastewater Discharge**

  $$Q_{wastewater} = Q_{water} \times f$$

- **Runoff Discharge**

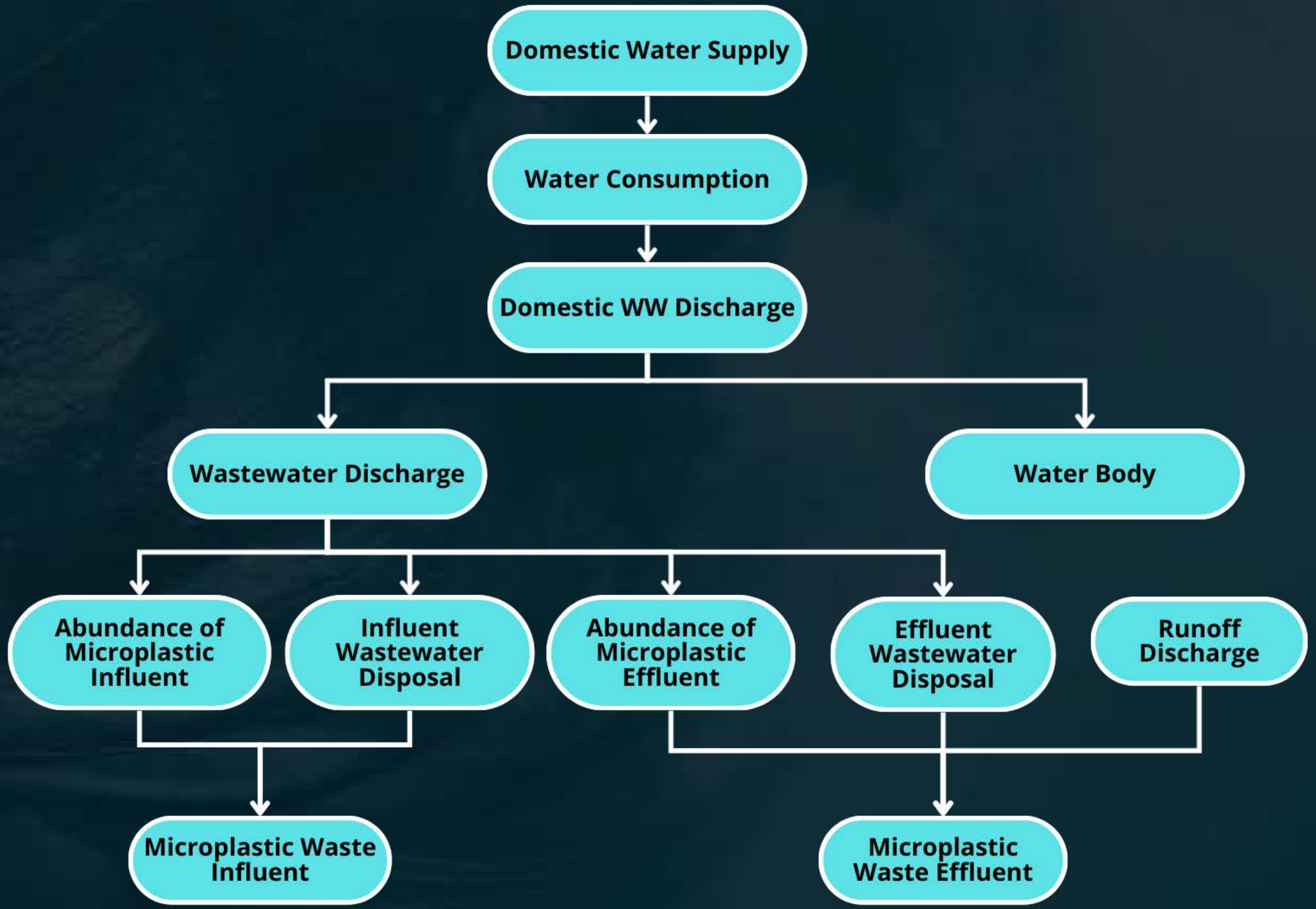
  $$Q_{runoff} = C \times I \times A$$

- **Influent Microplastic Influx**

  $$Influent_{influxMicroplastic} = Q_{influent} \times C_{influent}$$

- **Effluent Microplastic Influx**

  $$Effluent_{influxMicroplastic} = Q_{effluent} \times I \times C_{effluent}$$



Description

N = Number of residents/users

K = Water consumption per capita (L/person/day)

f = Fraction of water that becomes waste (generally 0.6-0.9)

C = Runoff coefficient (concrete: ±0.85)

I = Rainfall intensity (mm/hour)

A = Surface area (m²)

C influent & effluent = Microplastic abundance, particles/L

METHODOLOGY
Agriculture

MPS FLUX FROM AGRICULTURE:

- Irrigation Cross-Sectional Area (Ap):

  Ap= Irrigation Channel Width × Irrigation Water Depth
- Irrigation Inlent Channel:

  Qin= *Irrigation Cross-Sectional Area* × Irrigation Water Velocity
- *Runoff Coefficient (C):*

  Agricultural Coefficient x Average Rainfall Over 1 Year
- *Runoff Volume:*

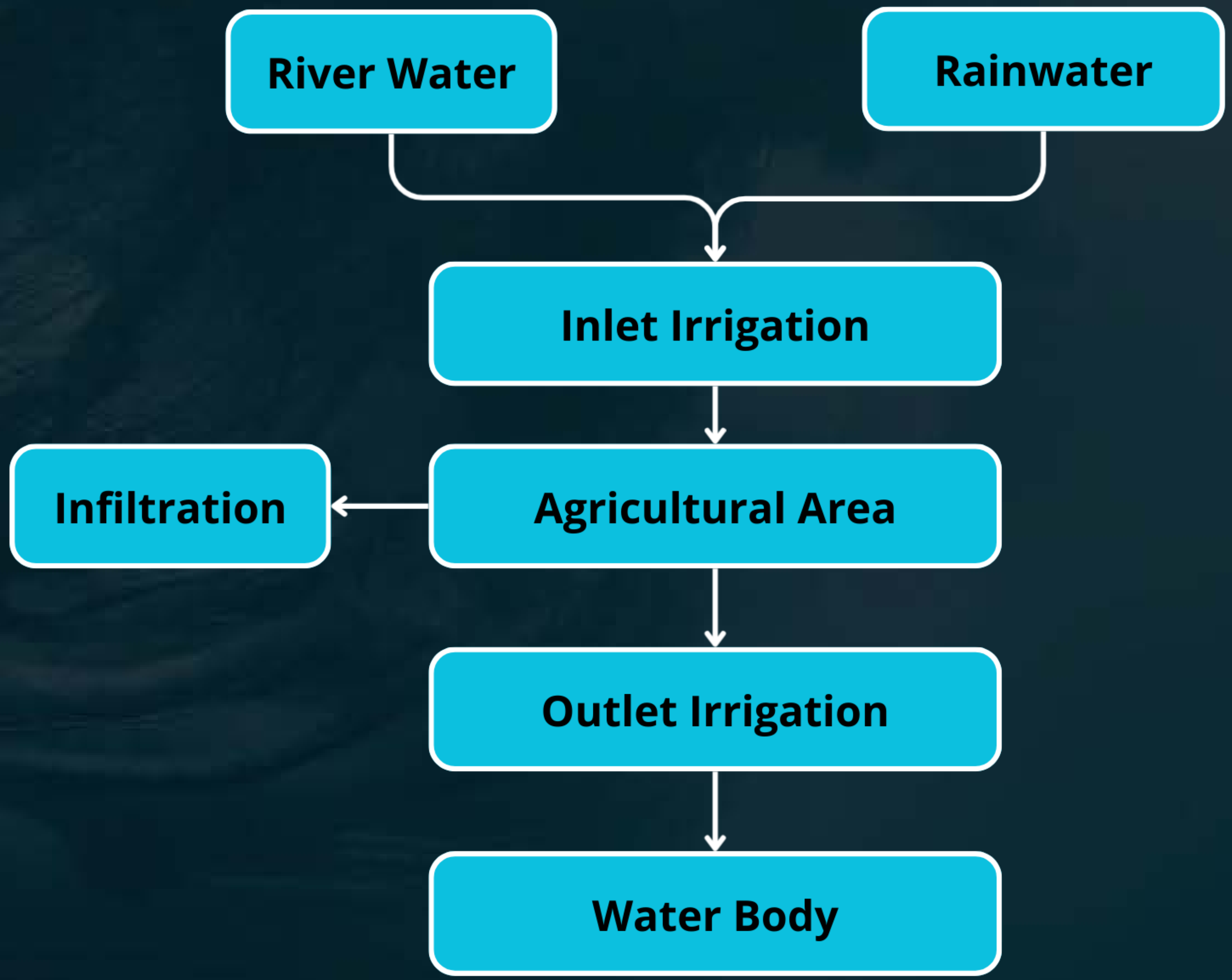
  Runoff Coefficient x paddy field area
- *Rainfall Volume:*

  Paddy field area x Averange Rainfall Over 1 Year
- Infiltration:

  Rainfall Volume x Runoff Volume
- Irrigation Outlet Channel:

  Qout: Irrigation Inlet Channel + Rainfall Outlet – Infiltration
- Total MPs discharge from Agriculture:

  $MP = Cavg$ × Qoutlet Irrigation



Description

C avg = average sample abundance (partikel/liters)

METHODOLOGY
Livestock

MPS FLUX FROM LIVESTOCK:

- **Livestock clean water debit**

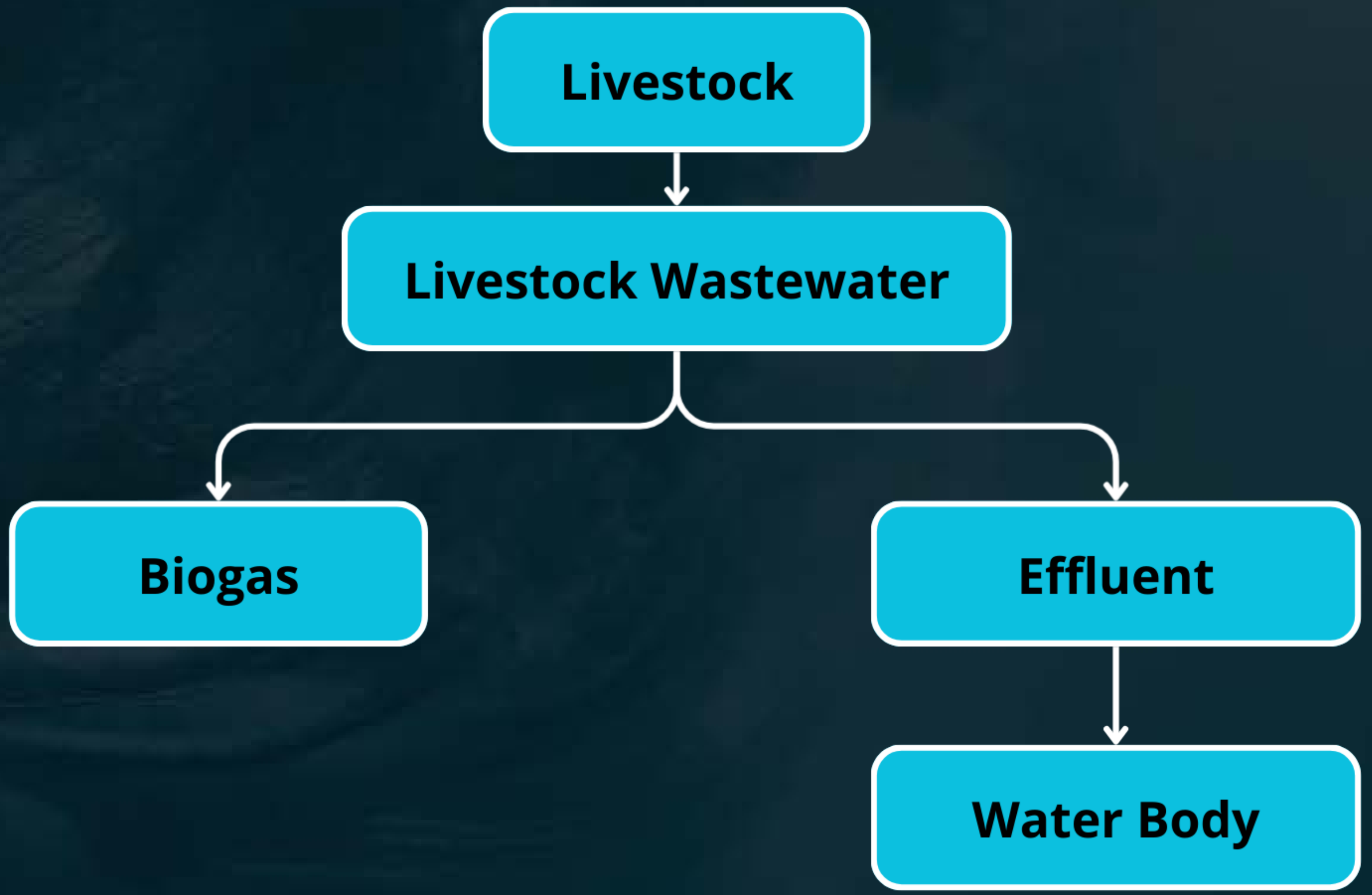
  $Q_{clean\ water} = \textit{Clean water consumptions} \times \textit{number of cows}$

- **Livestock wastewater discharge**

  $Q_{ww} = \textit{Percentage of wastewater} \times \textit{clean water debit}$

- **Total MPs discharge from livestock**

  $MP = C_{avg} \times Q_{ww}$



Description

Q = Debit (Liters/day/cows)

C avg = Average Microplastic Abundance (Particles)

METHODOLOGY
Rainwater

MPS FLUX FROM RAINWATER:

TOTAL MICROPLASTIC DISTRIBUTION ON LAND

- **Rainwater Volume (Land Area)**

  $H \times A_1 \times 0.001$

- **Runoff volume**

  Rainfall volume (land) × C

- **Microplastic Distribution (Runoff)**

  Runoff Volume × Microplastic Abundance

- **Distribution of Microplastics Deposited on Land**

  (Rainfall Volume (Land) × Microplastic Abundance) – Distribution of Microplastics (Runoff)

TOTAL MICROPLASTIC DISTRIBUTION ON SURFACE WATER

- **Rainwater Volume (Land Area)**

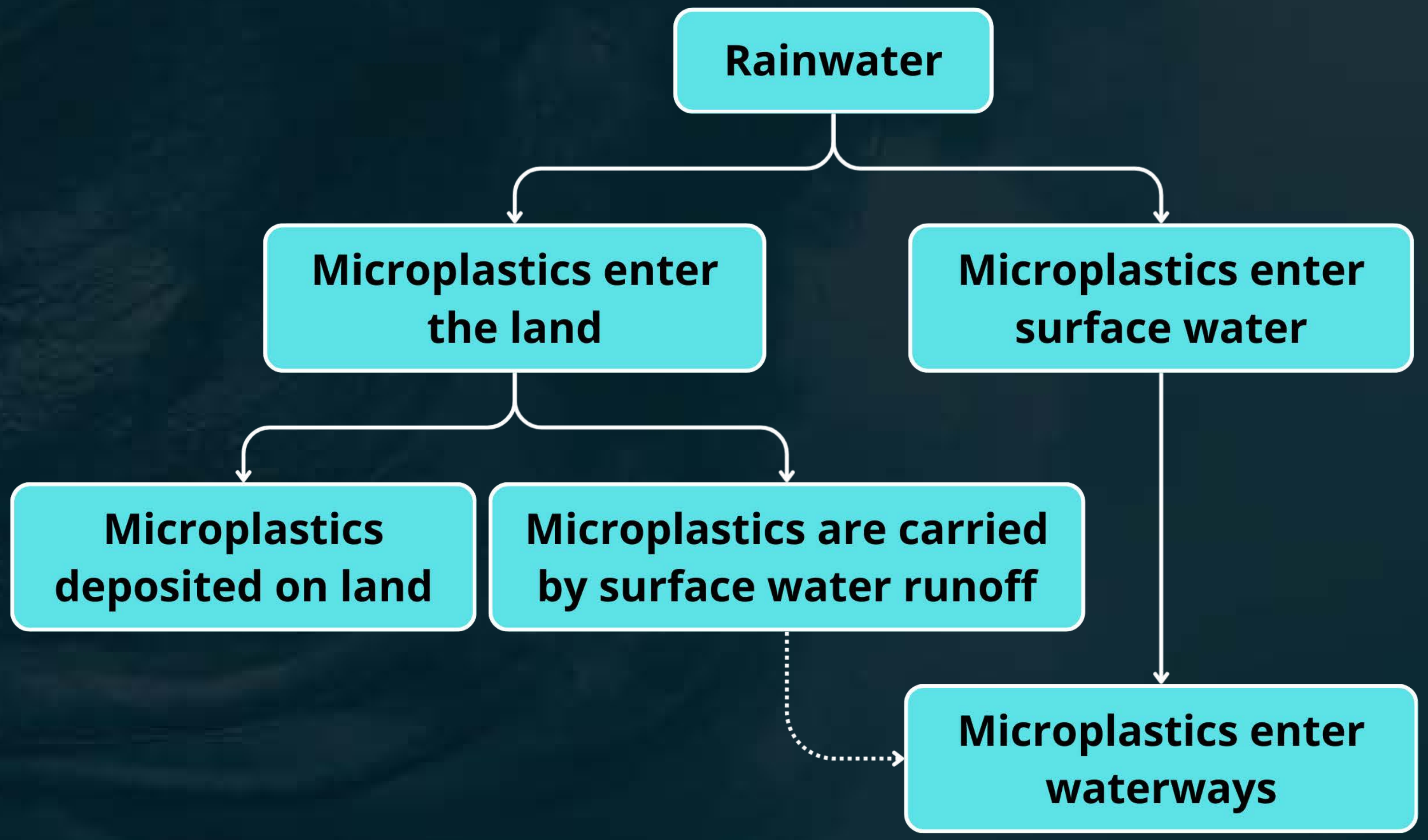
  $H \times A_2 \times 0.001$

- **Microplastic Distribution (Surface Water)**

  Rainwater Volume (Surface Water) × Microplastic Abundance

- **Distribution of Microplastics in Surface Water**

  Distribution of Microplastics (Runoff) + Distribution of Microplastics (Surface Water)



Description

H = Average daily rainfall per rainy day (mm/day)

C = Urban surface water runoff coefficient

A1 = Land surface area (M^2) A2 = Land surface area (M^2)

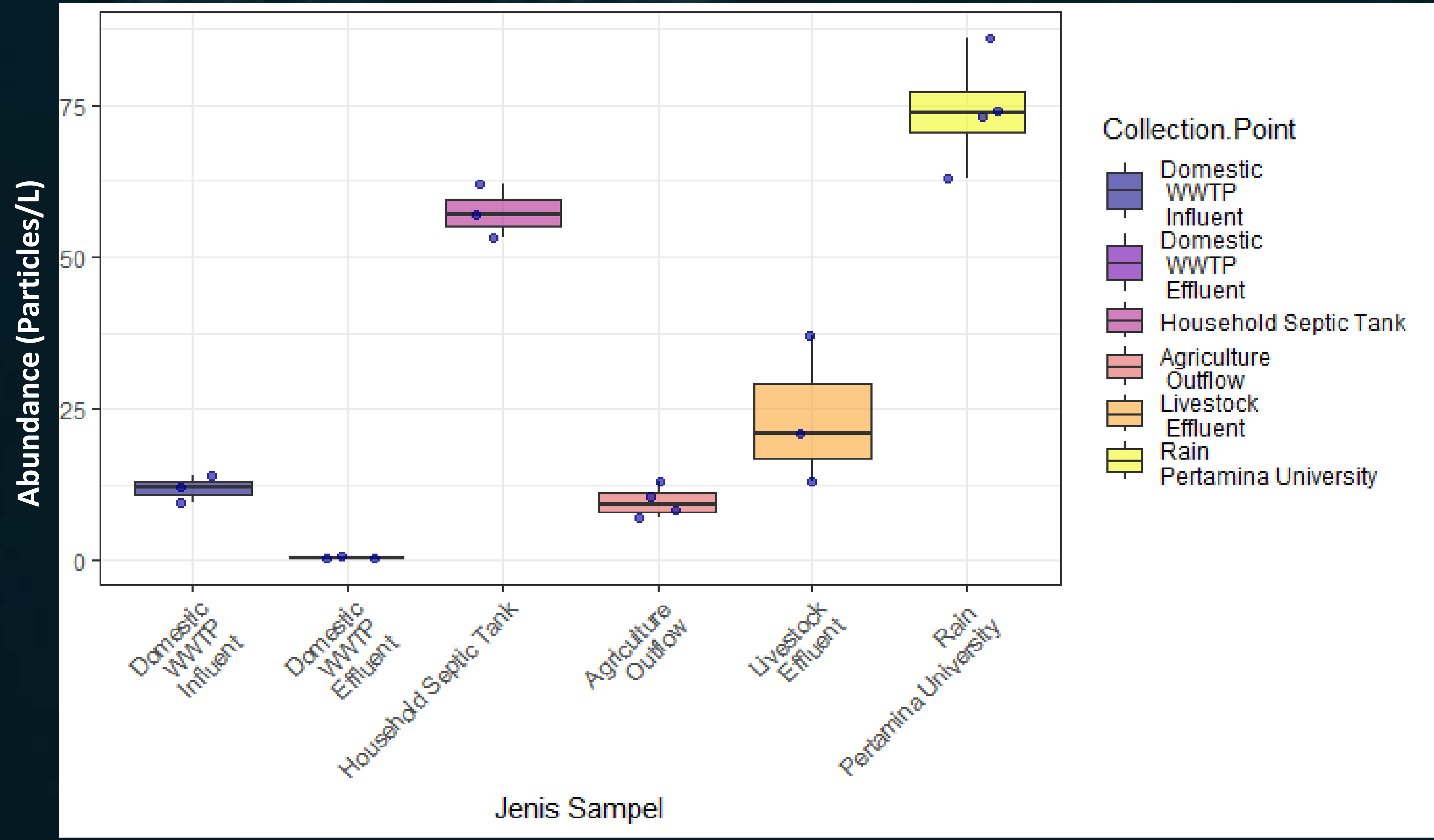
METHODOLOGY

QA/QC

- Use of non-plastic equipment (glass, metal, stainless steel filters).
- Filters are washed before and between sample processing, and all equipment is triple-rinsed with RO water.
- Samples are covered when not in use and stored under controlled conditions.
- Blank samples are taken to check for potential contamination.

RESULTS AND DISCUSSION

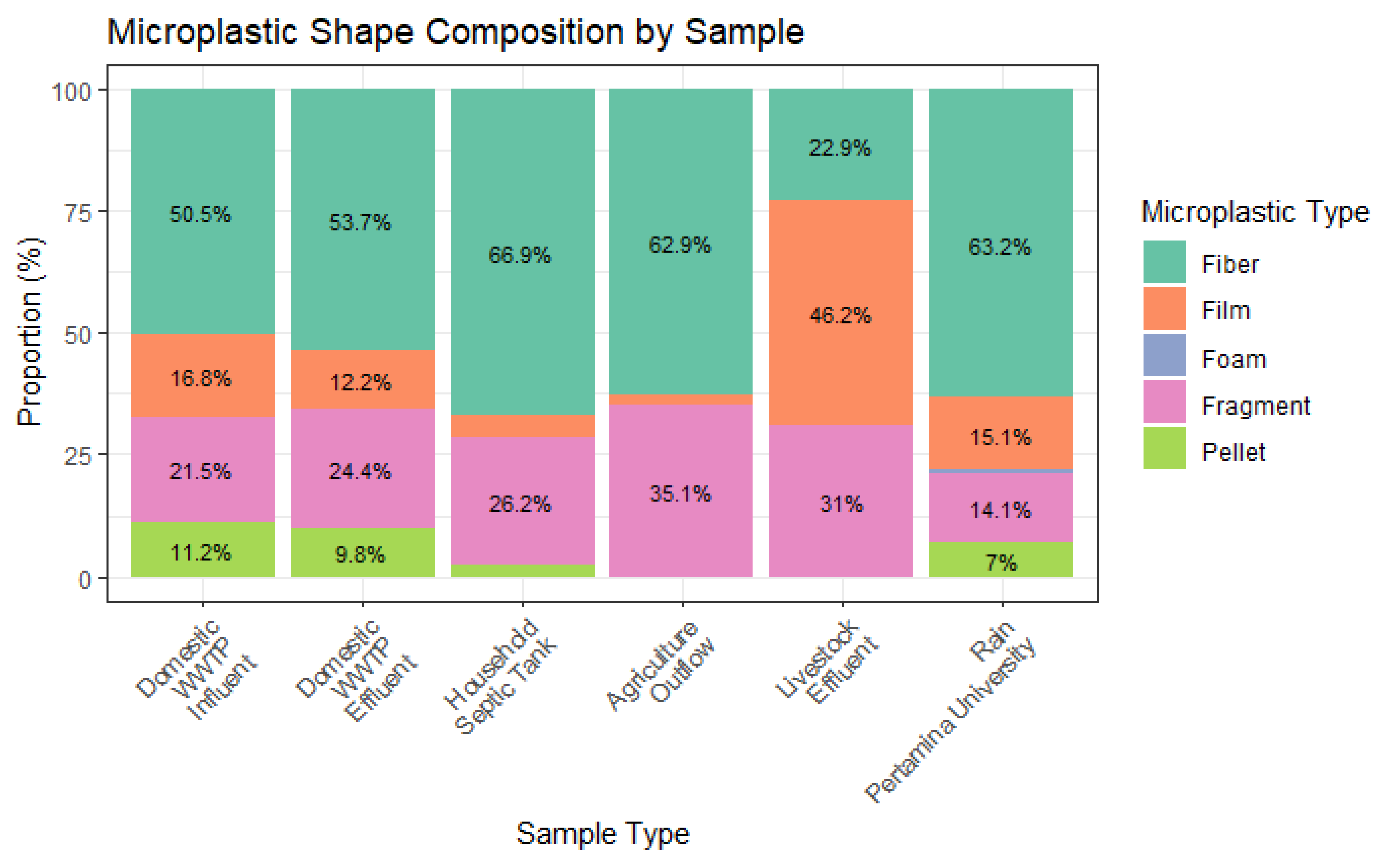
Microplastic abundance at Each Sampling Point



- **Rainwater (Pertamina University)** and **Household Septic Tank** show the **highest MP concentrations** (~70–80 and ~55–60 particles/L).
- **Livestock effluent** is moderate (~20–30 particles/L), while **Agriculture outflow** is lower (~10).
- **WWTP influent** has ~10–12 MPs/L, but **effluent** is nearly zero — showing effective removal

RESULTS AND DISCUSSION

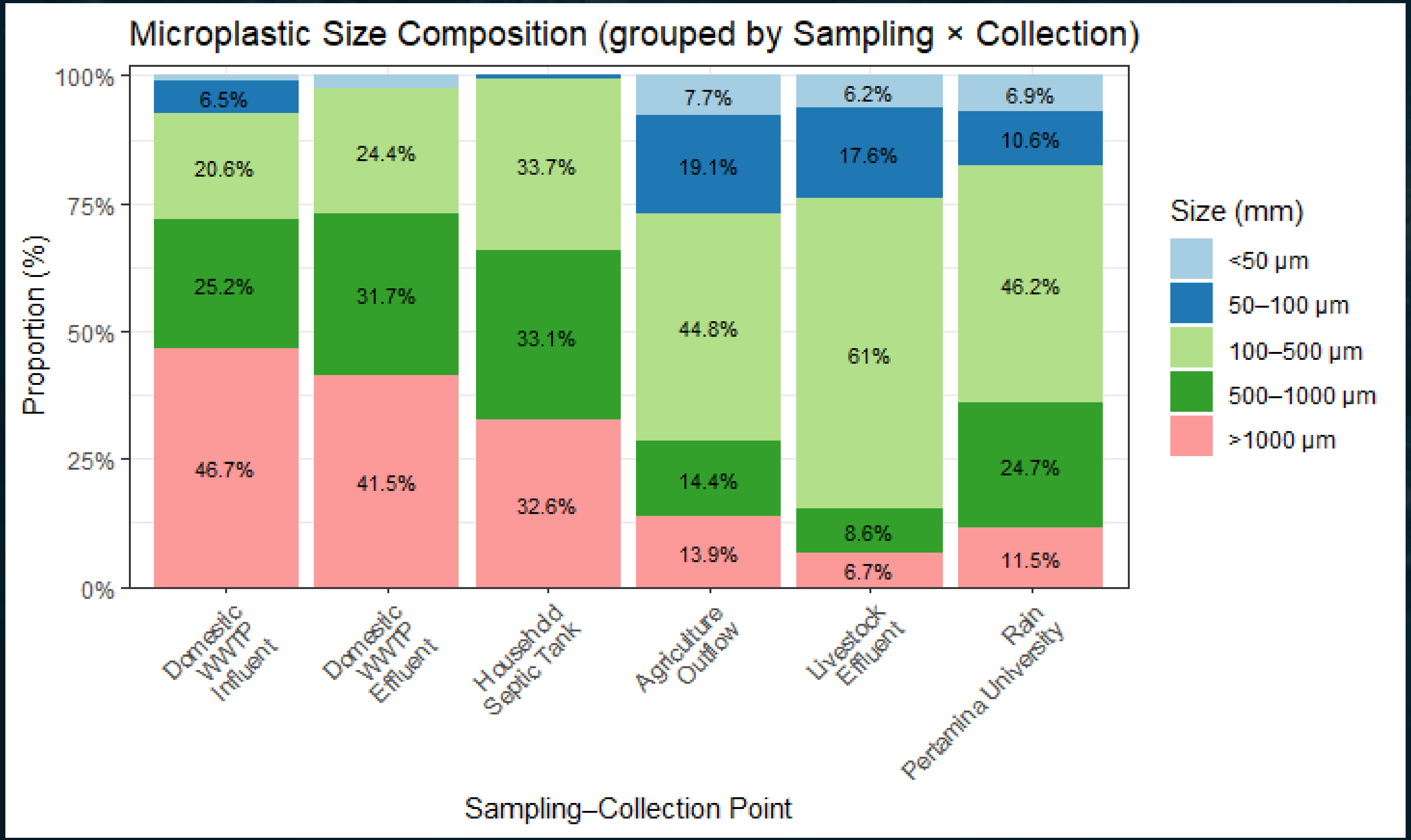
Microplastic Characteristics from Each Sampling Point



- **Fibers dominate** in almost all sources, especially in **rainwater (63%)** and **domestic effluents (50–67%)**, pointing to textile/laundry and atmospheric deposition as major pathways.
- **Fragments** are notable in **agriculture (35%)** and **septic tank (26%)**, reflecting breakdown of larger household/agricultural plastics.
- **Films** stand out in **livestock effluent (46%)**, likely from feed bags and farming plastics.
- **Pellets and foams** are consistently low (<12%).

RESULTS AND DISCUSSION

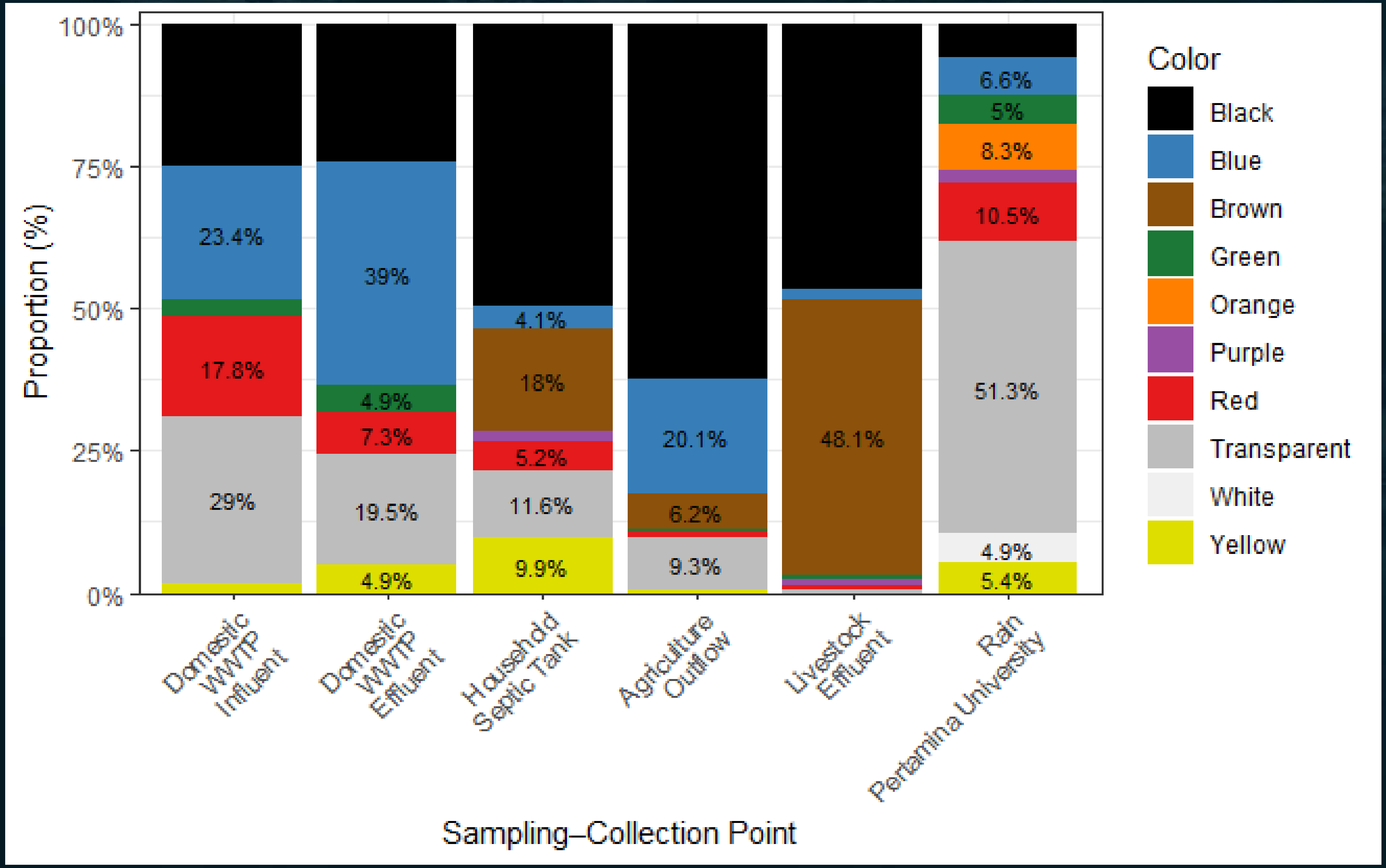
Microplastic Characteristics from Each Sampling Point



- **Large MPs (>1000 µm)** dominate **domestic wastewater (influent, effluent, septic tank: 33–47%)**, indicating direct household inputs of larger particles.
- **Smaller MPs (100–500 µm, 500–1000 µm)** dominate **agriculture (≈60%), livestock (≈70%), and rain (≈70%)**, reflecting more degraded or diffuse sources.
- **Very fine MPs (<50 µm)** are minor across all categories (<10%).

RESULTS AND DISCUSSION

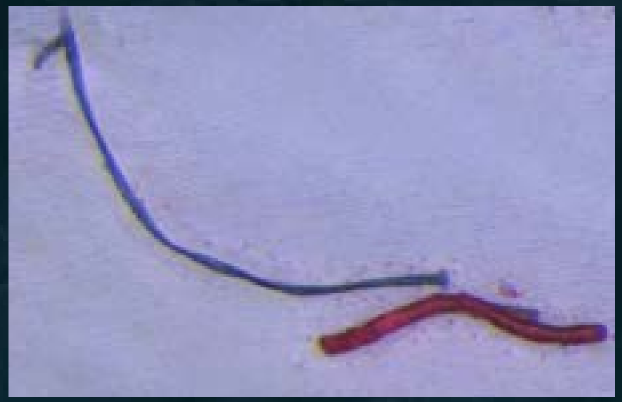
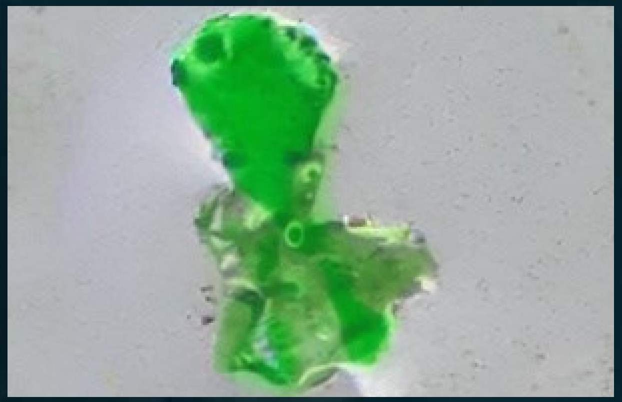
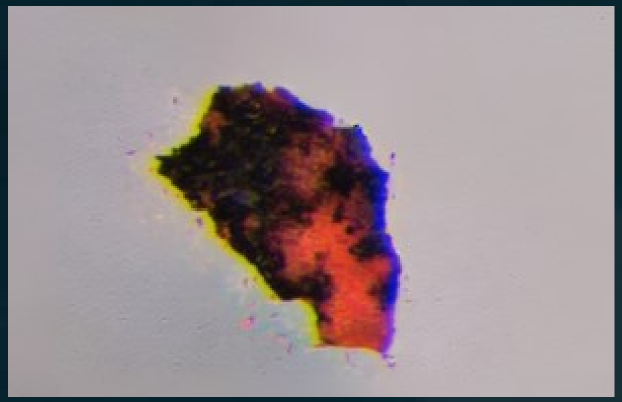
Microplastic Characteristics from Each Sample Point



- Strongly enriched in **transparent MPs (≈51%) in rainwater**, unlike other sources Suggests **atmospheric deposition of degraded films and packaging** — airborne fragments that have lost pigmentation.
- **Livestock effluent** → Unique **brown dominance (~48%)**, pointing to **farm-related plastics** (feed bags, ropes, soil-stained waste).
- **Domestic wastewater (WWTP influent/effluent)** → High share of **blue MPs (up to 39%)**, linked to **synthetic fibers from laundry**.

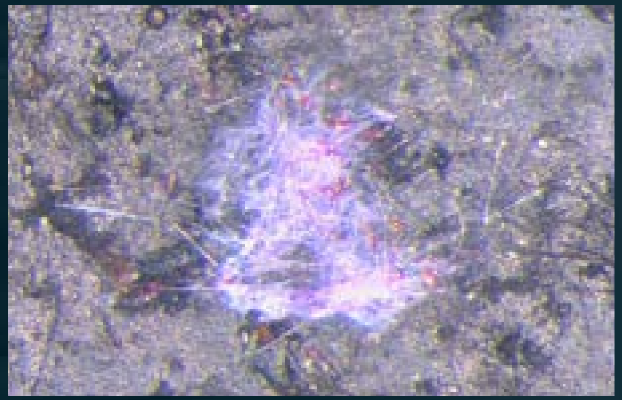
RESULTS AND DISCUSSION

The Shapes of Microplastics Observed in the Samples

Fragment


Film

Foam


Pellet

RESULTS AND DISCUSSION

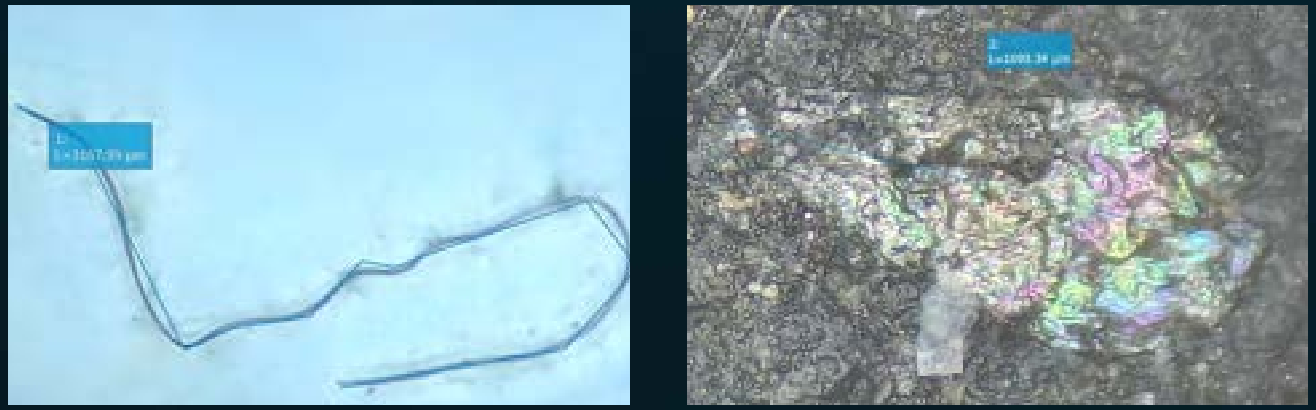
The Sizes of Microplastics Observed in the Samples

> 12 µm – ≤ 50 µm

> 50 µm – ≤ 100 µm

> 100 µm – ≤ 500 µm

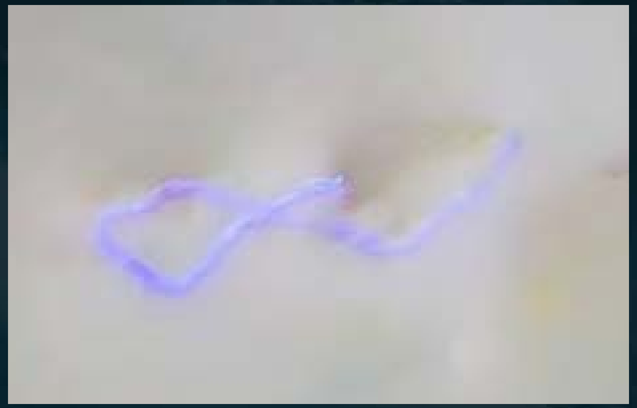
> 500 µm – ≤ 1000 µm



> 1000 µm – ≤ 5000 µm

RESULTS AND DISCUSSION

The Colors of Microplastics Observed in the Samples

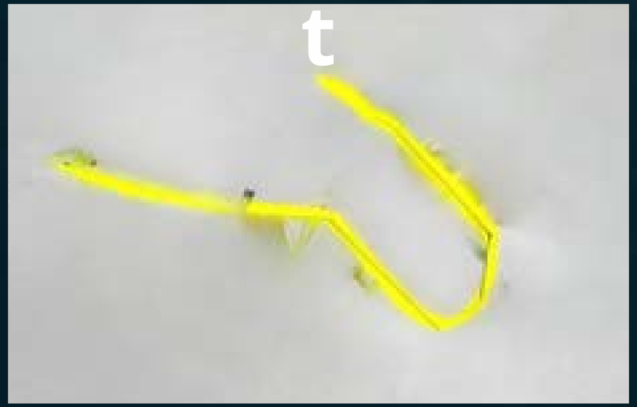


Transparent

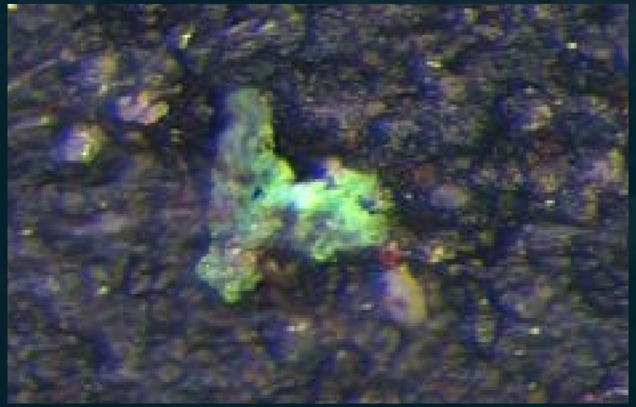
White

Red

Orange

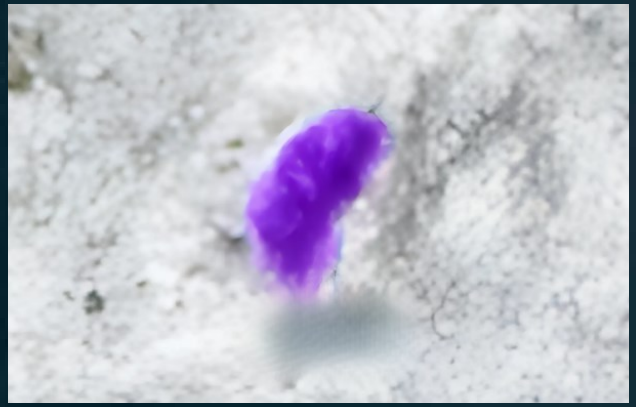


Yellow



Green

Blue



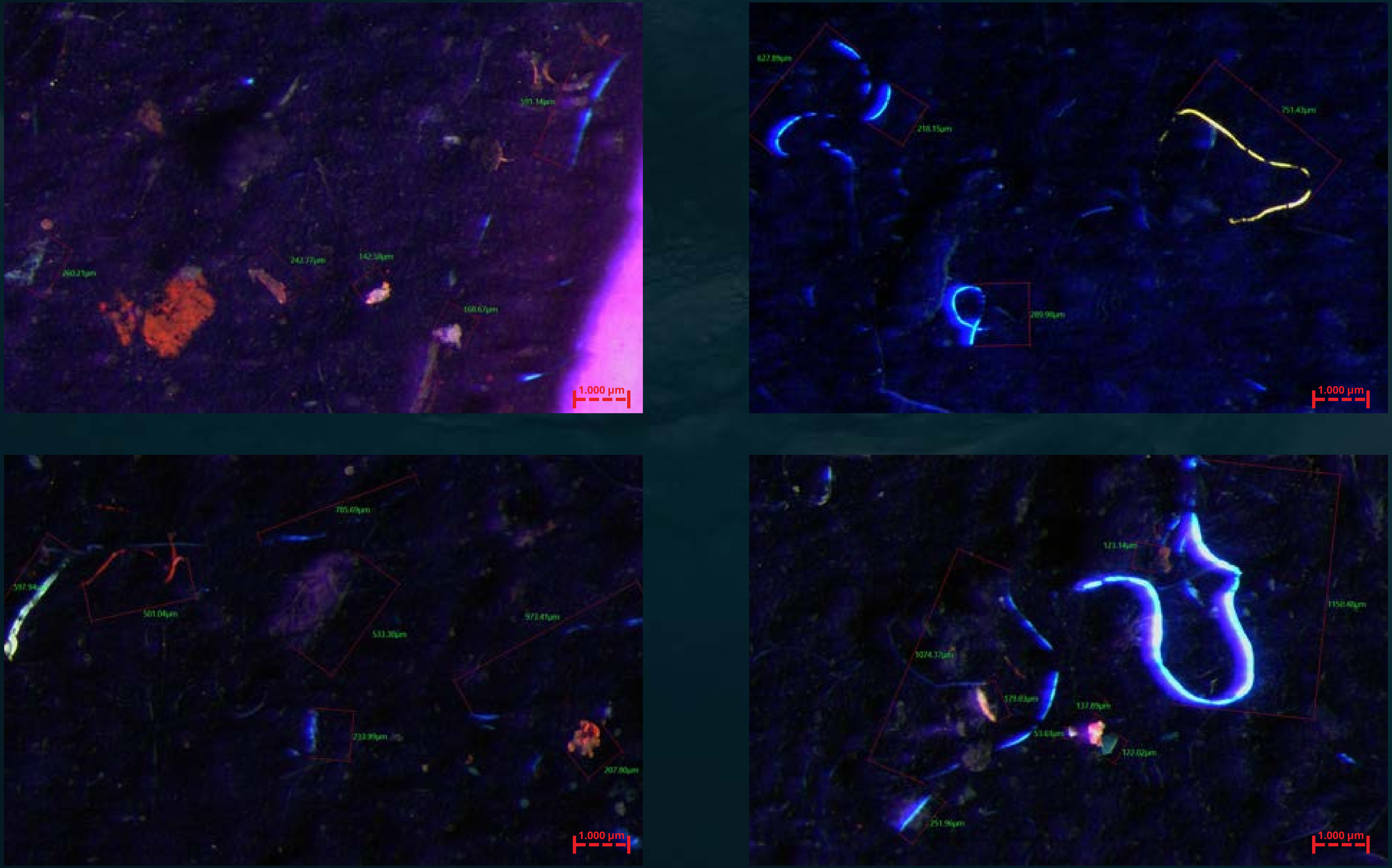
Purple

Brown

Black

RESULTS AND DISCUSSION

Microplastic observation using ultraviolet light on samples



CONCLUSION

Distribution of Influx at Each Sample Point