

Appendix I

Report for the project kick-off meeting and 1st
stakeholder consultation



Project Kick-off Meeting and 1st Stakeholder Consultation Report

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Asian Institute of Technology

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

1. Background

The research project titled "Enhancing the Science-Policy Interface to Manage Microplastic Influx from Major Cities into the Oceans in Southeast Asia" is funded by the Asia-Pacific Network (APN) for Global Change Research under its Collaborative Regional Research Programme (CRRP) scheme. The project research consortium is composed of researchers from three collaborative institutions: the Asian Institute of Technology in Thailand, Ho Chi Minh City University of Industry and Trade in Vietnam, and Universitas Pertamina in Indonesia.

This project aims at addressing the growing environmental threat of plastic debris and microplastics (MPs), particularly in Southeast Asia (SEA), a global hotspot for plastic waste discharge into the ocean. Despite SEA's significant role in plastic pollution, a major knowledge gap exists in understanding the complex interactions between land-based sources, aquatic pathways, and environmental sinks of MPs in urban coastal areas. The project aims to develop a comprehensive system model to quantify the influx of microplastics in urban aquatic systems across selected SEA cities. It seeks to answer key questions regarding the sources, pathways, and receptors of MPs and how this knowledge can inform better management and policy making. Key activities include reviewing existing research, formulating a source-pathway-receptor (SPR) framework, collecting field data, and engaging with stakeholders to ensure policy relevance. The project's outcomes are expected to inform evidence-based strategies for preventing marine plastic pollution and supporting sustainable management efforts across SEA.

The grant supports a two-year research initiative starting on October 1st, 2024, and focuses on three major cities in the respective countries. To ensure the project progresses according to the established goals, a kickoff meeting will be held at Universitas Pertamina in Jakarta, Indonesia.

2. Expected outputs of the meeting

- Official announcement and public launch of the funded research project.
- Initial knowledge and research sharing, alongside discussions among project investigators, national stakeholders, and the local community in Indonesia.
- Completion of the first internal project meeting and field visit in Indonesia.

Program

Date: Wednesday, October 9th, 2024

Venue: Ruang Auditorium, Gedung Griya Legita Lantai 3 (Morning session) & Ruang Mandala Saksana Astagatra (MSA), Gedung Griya Legita Lantai 3 (Afternoon session), Universitas Pertamina, Jl. Teuku Nyak Arief, Simprug, Kebayoran Lama, Jakarta 12220.

Online Access: Zoom link:

<https://us06web.zoom.us/j/84396245175?pwd=iAT8REmEcaoy2M9tu5wt00iWrvG6rh.1>

Time	Agenda
7:30 – 8:00	Registration
Project Kick-Off	
08:00-08:15	Welcome and Opening - Prof. Dr. Wawan Gunawan A Kadir, M.S, Rector of Universitas Pertamina - Prof. Dr. Erna Sri Adiningsih, APN's Scientific Planning Group Member for Indonesia
08:15-08:35	Project Overview Dr. Wenchao Xue, Associate Professor, Thailand, Asian Institute of Technology (AIT)
08:35-08:40	Group photo
Session 1: Knowledge & Research Sharing on Microplastic in Southeast Asia (SEA)	
08:40-9:00	Topic 1: Recent progress on microplastic research in Indonesia. Prof. Muhammad Reza Cordova (Researcher from Indonesian National Research and Innovation Agency) (TBC)
9:00-9:20	Topic 2: Microplastic accumulation in mangrove sediments: water ecosystems as source, transport and sink Dr. Simon Guerrero Cruz, Assistant Professor, Thailand, Asian Institute of Technology (AIT)
9:20-9:40	Coffee break
9:40-10:00	Topic 3: Microplastic Pollution in Vietnam: Occurrence and Removal Technologies Dr. Thi-Kim-Quyen Vo, Ho Chi Minh City University of Industry and Trade (HUIT)

Time	Agenda
10:00-10:20	Topic 4: Overview of Recent Initiatives and Projects Addressing Microplastic Pollution in Thailand Ms. Mutita Wattanasuk, Thailand, Asian Institute of Technology (AIT)
10:20-10:40	Q&A Session
10:40-13:00	Lunch break
Session 2: Stakeholder 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 <ul style="list-style-type: none"> · Understand the knowledge & research gaps · Identify the policy and management concern & needs · Enhance regional collaboration & networking · Roles of young talent capacity building & stakeholder engagement
16:00	Closing remarks Dr. Wenchao Xue, Principal Investigator.

4. Participants

No	Name	Affiliation
Project members		
1	Dr. Wenchao Xue, Project Proponent	Asian Institute of Technology (AIT), Thailand
2	Dr. Simon Guerrero Cruz, Collaborator	Asian Institute of Technology (AIT), Thailand
3	Dr. Thi Kim Quyen Vo, Collaborator	Ho Chi Minh City University of Industry and Trade (HUIT), Vietnam
4	Ms. Tran Pham Yen Nhi	Ho Chi Minh City University of Technology, Vietnam

No	Name	Affiliation
5	Dr. Betanti Ridhosari	Universitas Pertamina (UP), Indonesia
6	Dr. Nurulbaiti Listyendah Zahra	Universitas Pertamina (UP), Indonesia
7	Dr. Evi Siti Sofiyah	Universitas Pertamina (UP), Indonesia
8	Ms. Mutita Wattanasuk	Asian Institute of Technology (AIT), Thailand
Invited Participants		
1	Rector of Universitas Pertamina	
2	Vice Rector for Research and Cooperation, UP	
3	Vice Rector for Financial and Human Resources	
4	Vice rector for Academic and Students Affairs	
5	University Secretary	
6	Dean of the Faculty of Infrastructure Planning, UP	
7	Vice Dean of the Faculty of Infrastructure Planning, UP	
8	DPPM	
9	Prof. Muhammad Reza Cordova	
10	APN Indonesia Executive Director, Indonesian Space Agency Secretariat (INASA), National Research and Innovation Agency, APN's Scientific Planning Group Member for Indonesia (Attend in Virtually)	
11	Students of Universitas Pertamina (Metnum – 45 people)	
12	Students of Universitas Pertamina (PIPAM – 30 people)	
13	Researcher from Universitas Pertamina (6 people)	
14	Research Student (5 people)	
Key Stakeholders		

No	Name	Affiliation
5	Prof. Muhammad Reza Cordova, M.Si, Ph.D.	Researcher at the Research Center for Oceanography, Indonesian National Research and Innovation Agency
6	Tulus Laksono, S.H	Director of Water Pollution Control, Ministry of Environment and Forestry of Indonesia
7	Asri Indivani, ST., M.Sc.	Acting President Director of Perumda Paliaya (Jakarta Regional Public Company for Sanitation)
8	Ir. Tanozisoichi Lase, M.Sc.	Director of Sanitation, Ministry of Public Works and Public Housing
10	Ratih Rimayanti	National Marine Coordinator, NGO Fauna & Flora - Indonesia Program
11	Students and Researcher from Universitas Pertamina	

Day 1. Monday, October 7th, 2024 Activity 1 – Pre-Kickoff Meeting

The first Project Work Meeting held on October 7, 2024, marked an important preparatory milestone ahead of the official project kickoff. The session aimed to align the project team's shared understanding of objectives, scope, and implementation strategies under the regional initiative on microplastic influx from urban sources into aquatic systems. The meeting opened with introductions among project members, fostering collaboration and a shared sense of purpose among partners from Thailand, Indonesia, and Vietnam.

Discussions centered on defining the criteria for sampling site selection, focusing on identifying representative locations that capture major sources of microplastic pollution—wastewater discharges, agricultural runoff, and airborne fallout. The team emphasized that each participating country will adapt its sampling strategy to reflect local pollution characteristics, using data such as Indonesia's and Vietnam's pollution census information to ensure relevance and comparability.

The group also reviewed the proposed sampling timeline, aligning field activities with both wet and dry seasons to capture seasonal variation in microplastic distribution. Parallel planning covered laboratory procedures, including sample preparation, filtration, and polymer identification, to guarantee scientific rigor and cross-country standardization. A key output was the development of a regional sampling plan, beginning with Bangkok as the pilot site and extending to the other partner cities.

Another major component of the meeting addressed secondary data collection, outlining reliable institutional sources, data-sharing mechanisms, and protocols for metadata documentation. The team agreed to integrate stakeholder engagement into every phase of the project, ensuring that local authorities, community representatives, and environmental agencies contribute insights that strengthen policy relevance.

The meeting also clarified roles and responsibilities among partners. The Asian Institute of Technology (AIT) will serve as the lead coordinator for all technical activities, including literature review, secondary data collection, laboratory training, and facilitation of fieldwork logistics. AIT will also oversee laboratory capacity-building in Jakarta, utilizing existing equipment and preparing standardized training materials to ensure quality control across countries.

By the end of the meeting, the team had established a clear roadmap for implementation. Immediate next steps include finalizing field visit schedules, refining sampling strategies, and coordinating laboratory training sessions in each country. The productive discussions and collaborative spirit demonstrated on Day 1 set a strong foundation for the project's success, ensuring that all partners move forward with shared understanding, scientific integrity, and commitment to tackling microplastic pollution across Southeast Asia.

Photo of Activities



Figure 1: 1st Project Work Meeting

Day 2. Tuesday, October 8th, 2024 Field Trip

On October 8th, 2024, three field visits were conducted to assess microplastic (MP) pollution management across different locations: the Krukut Wastewater Treatment Plant, rice paddy fields near Jakarta, and the Cikoko Livestock Farm.

Krukut Wastewater Treatment Plant (WWTP)

The field visit to the Krukut Wastewater Treatment Plant (WWTP) provided critical insights into Jakarta's wastewater infrastructure and its implications for microplastic management. As Indonesia's first multi-story treatment facility, Krukut WWTP employs Moving Bed Biofilm Reactor (MBBR) technology to process approximately 8,640 m³ of wastewater per day. Observations at the facility enhanced the team's understanding of Jakarta's treatment coverage—currently limited to two main WWTPs, together serving only about 2% of the city's total wastewater.

On-site assessment enabled identification of key sampling points at both the inlet and outlet to monitor concentration changes and evaluate removal efficiency of microplastics through treatment stages. The field experience also revealed critical junctures where microplastics may enter, accumulate, or escape within the treatment process. These findings will inform refinement of sampling strategies and calibration of the project's models on removal efficiency and mass balance.

Beyond the technical perspective, the visit provided valuable context for policy relevance and the Source–Pathway–Receptor (SPR) framework adopted in this project. Understanding Jakarta's limited treatment capacity underscores the urgent need for integrated wastewater management strategies to reduce urban discharge into rivers and coastal areas. Insights from this visit will directly feed into ongoing modeling work, policy recommendations, and regional strategies for sustainable wastewater and microplastic management in Southeast Asian cities.

Photo of Activities





Figure2: Field visit at Krukut Wastewater Treatment Plant (WWTP), Jakarta

Rice Paddy Fields,

The second visit focused on a rice paddy field located near Jakarta, covering approximately 50 rai (8 hectares) and reliant primarily on river water for irrigation. The site provided an essential opportunity to assess irrigation hydrodynamics, sediment interactions, and sampling feasibility for detecting microplastic contamination within agricultural systems.

The research team identified key sampling points at the irrigation pond to represent inflow and storage conditions. To capture seasonal variations, sampling during the rainy season will be extended to the discharge outlet, enabling comparative analysis between stagnant and flowing conditions. This adaptive sampling design ensures that both wet and dry season data are collected, facilitating understanding of how microplastics accumulate, settle, or mobilize under different flow regimes.

Discussions with the landowner and local farmers yielded valuable insights into local irrigation practices, and drainage management. These exchanges helped refine hypotheses about how microplastics might enter or persist in the paddy ecosystem. The engagement also reinforced collaboration with local stakeholders, ensuring future monitoring aligns with traditional farming schedules and minimizes disruptions to agricultural productivity



Figure 3: Field visit at rice paddy field near Jakarta

Cikoko Livestock Farm, Jakarta

The final visit took place at Cikoko Livestock Farm, where biogas technology is utilized for managing wastewater from livestock operations. All effluent from animal enclosures is piped into a biogas digestion system, where organic matter undergoes anaerobic breakdown. The process generates dry sludge reused as fertilizer, while treated effluent is applied on-site or distributed to agricultural outlets for crop application.

Field observations highlighted both the efficiency and complexity of wastewater flow through the biogas system, particularly concerning microplastic behavior within anaerobic processes. Because the system is fully enclosed, no direct discharge point exists for untreated wastewater, creating challenges for determining sampling locations. The research team identified the need for strategic sampling points to monitor potential microplastic presence in both the treated effluent and sludge-derived fertilizer products.

This site provided a valuable example of circular resource management and its intersection with emerging microplastic issues. The findings will contribute to developing best-practice

recommendations for managing agricultural wastewater and by-products in a sustainable and microplastic-conscious manner.

Photo of Activities



Figure 4: Field visit at Cikoko Livestock Farm, Jakarta

Summary

The three field visits provided a comprehensive overview of microplastic pathways across urban wastewater, agricultural irrigation, and livestock management systems. Observations strengthened the project's Source–Pathway–Receptor framework, linking scientific data collection with real-world practices and policy implications. Findings from these visits will guide refined sampling protocols, enhance model calibration, and inform regional strategies for sustainable microplastic mitigation across Southeast Asia.

Day 3. Wednesday, October 9th, 2024 Activity 1 – Project Kickoff

Opening Remarks by Prof. Dr. Wawan Gunawan A Kadir, M.S., Rector of Universitas Pertamina

Prof. Dr. Wawan Gunawan A. Kadir, Rector of Universitas Pertamina, delivered a warm and inspiring welcome to participants, reaffirming the university's full support for the Knowledge and Research Sharing project on microplastic pollution in Southeast Asia. In his opening address, he emphasized Universitas Pertamina's strong commitment to advancing sustainability, environmental science, and innovative solutions in alignment with the United Nations Sustainable Development Goals (SDGs).

The Rector underscored the pivotal role of academic institutions in addressing complex environmental issues through research, innovation, and collaboration. He highlighted that universities are not only centers of knowledge but also catalysts for action—bridging science, policy, and society to create lasting environmental impact. In this regard, Prof. Wawan stressed the importance of cross-border academic partnerships, particularly among ASEAN nations such as Indonesia and Thailand, as a foundation for building regional research networks and co-developing effective solutions to tackle plastic pollution.

In closing, he reaffirmed Universitas Pertamina's dedication to supporting future research and innovation in environmental management. He encouraged participants to actively engage in the project's activities and assured them of the university's continued institutional support, resources, and collaboration. Prof. Wawan expressed optimism that this partnership would lead to practical outcomes—not only in reducing plastic pollution but also in fostering a cleaner, healthier environment for future generations.

Opening Remarks by Prof. Dr. Erna Sri Adiningsih, APN's Scientific Planning Group Member for Indonesia

Prof. Dr. Erna Sri Adiningsih delivered her opening remarks by expressing sincere appreciation for the Asia-Pacific Network for Global Change Research (APN) and its continued support for collaborative environmental initiatives in Indonesia. She acknowledged the significance of the current APN project on microplastic pollution as a vital step toward addressing one of the region's most pressing environmental challenges.

Her remarks emphasized the importance of regional cooperation and shared scientific knowledge in tackling complex transboundary issues such as plastic and microplastic pollution. She noted that APN's long-standing mission of promoting knowledge exchange, capacity building, and scientific collaboration across the Asia-Pacific region provides an essential foundation for creating evidence-based solutions and informed policymaking.

Prof. Erna highlighted APN's instrumental role in strengthening local research capacity, connecting universities, policymakers, and community stakeholders, and supporting early-career researchers. She encouraged greater participation from Indonesian researchers

and institutions in generating scientific data that can inform national and regional strategies for sustainable environmental management.

In conclusion, she reaffirmed Indonesia's commitment to APN's mission and expressed confidence that the outcomes of this project would significantly enhance scientific understanding of microplastic pollution. She also underscored the project's potential to develop practical, policy-relevant solutions that contribute to cleaner ecosystems and more sustainable development pathways across Southeast Asia.

APN Project Overview Presented by Dr. Wenchao Xue, Asian Institute of Technology, Thailand

Dr. Wenchao Xue from the Asian Institute of Technology (AIT), Thailand, delivered an in-depth presentation on the Asia-Pacific Network for Global Change Research (APN) project titled *"Enhancing the Science–Policy Interface to Manage Microplastic Influx from Major Cities into the Oceans in Southeast Asia."* The project, led by AIT in collaboration with partner institutions from Indonesia and Vietnam, is scheduled to run from 1 October 2024 to 30 September 2026.

The presentation outlined the project's overarching goal of improving understanding and management of microplastic (MP) pollution originating from urban environments such as stormwater runoff, wastewater discharges, and agricultural activities. Dr. Xue emphasized that the initiative represents a regional collaborative effort to identify, measure, and mitigate microplastic influx from major Southeast Asian cities into marine ecosystems.

Central to the project is the development of a Source–Pathway–Receptor (SPR) framework, which will be used to trace the movement of microplastics through various environmental compartments—from cities and river systems to coastal and marine environments. The project also aims to quantify the magnitude, transport, and ecological impacts of microplastics while promoting science-policy collaboration to strengthen evidence-based environmental governance across the region.

Key project components include comprehensive literature reviews, field sampling, and data analysis in strategically selected sites such as the Bangkok Metropolitan Region (BMR). Early activities—such as stakeholder consultations and field visits conducted in October 2024—have already provided valuable baseline insights, helping refine sampling strategies and identify major microplastic sources. Capacity building was highlighted as a core priority, focusing on training research assistants, developing standardized methodologies, and facilitating regional workshops and webinars to enhance local expertise and knowledge exchange.

Dr. Xue concluded by outlining the project's expected outputs, which include peer-reviewed scientific publications, urban microplastic datasets, and policy-oriented frameworks to support national and regional decision-making. Public outreach efforts will also involve social media engagement and regional dissemination events to raise stakeholder awareness. Ultimately, the project seeks to bridge scientific knowledge with policy action, strengthen cross-border collaboration among Southeast Asian countries, and contribute to the sustainable management

of microplastic pollution in the region's aquatic ecosystems. *More information see attached presentation*

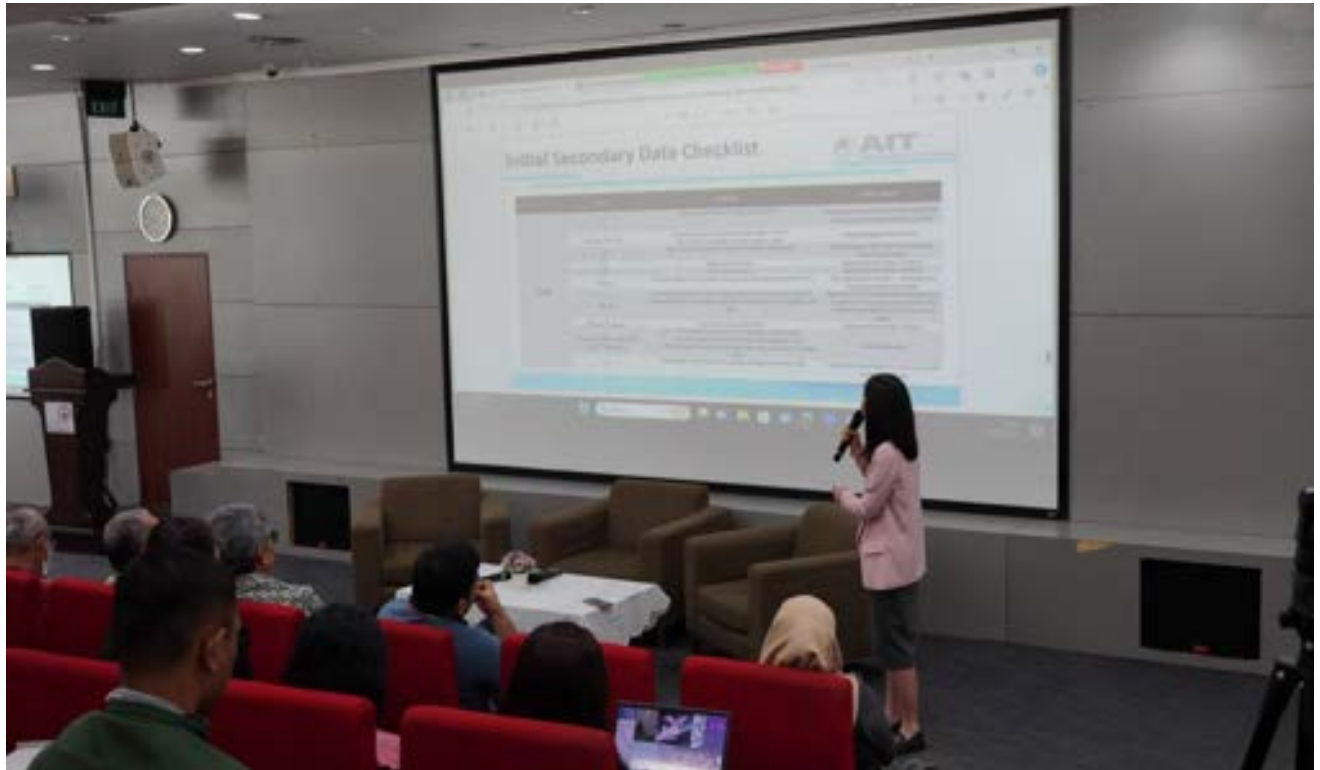
Photo Activities



Welcome remarks by Prof. Dr. Wawan Gunawan A. Kadir, Rector of Universitas Pertamina



Opening Remarks by Prof. Dr. Erna Sri Adiningsih, National Research and Innovation Agency, Indonesia. Member of APN Scientific Planning Group



Project Introduction by Dr. Wenchao Xue from Asian Institute of Technology



Project Kick-off Meeting

Activity 2 – Knowledge & Research Sharing on Microplastic in Southeast Asia (SEA)

Recent Progress on Microplastic Research in Indonesia.

Presented by Professor Muhammad Raza Cordova, Indonesian National Research and Innovation Agency (BRIN)

The second activity of the Knowledge and Research Sharing event featured a presentation by Professor Muhammad Raza Cordova from the Indonesian National Research and Innovation Agency (BRIN), who provided an in-depth overview of the recent progress in microplastic research in Indonesia. His presentation offered a comprehensive picture of the country's growing scientific efforts to understand and mitigate microplastic contamination within marine and coastal ecosystems.

Findings revealed that plastic waste originating from major urban centers—particularly Jakarta—travels rapidly through ocean currents, reaching the Indian Ocean in less than six months and, in some cases, extending as far as the South African coast within a year. This remarkable transboundary transport demonstrates how local pollution contributes to global environmental impacts, underscoring the urgency for upstream waste reduction and international cooperation. Rainfall patterns were also identified as a key factor influencing plastic accumulation on beaches, with the majority of pollutants traced to rivers located within a 30–50 km radius of the coastline.

Indonesia's tropical climate further exacerbates microplastic generation due to continuous exposure to intense sunlight and ultraviolet radiation, which accelerate plastic fragmentation. While this process reduces material size, it increases environmental persistence and toxicity. Professor Cordova emphasized that these micro-sized particles are not only difficult to detect but also pose severe risks to ecosystems and human health. Alarming recent evidence has even confirmed the presence of microplastics in human brain tissues, likely introduced through inhalation, raising deep concerns about the long-term consequences of exposure.

The presentation also shed light on research gaps and methodological challenges in Indonesia's microplastic studies. Most research efforts are still concentrated on Java Island, leaving large areas such as Sumatra, Kalimantan, and the Lesser Sunda Islands insufficiently studied. Moreover, the absence of standardized sampling and quality assurance protocols across research institutions has limited data comparability. Professor Cordova stressed the need for robust chemical composition analyses to accurately identify microplastic polymers, as misclassification remains a common limitation in existing studies.

To overcome these barriers, he underscored the necessity of preventive measures—particularly managing plastic waste in rivers and urban systems before it reaches the ocean. Strengthening international research collaboration was identified as a key priority to harmonize methodologies, improve data reliability, and enhance the region's collective capacity to monitor and mitigate plastic pollution.

In conclusion, Professor Cordova emphasized that Indonesia must scale up both national and regional actions to address the accelerating threat of microplastic contamination. The presentation called for coordinated scientific efforts, methodological standardization, and sustained cross-border partnerships. These actions are vital for developing effective solutions that safeguard marine ecosystems, human health, and the shared environmental future of Southeast Asia.

Microplastics in Mangrove Sediments: The Role of Microorganisms in Degradation

Presented by Dr. Simon Guerrero Cruz from Asian Institute of Technology,

Dr. Simon Guerrero Cruz, from the Asian Institute of Technology (AIT), presented a comprehensive study on the occurrence and behavior of microplastics within mangrove sediments, focusing on the pivotal role of microorganisms in their degradation. Building upon his background in wastewater treatment and rice agriculture, Dr. Guerrero Cruz has expanded his research to include microplastic contamination—an emerging global concern since 2004. His work integrates the study of microplastic pollution, microbial processes, and greenhouse gas mitigation in anthropogenic ecosystems such as mangroves.

Mangrove forests, though covering only a small portion of the Earth's surface, play an essential role in carbon sequestration, biodiversity conservation, and coastal protection. They can absorb up to ten times more carbon than terrestrial forests, making them vital in combating climate change. However, increasing human activities—particularly plastic pollution—have led to the

accumulation of microplastics in mangrove sediments. These plastics gradually fragment into nanoplastics, disrupting natural sediment processes, threatening mangrove health, and posing risks to organisms within these ecosystems.

Dr. Guerrero Cruz emphasized the importance of microorganisms in maintaining ecosystem stability through carbon and nitrogen cycling. However, the accumulation of microplastics interferes with these biogeochemical cycles, contributing to environmental degradation. He introduced the concept of the “plastisphere”—a newly recognized ecological niche where microorganisms colonize and interact with plastic surfaces. In mangrove ecosystems, this plastisphere significantly influences the structure, diversity, and functionality of microbial communities, affecting nutrient cycling and organic matter decomposition.

His ongoing research, conducted in collaboration with the Royal Netherlands Institute for Sea Research (NIOZ), investigates the spatial distribution of microplastics across different sediment depths and their effects on microbial assemblages. Preliminary findings indicate that microplastic abundance and characteristics—including particle size, polymer type, and color—correlate with distinct shifts in microbial community composition.

The ultimate goal of this research is to identify specific microbial taxa capable of plastic degradation and to determine the environmental conditions that promote or hinder these processes. This understanding could pave the way for biotechnological applications that harness microbial pathways to degrade plastics more effectively.

In conclusion, Dr. Guerrero Cruz highlighted the need for continued interdisciplinary research into the complex interactions between microplastics and microorganisms. He expressed optimism that microbial-based innovations could play a key role in mitigating plastic pollution within mangrove ecosystems and beyond. The session underscored the promise of combining microbiological science with environmental engineering to develop sustainable, nature-based solutions for one of today’s most urgent environmental challenges.

Q&A Session

The Q&A session featured a dynamic exchange of ideas and technical insights between participants and two leading experts — **Prof. Cordova** and **Dr. Guerrero Cruz** — reflecting the collective urgency and scientific depth surrounding microplastic research in Southeast Asia. The discussion underscored not only methodological challenges but also the broader implications for human health, ecosystem stability, and regional policy harmonization.

Microplastic Distribution Modeling

Participants inquired about the application of hydraulic and ocean circulation models to simulate the distribution of microplastics. Questions focused on how input sources, particularly river systems, are represented in models—whether as averaged loads or through discharge-based variability—and how seasonal fluctuations such as rainfall are incorporated.

Professor Cordova explained that current modeling efforts integrate empirical field data

collected twice annually from coastal and marine sites to capture seasonal trends. The models combine ocean-current dynamics, wave interactions, and hydrodynamic parameters to replicate real-world microplastic transport and accumulation. While model validation remains challenging due to inconsistent data quality across Indonesian studies, ongoing collaborations with international partners and the continuous addition of new datasets are improving precision, reproducibility, and policy relevance. The discussion reinforced the need for standardized regional modeling protocols and shared databases to strengthen cross-country comparability.

Airborne Microplastics

Attention turned to the emerging issue of microplastics in the atmosphere. Participants asked about sampling methods and the environmental factors influencing particle dispersion. Professor Cordova described the use of air-sampling and rainfall-deposition devices, similar to greenhouse-gas monitoring systems, to capture airborne microplastic particles. Data show elevated concentrations near transport corridors, industrial areas, and landfills, with tire abrasion contributing roughly 30 percent of airborne microplastic particulates.

The discovery of microplastics in human brain tissue underscored the potential health risks of inhalation exposure. However, the atmospheric transport mechanisms of microplastics remain poorly understood. The session emphasized the need for systematic monitoring and multidisciplinary research to better define persistence, transport pathways, and toxicological impacts.

Antibiotic-Resistant Microbes on Microplastics

Discussion then shifted toward microbial colonization on plastics and the possible transfer of antibiotic-resistant genes. Dr. Guerrero Cruz explained that microplastics act as substrates for biofilm formation, creating microhabitats that can harbor antibiotic-resistant bacteria. As these plastic fragments move through aquatic environments, they disperse microbial communities that may influence nutrient cycling and ecosystem resilience.

This phenomenon effectively turns microplastics into biological vectors with implications extending beyond environmental science to public health and antimicrobial-resistance management. The experts agreed that genomic studies and biosafety assessments are needed to determine how the plastisphere contributes to the spread of resistance genes.

Rising Microplastic Levels Despite Improved Waste Management

Participants questioned why microplastic concentrations continue to rise despite reported improvements in national waste management. Professor Cordova clarified that while collection efficiency has increased in some municipalities, plastic debris accumulation remains high along coastlines—especially beyond urban centers such as Jakarta. Continuous fragmentation of macroplastics replenishes microplastic stocks even where waste systems are advanced.

Dr. Guerrero Cruz added that urban sediments and drainage networks often retain microplastic residues that are remobilized during flood events, producing sudden spikes in pollution. The discussion identified a gap between policy frameworks and ground-level outcomes,

emphasizing the importance of source-focused waste management, stormwater control, and flood-resilience planning to prevent re-contamination.

International Guidelines and Standards

The final discussion addressed the absence of harmonized international standards for microplastic monitoring. Professor Cordova noted that although global frameworks are still evolving, regional collaborations are progressing rapidly. Joint initiatives among Indonesia, Thailand, Vietnam, and Myanmar are drafting standardized sampling, extraction, and analytical protocols. Indonesia's Ministry of Environment and Forestry is preparing to release its first national microplastic assessment guidelines by the end of the year.

Dr. Guerrero Cruz added that existing air- and water-quality standards—such as PM10 and PM2.5—do not yet incorporate microplastic metrics, leaving significant analytical and policy gaps. Future revisions could include particle-size-specific thresholds and polymer identification techniques to enable consistent environmental reporting.

In closing, participants agreed that developing standardized methodologies and cross-border frameworks is essential for ensuring data comparability, guiding risk assessment, and promoting coordinated regional action. The exchange highlighted the growing recognition that microplastic pollution is not just a scientific issue but a shared regional priority requiring unified policies and sustained collaboration.

Concluding Remarks

Closing reflections highlighted both scientific innovation and policy responsibility as dual imperatives in combating microplastic pollution. Dr. Guerrero Cruz emphasized the transformative potential of biological pathways for plastic degradation. Recent findings from international research teams revealed a fungal strain capable of degrading polypropylene and polyethylene within oceanic biofilms from the Pacific Garbage Patch.

Building on this knowledge, ongoing research in mangrove ecosystems seeks to identify microbial taxa capable of degrading plastics under both aerobic and anaerobic conditions. These environments provide natural laboratories for studying biogeochemical processes that can be leveraged for scalable, nature-based technological applications. The exploration of microbial metabolism for plastic degradation presents a frontier opportunity for sustainable environmental biotechnology.

Prof. Cordova concluded the session by reaffirming the urgency of addressing plastic pollution at its source. Reducing plastic consumption—particularly single-use plastics—was identified as the most effective preventive measure. Comprehensive cleanup campaigns targeting rivers, coastal zones, and marine systems remain indispensable for managing legacy pollution.

Beyond technical solutions, the session underscored a broader ethical responsibility: ensuring environmental integrity for future generations. The concluding message resonated as both a warning and a call to action:

“We borrow this land from the future, not from ourselves.”

This sentiment encapsulated the central theme of the discussion—scientific rigor must be matched with societal accountability and regional solidarity to confront one of the defining environmental challenges of the century.

Microplastics in Wastewater Treatment in Vietnam

Presented by Dr. Thi Kim Quyen

Dr. **Thi Kim Quyen**, lecturer in Environmental Engineering at Ho Chi Minh City University of Industry, presented an in-depth overview of microplastic contamination within Vietnam’s wastewater treatment systems. Her presentation examined how domestic activities, fishing operations, and surface runoff contribute to the generation and transport of microplastics into aquatic environments. Improper waste management practices were identified as a major cause, enabling plastics to enter rivers and canals where physical degradation and photo-oxidation fragment larger debris into microplastics. Fishing gear, particularly synthetic nets and lines, was also recognized as a significant source of plastic contamination in coastal and estuarine zones.

Dr. Quyen emphasized the vital role of municipal wastewater treatment plants (WWTPs) as key interception points in preventing microplastics from entering natural waterways. Data from Vietnamese facilities show that systems equipped with primary sedimentation units, sand filtration, and flocculation achieve removal efficiencies of up to 90%. By contrast, conventional activated sludge systems typically demonstrate lower efficiencies—ranging from 50% to 70%. Membrane bioreactor (MBR) technologies were highlighted as a promising solution due to their superior filtration performance. Ongoing research in Vietnam is currently optimizing parameters such as salinity and hydraulic retention time to enhance removal efficiency, with results expected in forthcoming publications.

One of the key challenges discussed was the management of treatment residues, particularly sludge. A large proportion of captured microplastics accumulates in this sludge, which is often repurposed as agricultural fertilizer. This practice unintentionally creates a secondary pollution pathway, reintroducing microplastics into soil and freshwater environments. Addressing sludge-derived contamination was therefore identified as a research and policy priority to ensure circular and sustainable wastewater management.

Laboratory analyses conducted by Dr. Quyen’s team revealed that fibers account for over 90% of all microplastic particles detected in wastewater samples. These fibers originate primarily from synthetic textiles, detergents, and washing machine effluents. Due to their high mobility, persistence, and ability to adsorb hazardous chemicals, fibrous microplastics pose unique challenges for removal and long-term containment.

In her concluding remarks, Dr. Quyen called for the development of biological degradation technologies capable of breaking down microplastics rather than merely removing them. She highlighted emerging research on enzymatic and microbial degradation pathways, which may allow for in situ biodegradation within treatment systems. The presentation concluded by emphasizing the importance of collaborative research and capacity building, recognizing the contributions of early-career researchers and students. Dr. Quyen extended an open invitation for regional cooperation in developing sustainable, low-cost, and scalable solutions for microplastic management within wastewater treatment infrastructure.

Microplastic Pollution in Urban Waterways in Thailand

Presented by Ms. Mutita Wattanasuk

Ms. **Mutita Wattanasuk**, Associate Researcher at the Asian Institute of Technology (AIT), presented an insightful study on the prevalence, pathways, and composition of microplastic (MP) pollution in major urban aquatic systems in Thailand. The research focused on the Bangkok Metropolitan Region (BMR)—a densely populated and industrially dynamic area where urban runoff, wastewater discharges, and stormwater systems converge into key waterways, notably the Chao Phraya River.

Findings revealed that microplastic pollution is an escalating environmental threat in urban Thailand, exacerbated by rapid industrialization, high population density, and insufficient waste management infrastructure. In the Lower Chao Phraya River, microplastics were found to be dominated by fibers, fragments, and foams, primarily originating from fishing gear, packaging materials, and consumer waste improperly disposed into waterways.

The study further identified urban stormwater runoff as a major transport pathway for microplastics. Among pollution sources, industrial estates contributed the largest proportion, followed by commercial and transportation zones. Microscopic analyses revealed particles derived from tire abrasion, construction debris, and personal care products within surface flow channels. In addition, sewage networks and decentralized wastewater treatment systems (DEWATS) were identified as critical release points for fiber-shaped microplastics, largely stemming from household laundry effluents and textile fibers entering local drainage systems.

The accumulated pollution from these sources ultimately discharges into Thailand's riverine and coastal ecosystems, where microplastics persist in both sediment and aquatic organisms. This persistence poses long-term risks to biodiversity, food safety, and public health through trophic transfer and chemical adsorption mechanisms. The study underscored that the infiltration of microplastics into the food chain threatens not only aquatic species but also human communities dependent on coastal and marine resources.

Ms. Wattanasuk emphasized that addressing urban microplastic pollution requires integrated, multi-level interventions. Policy measures should prioritize waste reduction at the source—including restrictions on single-use plastics, enhancement of recycling systems, and regulation of industrial discharges. Equally important are community-level behavioral shifts,

such as responsible waste sorting, reduced plastic use, and adoption of sustainable alternatives, to reduce plastic leakage from households and industries alike.

The presentation concluded with a strong call for cross-sector collaboration among local governments, industries, and communities to build an integrated framework for urban plastic management. Only through coordinated efforts across policy, science, and society can Thailand effectively protect its water resources and reduce the long-term environmental and socio-economic footprint of microplastic contamination in its urban ecosystems.

Q&A Session Summary

The Q&A session facilitated an active exchange of ideas among regional experts, highlighting both technical and practical challenges in managing microplastic pollution. Questions and discussions were guided by **Dr. Thi Kim Quyen and Ms. Mutita Wattanasuk**, with contributions from researchers across Indonesia, Thailand, and Japan, reflecting a shared commitment to advancing scientific understanding and collaborative solutions in Southeast Asia.

Dr. Eng. Mega Mutiara Sari, Vice Dean of Infrastructure Planning Faculty, shared insights from research conducted across Jakarta, Kalimantan, and Bali in collaboration with Japanese partners. The study identified microplastics in rivers, fish, and drinking water systems, providing critical data on contamination pathways and ecosystem exposure. Two key technical questions were raised:

1. How the shape of microplastic particles influences removal efficiency in water treatment plants.
2. How treatment facilities handle sludge containing residual plastic particles.

Ms. Mutita Wattanasuk addressed the first question by emphasizing that the morphology of microplastics strongly affects sedimentation and filtration performance. Compact or spherical particles tend to settle more effectively, while irregular, elongated, or fibrous microplastics exhibit buoyant behavior and resist conventional treatment processes. Although current research primarily focuses on surface water systems, evidence indicates that a substantial proportion of microplastics persist in treated water despite advanced membrane filtration. This finding reinforces the necessity for both technological innovation and public engagement to minimize plastic discharge at the source.

Additional perspective was provided by Dr. Wenchao Xue, who elaborated on the complexities of microplastic removal through filtration systems. Membrane-based technologies—particularly polymeric and ceramic membranes—were identified as among the most effective methods currently available. However, the discussion also recognized a sustainability paradox, as many high-performance filtration materials themselves derive from plastic polymers. Balancing innovation with long-term environmental responsibility was therefore highlighted as a critical consideration for future research and policy development.

Concerns regarding data reliability and sampling sources were also discussed. Dr. Evi Siti Sofiyah from Universitas Pertamina, Indonesia, questioned whether the reported datasets were based on operational wastewater systems or laboratory-scale experiments. Dr. Thi Kim Quyen clarified that the majority of datasets were collected from functioning wastewater treatment plants, where primary sedimentation plays a vital role in capturing larger plastic debris. Smaller microplastics, however, frequently bypass existing systems due to their minute size and density. Laboratory experiments were acknowledged as valuable for mechanism-specific studies, but the discussion concluded that field-scale investigations remain indispensable for capturing the true variability and complexity of real-world wastewater dynamics.

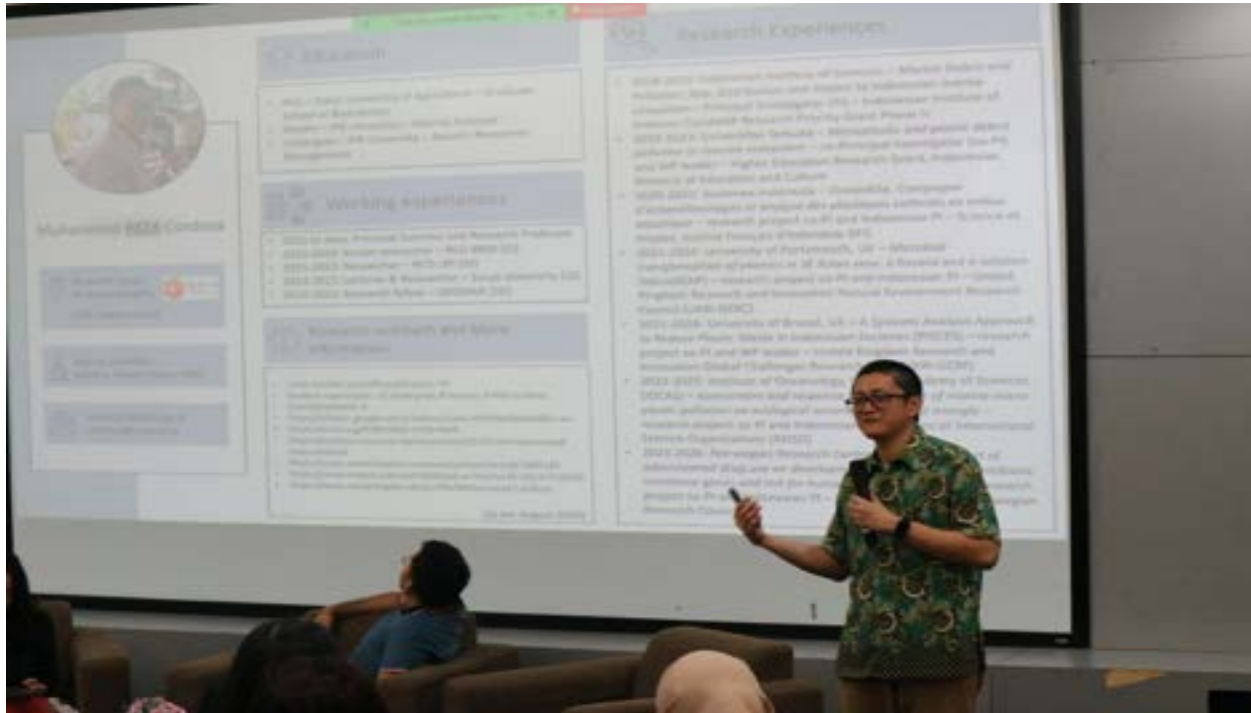
The session underscored the importance of integrating laboratory findings with field-based evidence to enhance understanding of microplastic behavior in treatment systems. Participants emphasized the necessity of interdisciplinary collaboration—linking environmental engineers, chemists, policymakers, and community stakeholders—to translate research into practical solutions. The exchange reinforced that effective microplastic management requires not only technological advancement but also public awareness, behavioral change, and policy coherence across sectors.

Collectively, the dialogue reflected a regional consensus: addressing microplastic pollution demands sustained research, resource mobilization, and shared accountability to ensure long-term environmental resilience in Southeast Asia.

Summary

The talk-show and Q&A session highlighted the growing regional collaboration on microplastic research among scientists from Vietnam, Thailand, and Indonesia. Experts discussed the need to harmonize data collection and strengthen wastewater treatment technologies to reduce microplastic release from urban systems. Insights were shared on how microplastic particle shape affects removal efficiency, the persistence of fibers in treated water, and the challenge of plastic residues in treatment sludge. Participants also emphasized sustainability concerns over plastic-based filtration materials and called for innovation in eco-friendly alternatives. The session underscored the importance of integrating laboratory findings with field data, improving public awareness, and translating research outcomes into policy and community action. A collective commitment emerged to build a regional framework for data sharing, technology development, and behavioral change aimed at mitigating microplastic pollution across Southeast Asia's water environments.

Photo Activities







Knowledge sharing and research exchanges by regional researchers and project collaborators on Microplastic pollution and management in SEA.

1st stakeholder consultation

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

Dr. **Wenchao Xue** from the **Asian Institute of Technology (AIT)** introduced the regional project titled “*Enhancing the Science–Policy Interface to Manage Microplastic Influx from Major Cities into the Oceans in Southeast Asia.*” The initiative seeks to bridge the gap between scientific research and policymaking, addressing the growing challenge of microplastic pollution across urban and coastal systems in the region. Dr. Xue emphasized that understanding how urban environments contribute to microplastic generation and transport is essential to designing effective solutions. The project aims to establish a systematic research and policy framework that traces microplastics from their sources through environmental pathways to their impacts on marine ecosystems, focusing on densely populated cities with complex waste management systems.

A core goal of the project is to quantify the annual flux of microplastics from urban environments into the oceans. This involves analyzing the waste management practices, infrastructure gaps, and behavioral drivers in different Southeast Asian countries, each of which operates under distinct regulatory and cultural contexts. Through quantitative modeling and system analysis, the project seeks to map how plastics move through cities, rivers, and coastlines, identifying critical leakage points and proposing interventions that address pollution at its source. To ensure coherence and collaboration, the research has been structured into working packages that connect field studies, data modeling, and policy translation, ensuring that scientific findings are actionable and policy-relevant.

Dr. Xue underscored the central role of stakeholder engagement in ensuring that the project’s research remains grounded, inclusive, and impactful. A series of policy dialogues, workshops, and multi-sector consultations are being conducted with experts from urban management, environmental protection, and public health sectors. These activities are designed to gather feedback, validate findings, and align research priorities with the needs of policymakers and local communities. Today’s roundtable formed part of this participatory process, offering a platform for stakeholders to share regional perspectives, practical challenges, and policy insights, thereby shaping the project’s ongoing direction and enhancing its real-world applicability.

One of the major challenges identified by Dr. Xue concerns the complexity and variability of data collection across Southeast Asia. The diversity of urban systems, waste management structures, and data availability makes it difficult to adopt a uniform approach to measuring microplastic flows. To overcome these challenges, the project team is working closely with national research partners and municipal authorities to collect both primary and secondary data while conducting initial evaluations of local waste and water management systems. This

collaborative approach ensures that data collection methods are context-sensitive while contributing to a shared regional evidence base.

The project ultimately aims to deliver evidence-based policy recommendations to help governments, industries, and communities design effective and sustainable waste management interventions. These recommendations will focus on reducing plastic generation at the source, enhancing recycling and circular economy initiatives, and preventing plastic leakage into riverine and marine ecosystems. Dr. Xue highlighted that the project's overarching ambition is to establish a robust science–policy interface—a collaborative platform that connects researchers, policymakers, and stakeholders—ensuring that scientific evidence directly informs decision-making processes at local, national, and regional levels.

In conclusion, Dr. Xue outlined the project's next steps, which include refining the conceptual framework, expanding data collection activities, and organizing a series of stakeholder workshops and policy dialogues across participating countries. These efforts will strengthen collaboration and ensure that the project continues to deliver practical, scalable, and policy-oriented solutions to mitigate microplastic pollution. Dr. Xue reaffirmed the importance of maintaining continuous engagement and adaptive research practices, ensuring that the project remains responsive to emerging challenges and contributes meaningfully to a sustainable and science-driven response to plastic pollution in Southeast Asia.

Key Stakeholders

The stakeholder dialogue brought together representatives from key ministries, research institutions, utilities, and civil society organizations to share insights and experiences on addressing microplastic pollution in Indonesia. Their inputs reflected both a **high level of awareness** about the environmental and health implications of microplastics and a clear understanding of the **policy and infrastructure challenges** that hinder effective management. Each stakeholder's contribution revealed specific concerns, institutional priorities, and opportunities for collaboration with the **APN project, “Enhancing the Science–Policy Interface to Manage Microplastic Influx from Major Cities into the Oceans in Southeast Asia.”**

- **Prof. Muhammad Reza Cordova, M.Si, Ph.D.**
 - Researcher at the Research Center for Oceanography, Indonesian National Research and Innovation Agency (BRIN).
 - Focuses on microplastic sampling and marine coastal protection efforts across Indonesia.
- **Tulus Laksono, S.H.**
 - Director of Water Pollution Control, Ministry of Environment and Forestry of Indonesia.
 - Oversees water pollution control policies and microplastic management efforts.
- **Asri Indivani, ST., M.Sc.**
 - Acting President Director of Perumda Palyja (Jakarta Regional Public Company for Sanitation).

- Responsible for wastewater management operations in Jakarta and initiatives to address plastic and microplastic contamination in wastewater systems.
- **Ir. Tanozisoichi Lase, M.Sc.**
 - Director of Sanitation, Ministry of Public Works and Public Housing of Indonesia.
 - Works on domestic waste management strategies and the development of urban sanitation infrastructure.
- **Ratih Rimayanti**
 - National Marine Coordinator, NGO Fauna & Flora Indonesia.
 - Focuses on mitigating land-based pollution impacts on marine ecosystems, collaborating with a global team to address marine plastic pollution.

Meeting Summary: Key Contributions and Stakeholder Engagement

During the stakeholder roundtable discussion on microplastic management, representatives from government agencies, academia, and the private and civil sectors shared their institutional perspectives, challenges, and contributions related to the APN project *“Enhancing the Science–Policy Interface to Manage Microplastic Influx from Major Cities into the Oceans in Southeast Asia.”* The dialogue reflected a strong collective awareness of the growing threat of microplastic pollution and the need for integrated solutions that connect research, policy, and practical implementation.

Ms. Tulus Laksono from the Ministry of Environment and Forestry (MoEF) opened by noting that although Jakarta’s overall solid waste generation is relatively low, plastic pollution remains a serious and expanding environmental issue. She reported that microplastics have been found in multiple environmental compartments—rivers, sediments, and aquatic organisms—highlighting their pervasiveness. MoEF expressed particular concern about the lack of standardized national monitoring systems and limited data comparability across research efforts. The Ministry emphasized that closer collaboration between government, academia, industry, and communities is crucial to developing effective and harmonized microplastic management strategies. The APN project was recognized as a valuable mechanism to fill this gap, as its *Source–Pathway–Receptor (SPR)* framework and harmonized sampling protocols can help establish national monitoring standards and support policy development. Through participation in the project, MoEF aims to integrate research findings into future ministerial regulations and enhance evidence-based environmental governance.

A representative of **Ir. Tanozisoichi Lase** from the **Ministry of Public Works and Public Housing (PUPR)** outlined Indonesia’s strategy to improve domestic waste management. The representative reported that 62.2 percent of national waste is currently managed through collection and treatment systems, with a target to reach full coverage—100 percent—by 2024. This goal will be achieved through expansion of TPS3R (Reduce–Reuse–Recycle) and TPST (Integrated Waste Processing) facilities that convert waste into fertilizers, biogas, and recyclable materials. However, PUPR raised concerns about ongoing plastic leakage from unserved urban areas and drainage networks that lack proper infrastructure. The project’s modeling and data collection activities were viewed as directly relevant to the ministry’s objectives, providing scientific evidence to identify leakage points and inform infrastructure upgrades. In turn, PUPR’s

collaboration will supply critical operational data to refine the project's quantitative models and strengthen its recommendations for integrated waste and water management.

From the Jakarta water utility Perumda Palyja, **Ms. Asri Indivani** discussed the city's challenges in managing microplastics through wastewater treatment systems. She explained that most urban households still rely on septic tanks, which create potential for microplastic release through sludge disposal. While modern technologies such as Moving Bed Biofilm Reactors (MBBR) and Fixed Aerated Bed (FAB) systems have improved pollutant removal, microplastics remain present in both treated effluent and drinking water. The absence of national regulatory standards for microplastic concentrations in wastewater and potable water was identified as a key institutional gap. Collaboration with the APN project provides an opportunity for Perumda Palyja to conduct joint sampling and data validation, generate baseline evidence to advocate for regulatory standards, and explore the potential for water reuse and sludge management innovations.

The academic and research community, represented by **Dr. Luqman Hakim and Professor Muhammad Raza Cordova**, presented ongoing studies on microplastic pollution across Indonesia. Dr. Luqman shared field data from the southern coast of Java, showing that microplastics account for 16.32 percent of total waste in West Java, with the highest concentrations occurring in river and coastal areas. His findings underscored the need to implement Ministerial Regulation No. 83/2018, which promotes circular economy principles and public education campaigns to reduce plastic use. Professor Cordova emphasized the need to translate research findings into policy briefs to support government decision-making and called for open data sharing among universities, NGOs, and policymakers to ensure regional consistency and coordination. Both researchers highlighted the importance of maintaining partnerships with local governments, particularly during political transitions, to guarantee that microplastic policies remain sustainable and actionable. Their collaboration with the APN project strengthens the regional research network, enabling data harmonization and comparative analysis between Indonesia, Thailand, and Vietnam.

Representing civil society, **Ms. Ratih Rimayanti, an NGO leader**, highlighted the importance of bridging research, policy, and community action. She stressed that public awareness of plastic pollution remains low, especially in coastal and urban areas where community participation in waste segregation and reduction is limited. Ms. Ratih advocated for nature-based solutions—such as restoring mangrove ecosystems, expanding urban green spaces, and enhancing coastal buffers—as effective, sustainable approaches to mitigate microplastic impacts while building climate resilience. The APN project’s scientific evidence and outreach activities can directly support NGO-led education and advocacy campaigns, helping translate research findings into accessible messages for the general public and decision-makers.

Across all discussions, stakeholders expressed a shared recognition that microplastic pollution is a complex, cross-sectoral challenge requiring close collaboration between science, policy, and practice. Common issues identified included inconsistent monitoring methodologies, fragmented data, limited regulatory standards, and insufficient public engagement. The APN project addresses these concerns by establishing standardized monitoring methods, creating a science–policy interface for evidence-based decision-making, and promoting capacity building among partner institutions. Furthermore, by engaging local governments and communities alongside national ministries and regional research institutions, the project ensures that both top-down and bottom-up perspectives are incorporated into long-term management strategies.

Next Steps and Conclusion

In her concluding remarks, **Dr. Wenchao Xue** outlined the next steps for the project, including refining the conceptual framework, advancing data collection efforts, and organizing additional stakeholder workshops and policy dialogues. The primary objective is to establish a robust science-policy interface that fosters effective collaboration between researchers and policymakers, ensuring that research findings lead to actionable policies.

Dr. Xue underscored the importance of continuous consultation and adaptation to emerging challenges in microplastic management. She emphasized the need for collaborative efforts to develop practical solutions that address the complex issue of microplastic pollution. The roundtable discussion reaffirmed the importance of aligning scientific research with policy initiatives, promoting regional collaboration, and engaging the public to tackle microplastic pollution effectively. With contributions from experts, government representatives, and NGOs, the project aims to formulate comprehensive strategies to manage the influx of microplastics from urban areas into oceans, promoting sustainable environmental management in Southeast Asia.

Photo Activities







National and local stakeholder roundtable discussion



Closing of the project kick-off and stakeholder engagement event

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

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

Presented by: Wenchao Xue

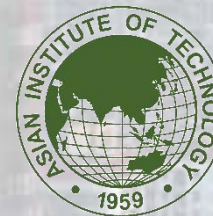
Environment Engineering and Management, School of
Engineering and Technology, Asian Institute of Technology

wenchao@ait.ac.th

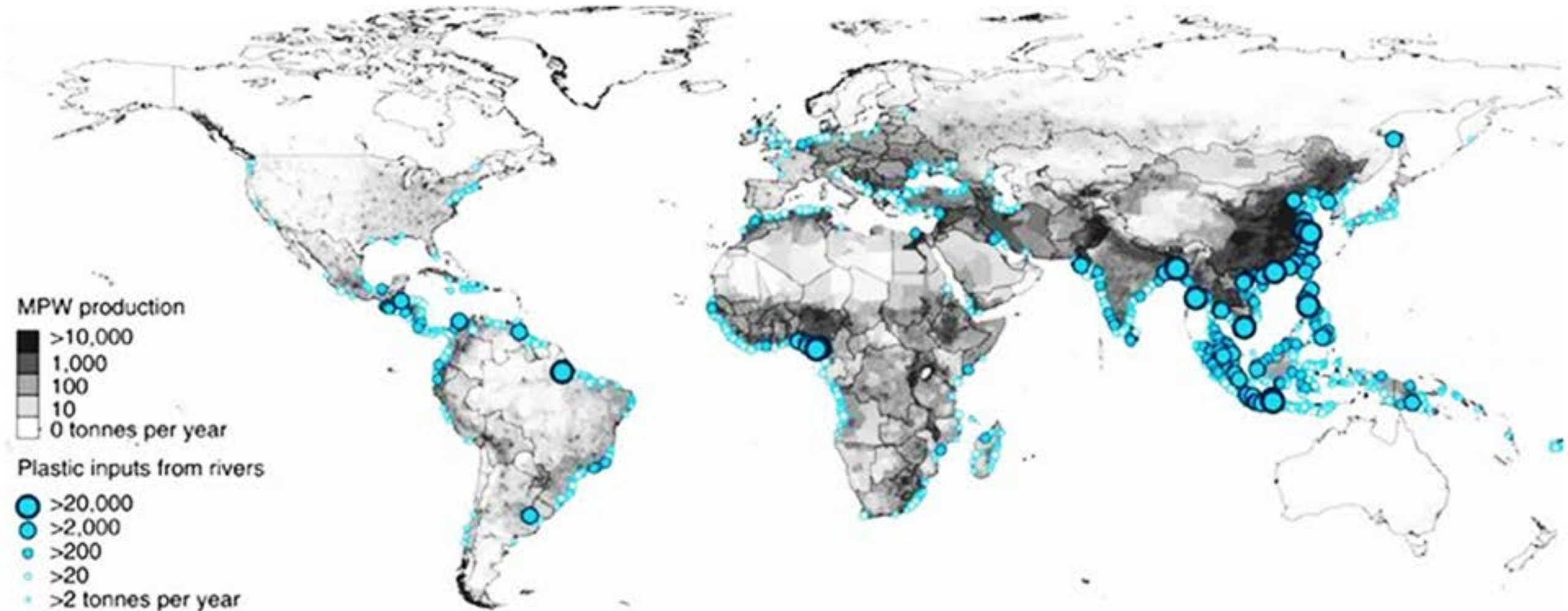
Project Duration: Oct 1, 2024 – Sep 30, 2026

Partner Institutes:

- Asian Institute of Technology, Thailand
- Ho Chi Minh City University of Industry and Trade (HUIT), Vietnam
- Universitas Pertamina (UP), Indonesia



Global Plastic Wastes

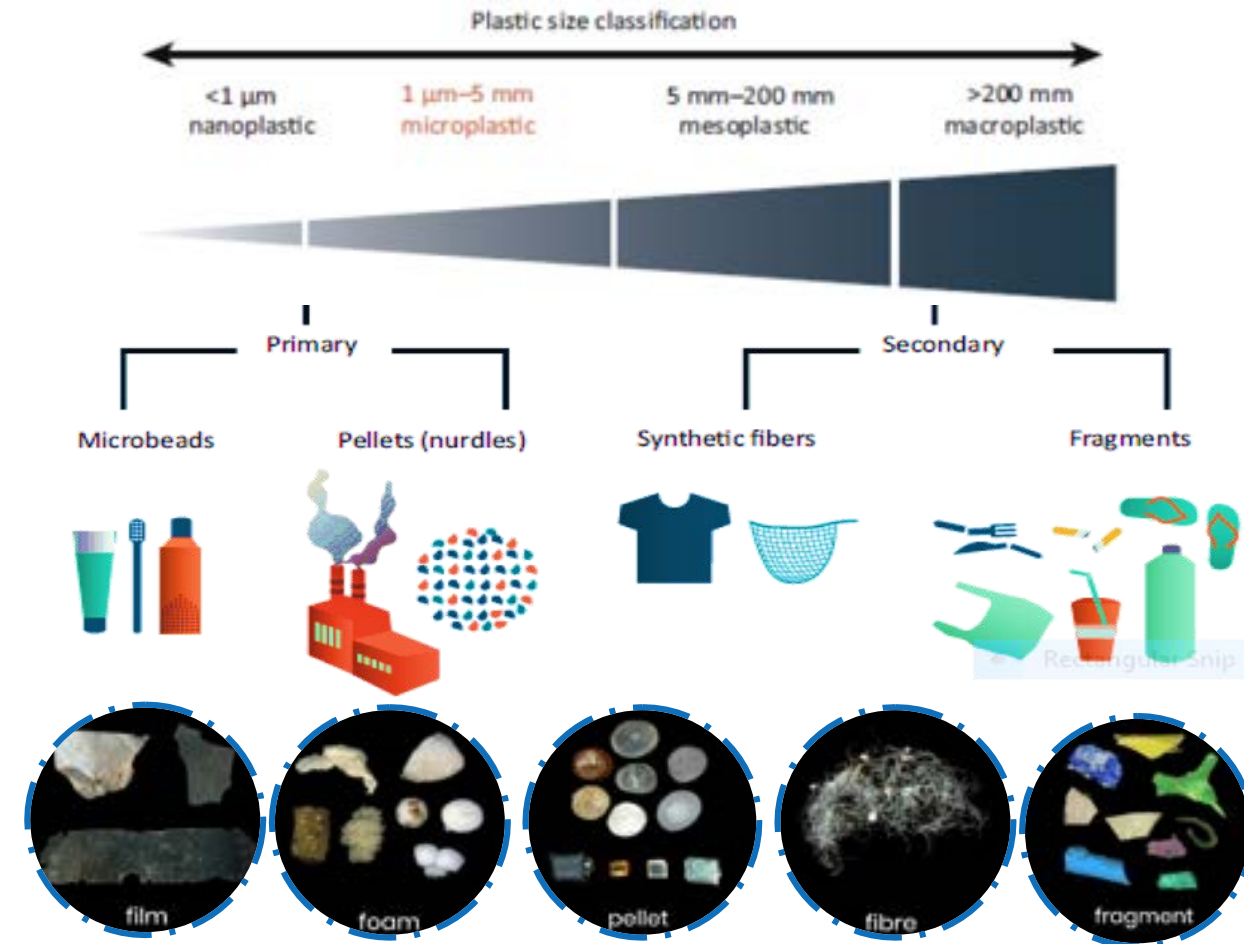


Environmental Concern on Microplastics

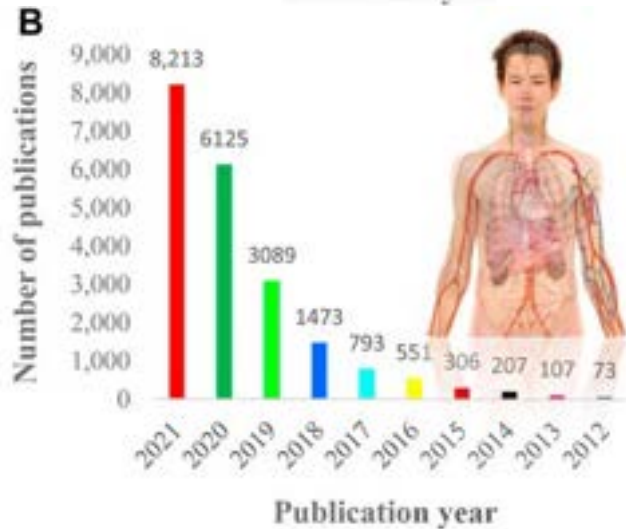
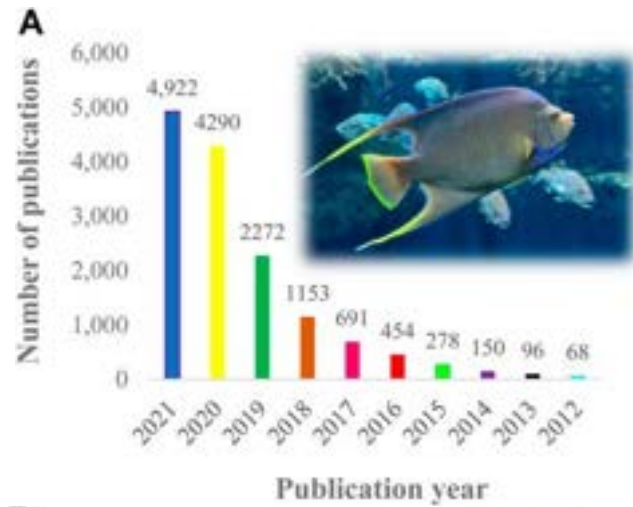


Microplastics

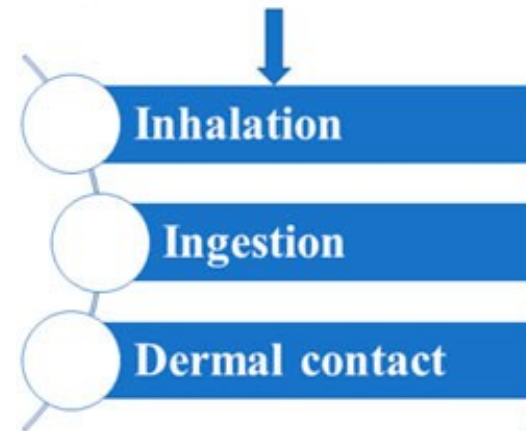
- *Small plastic particles that are less than 5mm in size.*
- Because of their suspected environmental **persistence**, **adsorption of toxic compounds**, and **bioaccumulation** through the food chain, MPs are potentially causing **diseases and death of aquatic fauna**, raising concerns about **human health** (Enfrin et al., 2019; Hou et al., 2021), and further threatening the **marine economy** on which many countries and regions rely heavily (Lee, 2015).
- Microplastics found in aquatic environments through various sources such as **stormwater runoff**, **wastewater treatment plant effluent**



Effects of MPs in Human Health



Exposure routes of MPs in body



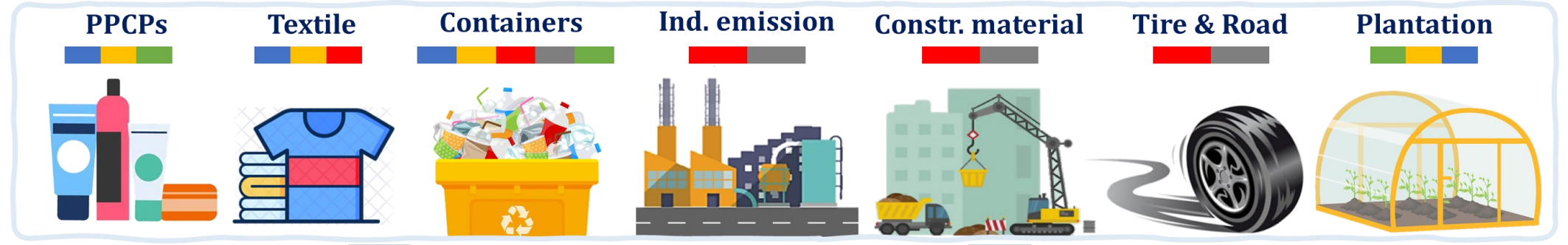
Effects of MPs in human



Bhuyan, 2022

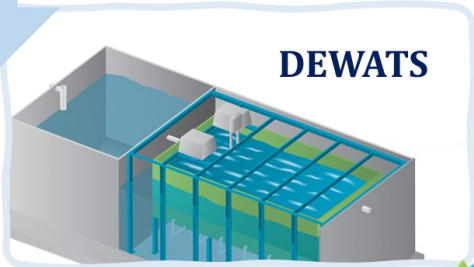
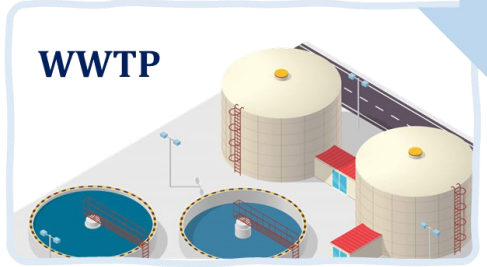
Microplastics in Urban Waterways

Urban sources of microplastics : ■ Residence ■ Commerce ■ Industry ■ Transportation ■ Agriculture



Urban sewage

Accidental losses
 Operational losses

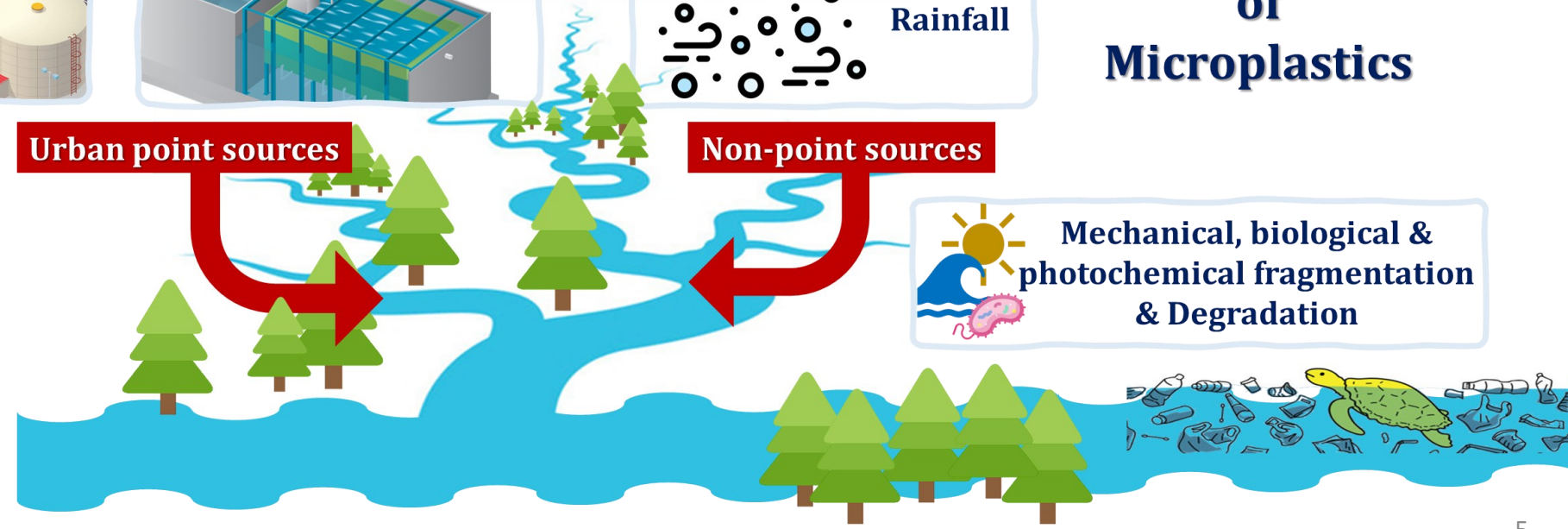


Urban Pathways of Microplastics

Urban point sources

Non-point sources

Mechanical, biological & photochemical fragmentation & Degradation

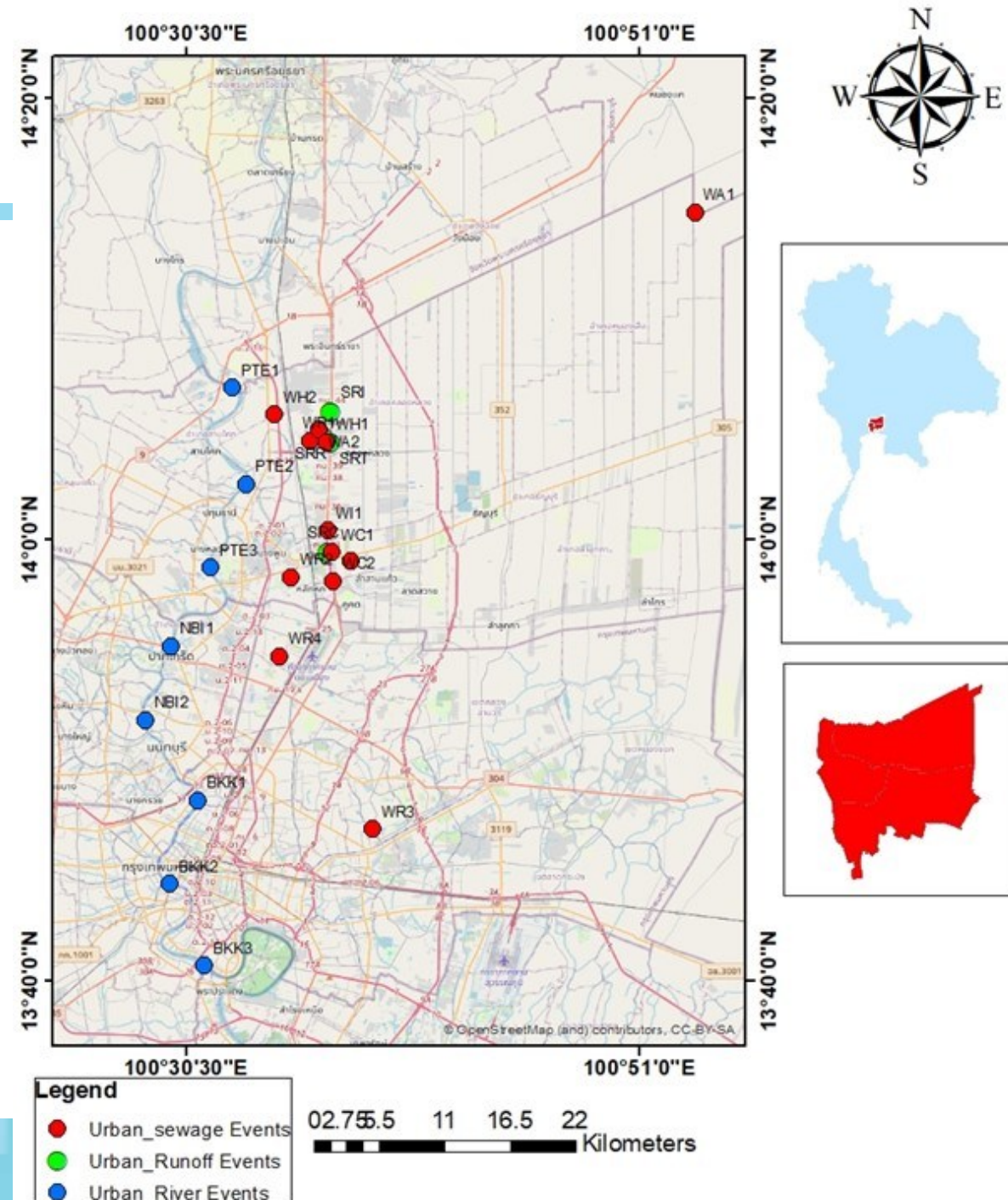


Our Previous Efforts

2020 - 2024

Investigations on Microplastic Pollutions in Urban Aquatic Systems in BMR

- ✓ To understand the presence, temporal and spatial variabilities of microplastics in the Lower Chao Phraya river
- ✓ To investigate the abundance and characteristics of microplastics in urban storm runoff
- ✓ To exam the variability of microplastics in different types of human-derived sewages
- ✓ To exam the elimination efficiency of microplastics in decentralized wastewater treatment facilities



Current Research and Knowledge Gaps



- ❑ **Urban stormwater runoff**, a few recent studies have analyzed and compared MP abundances under different land uses. For instance, Su et al. (2020) note that the intensity of **intensity of land use exacerbated the abundance of MPs in urban water**.
- ❑ In addition, **industry, commerce, and/or transportation** may be primarily responsible for the MPs detected in urban stormwater runoffs (Liu et al., 2019; Mak et al., 2020; Sugiura et al., 2021; Werbowski et al., 2021).
- ❑ In urban waterways, **wastewater treatment plants (WWTPs) may have a significant pathway for the release of microplastics**. In the influent wastewater, MPs consist of microfibers, Polyester, and fragments with an average abundance of **26.6±11.8 MPs** (van Wezel et al., 2016). Making it a potential source of microplastic contamination in agricultural soil or nearby environment.
- ❑ **Agricultural surface runoff found the occurrence and emission characteristics of MPs under various short-term fertilizer applications**. Chen et. al (2022) investigated the presence of MPs in a composite runoff mixed with agricultural drainage water and runoff, revealing a maximum abundance of $6.90 \pm 1.00 \text{ particle} \cdot \text{L}^{-1}$ and an emission rate of $247.6 \pm 98.3 \text{ tons} \cdot \text{a}^{-1}$, constituting **12.40 % of the total MP load in receiving water bodies**.
- ❑ Current studies often overlook the interconnectedness among various environmental compartments and pathways in aquatic ecosystems, leading to an incomplete understanding of the problem.

Current Research & Knowledge Gaps



- What is an appropriate framework to reflect the primary **sources, pathways, and receptors** of microplastics (MPs) released into oceans from major Southeast Asian cities?
- How can we **quantitatively estimate the influx of MPs** from Southeast Asian cities to the oceans?
- How did the **urban development, climate condition, and environmental management practices influence** their MPs pollutions?
- How can a comprehensive understanding of the pathways and influx of MPs from cities contribute to **improve the management and policymaking** in Southeast Asian countries?



Objectives:



❖ *Overall :*

The project includes three objectives aiming **at gaining a systematic understanding of MPs entering the oceans through urban aquatic systems in the SEA Region**

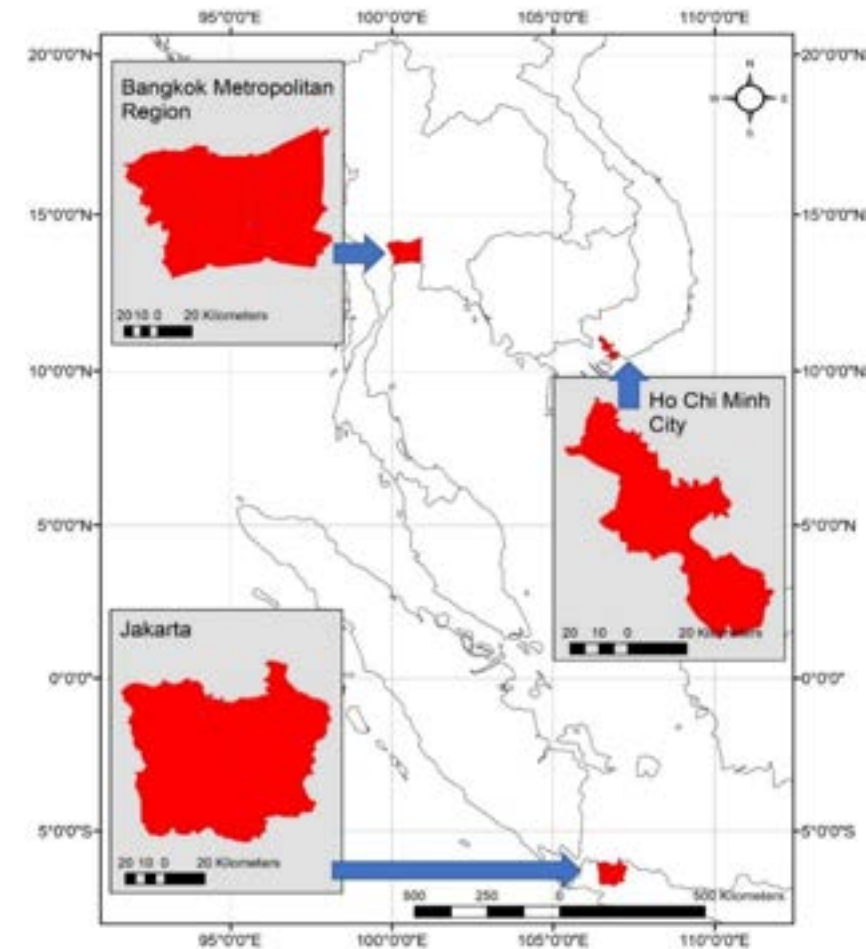
❖ *The specific objectives of this study are:*

- 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.**

Study Domain



City	Geographical Details	Pollution Sources
Bangkok Metropolitan Region (BMR), Thailand	<ul style="list-style-type: none"> - Area: 7,762 km² - Population: 6+ million - Located along Chao Phraya River. - Tropical monsoon climate, with rainy season from May to October. 	<ul style="list-style-type: none"> - Domestic wastewater from high-density urban areas. - Industrial wastewater from industrial zones in Samut Prakan and Pathum Thani. - Mixed sources at confluences of urban canals and rivers.
Jakarta, Indonesia	<ul style="list-style-type: none"> - Area: 661.23 km² - Population: 11.35 million - Located on the northwest coast of Java Island. - Equatorial tropical climate, wet season from November to March. 	<ul style="list-style-type: none"> - Population growth and land subsidence in Jakarta are major factors contributing to increasing pollution. - Surface water pollution in Jakarta comes from residential and commercial wastewater, industry, agriculture, solid waste and leakage from septic tanks. - Domestic wastewater from households using septic tanks, particularly in slum areas. - River and canal pollution, particularly in the Ciliwung River.
Ho Chi Minh City, Vietnam	<ul style="list-style-type: none"> - Area: 2,095 km² - Population: 9 million - Located near the Mekong Delta, along Saigon and Dong Nai rivers. - Tropical monsoon climate, wet season from May to November. 	<ul style="list-style-type: none"> - The Saigon River in Ho Chi Minh City is heavily polluted by domestic waste, industrial discharge, and plastic waste with only a small fraction of household sewage being properly treated. - The pollution is worsened by open dumping habits and inadequate wastewater treatment, leading to significant environmental and public health risks, especially during the rainy season.



Research Teams & Responsibilities



Dr. Wenchao Xue, PI
Dr. Simon Guerrero Cruz, Co-PI
Ms. Mutita Wattanasuk



Dr. Bob Adyari
Dr. Betanti Ridhosari
Dr. Nurulbaiti Listyendah Zahra
Dr. Evi Siti Sofiyah

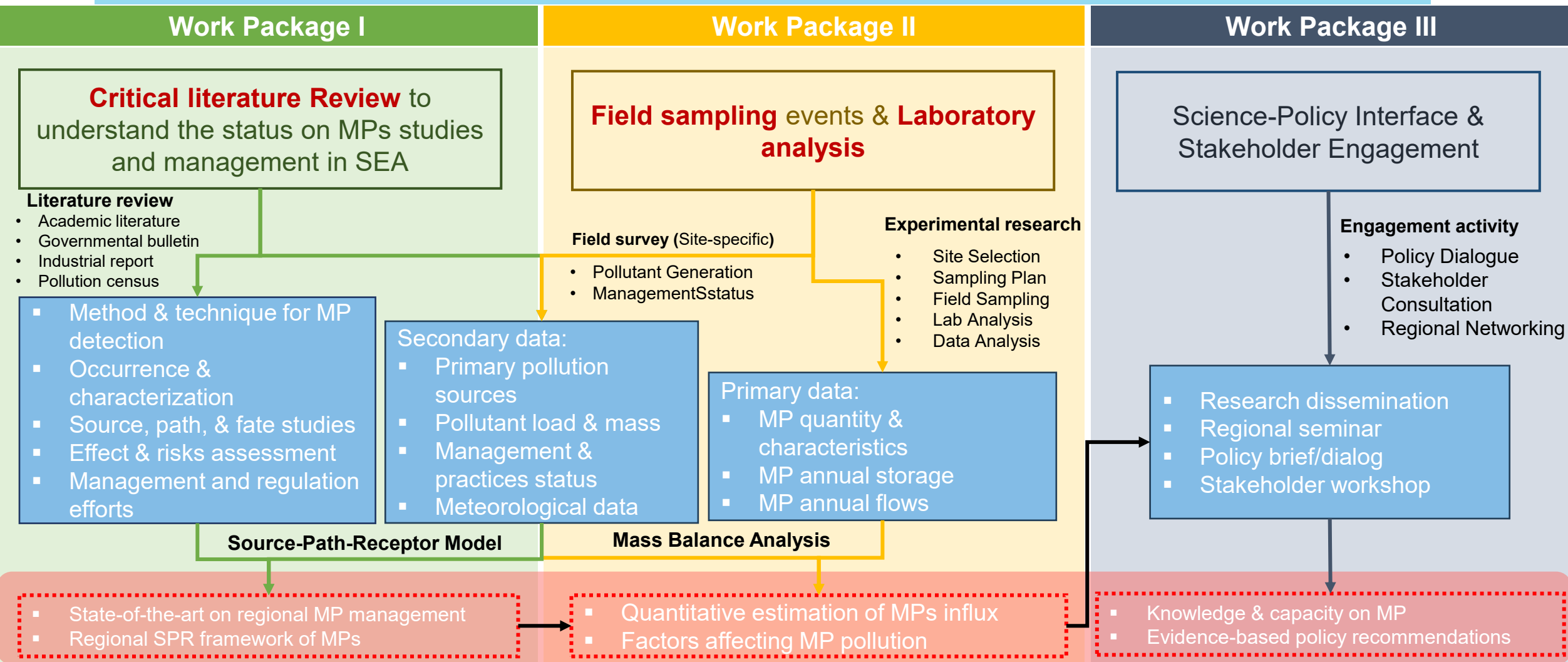


Dr. Thi Kim Quyen Vo

- Project management and coordination
- Leading all project activities, including literature review and secondary data collection
- Providing technical training for all project research assistants (RAs)
- Conducting field sample collection and analysis
- Performing data analysis and management
- Preparing policy briefs
- Organizing project meetings and workshops
- Preparing project reports

- Conducting literature review and secondary data collection in respective countries
- Identifying and communicating with national and local stakeholders
- Jointly designing sampling events
- Collecting field samples in respective countries
- Co-organizing and participating in project meetings and workshops

Methodology Framework



Project Timeline



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

Preliminary Efforts & Preparation



- ✓ Project preparation meetings & Field visits
- ✓ Identification of Primary Sources & Paths of MPs (BMR)
- ✓ Selection of tentative Sampling Sites (BMR)
- ✓ Determination of MP Sampling & Analysis Method
- ✓ Preparation of Secondary Data Checklist

SDG6

Project preparation meetings & Field visits



AIT
Asian Institute of Technology

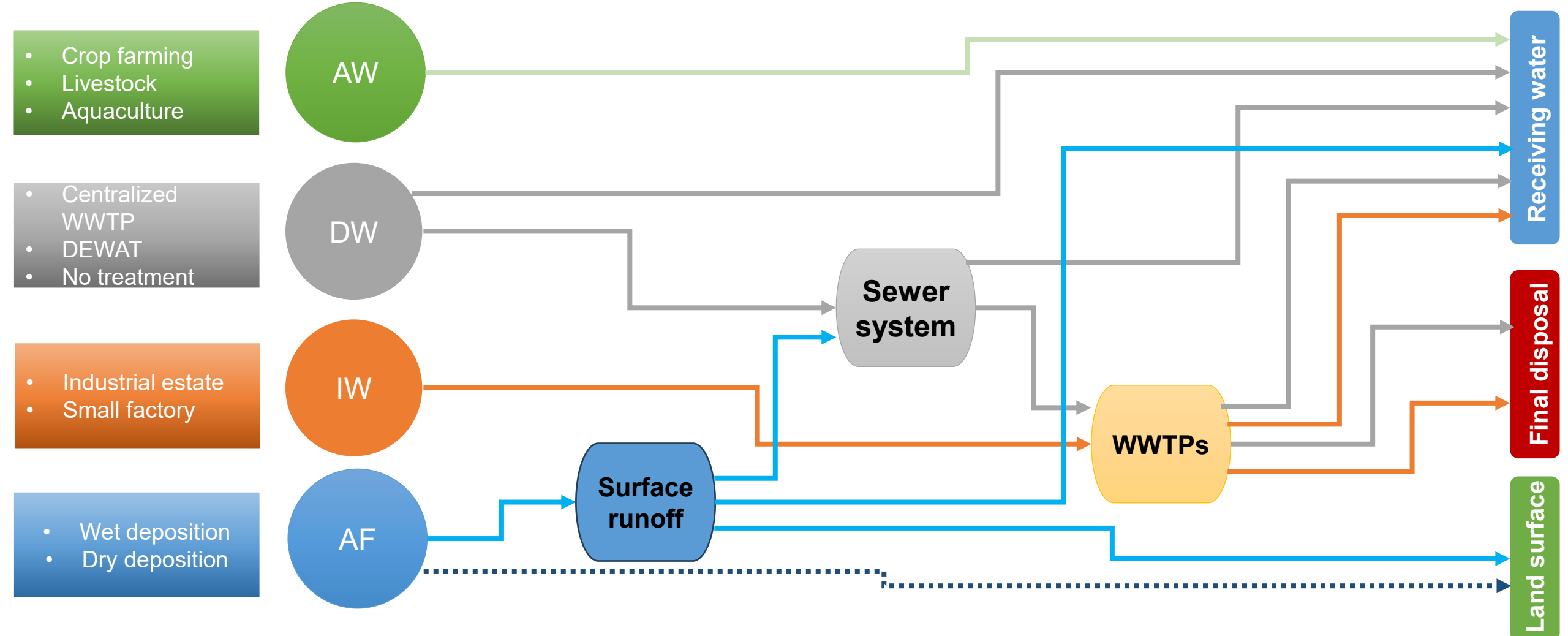


Working Group Meeting @Univertas of Pertamina on 7th Oct 2024



Field Visits on 8th Oct 2024

Identification of Primary Sources & Paths



Tentative Sampling Sites (BMR)

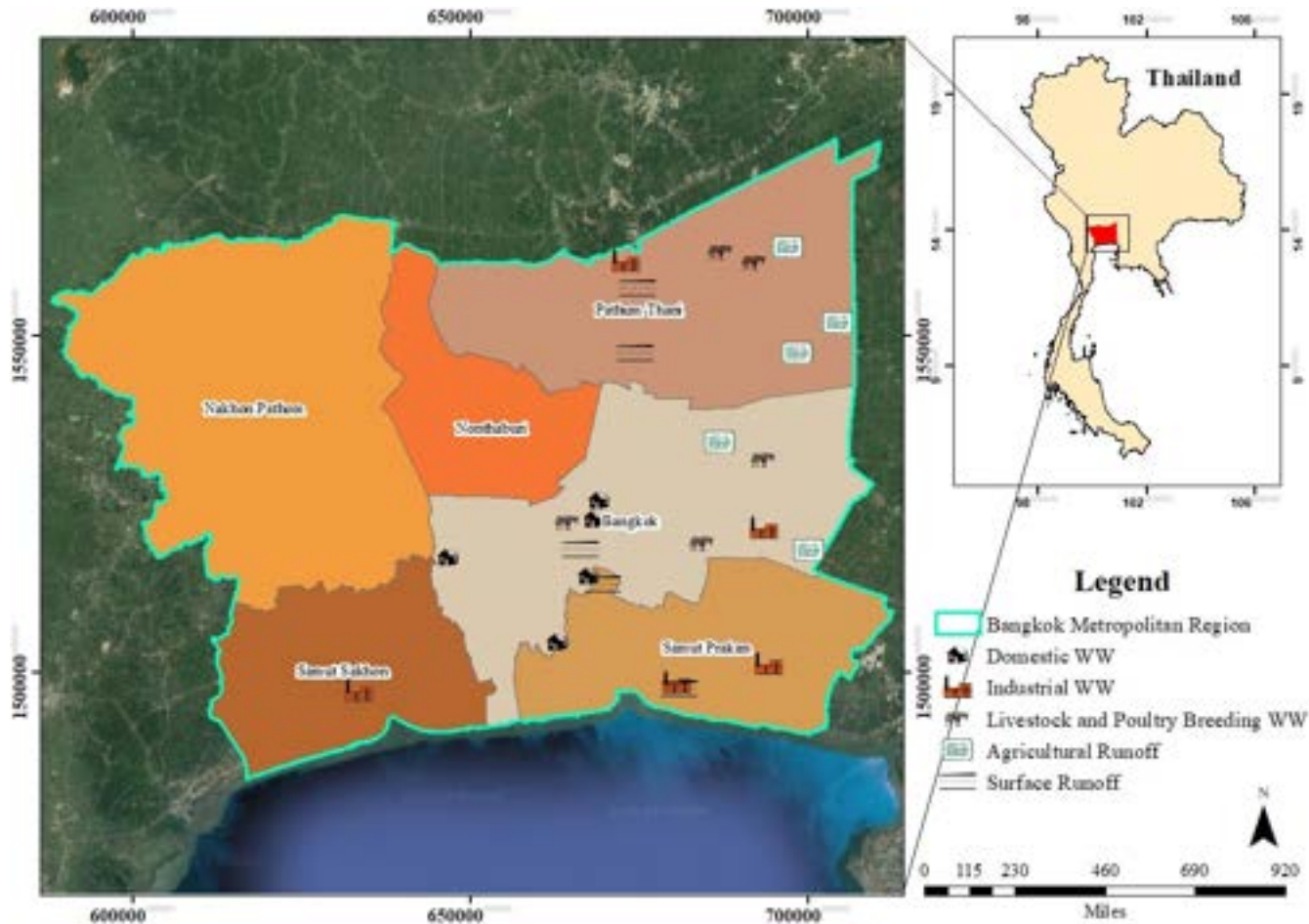


Table 3.1: Sampling Sites

Site ID	Location	Treatment System	Coordinate X	Coordinate Y	Capacity (m ³ /day)	Sewage Destination	Type of Wastewater
Domestic Wastewater							
DW-1	Chon Nonsi Water Quality Control Plant	Cyclic Activated Sludge System	667480	1514486	200,000	Chao Phraya River	Domestic
DW-2	Nong Khaem Water Quality Control Plant	Activated Sludge	686613	1517240	157,000	Rat Chaiyom Suk Canal	Domestic
DW-3	Thong Khro Water Quality Control Plant	Vertical Loop Reactor Activated Sludge	667896	1504664	177,000	Banue Chak Canal	Domestic
DW-4	Don Daeng Water Quality Control Plant	Biological Activated Sludge Process with Nutrient Removal	668427	1522871	150,000	Makkasan Swamp and Sertum Canal	Domestic
DW-5	Chatuchak Water Quality Control Plant	Cyclic Activated Sludge System	669057	1525543	150,000	Banue Van Canal	Domestic
Industrial Wastewater							
IW-1	Lakshana Industrial Estate	Activated sludge	691421	1521702	18,000	Prasert Business Canal	Key Industries: Electronics, automotive parts, and textiles
IW-2	Bangpu Industrial Estate	AS1: Activated Sludge, AS2: Activated Sludge, RBC: Rotating Biological Contactor	680480	1498708	AS1: 80,000, AS2: 3,600, RBC: 2,300	Sukhothajit Canal	Key Industries: Automotive, electronics, and petrochemicals
IW-3	Bangplee Industrial Estate	Activated sludge	694208	1501467	8,000	Chorakhe Noi Canal	Key Industries: Textiles, Packaging materials, and food processing

Site ID	Location	Treatment System	Coordinate X	Coordinate Y	Capacity (m ³ /day)	Sewage Destination	Type of Wastewater
IW-4	Samut Sakhon Industrial Estate	Activated sludge	671422	1497634	18,000	Siva Canal	Key Industries: Food processing, textiles, and consumer goods
IW-5	Nava Nakhon Industrial Estate	Activated sludge	671064	1561077	46,000	Rangsit Prayurarak Canal	Key Industries: Electronics, consumer goods, and packaging







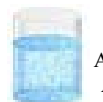







Agricultural Runoff							
AR-1	Phatphrak Organic Farm	-	698355	1547298	-	Canal 4	Crop Farming
AR-2	Khlong Sam Wa Paddy Field	-	686644	1514122	-	Sam Wa Canal	Paddy Field
AR-3	Khlong Thong Paddy Field	-	700227	1518215	-	Bang Canal	Paddy Field
AR-4	Khlong E1 Paddy Field	-	704437	1551872	-	Sam Sarp Canal	Paddy Field
AR-5	Nong Suan Paddy Field	-	697095	1563032	-	Canal 17 & E1	Paddy Field

Livestock and Poultry Breeding Wastewater							
LPBW-1	Brahman Cow Farm	-	684336	1518241	-	-	Livestock
LPBW-2	Sujitra Farm	-	691521	1531668	-	-	Poultry Breeding
LPBW-3	Suan Chatsalada Dairy Farm	-	664459	1522380	-	-	Livestock
LPBW-4	Jita Farm	-	687031	1562270	-	-	Poultry Breeding
LPBW-5	Phonkorakho Farm	-	692051	1560873	-	-	Poultry Breeding

Surface Runoff							
SR-1	Lumphini Park	-	666291	1518309	-	-	-
SR-2	Bang Krachon Plaza Pralong	-	669159	1511226	-	-	-
SR-3	Future Park Rangsit	-	674451	1541389	-	-	-
SR-4	Bang Pu Industrial Estate	-	680889	1497707	-	-	-
SR-5	Asian Institute of Technology	-	674613	1557040	-	-	-

Sampling & Laboratory Methods



Environmental Compartment	Wastewater from WWTP	Agricultural Runoff	Atmospheric Deposition
Sampling Size	1 L sewage WW for DW 1 L Influent WW 10 L Effluent WW	5 L of runoff	
Sampling Device	 Stainless-steel bucket	 Stainless-steel bucket	 Glass bottle + Funnel
Sieving Tool	 Sieve 5 mm 1 mm 0.025 mm	 Sieve 5 mm 1 mm 0.025 mm	 Sieve 0.025 mm
Digestion	 Add 20 ml Iron (II) And 20 ml H ₂ O ₂	 Place the beaker on the hotplate for 30 min heat at 75°C	
Density Separation	 Add 6 g NaCl Transfer the solution to funnel separation Leave it separate for 24 hr		
Filtration	 Option 1 Sieve size 0.025 mm	 Option 2 Nile Red Staining	
Identification	 Stereomicroscopes Physical characteristics of MPs Shape, size, color, and number	 Fluorescence Microscopy Physical characteristics of MPs Shape, size, and number	
	 FTIR Chemical characteristics of MPs Select ~30% of the particle observed in a microscopic Identify polymer types of MPs		

Initial Secondary Data Checklist



	Item	Details	Data source
Data	V_1	Total annual domestic water consumption	Metropolitan Waterworks Authority (MWA) Provincial Waterworks Authority (PWA)
	$p_{dw}, p_{ww}, D_{dw}, D_{ww}$	The percentage of wet&dry weather days in a year. The number of wet&dry weather days in a year	Meteorological Department
	V_2	Total annual discharge volume of industrial wastewater	Annual Report 2023 from the Industrial Estate Department
	A_w	Water Surface Area	Department of Lands, Thailand
	A_l	Land Surface Area	Department of Lands, Thailand
	A_f, A_g	The land surface area of forced , and gravity drainage catchments (m ²),	Drainage system Division , Drainage and Sewerage Department BMA
	n_{pig}, V_b	The total equivalent number of pigs based on the conversion ratios for different livestock, and baseline volume of wastewater discharged by 100 pigs	Department of Livestock Development, and A pollution risk assessment model for the cropland applications of animal manure report
	$A_{dry\ field}, A_{paddy\ field}$	Area of Dry and paddy Fields	Department of Lands, Thailand
	$n_{water\ receding\ field-ww}, D_{water\ receding\ field-ww}, Q_{dry\ paddy\ field-ww}, Q_{paddy\ field-ww}$	<ul style="list-style-type: none"> The average number of water receding in paddy fields The total direct runoff volume from dry and paddy fields The average draining depth during water receding events in paddy fields 	Literature Review
	L_g	Total length of watercourses in gravity drainage catchments (m).	Calculated according to the urban rainwater drainage planning

Initial Secondary Data Checklist



Item	Details	Data source	
r_g	The percentage of domestic water that becomes sewage.	Community Wastewater and Wastewater Treatment Report (Pollution Control Department, 2023)	
r_c (domestic)	The percentage of domestic sewage that is collected by the sewer system	Pollution Control Department, Ministry of Natural Resource and Environment	
r_c (industrial)	The rate at which industrial wastewater is collected by the sewer system	Calculated according to.....	
r_s	The percentage of microplastic swept from the land surface during dry weather	Wu, 2015	
Transfer coefficients	r_d, r_r	The percentage of wastewater reused for fertilizing farmland The percentage of wastewater directly discharged into receiving water without storage.	-
	λ_1	Integrated Surface Runoff Coefficient	-
	λ_2	Integrated Surface Runoff Coefficient	-
	r_{settle}	The sewer sediment settling rate in dry weather	Calculated according to local sewer study
	r_{scour}	Rate of wet weather overflow in sewer system	Calculated according to local sewer study
	r_i	The storm sewage interception rate, which refers to the percentage of storm sewage intercepted and directed to WWTP	-

- ✓ Conduct the critical literature review on “Current Status of MPs Study and Management in Southeast Asia”
- ✓ Draft the conceptual “Source-Pathway-Receptor” Framework for BMR, Thailand
- ✓ Refine the MP investigation and analysis plan and methodology
- ✓ Initiate field sampling event at BMR region

Thank You

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