Brunel University of London

PISCES

POLICY REPORT

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Evidence-based Strategies for Reducing Plastic Waste in Indonesia

PISCES – Plastics in Indonesian Societies

Susan Jobling, Eleni Iacovidou, Spyridoula Gerassimidou, Joyashree Roy, Melanie Austen, Fabrizio Ceschin, Reza Cordova, Lesley Henderson, Gede Hendrawan, Sabine Pahl, Radisti Ayu Praptiwi, Emenda Sembiring' Eddy Setiadi Soedjono, Sudarso, Richard Thompson, Costas Velis and Kayleigh Wyles

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About This Report

This Report summarises findings from the interdisciplinary research programme, Plastics in Indonesian Societies (PISCES), designed to address the growing risks of plastic pollution in Indonesia through systems-based evidence and actionable policy pathways. Its goal was to catalyse Indonesia's National Action Plan to support systemic change under a circular economy framework.

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1. *A Systems Analytical Approach to Reducing Plastic Waste in Indonesian Societies NE/V006428/1*

Authors

Coordinating Lead Authors

Susan Jobling, Professor of Ecotoxicology, Centre for Pollution Research and Policy, Brunel University of London, UK

Eleni Iacovidou, Senior Lecturer in Environmental Management, Director of Centre for Pollution Research and Policy, Brunel University of London, UK

Spyridoula Gerassimidou, Senior Research Fellow, Sustainability Assessment of Resource and Waste Management Systems, Centre for Pollution Research and Policy, Brunel University of London, UK

Joyashree Roy, Distinguished Professor, SMARTS Center Director Asian Institute of Technology (AIT), Thailand. Former Professor Economics, Jadavpur University, Kolkata, India

Lead Authors
(in alphabetical order):

Melanie Austen, Professor of Ocean and Society, Director of Centre for Systems Thinking: Ocean, Land and Society, University of Plymouth, UK

Fabrizio Ceschin, Reader in Sustainability and Design, Design for Sustainability Research group, Brunel University of London, UK

Muhammad Reza Cordova, Professor of Ecotoxicology, Principal Scientist, Indonesian National Research and Innovation Agency (BRIN), Indonesia

Gede Hendrawan, Assistant Professor of Oceanography, Centre for Remote Sensing and Ocean Sciences (CReSOS), Udayana University, Bali, Indonesia

Lesley Henderson, Professor of Science Communication, Journalism, Media & Communication, University of Strathclyde, UK

Sabine Pahl, Professor of Urban and Environmental Psychology, Environmental Psychology Research Unit, University of Vienna, Austria

Radisti Ayu Praptiwi, Researcher, Research Center for Ecology and Ethnobiology, National Research and Innovation Agency (BRIN), Indonesia

Emenda Sembiring, Professor of Environmental Engineering, Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung (ITB), Indonesia

Ir. Eddy Setiadi Soedjono, Professor of Environmental Engineering, Institut Teknologi Sepuluh Nopember (ITS), Indonesia

Sudarso, Professor of Sociology, Universitas Airlangga, Indonesia

Richard Thompson, Professor of Marine Biology, Director of Marine Institute, University of Plymouth, UK

Costas Velis, Associate Professor in Waste and Resource Engineering, Imperial College London, Imperial College London, UK.

Kayleigh Wyles, Professor of Environmental Psychology, School of Psychology University of Plymouth, UK

Foreword

This Policy Report represents a significant milestone in our collaborative effort to transform high-quality academic research into practical, evidence-based policy pathways for change through the PISCES programme.

PISCES focuses on reducing the impact of plastic waste on Indonesian societies through systems analysis, technology and innovation, and policy co-creation. Central to this effort is the recognition that plastic pollution is not solely an environmental challenge, but a deeply interconnected issue that spans social, economic, environmental, technical and policy dimensions - rooted in systemic failures of currently practiced systems.

At the core of this endeavour is a critical question: "*What system-level interventions can effectively reduce plastic pollution[2] in Indonesia, and how do we ensure they are feasible, impactful, and equitable?*"

Addressing this question requires more than technical solutions; it demands a change in mindsets, cultural attitudes and policies. Effective policies alone will not solve the plastic crisis unless they are genuinely embraced, enacted, and continuously adapted by the communities they are designed to serve.

Likewise, shifting social norms and public expectations will not result in lasting change unless matched by supportive legislation, targeted investment, infrastructure, and robust

regulatory frameworks. Systemic change, therefore, depends on the dynamic interplay between structural reforms and cultural transformations.

Through PISCES, we have built strong collaborations between researchers, policymakers, communities and private sector stakeholders. This partnership has deepened our understanding of how technological, political, economic and behavioural drivers influence plastic pollution, and how these drivers play out in the Indonesian context.

Together, we have identified key barriers and levers to overcome those and manifest change. We have aimed to assess which interventions, policies, and regulatory changes are most likely to reduce plastic pollution, and how these can be supported by the necessary innovations, capacities, and coalitions to achieve a tangible, real-world impact.

Our focus has been on urban environments in medium, small, and remote cities - places where limited waste infrastructure and services contribute to disproportionate plastic pollution. These locations are critical pressure points in the plastics value chain, and they offer opportunities for targeted, scalable interventions to create meaningful change.

By embedding the plastic pollution challenge within the broader issues of waste generation, management, and circular economy failures in a Global South context, PISCES delivers context-sensitive solutions grounded in Indonesian realities and, to some extent, those of the Global South more widely.

[2]**Plastic pollution (also referred to as plastic waste leakage or plastic emissions)** is plastic waste that escapes from the intended waste management system and enters the environment where it causes pollution. Pollution can occur through littering, dumping, inadequate waste collection, poorly managed landfills, or open burning.

How to Use This Report

The ideas and recommendations presented in this report are intended to support stakeholders across sectors - government, industry, and civil society - and to encourage policymakers and industry leaders to drive meaningful change. They are designed to complement and build upon recent national and global initiatives from the Indonesian government and the UN Global Plastics Treaty. Aligning local action with global frameworks is key to coordinated and forward-looking responses to plastic pollution.

Acknowledgements

We would like to thank the many researchers, including postdoctoral fellows and PhD students, who provided figures, data analysis, and research input that informed this report[3].We are also deeply grateful to our Advisory Board members, funders, partners (national, regional and local governments of Indonesia, businesses and NGOs, CBOs and citizens)[4] who contributed their knowledge, insights, experiences, and ambition to the PISCES Programme. The recommendations presented in this report reflect a shared understanding; that solving the plastic crisis will require not only new regulations but also improved infrastructure, robust data and monitoring methods, stronger cross-sectoral relationships, and deeper connections between people and their environments.

As we set out the pathways for change, the challenge now is to involve the full range of stakeholders to translate this joint ambition into tangible action. Our hope is that this Report serves both as a resource and a source of inspiration for everyone committed to advancing systemic change to tackle plastic pollution. Our collective objective now is to align vision with action, enabling both policy and public perception to evolve collaboratively

[3]PISCES Researchers and Partner Institutions:

Universitas Airlangga, Surabaya, Indonesia.
Nur Syamsiyah, Department of Sociology
Lingaar Rama, Department of Sociology

Asian Institute of Technology (AIT), Thailand
Dr Satabdi Datta, SMARTS Center.

Institut Teknologi, Bandung (ITB), Indonesia
Dr Fenitra Rakotoarisoa, Faculty of Civil and Environmental Engineering,
Yulianti Pratama, Faculty of Civil and Environmental Engineering,
Attar Ramadan, Faculty of Civil and Environmental Engineering,
Aisya Rahmania Dangkua, Faculty of Civil and Environmental Engineering,
Zayinatun Biladiyah Al Khoeriyah, Faculty of Civil and Environmental Engineering,

Brunel University of London, UK
Dr Nazli Terzioglu, Design for Sustainability Research Group
Dr Anouk Zeeuw Van Der Laan, Design for Sustainability Research Group
Yueyoon Fan, Design for Sustainability Research Group
Nieke Monika, Department of Sociology.

Universitas Esa Unggul, Indonesia
Wulan Prawestiwuland, Sustainability Research Cluster and Department of Biotechnology
Sainal Sainal, Sustainability Research Cluster and Department of Biotechnology
Ahmad Badruzzaman, Sustainability Research Cluster and Department of Biotechnology

Indonesian National Research and Innovation Agency (BRIN), Indonesia
Muhammad Hafizt
Singgih Prasetyo Adi Wibowo
Yaya Ihya Ulumuddin
Triyoni Purbonegoro
Deny Yogaswara
Muhammad Taufik Kaisupy
Riyana Subandi
Sofia Yuniar Sani

University of Leeds, UK
Dr Josh Cottom, School of Civil Engineering,
Dr Ed Cook, School of Civil Engineering,

University of Plymouth, UK
Carya Maharja, School of Psychology,
Dr Ana Voronkova, School of Psychology
Dr Matthew Ashley, Centre for Marine and Coastal Policy Research.
Dr Max Kelly, International Marine Litter Unit, University of Plymouth

Universitas Udayana Bali, Indonesia
I Putu Ranu Fajar Maharta, Center for Remote Sensing and Ocean Sciences (CReSOS)
I Made Dharma Raharja, Center for Remote Sensing and Ocean Sciences (CReSOS)
Putra Bagus Panji Pamungkas, Center for Remote Sensing and Ocean Sciences (CReSOS)
Ade Riestiari Sudarmawan, Center for Remote Sensing and Ocean Sciences (CReSOS)
I Made Oka Guna Antara, Center for Remote Sensing and Ocean Sciences (CReSOS)

[4]Advisory Board Members

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Partners and Collaborators

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Contents.

Executive Summary - Framing the Challenge for the National Plan of Action (NPOA), 2026

Challenge: Despite bold commitments, systemic barriers undermine progress on plastic pollution

Indonesia has demonstrated global leadership through Presidential Regulation No. 83/2018 and its National Plan of Action (2017–2025) yet is unlikely to meet its 2025 target to reduce marine debris by 70%. Over 54% of waste remains unmanaged, especially in under-served coastal zones, where dumping, open burning, and low-value plastics persist.

Plastic pollution - plastic that escapes the waste management system into the environment, including harmful air emissions from burning[5] - continues at high levels.

Current approaches are insufficient to address structural challenges because they do not address the deeper systemic barriers - fragmented governance, infrastructure gaps, behavioural norms, and economic disincentives - that lock in plastic pollution.

Response: PISCES offers a new strategy for the 2026 National Plan of Action:

1. **A shift in framing - from fragmented to coordinated action that delivers system-wide transformation.** PISCES recommends the use of a systems-based tool, namely **CVORR (Complex Value Optimisation for Resource Recovery)**, to integrate environmental, technical, economic, political and social systems. Applying CVORR, PISCES has mapped plastic mass and monetary flows, stakeholders, and identified systemic "lock-ins" (e.g. open burning, single use plastic (SUP) sachet dependency, uncoordinated institutional mandates, and low recycling incentives) and prioritised locally tailored interventions that generate cross-sectoral benefits.

2. **A data-driven rethink of infrastructure and investment priorities.** PISCES modelling reveals that total municipal waste generation for Indonesia in 2020 was more than double that recorded in the official (SIPSN) database - potentially resulting in major evidence gaps to guide planning in some areas. It identifies **hotspots of high plastic pollution in coastal and ecological areas** which threaten biodiversity, flood resilience, and tourism-based livelihoods. These findings highlight the urgent need to prohibit open burning, improve waste collection reliability, and use sub-district level waste generation data to inform targeted investment.

3. **A major upgrade in Extended Producer Responsibility (EPR) and reuse systems.** PISCES recommends an **inclusive EPR system** that links upstream producers to downstream stakeholders (including the informal sector), **incentivises design for reuse, and prioritises food and beverage SUP** (sachets, takeaway polystyrene containers, and plastic bags) for reduction or redesign. This recommendation is grounded in PISCES Living Lab findings, which show how novel reusable packaging solutions can be co-developed, adapted, tested, and refined with users and stakeholders, revealing both barriers to adoption and opportunities to enhance uptake. When combined with support for businesses, policymakers, and local communities, Living Labs can function as integral components of waste management infrastructure, providing hands-on spaces to co-design, adapt, and trial packaging and waste-management solutions before broader scaling.

4. **Make behaviour change central, not marginal.** PISCES recommends context-specific achievable actions to transform **deeply rooted social norms and perceptions** (e.g., burning as cleansing) that drive entrenched disposal practices. Campaigns must combine the power of community influencers, culturally tailored messaging, and improved infrastructure to enable better choices.

5. **A national framework for monitoring, risk management and adaptive policy.** PISCES identifies significant economic, environmental and social benefits from these interventions and proposes a standardised, nationwide **Monitoring, Reporting and Verification system**. This would be combined with **econometric cost-of-inaction models** and tools to track plastic-related risks to fiscal burden, ecosystems, flood resilience and coastal livelihoods. Together, these measures make the National Plan of Action not only smarter, but more adaptable and accountable over time.

Translating Insights into Action

The Executive Summary outlines a bold shift: from fragmented action to systemic, locally adapted solutions. The **26 Evidence-based Policy Recommendations** represent the **core of the PISCES response -** practical steps to inform the forthcoming 2026 National Plan of Action. Organised by strategic pillar, the recommendations are not standalone: they work together to help policymakers move from pilots to scalable, evidence-based interventions—across ministries, across provinces, and from upstream production to downstream waste generation.

[5] Open burning of plastic waste releases toxic pollutants, including dioxins and particulate matter, which pose serious risks to human health by causing respiratory illnesses and other diseases. Additionally, burning plastic contributes to greenhouse gas emissions, undermining climate goals.

Evidence-based Strategic Policy Recommendations for NPOA 2026

PISCES proposes 26 recommendations for 2026. These are a combination of policy, infrastructural, governance, and behavioural changes to enable decision-makers to 1] Strengthen collection and management 2] Reduce SUP 3] Enable behavioural change and social innovation 4] Enhance governance and regulatory compliance, and 5] Support adaptive, evidence-based policy, providing data and tools to monitor impact, inform mid-course corrections, and scale up what works - making policy responsive and resilient.

Policy Vision for 2035

By embedding these 26 recommendations into the forthcoming NPOA, Indonesia can:

- Significantly reduce plastic waste and pollution
- Build resilience to climate and disaster-related risks
- Protect marine and coastal ecosystems and the economic and social benefits they provide
- Unlock economic value through circular systems
- Become an ASEAN leader for evidence-based plastic governance

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Position NPOA 2026 as a Systems-Based Strategy for Impact

1. **Adopt CVORR (CVORR: Complex Value Optimisation for Resource Recovery) as the national planning tool to guide holistic decision-making.** Use the tool to conduct system-wide baseline assessments to understand and map plastic flows, pollution sources, stakeholders' roles and dynamics, infrastructure gaps, and socio-economic barriers to identify leverage points across the system, showing where policies and strategic planning can achieve the greatest value return across sectors. section 4.1

2. **Conduct location-specific analyses to identify suitable social and material-based interventions to drive change.** Use monitoring techniques to map plastic pollution, behavioural patterns, service gaps, and socio-cultural drivers. Support adaptive planning and budget flexibility for local governments to address regional disparities. key finding 4.1

> *Together, these targeted strategies can effectively identify key sources of plastic pollution and guide policy interventions to address them, supporting a comprehensive restructuring of the waste collection services to improve both sustainability and efficiency.*

Invest in Upgrades of Localised Waste Management Systems

3. **Update Indonesia's official waste generation standards to correspond to an average of 0.63 kg/person/day,** based on PISCES modelled findings, and use it to guide investment decisions, and infrastructure planning. key finding 1.1

4. **Mandate localised, verified waste composition data at the sub-district (kecamatan) level,** including detailed categorisation of plastic types, to inform reduction, substitution and redesign strategies. key finding 1.1

5. **Expand waste collection and management services,** prioritising underserved plastic pollution 'hotspot' and coastal regions. key findings 1.2, 1.3, 1.4

6. **Improve the reliability of formal waste collection service systems,** ensuring equitable coverage for urban, peri-urban, and rural areas to eliminate the need for dumping and burning, including incentives for local governments to maintain service quality, affordability and reliability. key finding 3.2

7. **Upgrade unmanaged dumpsites and informal disposal sites, enforce bans on illegal dumping in rivers and natural spaces, and invest in riverbank protection, litter traps, and seasonal clean-up strategies along key plastic pollution pathways.** key findings 1.3, 1.4, 1.5, 1.7

8. **Eliminate open burning at dumpsites** through a combination of bans and enforcement and integrate open burning reduction targets into national climate strategies and local waste management regulations with public education **to increase awareness of environmental and human health harm**. key findings 1.9 and 3.2, 3.5, 3.6, Note 5.

Mainstream Circular Economy Enabling Innovations

9. **Mandate an inclusive comprehensive Extended Producer Responsibility (EPR) scheme,** covering both recycling and reuse, linking upstream producers with downstream stakeholders (including the informal sector), initially targeting the most polluting food and beverage single-use plastics key findings 1.8 3.1

10. **Design and implement policies that reduce reliance on sachets and** make alternatives cost competitive. Support the scaling of reuse models and engage small retailers (e.g. warungs) to trial and scale up these systems, supported by enabling infrastructure and micro-enterprise initiatives. Key findings 3.1 3.7

11. **Embed design-for-reuse and recyclability into national packaging standards,** with clear criteria for producers, small and medium-sized enterprises (SMEs), and retailers, including reusable packaging requirements for priority product categories. key finding 3.7

12. **Mobilise funds to formalise the set up and scaling of PISCES Living Labs in diverse regions nationwide -** as community-embedded, participatory spaces to co-design, test, adapt and replicate packaging innovation, waste reduction solutions, and behaviour change interventions tailored to local contexts. Provide policy and financial incentives for businesses to use these labs as testbeds for scalable, circular packaging solutions. While current pilots have focused on stationary community-based labs, mobile or hybrid models could be explored in future to increase reach and adaptability. Section 3.1, key finding 3.7

Enable Behaviour Change and Social Innovation

13. **Mainstream behaviourally informed waste management policy design**, recognising how current social norms (e.g., burning as "cleansing"), community connectedness, collection service availability and reliability, and awareness of plastic pollution harms to health and nature drive disposal behaviours to support new social norms. Pair behavioural interventions with enabling conditions, such as reliable waste services, affordable reuse systems, easy-to-use sorting infrastructure. key finding 3.3 3.4, 3.5

14. **Design and deliver public education campaigns that target specific behaviours** (e.g., sachet use, open burning, dumping) with culturally appropriate messaging tailored to different demographics (gender, age, education levels).key finding 3.6

15. **Engage trusted community influencers, such as traditional and religious leaders, and educational institutes as role models in targeted behaviour change campaigns** to reinforce better waste disposal and reduce demand for sachets. Track behavioural shifts through longitudinal monitoring and adjust strategies. key finding 3.6

16. **Standardise and localise waste sorting systems, using simple visual tools and clear instructions** adapted to local languages and literacy levels to support household-level participation. key finding 3.7

Close Governance Gaps

17. **Clarify institutional mandates across national, provincial, and district levels,** reducing overlaps, ensuring that roles in waste management, EPR enforcement, and pollution prevention are clearly assigned, resourced, and held accountable. key finding 4.4

18. **Formalise and integrate the informal waste sector into official waste management systems,** recognising their role in collection and recycling, offering training, safety equipment, fair compensation, and pathways to formal service contracts or inclusion in EPR systems. key finding 4.2

19. **Establish inter-provincial coordination mechanisms to manage transboundary plastic pollution,** especially in coastal and riverine systems (e.g., Java–Bali dynamics), with shared monitoring, enforcement, and response mechanisms. key finding 2.2.

20. **Create national and regional multi-stakeholder coordination platforms,** bringing together government, industry, the informal sector, civil society, and academia to co-design roadmaps, develop knowledge sharing platforms and toolkits, align financing, and coordinate implementation. key finding 4.5

21. **Strengthen regulatory enforcement mechanisms** key finding 4.3**, including:**

    - Routine inspections and compliance checks.
    - Fines for open burning at open dumpsites, illegal dumping, and single use plastic violations.
    - Integration of environmental levies or retribution into ring-fenced funds for local waste service improvements.

- Protections for vulnerable ecosystems impacted by plastic pollution, including mangroves, coral reefs, seagrasses, and beaches, through clear regulatory mandates on waste disposal, bans on dumping in sensitive habitats, and penalties for non-compliance. key findings 2.3, 2.4
- Incorporation of ecosystem-based enforcements into coastal spatial plans and disaster risk frameworks, ensuring agencies are equipped to act against activities that drive ecosystem degradation from plastic waste. key finding 2.5.
- Transparent publication of compliance performance at provincial and district levels.

22. **Invest in capacity-building for local governments in systemic plastic management and governance,** including technical training in waste operations, ecosystem risk assessment monitoring, circular economy implementation, data analysis and management, enforcement procedures, and community engagement. key finding 4.4.

Build a National Monitoring, Evaluation, and Risk Management System

23. **Implement nationwide environmental monitoring of plastic in terrestrial, riverine, and marine ecosystems. Use the PISCES source-focused rapid litter survey method and habitat and ecosystem service impact assessments** as standardized tools for regular assessment and monitoring to track and target plastic pollution sources, and uncontrolled release of plastic waste and evaluate policy effectiveness Theme 1., Theme 2. key findings 1.6,1.7, 2.3, 2.4

24. **Integrate plastic-related flood risk and ecosystem service loss considerations into national and local development, spatial and coastal disaster preparedness and climate adaptation planning.** Include drain blockages and infrastructure damage. Equip local planners and regulators with enabling tools. Theme 2. key finding 2.5.

25. **Adopt and apply PISCES economic modelling tools Theme 2. to quantify the cost of inaction at national and provincial levels**. Improve data collection and management to aid identification of costs, help minimize fiscal burden on financial resources and justify investment in prevention and management measures. key finding 2.5

26. **Establish a national Monitoring, Reporting, and Verification framework,** requiring all provinces and districts to collect and report data on waste generation, plastic pollution, recycling rates, open burning, and policy outcomes using standardised indicators. Establish comprehensive, measurable metrics for monitoring plastic waste management performance**,** including environmental, economic, social and technical metrics to enhance accountability and drive continuous improvement. key finding 4.3.

Technical Report

The Situation: Inadequate waste management and everyday behaviours are driving a plastic pollution crisis that threatens Indonesia's people, ecosystems, and economy.

Indonesia is facing an escalating crisis of plastic pollution, primarily driven by substantial waste generation, inefficient waste management systems, and ineffective policy enforcement. Despite the concerted efforts of both informal and formal recycling sectors to collect certain fractions of plastic waste, the release of plastic waste into the environment remains a critical challenge. A significant proportion of uncollected plastic waste is burned or dumped in informal sites, contributing directly to environmental degradation. This uncontained waste exacerbates flood risks, damages infrastructure (e.g., drainage blockages), and contaminates the air, soil, rivers, coasts and oceans.

The negative environmental impacts are compounded by the social costs associated with the externalities of plastics. These costs manifest in lost tourism revenue, damaged fisheries, clean-up expenses, and the social effects of living in polluted and degraded environments. These challenges inhibit progress towards several Sustainable Development Goals (SDGs), such as clean water and sanitation, sustainable cities and communities, and responsible consumption and production.

In response to this crisis, the Indonesian government introduced an ambitious National Action Plan (NAP) in 2017, aiming to reduce marine plastic debris by 70% by 2025 (Perpres No. 83/2018). Since then, the government has established a regulatory framework for plastic waste management and is implementing strategic efforts to improve environmental governance through a mix of formal legal measures and informal, community-based mechanisms (Faishal, 2022). Despite these measures, by 2021, these efforts had proven largely ineffective (UN-ESCAP, 2021), with little evidence suggesting that Indonesia would meet its 2025 targets.

Despite numerous innovative and progressive initiatives to prevent plastic waste from entering the environment, progress remains impeded by a range of complex, interrelated challenges. These include increasing plastic production and consumption, insufficient waste management infrastructure, a lack of public education, the decentralization of waste collection, and a lack of effective Extended Producer Responsibility (EPR) mechanisms. These issues are further compounded by poverty and the proliferation of reusable or biodegradable products and packaging, which, without robust EPR implementation, create unintended environmental burdens.

While current policies set ambitious targets for reducing plastic waste and improving waste management, they suffer from unreliable data collection systems, and insufficient technical guidance and resource allocation for effective implementation. The lack of a comprehensive, functioning monitoring system further hampers the ability to evaluate policy impacts. The consequences of inaction are undoubtedly significant, yet the potential benefits of a well-designed circular economy for plastics remain little explored**.**

The PISCES Programme - Addressing the Plastic Pollution Challenge Through a Systems Approach

Funded by UK Research and Innovation, Global Challenges Research Fund and co-designed with the Indonesian government's Coordinating Ministry for Maritime Affairs and Investment, the PISCES project (2021-2025) aims to inform and catalyse Indonesia's National Action Plan to reduce and eliminate plastic pollution under a circular economy framework.

The PISCES project employs a structured, systems-based approach that integrates environmental, social, economic, and technical research through six interconnected work packages, each feeding into the four themes described in this report. This multifaceted strategy enables a comprehensive understanding of the causes of plastic pollution and the complex barriers to effective intervention. By applying interdisciplinary methodologies, PISCES aims to generate evidence-based recommendations that enhance current efforts to drive practical, scalable solutions for addressing plastic pollution.

This policy paper synthesises key findings from the four themes of the PISCES programme and provides a systems-based toolbox of methods and approaches to support targeted and scalable interventions that can be monitored to ensure progress in achieving targets. It offers actionable recommendations to strengthen Indonesia's transition to a circular plastics economy

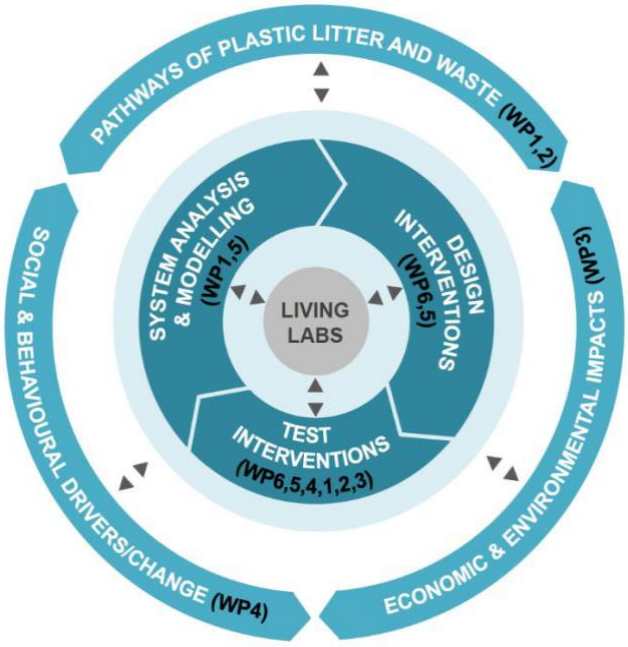

Figure 1. PISCES Programme structure - *outlining how the six work packages (WP) and interconnections between them provide the integrated requirements of PISCES systems-based approach. There are four themes: 1. Modelling and monitoring of sources, distribution and fate of plastic waste and litter, 2. Socio-economic and environmental impacts. 3. Social, behavioural and technical drivers of plastic consumption, use and disposal and of changes needed to implement interventions. 4. Identification of policy gaps, implementation barriers and points of leverage via systems analysis.*

Theme 1. Enabling data-driven targeting of plastic pollution through modelling and monitoring.

Why is it important?

Effective action on plastic pollution in Indonesia requires a clear understanding of where plastic waste originates, how it moves through the environment, and where it accumulates. Modelling and monitoring systems are essential for identifying pollution hotspots, informing targeted interventions, assessing impacts, and shaping effective policy. Because most pollution stems from uncollected waste, accurate modelling requires detailed insights into solid waste generation and collection practices, and littering behaviours across Indonesia.

How did PISCES contribute?

PISCES activities under this theme built on Indonesia's national datasets (SIPSN; Sistem Informasi Pengelolaan Sampah Nasional) and conducted extensive waste characterisation and litter surveys to fill critical data gaps. This work enabled the development of improved models to estimate waste generation, composition, and uncontrolled release from land-based sources, across every regency of Indonesia, revealing hidden waste flows and key pollution hotspots.

To validate the modelling, PISCES developed and deployed a rapid litter survey methodology nationwide. This approach not only quantified litter, but also examined packaging types, material composition and usage patterns, enabling source attribution and guiding intervention design.

These tools generated strong evidence to inform national and local policies, ensure a precise targeting of interventions, and improve accountability, **ensuring that action is directed to where it can deliver the greatest environmental and societal impact.**

Key Findings

1.1 Waste generation is under-estimated. Low-value flexible plastic is a major component: PISCES modelling estimates Indonesia generated 62 million tonnes of municipal solid waste in 2020, more than double that recorded in the SIPSN database (https://sipsn.kemenlh.go.id/sipsn/public/data/timbulan). This corresponds to a national average of 0.63 kg/capita/day, exceeding the current national average of 0.45 kg. This discrepancy may adversely affect planning and policy decisions. 16% of this waste is plastic although our sampling found this can be as high as 33% in some kecamatans dominated by low-value multi-layer sachets and plastic bags.

1.2 Waste collection and management gaps: On average, only 46% of municipal solid waste is formally collected and managed. The remaining 54% is self-managed – typically, burned, buried, dumped, or discarded into the environment.

1.3 Significant uncontrolled release of solid plastic waste into the environment: 5.6 million tonnes entered the environment in 2020, with ongoing inputs annually.

1.4 **Plastic pollution hotspots**: Models estimate coastal provinces (especially Jawa Barat, Jawa Timur, and Jawa Tengah) show the highest plastic pollution inputs (>1Mt/yr) due to a combination of high plastic waste generation and low collection rates (in *alignment with expert opinions; Theme 2).*

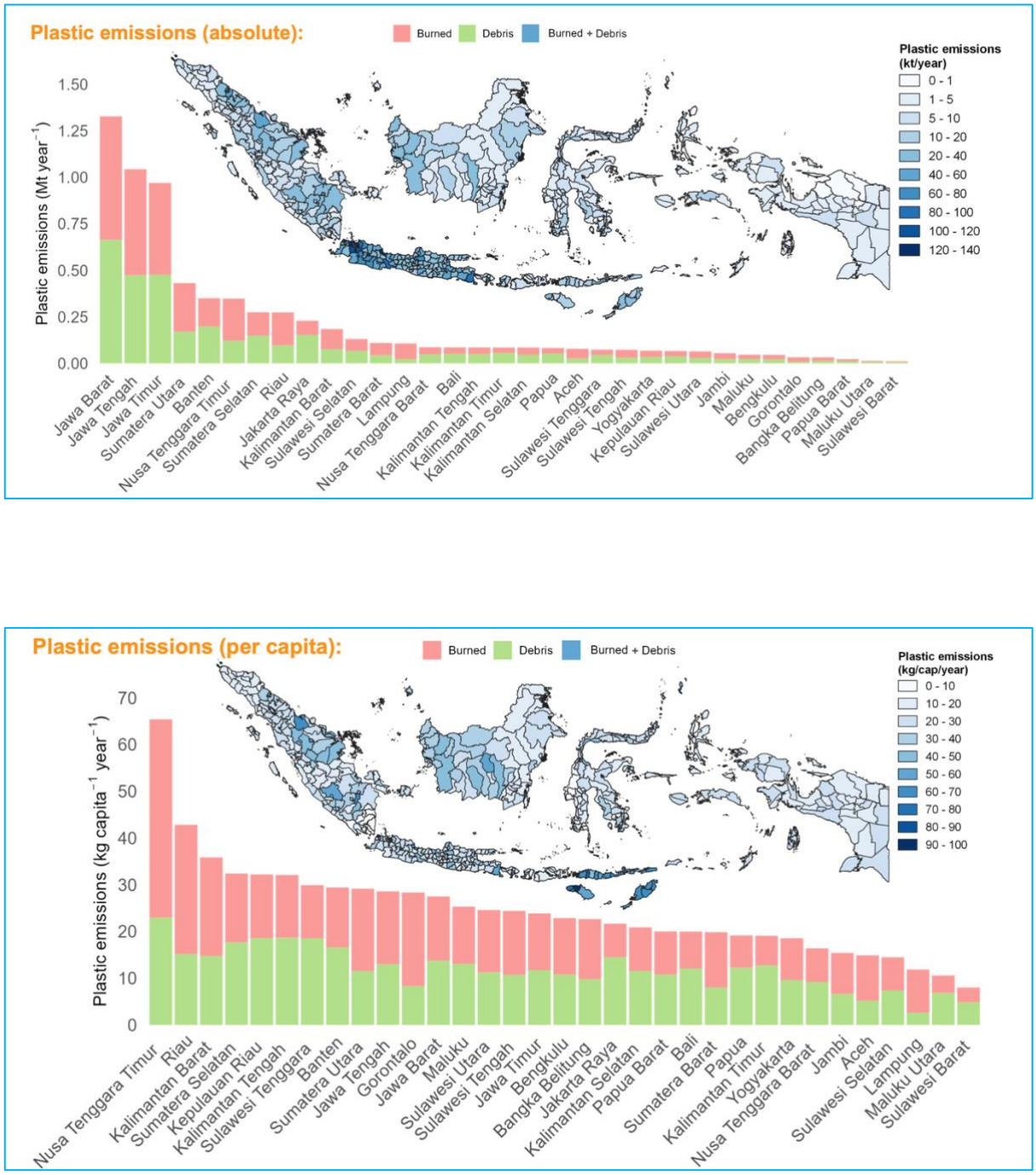

Figure 2. Stacked bar charts show modelled plastic pollution inputs into the environment (described here as plastic emissions) in terms of absolute mass(kg) and mass per capita in Provinces (stacked bar charts) and per Regency (maps) of Indonesia.

1.5 **Pathways to the environment**: Approximately 4% of plastic debris entering the environment reaches the ocean annually; while the remainder accumulates on land - in vegetation, soils, and rivers. This is in addition to what is openly burnt.

1.6 **PISCES global review of existing methods monitoring plastic pollution (NOAA; CSIRO; OSPAR; UNEP/IOC; Indonesian government), revealed a predominance of beach surveys.** These approaches are not source focused.

1.7 **PISCES land-based surveys reveal river-bank hotspots and align with our models:** Source-focused litter surveys, covering 26 km² across 20 kecamatan (26,000 km²), show highest levels of litter in the natural environment. These occur in concentrated waste piles (> 60% of the total weight surveyed), particularly in densely populated areas with limited waste services. Riverbanks, especially during the rainy season, contain more than twice the litter of roads or paths.

1.8 **Dominant litter types**: Sachets, takeaway food and beverage packaging, and plastic bags are most observed littered items, often found near food vendors. Flexible packaging made up 75–80% of the plastic litter observed (*in alignment with Theme 3).*

1.9 **Major air pollution source: Open burning** accounts for 77% of modelled plastic waste emissions (by weight). Open burning occurs at dumpsites, and for uncollected waste, along roads, tracks and riverbanks *(in alignment with Theme 3).*

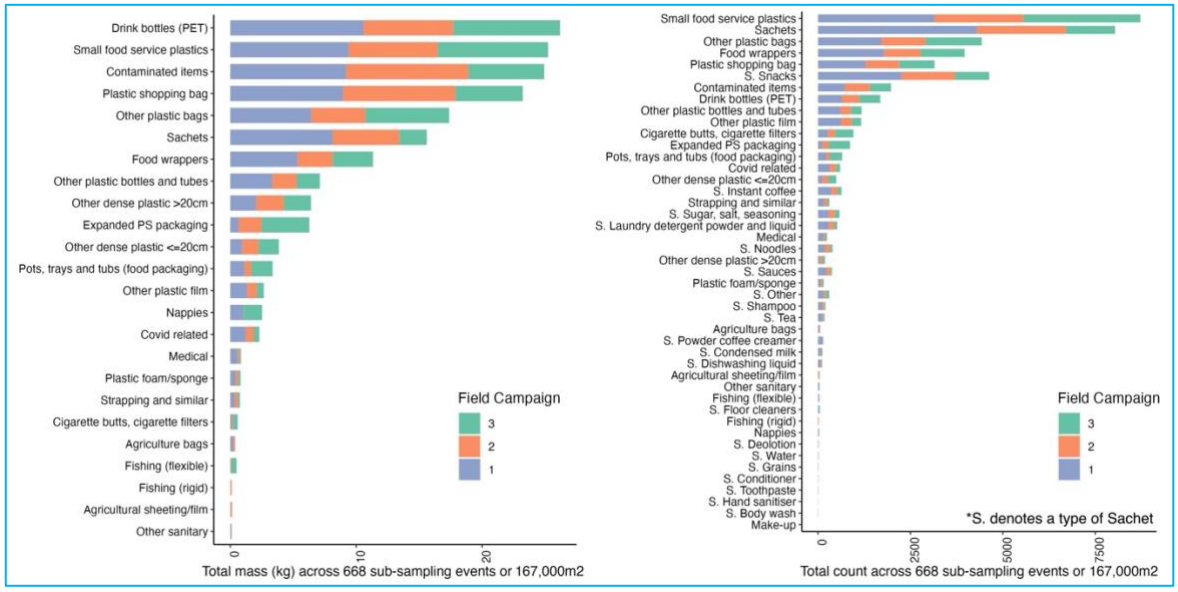

Figure 3. Plastic litter characterisation by mass (kg) and count across 668 individual sub-sampling events over 20 kecamaten. Area surveyed 1km²/1000km² (26km² total)

Recommendations

- **Update the national standard for waste generation** to 0.63kg/capita/day to reflect the higher rates PISCES found and use to guide more effective policy and investment decisions.

- **Mandate localized and verified waste data collection for National Planning.** Establish a national framework that requires *regular, standardized, and verified waste composition and generation surveys* at the Kecamatan (sub-district) level[1]. Use detailed compositional data to target problematic plastics. Ensure surveys capture disaggregated plastic types to support policy decisions on reduction, substitution, or redesign of low value plastics.

- **Expand, incentivize and prioritise waste collection and management, especially in underserved hotspot regions, and coastal settlements.**

- **Monitor and Facilitate Adaptive Management: Adopt a source-focused rapid litter survey method** as a standardized tool for regular monitoring across riverbanks, urban areas, and beaches to track pollution sources and evaluate policy effectiveness**.**

- **Upgrade unmanaged dumpsites and improve infrastructure and clean-ups along key plastic pollution pathways with enforcement against illegal dumping in natural areas.** Adapt waste management strategies and expand riverbank protection and litter capture systems, based on seasonal variations and observed trends.

- **Prohibit open burning at open dumpsites** and consider introducing open burning reduction targets in Indonesia's climate strategy and local waste management plans

- **Enforce local bans or redesign incentives for sachets, and food and beverage packaging (include expanded polystyrene takeaway food containers, plastic bags and films and small plastic cups) -** identified as the most prevalent litter items - particularly in high-plastic pollution zones, focusing first on distribution channels like warungs and mobile vendors. Implement enabling policies and economic incentives that reduce user burden and support the adoption of reusable packaging

Theme 2: Assessing socio-economic and environmental costs of plastic pollution

Why is this important?

Plastic pollution harms marine biodiversity; disrupts coastal ecosystems; blocks urban drainage systems, causing floods; endangers public health; and negatively affects critical sectors like tourism and fisheries. Yet, a major barrier limiting motivation to develop and implement effective policy and action is the lack of robust data and methodologies to assess the full extent and impact of plastic pollution on coastal habitats, species, ecosystem services and the economy.

How did PISCES address these gaps?

To support targeted responses, PISCES developed and applied a suite of tools to model and map where land-based plastic waste accumulates, how it affects ecosystem services, biodiversity and human wellbeing, and the economic costs of inaction.

These are the following:

- **Oceanographic particle tracing model:** Developed and applied to track and trace plastic movement from land to sea and predict coastal accumulation hotspots.
- **Habitat sensitivity mapping tools:** To identify the locations of key habitats and their vulnerability to plastic pollution and to understand where plastic threatens biodiversity and ecosystem services like food provisioning, flood control, and recreation, and where benefits to human wellbeing are at risk of being reduced or lost.
- **Economic modelling tool**: Used to estimate the costs of 'inaction' (failure to act), comparing the long-term financial impacts on tourism, flood damage, and infrastructure, with the investment costs required for building effective plastic waste management systems.

These tools were piloted in the Bali Strait (West Bali and East Java), where the amount of unmanaged plastic waste reaching the ocean is high. The evidence generated demonstrates where targeted plastic waste management interventions and monitoring efforts should be prioritised at local and national scales.

Key Findings:

2.1 **Plastic pollution hotspots:** Results from a survey of national experts predict that Java coastlines are likely to be the most plastic-polluted in Indonesia over the next decade. *(in alignment with theme 1)*

2.2 **Oceanographic models predict that coastal accumulation in the Bali Strait of land-based riverine plastic is greatest along the coastlines of Jembrana and Badung (Bali) and Banyuwangi and Muncar (East Java).** Plastic litter coming from rivers in both Bali and Java affect Bali's coast, while Java's coastline is mostly harmed by pollution from its own rivers.

2.3 **Vulnerable ecosystems identified:** Systematic evidence review, and expert opinion identified mangroves, coral reefs, seagrass, and sandy beach habitats as most vulnerable to plastic pollution. Species, such as turtles, whales, dolphins, whale sharks, and manta rays are especially at risk from exposure to plastic litter.

2.4 **Ecosystem services at risk: Unmanaged plastics in the coastal environment harm important natural services that support the economy and people's wellbeing.** These include food supply from fishing including nursery and breeding habitats that support the fish, natural protection from flooding and coastal erosion, and recreational services provided by beaches that attract tourists and promote health and wellbeing for both visitors and local communities.

2.5 **Economic costs of inaction:** Unmanaged plastic pollution increases government spending on flood-related repairs, infrastructure recovery, and beach clean-ups, placing a higher financial burden on public budgets across all 34 provinces over the last 10 years. If no action is taken, economic models show plastic pollution will continue to damage Indonesia's economy across all 34 provinces over the next decade. The impacts include fewer tourists visiting polluted beaches and coastal areas, rising costs for regular beach cleanups, and worsening flood damage, especially when plastic waste blocks drains. For example:

- A small boost in tourism (1.1% growth in GDP) leads to a 0.5% rise in beach cleaning costs, because more beaches need to be kept clean.
- A 1.1% increase in flood damage triggers a 0.34% rise in emergency government spending on repairs — higher than the cost increases from other disasters (which is around 0.24%) This financial cost is 15 times higher than the investment required to build and maintain an effective plastic waste infrastructure.

	Ecosystem Services	Well-being Dimensions			
		Physical Health	Mental Health	Household Income	Housing Conditions
Mangrove	Food Provisioning	0.37*	0.39*	0.43*	0.18
	Genetic Materials	0.40	0.28	0.37*	0.40*
	Erosion Control	0.27	0.31	0.54*	0.37*
	Flood Protection	0.23	0.30	0.44*	0.33*
	Nursery Habitat	0.12	0.29	0.34*	0.16
	Recreation	0.19	0.34*	0.39*	0.01
Sandy Beach	Food Provisioning	0.34	0.59**	0.51*	0.46*
	Genetic Materials	0.51*	0.31	0.54**	0.54**
	Erosion Control	0.19	0.18	0.11	0.18
	Flood Protection	0.10	0.16	0.07	0.29
	Nursery Habitat	0.55**	0.45*	0.64**	0.66**
	Recreation	0.19	0.51*	0.35*	0.55**
Seagrass	Food Provisioning	0.30	0.48*	0.62*	0.39*
	Genetic Materials	0.36*	0.26	0.47*	0.37
	Erosion Control	0.46*	0.52*	0.47*	0.49*
	Flood Protection	0.20	0.39*	0.31	0.29
	Nursery Habitat	0.39*	0.48*	0.45*	0.51*
	Recreation	0.11	0.11	0.27	0.41*
Coral Reef	Food Provisioning	0.60**	0.44*	0.46*	0.38*
	Genetic Materials	0.34*	0.46*	0.55**	0.39*
	Erosion Control	0.29	0.51*	0.38*	0.30
	Flood Protection	0.23	0.55**	0.36*	0.34*
	Nursery Habitat	0.39*	0.47*	0.52*	0.39*
	Recreation	0.25	0.41*	0.48*	0.27
Pelagic Sea	Food Provisioning	0.42*	0.18	0.45*	0.31
	Genetic Materials	0.30	0.00	0.34	0.17
	Erosion Control	0.34	0.13	0.33	0.25
	Flood Protection	0.31	0.26	0.21	0.27
	Nursery Habitat	0.42*	0.33	0.40*	0.34
	Recreation	0.39*	0.24	0.49*	0.53*
Subtidal Sediment	Food Provisioning	0.37*	0.36*	0.33*	0.21
	Genetic Materials	0.07	0.20	0.30	0.17
	Erosion Control	0.44*	0.34*	0.26	0.37*
	Flood Protection	0.31	0.32	0.15	0.33
	Nursery Habitat	0.55*	0.55*	0.48*	0.46*
	Recreation	0.37*	0.44*	0.24	0.42*

Weak Negative Impacts | Moderate Negative Impacts | Strong Negative Impacts

Figure 4. *Spearman's rank correlations between ecosystem services and human health and well-being dimensions (color-shaded cells are statistically significant correlations at *p < 0.05 and **p < 0.001), based on estimates provided by experts particpating in an iterative Delphi survey.*

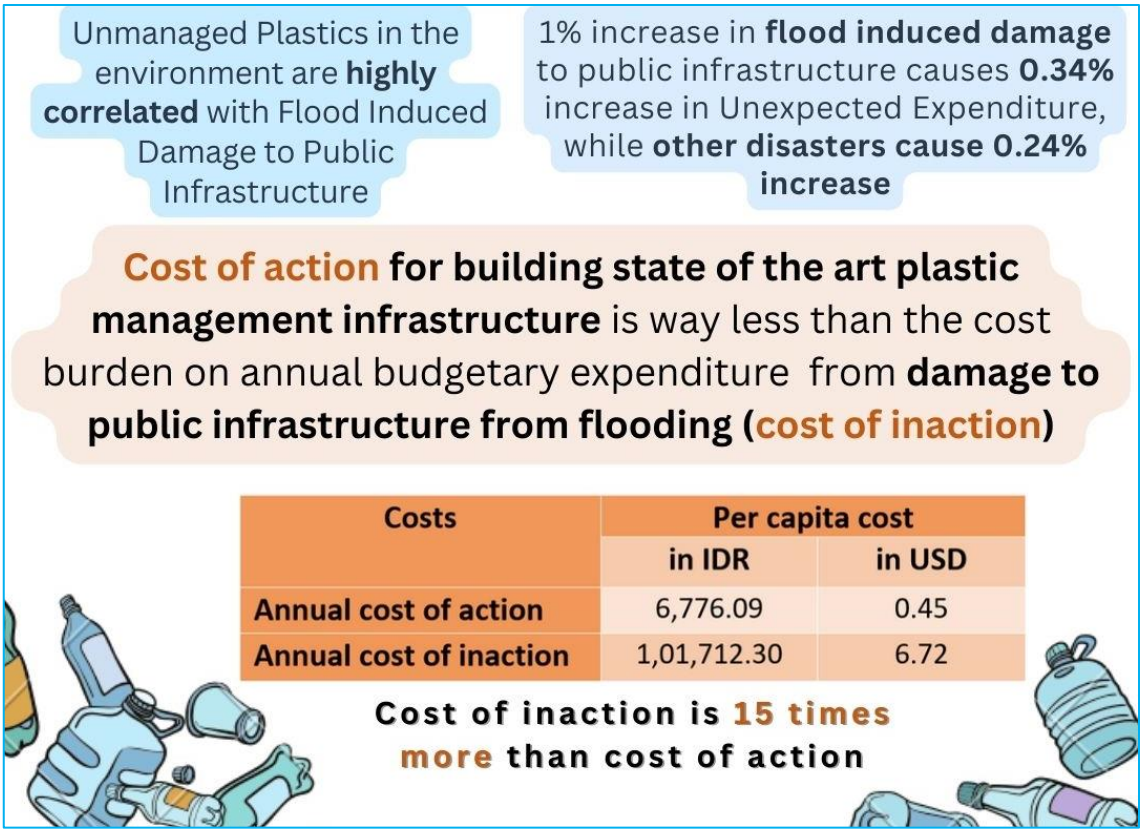

Figure 5. Fiscal burden of flooding due to unmanaged plastics in the environment.

Recommendations

- **Use PISCES predictive coastal accumulation modelling and habitat sensitivity tools to identify and designate Coastal Plastic Pollution Priority Zones for targeted clean-up, regulation, and ecosystem restoration, especially in high accumulation regions.**

- **Develop Cross-Province Plastic Governance Mechanisms where coastal pollution impacts cross provincial boundaries (e.g. Bali-Java dynamics). Support inter-regional coordination and shared responsibility for plastic pollution, clean-up, and enforcement.**

- **Prioritize Habitat Protection in High-Risk Areas.** Prioritise protective regulations for mangroves, seagrass beds, coral reefs, and beaches found to be most at risk/impacted, paired with local enforcement and sustainable tourism guidelines.

- **Integrate Risk of Ecosystem Service Losses into National Planning.** Include plastic-related risks to food provisioning, flood control (drainage blocks), and tourism into local and national development and coastal spatial plans

- **Include Plastic-Related Flood Risk in Disaster Preparedness and Climate Resilience Strategies –** Mandate integration of plastic waste impacts (e.g. drain blockages, infrastructure damage) in disaster risk reduction and climate adaptation planning, particularly in flood-prone coastal cities.

- **Use Economic Cost Models to Drive Policy and Investment:** Adopt PISCES econometric models to quantify the cost of inaction at national and provincial levels and build the business case to justify investment in plastic waste prevention and management measures with strong

economic rationale. Improve data collection and management to aid identification of the costs of actions and inactions to help minimize fiscal burden on financial resources.

Theme 3. Creating sustainable relationships to foster social, behavioural and technical changes needed to prevent and reduce plastic waste and pollution

Why is this important?

Plastic pollution is fundamentally a human challenge - shaped by everyday behaviours, habits, social norms, cultural values, power structures, and community dynamics. Yet these social and behavioural dimensions are often overlooked in plastic reduction efforts.

To achieve lasting change, we need not only technical solutions like better materials and improved waste management infrastructure, but also evidence of how citizens engage with these solutions in different contexts. *By generating research insights into what drives single-use plastic consumption and inappropriate waste disposal behaviour and engaging with citizens to understand barriers to adoption of solutions,* we can begin to create the social and infrastructural conditions to drive wide-scale behavioural change.

Deep citizen engagement and strong, cross-sector collaboration are essential to supporting these social transformations and unlocking the circular economy solutions necessary for a cleaner, healthier, and more sustainable future.

How did PISCES address these gaps?

PISCES studied the actions and perceptions of over 1,000 individuals across East Java, Banyuwangi and Jembrana, Bali, to understand plastic consumption and disposal behaviours, and to co-design locally relevant interventions.

Key activities included:

- **Behavioural research:** Collection of evidence, through focus groups, interviews, observational research and surveys, to identify motivations, habits, and perceptions behind single use plastic use and waste disposal practices.
- **Establishment of the PISCES Living Lab:** Development of a real-world collaborative platform for public-private-community collaboration to co-design and test plastic pollution solutions with local community members and stakeholders.
- **Co-design and testing of interventions:** Engaging local government, private, academic and community stakeholders in the identification of barriers and strategies to improve the adoption of better packaging and waste systems, and the co-design and testing of alternative solutions to plastics and plastic waste management.
- **Piloting reusable packaging:** Pioneered real-world testing of alternative packaging in small shops in Banyuwangi to evaluate user behaviour, feasibility and adoption over time.

Key Findings:

3.1 **Single-use sachets dominate the packaging market:** Sachets are the most popular type of packaging for multiple household goods bought regularly - often daily - primarily from small shops (warungs), due to affordability, perceived hygiene, ease of

portioning, storage and disposal. Usage is highest amongst people with lower education levels and monthly income groups. (*In alignment with Theme 1)*

3.2 **Prevalence of open burning and informal dumping is linked to waste service gaps**: Householders most commonly report burning or dumping their plastic waste, particularly where formal waste services are unavailable. While improved access to waste collection services substantially reduces the frequency of burning, it does not eliminate it., as inconsistent collection weakens trust and willingness to pay for formal management. *(Alignment with Theme 1)*

3.3 **Waste disposal choices are driven by complex social dynamics:** Disposal choices depend on the value of specific items of waste, community attachment, social expectations, and cultural or religious influences. Strong community ties tend to promote responsible disposal, while some cultural beliefs may discourage these practices. Some environmentally concerned citizens still burn waste to prevent local litter, showing the need to align norms with effective alternatives.

3.4 **Sachet use is strongly habitual and socially reinforced, but less common among individuals who were concerned about plastic pollution**, felt connected to the natural world, and considered the long-term consequences of their actions.

3.5 **Limited awareness and perceptions of environmental or human health harm:** Many households view burning and dumping as hygienic and harmless, often believing "nature will fix itself".

3.6 **Education and tailored communication are key drivers of change:** Digital media is an important source of information, increasing awareness of harms caused by plastic pollution, but its use varies dependent on education levels, gender roles, age and family/community structures. Sustained behaviour change requires integrated approaches combining education, community engagement, and support for new social norms engaging trusted community and religious leaders as champions for change.

3.7 **PISCES Living Labs are spaces that provide vital physical infrastructure to** foster engagement, enabling communities and local governments to **identify barriers** to behavioural change and explore, test and adopt context-specific strategies needed to **shift attitudes** and **re-shape practices**. The evidence generated from PISCES Banyuwangi Living Lab real-world user testing and piloting of alternative solutions co-created with local public and private stakeholders showed:

- **Barriers to reusable packaging adoption included cost, inconvenience of returning containers, and user disinterest/lack of awareness in small financial incentives for return.** Solutions must address *both* design of packaging systems and contextual factors (cultural norms, beliefs) for success.
- **Waste sorting improved when visual labels were combined with written guidance**, reducing confusion and contamination. This highlighted that education, better design and community engagement are essential.
- **Piloting of reusable packaging for selected foods in small shops in Banyuwangi was successful.** There was a 71% increase in the number of stores participating over 3 months; and week-on-week sales growth of 33%.

Figure 6. PISCES Living Lab: user testing one of the codesigned solutions in the living lab experience simulation environment.

Recommendations

- **Design and Implement Policies that reduce reliance on sachets by addressing their root drivers** - affordability, convenience, and habit - while promoting viable alternatives. Target lower-income households with subsidies, incentives, or loyalty schemes to make alternatives cost-competitive and engage small retailers (e.g. warungs) to trial and scale up refill/reuse systems supported by enabling infrastructure and micro-enterprise initiatives.

- **Improve Waste Collection Reliability -** Expand and improve formal waste management infrastructure and service reliability, to reduce reliance on burning and informal dumping.

- **Mainstream Behaviourally-Informed Waste Management Policy Design –** Integrate insights on social norms around burning, community motivations into local and national plastic reduction strategies and raise awareness of plastic pollution harms to health and nature with messaging adapted to education levels, gender roles. Design interventions that combine public education and awareness, enforcement mechanisms, community

engagement, and support for new social norms. Engage trusted community figures, such as traditional and religious leaders, as role models in targeted behaviour change campaigns to reinforce better waste disposal and reduce demand for sachets. Use entertainment and social media in creative ways to reach publics who may not engage with other messaging formats (e.g. news media). Track behavioural shifts through longitudinal monitoring and adjust strategies

- **Fund and formalise the set-up of community PISCES Living Labs in diverse regions with different socio-economic contexts** to test, adapt and replicate context-appropriate packaging and waste solutions tailored to local needs. Provide policy and financial incentives for businesses to use these labs as testbeds for scalable, circular packaging solutions.

- **Design Reuse Policies that address real- world barriers and embed reuse in packaging design standards.** Establish an Extended Producer Responsibility (EPR) scheme for reuse to at least the equivalent of recycling, including modulated fees to close the cost gap between reuse and single-use, deposit-return schemes and enforceable reuse targets, guidance and mandatory reporting for producers and brands, imposing penalties for non-compliance, and support for shared infrastructure to reduce costs and accessibility. Incentivise reuse uptake by piloting deposit-return and financial incentives to increase return rates and shift consumer habits

- **Standardise and Localise Waste Sorting Tools** - Introduce clear, visual waste sorting systems combined, written guidance and community-based awareness campaigns nationwide, tailored to local literacy and language.

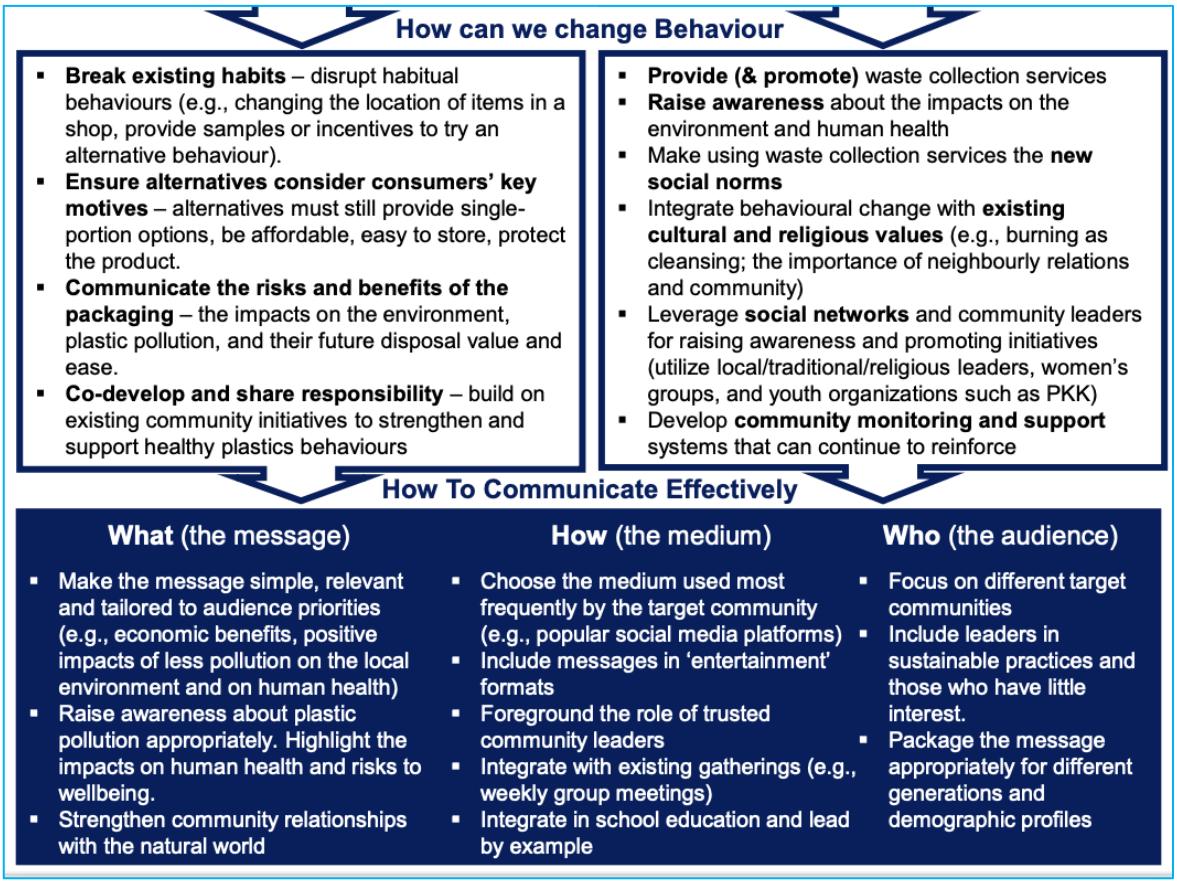

Figure 7. How to change behaviour and communicate effectively.

Theme 4. Addressing Policy Gaps and Implementation Barriers via a Systems Approach

Why is this important?

Interventions - such as technical innovations (new materials, reuse systems), infrastructural improvements (enhanced waste management), policy reforms (addressing weak enforcement), economic measures (reducing investment barriers) and communication strategies (education, training and coordination) – are gaining momentum. Yet, Change is difficult. The impact of interventions is slowed-down by a lack of holistic and systemic understanding, well-defined implementation pathways and cross-sectoral alignment of priorities and efforts.

A systems approach helps overcome these challenges by mapping the flows, roles, relationships and interdependencies between stakeholders, both internal (those who play a direct role in the physical production, consumption and waste generation and management of plastics) and external (those who are not directly engaged in the physical flow of plastics). It identifies points of leverage, reveals unintended consequences, and uncovers structural barriers to implementation, including overlapping responsibilities, institutional and funding constraints, misaligned efforts, and political inertia.

By integrating research, stakeholder insights, and policy analysis, we can co-design **strategies that are not only evidence-based and context-specific but also adaptive, scalable and capable of** addressing the systemic root causes of plastic pollution.

How did PISCES address these gaps?

PISCES applied the **CVORR systems-based tool** (Complex Value Optimisation for Resource Recovery) to map Indonesia's plastic value chain.

CVORR consists of three main parts: the *baseline analysis* (core stage), *system assessment/evaluation* (intermediary stage) and *system refinement and optimisation* (final stage). Its use reveals how entrenched norms, regulatory aspects and structural misalignments cause systemic inefficiencies, inhibit change and where strategic interventions can unlock progress **towards a circular economy for plastics.**

Key Findings

4.1 Local variability in human practices, infrastructure, governance and community needs drives systemic challenges: Indonesia's geographical and population diversity, and uneven infrastructure and socio-economic differences, create significant challenges for infrastructure development and governance. In many areas, the continued use of plastic sachets is driven by longstanding habits, affordability, accessibility and convenience due to deeply embedded norms that persist despite awareness-raising campaigns. Meanwhile, inadequate waste collection and management infrastructure and limited technical capacity contribute to widespread open burning and dumping, exacerbating environmental degradation and public health risks (*in alignment with Themes 1 and 3).* These challenges are interlinked as weak infrastructure reinforces behavioural reliance on single-use plastics of low functionality (in terms of duration of use and recyclability potential) and low perceived value, while persistent norms reduce pressure to improve services. Together, they intensify the economic, environmental,

and social burdens of plastic waste, undermining long-term sustainability and resilience.

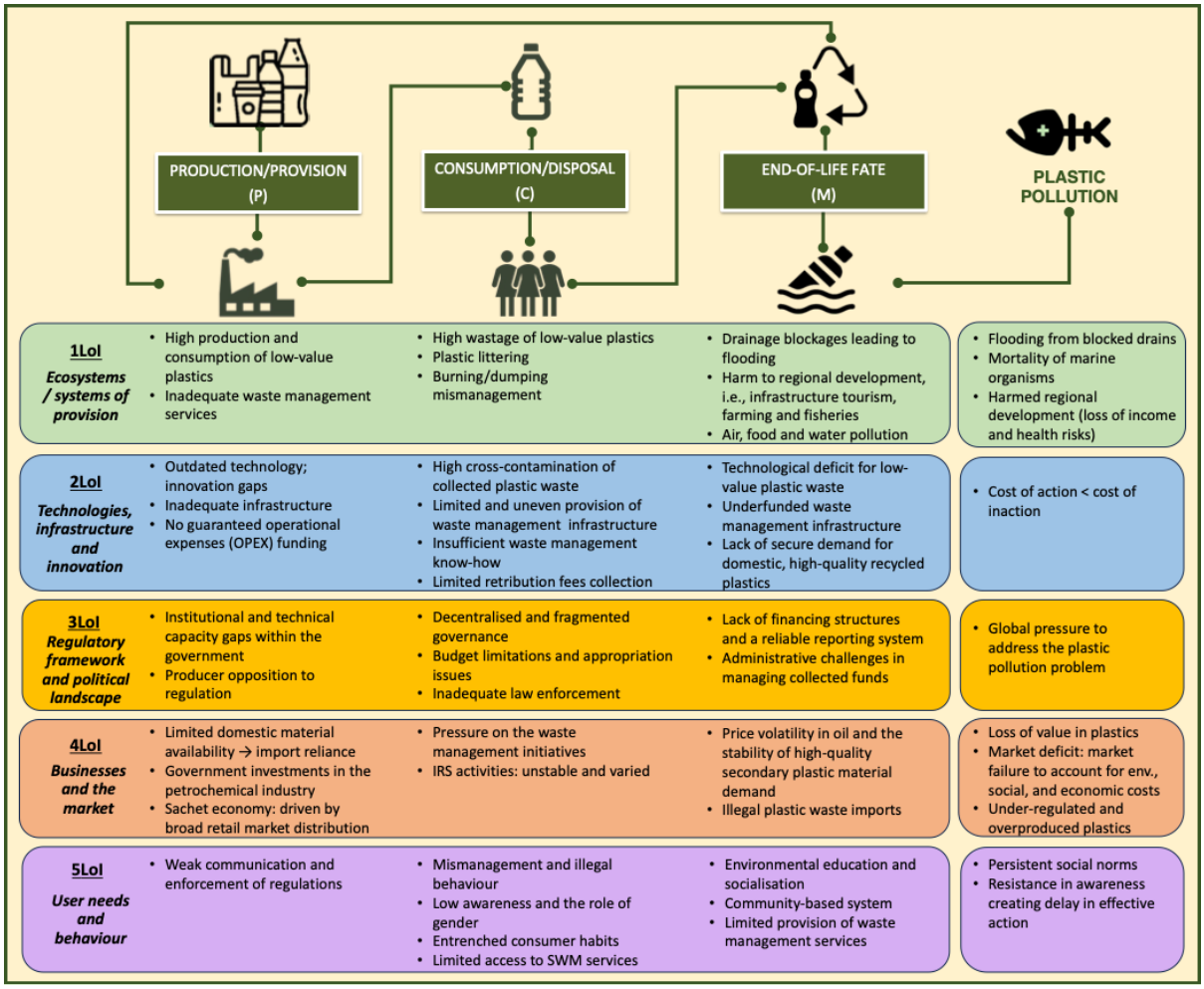

Figure 8. Systemic inefficiencies in the Indonesian plastics value chain, analysed using the five Levels of Intervention (5LoI) from the CVORR framework. The figure focuses on the production, consumption/use, and end-of-life stages, and illustrates the resulting externalities from plastic pollution (represented in separate but aligned boxes based on the 5LoI).

4.2 **Power concentration upstream of the value chain**: A small number of upstream stakeholders, specifically industries that dominate plastic production and supply, hold a dominant position in the financial assets within the plastic value chain, indicating substantial lobbying power in negotiations with the government. These industry stakeholders exert significant influence over regulatory and market-based interventions, shaping policies and market dynamics upstream.

This powerful influence creates critical dynamics that restrict the ability of the plastics recycling industry to effect meaningful change, despite its potential to catalyse systemic change. As a result, recycling systems downstream of the value chain remain fragmented and under-resourced, constrained by low material quality, lack of investment and inconsistent regulations.

Meanwhile, the informal recycling sector (IRS), despite its critical role in promoting recycling in the plastics value chain, faces marginalisation and social injustice. These

challenges significantly impact the IRS's ability to collect plastic waste, especially of low value. Connecting upstream and downstream stakeholders through coordinated strategies is key to unlocking transformational potential.

4.3 **Weak regulatory enforcement:** Existing regulations are inconsistently enforced. This undermines efforts to fund and improve waste collection and management systems, making it difficult to attract private sector engagement and funding. At the same time, this inhibits efforts to shift consumer behaviour and discourages investment in sustainable waste solutions. Characteristically, inefficiencies in retribution fees stem from low, poorly collected, and non-levy-based funding systems that lack transparency and sufficient coverage, while the EPR scheme suffers from weak enforcement, inadequate reporting, lack of legal backing, and limited industry engagement.

4.4 **Fragmented governance and short-termism:** Overlapping responsibilities among national and local governments slow policy implementation and dilute accountability. Local government often prioritises short-term, election-driven priorities rather than long-term reforms, targeting resource and waste management strategies. This slows progress and weakens institutional capacity to address plastic pollution effectively. Strengthening governance structures and clarifying responsibilities is critical for effective resource and waste management. Building the capacity of local stakeholders can foster more resilient and adaptive value chains while reducing inequalities in resource access and decision-making authority.

4.5 **Limited stakeholder coordination:** The competition for financial resources and institutional support leads to diversification of stakeholders' activities, which in turn affects their access to resources and their overall influence. To address this, bridging gaps between public, private, and community-based stakeholders is essential for fostering collaborative problem-solving and ensuring long-term impact. Strong, inclusive collaboration across all levels and stages of the plastics value chain – both vertically (across government levels) and horizontally (across sectors) – is crucial for aligning incentives, capturing diverse perspectives and unlocking joint investment.

Multi-stakeholder platforms play a key role in promoting constructive dialogue, building trust, and enabling shared decision-making, which enhances transparency and accountability. Such coordinated efforts can catalyse cross-sector engagement, behavioural change and sustainable financing mechanisms, ultimately fostering shared responsibility. Moreover, supporting interactions through established policies and encouraging stakeholders to take ownership of the transition can build win-win partnerships vital for driving transformative, systemic change.

4.6 **No 'one-size-fits-all' solution:** Plastic pollution in Indonesia is a complex, multi-causal issue shaped by structural inequalities, social norms, economic constraints and power imbalances. Tailoring interventions to regional realities and stakeholder dynamics is essential to ensure feasibility, equity and impact. A systems-informed, stakeholder-driven approach that gradually and inclusively involves stakeholders—beginning with those who hold significant power and interest at the local scale—can establish the basis for sustainable, long-term systemic transformation.

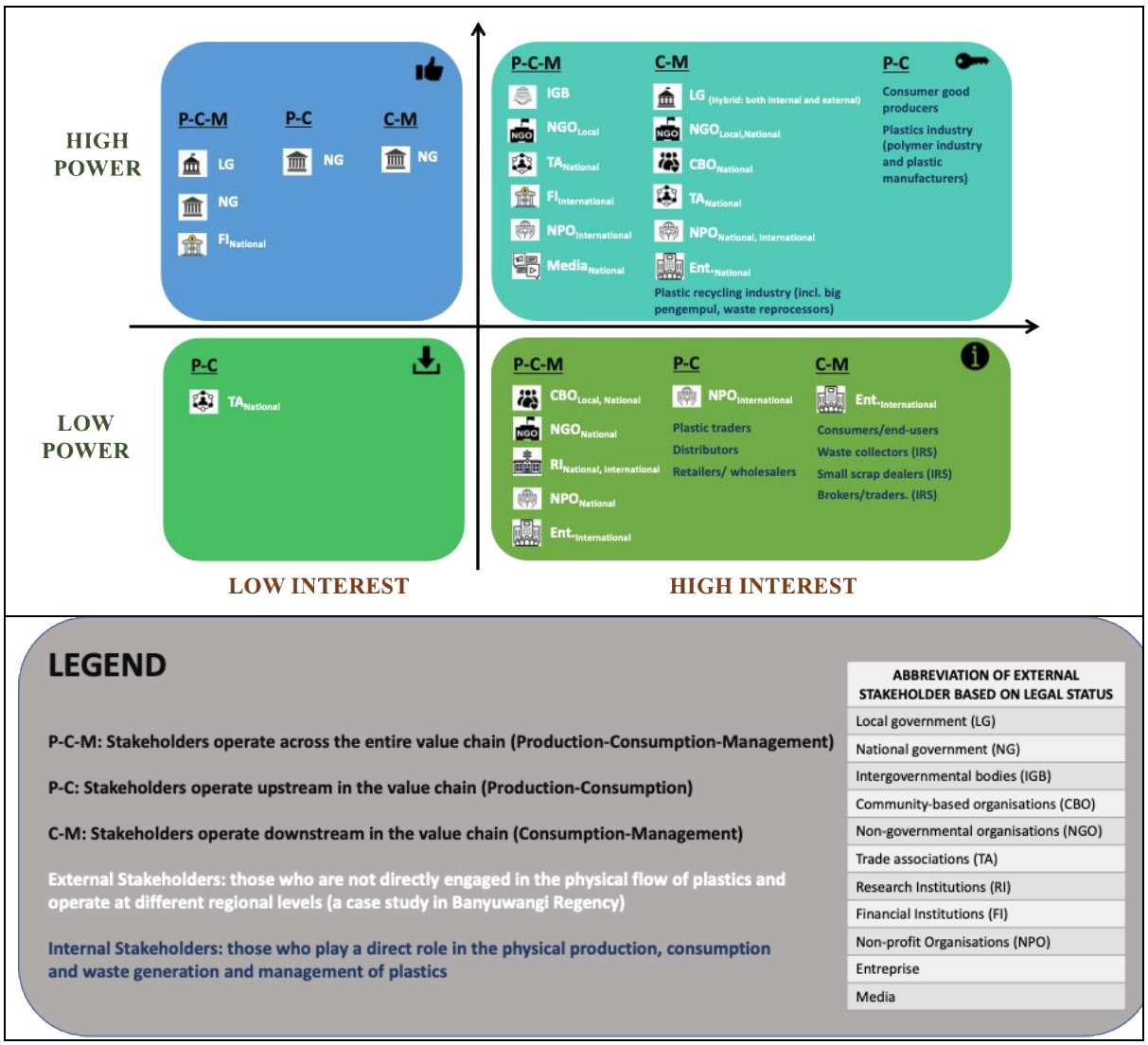

Figure 9. Power dynamics among internal and external stakeholders across the Indonesian plastics value chain, highlighting relative influence and system leverage points.

Recommendations:

- **Conduct location-specific systemic analyses to identify suitable social and material-based interventions to drive change**. Together with monitoring, this approach can effectively identify the key sources of plastic pollution, its drivers, hidden impacts and levers of change. It is crucial to account for regional differences in waste management capabilities and tailor solutions accordingly.

- **Embed systems thinking and stakeholder mapping into the new national plastic action plan for developing evidence-based policy,** requiring all new interventions to undergo socio-technical feasibility assessments and the potential development of multi-stakeholder platforms. Fund participatory Living Labs to pilot context-sensitive innovations, enabling iterative learning and scaling based on evidence and local buy-in.

- **Establishment of an inclusive policy framework that sets clear targets linked to clear guidance and measurable actions, including a streamlined EPR scheme.** This framework should ensure coordination between upstream and downstream stakeholders, including the informal sector. It should mandate that producers invest in waste collection and recycling infrastructure, adopt recycled content targets, and formally recognise informal waste workers

as essential service providers with access to training, appropriate equipment, and fair compensation.

- **Establish enforcement mechanisms for compliance with existing regulations.** This may involve increased inspections, penalties for disposal and mismanagement activities, transparent collection of retribution fees, implementation of standardised monitoring, and training for personnel supervising waste management practices.

- **Invest in capacity-building programs for local governments to improve technical expertise in waste management.** This could include workshops, knowledge-sharing platforms, and partnerships with NGOs and international organizations.

- **Establish comprehensive, measurable metrics for monitoring plastic waste management performance in Indonesia,** including environmental metrics (e.g., reduction in plastic waste and recycling rates), economic metrics (e.g., cost-effectiveness and revenue from plastic taxes and retribution fees), social metrics (e.g., public participation rates and awareness levels), and technical metrics (e.g., compliance rates with EPR regulations and quality of recycled materials) to enhance accountability and drive continuous improvement.

- **Clarify roles and responsibilities among national, regional, and local authorities to facilitate cohesive policy implementation.** A unified strategy should be developed, via an intergovernmental task force, that articulates clear lines of communication and accountability across all levels to ensure cohesive policy enforcement through collaboration among government bodies, the private sector, and civil society.

- **Develop a competitive and inclusive formal waste management system underpinned by a tailored fiscal instrument (e.g., a tax or levy) that accounts for and supports both formal and informal sector contributions.** This mechanism would enable national and local governments to facilitate the voluntary formalisation of informal recycling sector (IRS) actors by providing access to legal recognition, social protection, and income security, while ensuring that remuneration remains proportionate to the level and value of their contributions within the IRS network.

Conclusion: A unique opportunity

The next NPOA is more than a policy update – it is an opportunity. Success will depend not only on setting new targets but by the ability to correct the weaknesses of the current plan. That means strengthening governance, investing in infrastructure, enabling behavioural change and establishing the means for collecting and using credible data.

The PISCES programme offers both the evidence base, and tools needed to support this transformation and can continue providing support for the NPOA revision. With a clear political momentum, growing public awareness and strong partnerships, Indonesia is well-positioned to lead change.

The time to act is now.

About the Lead Authors

Coordinating leads

Professor Susan Jobling is a Professor of Ecotoxicology at Brunel University of London and Director and Principal Investigator of the PISCES Programme, and a specialist in creating and leading interdisciplinary research and enterprise programmes focusing on the health of people and the environment, bridging science and policy. Her work over the past three decades has focused on the safety of both environmental pollutants and has been influential in the development of widespread controls on some environmental contaminants.

Dr Eleni Iacovidou is a Senior Lecturer in Environmental Management at Brunel University of London, co-Investigator of the PISCES Programme (leading Theme 4 in this report), and Director of the Centre for Pollution Research and Policy. She is world-leading expert in Resource and Waste Management, Systems Thinking, and Circular Economy. The overarching aim of her work is to inform policy and strategic decision-making focused on achieving transformational change. Her pioneering systems-based approach, called CVORR, which is used in the PISCES project, has gained widespread recognition from policy and decision-makers both nationally and internationally.

Dr Loula Gerassimidou is a Senior Research Fellow at Brunel University of London, specializing in sustainability assessment of resource and waste management systems. She co-leads the application of the CVORR systems-based approach (CVORR) within the PISCES project and is a member of the Centre for Pollution Research and Policy. Her research focuses on developing evidence-based metrics through CVORR to monitor performance and support informed, efficient decision-making for sustainable resource use and waste management.

Professor Joyashree Roy is Distinguished Professor, Founder Director, SMARTS Centre, Asian Institute of Technology (AIT), Thailand, and former Professor of Economics, Jadvpur University, Kolkata, India. As an environmental and energy economist, she works on climate change mitigation, sustainable development, and low-carbon transitions, and served as Coordinating Lead Author for the Working group III of the IPCC in the Fourth, Fifth and Sixth Assessment Cycles. Her research contributes to Theme 2 in the report exploring the economic benefits and costs of action and inaction to combat plastic pollution.

Theme Leads

Professor Melanie Austen is Professor of Ocean and Society and Director of the Centre for Systems Thinking: Ocean, Land and Society at the University of Plymouth, UK. She leads interdisciplinary research on marine ecosystems, natural capital, and blue-green economies and serves on bodies such as Natural England and the Joint Nature Conservation Committee. Her work bridges science, policy, and communities to advance sustainable ocean stewardship. Professor Austen co-leads Theme 2 in the report focusing on where and how ecosystem services in coastal ecosystems are most likely to be impacted by plastic pollution.

Dr Fabrizio Ceschin is a Reader in Design for Sustainability at Brunel University London and co-lead of the Design Research Center. He is a leading expert in design-led solutions for sustainability transitions, product–service systems, and circular economy models and has extensive experience in international sustainability projects where he researches and advises on sustainable product and service design strategies. He co-leads Theme 3 in the report focusing on the Living lab testing of novel design solutions to the plastic packaging problem with users and stakeholders through a practical step-by-step process.

Professor Muhammad Reza Cordova is Principal Scientist at the Indonesian National Research and Innovation Agency (BRIN) and co-leader of Theme 1 in the report. His research focuses on marine pollution, particularly the distribution, occurrence, and toxicology of marine debris and microplastics in Indonesian waters and has significantly contributed to understanding the impacts of plastic waste in marine ecosystems. Actively involved in national and international collaborations aimed at addressing ocean plastic waste, his expertise is instrumental in shaping policies for marine conservation and sustainable waste management in Indonesia.

Dr I Gede Hendrawan is Associate Professor, Head of Centre for Remote Sensing and Ocean Sciences (CReSOS) at Universitas Udayana, Bali, Deputy Director of PISCES Programme and co-leader of Theme 2 in the report. His research focuses on coastal and marine environments, marine debris, and oceanographic modelling used in the PISCES Project to track plastic pollution. He has led initiatives to develop baseline data for marine debris in Bali and has contributed to formulating Bali's marine spatial plan and ocean health index.

Professor Lesley Henderson is a world-leading expert in science communication and media sociology at the University of Strathclyde. She specializes in environmental issues, focusing on social and behavioural dimensions of plastic pollution. She engages in public outreach, advisory roles, and interdisciplinary research initiatives, working intensively to bridge science and public understanding on environmental issues. Prof Henderson co-leads Theme 3 in

the report exploring which methods of communication and which messages about waste management and plastic pollution are most suitable to motivate change in attitudes and intentions.

Dr Radisti Ayu Praptiwi is a lecturer at Universitas Esa Unggul and interdisciplinary researcher at BRIN. Her research focuses on coastal and marine ecosystem services, climate impacts, and human interactions. Her work includes assessing effects of marine plastic pollution on tropical ecosystems, exploring the socio-ecological and cultural dimensions of ecosystems services and coastal management using participatory approaches to integrate local knowledge in environmental assessments. Her research contributes to Theme 2 in the report, identifying and mapping coral reef, hard bottom, sedimentary, seagrass and mangrove habitats to estimate the proportions of seabed covered by these habitats to inform alignment of habitats with ecosystem service delivery.

Professor Sabine Pahl is a Social Psychologist at the University of Vienna engaged in basic and applied research and her applied work focuses on the human dimension in environmental issues. She investigates perceptions and behaviour change, particularly in protecting marine environments, marine litter and microplastics and energy efficiency. Other applied work examines restorative effects of natural environments including the use of natural environments in healthcare. Her projects typically span research and application in interdisciplinary teams. She has provided science advice and input into policy at national, European and international levels, always contributing psychological and behavioural science perspectives. Professor Pahl contributes to Theme 3 in the report

Professor Emenda Sembiring is a leading environmental engineer at Institut Teknologi Bandung (ITB), Indonesia, specializing in solid waste management, recycling technologies, and sustainable urban environmental systems. With over two decades of experience researching waste treatment processes, resource recovery, and the environmental impacts of waste management practices in both urban and industrial contexts, she actively contributes to shaping national waste policies and environmental regulations in Indonesia, collaborating extensively with government agencies on improving municipal solid waste management infrastructure. Prof Sembiring co-leads Theme 1 in the report (leading on waste characterisation) and Theme 3 where she co-leads the Living lab experiments.

Professor Sudarso is a leading researcher in the Department of Sociology at Universitas Airlangga, Surabaya, Indonesia and co-leads Theme 3 in the report focusing on collection of evidence to identify motivations, habits, and perceptions behind single use plastic use and waste disposal practices. His research focuses on rural and urban sociology, with particular emphasis on social stratification, gender dynamics, and community development. He actively contributes to several research centres for Social Transformation and Community Development and Gender and Social Inclusion. His research employs both qualitative and quantitative methodologies to explore social issues and inform policy development, focusing on bridging research with practical community development initiatives.

Professor Eddy Setiadi Soedjono is a leading engineer in the Department of Environmental Engineering at Institut Teknologi Sepuluh Nopember (ITS) in Surabaya, Indonesia. He has over 25 years of experience, in water and sanitation engineering, focusing on drinking water treatment, wastewater management, and community-empowered environmental solutions. His research has significantly contributed to sustainable water supply systems and public health improvement in Indonesia. Prof Soedjono contributes to Theme 3 in the report alongside Prof Sudarso.

Professor Richard Thompson OBE FRS is a marine biologist, co-leader of theme 1 in the report and a leading authority on plastic pollution at the University of Plymouth, where he also serves as the Director of the Marine Institute and leads the International Marine Litter Research Unit. Over the past two decades, his research has been instrumental in documenting their global distribution - from Arctic Sea ice to the deep seas - and assessing their ecological impacts. Professor Thompson collaborates extensively internationally to inform marine pollution mitigation strategies and policies. Currently Co-Coordinator of the Scientists' Coalition for an Effective Plastics Treaty, he is helping to mobilise scientific expertise to guide the development of a global, legally binding plastics treaty.

Dr Costas Velis is an internationally recognised expert in resource recovery and plastics pollution, based at Imperial College London. His research focuses on understanding global plastic waste flows, recycling systems, and the circular economy, with an emphasis on bridging science, policy, and practice. His novel modelling tools, informing Theme 1 in this report, quantify plastic pollution from waste, linking pollution sources and environmental pathways at both local and global scales. Dr Velis chairs the Community of Practice on 'Harmonisation of Plastic Pollution Quantification Methodologies and Models' (UNEP GPML) and is also co-chair of the Working Group on 'Exposure' in the Lancet Countdown on Health and Plastics.

Professor Kayleigh Wyles is a leading environmental psychologist at the University of Plymouth, specialising in human - environment interactions, particularly concerning marine and coastal ecosystems, and contributes to interdisciplinary studies on marine plastic pollution, coastal urbanisation, and the psychological benefits of nature exposure. She engages in interdisciplinary projects globally and has served on the United Nations GESAMP Working Group on Microplastics, working to inform policies aimed at enhancing public engagement with the marine environment and promoting sustainable behaviours. Professor Wyles is co-leading Theme 3 of this report contributing generating research insights into what drives single-use plastic consumption and inappropriate waste disposal behaviour and engaging with citizens to understand barriers to adoption of solutions.

For more information, please contact the coordinating lead authors:

Prof Susan Jobling, Professor of Ecotoxicology, Centre for Pollution Research and Policy, Brunel University of London, UK. Susan.Jobling@brunel.ac.uk

Dr Eleni Iacovidou, Senior Lecturer in Environmental Management, Director of Centre for Pollution Research and Policy, Brunel University of London, UK. Eleni.Iacovidou@brunel.ac.uk

Dr Spyridoula Gerassimidou, Senior Research Fellow, Sustainability Assessment of Resource and Waste Management Systems, Centre for Pollution Research and Policy, Brunel University of London, UK. Loula.Gerasimidou@brunel.ac.uk

Prof Joyashree Roy, Distinguished Professor, SMARTS Center Director, Asian Institute of Technology (AIT), Thailand. Former Professor Economics, Jadavpur University, Kolkata, India. Joyashree@ait.asia

Cite: Jobling, Susan; **Iacovidou**, Eleni; **Gerassimidou**, Spyridoula; **Roy**, Joyashree; **Austen**, Melanie; **Ceschin**, Fabrizio; **Cordova**, Muhammad Reza; **Hendrawan**, Gede; **Henderson**, Lesley; **Pahl**, Sabine; **Praptiwi**, Radisti Ayu; **Sembiring**, Emenda; **Soedjono**, Eddy Sediadi; **Sudarso**; **Thompson**, Richard; **Velis**, Konstantinos; **Wyles,** Kayleigh. **Evidence-based Strategies for Reducing Plastic Waste in Indonesia**, Brunel University of London. https://doi.org/10.17633/rd.brunel.29881835

Brunel University of London
Kingston Lane
Ubbridge, UB8 3PH
www.brunel.ac.uk