PLASTIC WASTE IN JAKARTA BAY CAPTURED IN 2018 BY GARRY A. LOTULUNG [33]

HALTING THE FLOW OF PLASTICS FROM JAKARTA INTO THE JAVA SEA THROUGH INVESTMENT IN PLASTIC ALTERNATIVES AND IMPROVED REGULATION ENFORCEMENT

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Executive Summary

As the coastal capital of Indonesia, Jakarta is faced with the challenge of halting the flow of plastic debris into the Java sea. Every year, approximately 2,100 tons of macroplastic is emitted from Jakarta rivers and canals into the ocean. Most of this debris originate from Jakarta itself, reflecting its excessive mismanaged waste which end up in water bodies. Microplastics had been found in fish, snails, and crabs in Jakarta Bay, highlighting the threat of plastic debris toward wildlife and eventually humans as the top predator. Although studies found that styrofoam, wraps, and sacks make up for most of the debris, the Governor of Jakarta has only started to ban single-use plastic bags, with the exception of food containers where there is no better alternative. Moreover, this ban was introduced in the midst Jakarta's Large Scale Social Restriction due to COVID-19, causing further harm to Micro, Small, and Medium Enterprises in economically difficult times. Looking forward, the government has to discourage the use of styrofoam, plastic wraps, and plastic sacks, including those for food packaging. This can be done through supply-side policies in plastic alternatives such as Cassava and food waste, thus minimizing economic and social harm. Furthermore, an improvement in the enforcement of Local Regulation Number 3 of 2013 about Waste Management is needed to improve the compliance of households, area managers/developers, and producers. This may be done through campaigns as well as the recruitment and training of more civil servant investigators. Besides, improved citizen participation supports the government's river naturalization program in its efforts to reduce flooding.

Foundational Science

The durability of plastics is undeniably one of the main reasons humans rely on them today. Unfortunately, however, this same trait becomes a problem for the natural envirnonment, as it introduces potentially harmful novel entities [1]. The polymers which make up plastics, including those only used once, are resistant to attack by most microorganisms and thus would remain in nature and accummulate over time [2].

Figure 1. Map of Jakarta indicating monitoring locations: (1) BKB-Angke (Ciliwung), (2) Cengkareng Kapuk (Pesanggrahan), (3) BKT (various), (4) Sunter mouth (Sunter), (5) Cakung mouth (Cakung), (6) BKB-Grogol (Ciliwung), and (7) Haryono (Ciliwung) [3:3].

Location	River	Mean transport (May, 2018) (tonnes d^{-1})	Emission into the ocean? (Yes/No)	Yearly transport ($\times 10^3$ t yr^{-1})
BKB-Angke	Ciliwung	1.5	Y	1.0
Cengkareng Kapuk	Pesanggrahan	0.5	Y	0.4
BKT	Various	0.7	Y	0.6
Cakung Drain	Cakung	—	Y	0.1
Sunter Mouth	Sunter	—	Y	0.0
BKB-Grogol	Ciliwung	1.5	N	1.0
Haryono	Ciliwung	0.2	N	0.2
Total emission				**2.1**

Figure 2. Table of the measured mean and estimated yearly plastic transport for different locations [3:7].

In Jakarta, plastics which find its way to rivers would eventually flow into the Java Sea, as shown on Figure 1. Every year, approximately 2,100 tons of macroplastic is emitted from Jakarta rivers and canals into the ocean, with the distribution shown on Figure 2. Not only do these plastics disturb life underwater through physical entanglement [4], but they also disrupt the foodchain as animals ingest them and pass them on to the next predator. In fact, microplastics had been found in blue panchax fish (*Aplocheilus sp.*) in Ciliwung estuary, coastal waters of North Jakarta [5], and in snails (*Littoraria scabra*) and crabs (*Metopograpsus quidridentata*) in Pramuka Island, Jakarta Bay [6]. Concerningly, aside from containing adverse additives, these plastics also sorb harmful Persistent Organic Pollutants (POPs) [7]. Furthermore, as these plastics—along with the toxic substances they contain—move up the food chain, they bioaccummulate [8] and cause adverse effects to both vertebrate and invertebrate species in terms of feeding, energetic reserves, reproduction, growth, and survival [9]. This threat towards Jakarta Bay's biodiversity is crucial as its inshore reefs had been reported to have "very low biomass of fishes" due to eutrophication and reef degradation as a result of the anthropogenic perturbations of urbanization [10:513]. Besides, natural resources such as fish and shellfish are crucial in supporting the livelihood of those at the Fisheries Village Coastal Area [11]. Furthermore, through the process of bioaccumulation, as illustrated on Figure 3, marine plastic debris may eventually pose health risks toward humans as the top predator [8], as microplastics are known to pass the intestinal and placenta barriers in mammals [12].

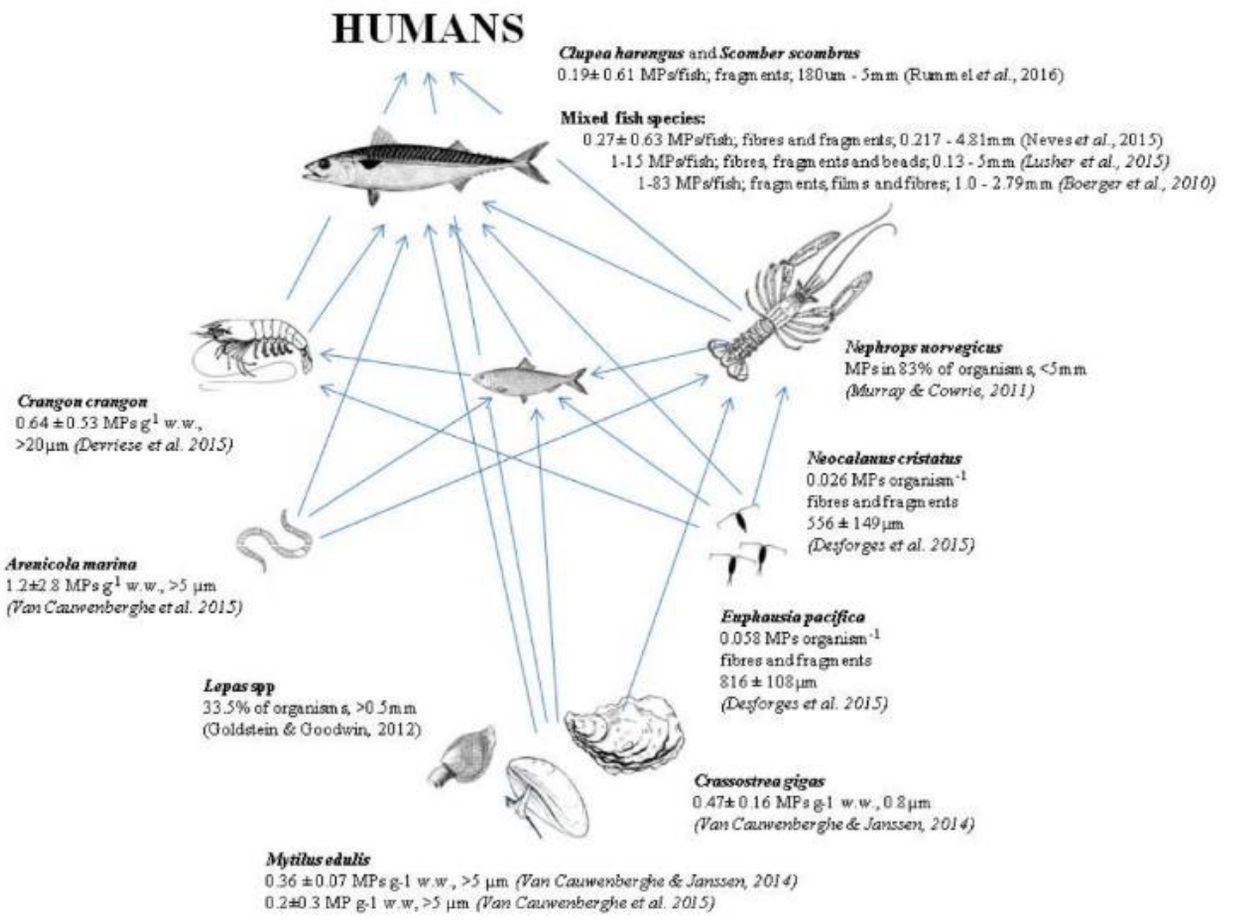

Figure 3. Model marine food web showing the load, size, and shape of microplastics (MPs) found in organisms across various trophic levels [13:3].

In 2010, Indonesia was reported to be the second largest contributor to mismanaged plastic waste [14:769]. As its coastal capital, Jakarta is a final ‘intervention point’, meaning there is a large responsibility for Jakarta to halt the flow of plastic waste, both from surrounding more-elevated areas as well as Jakarta itself, before they enter the ocean. Ironically, most of the plastic debris deposited at its river mouths originate from Jakarta itself, not surrounding areas [3:7]. Therefore, this capital city is faced with a pressing challenge to manage its household, industrial, and transferred plastic flow to support Indonesia in achieving Sustainable Development Goals 12 Responsible Consumption & Production and 14 Life Below Water by 2030.

Assessment of Existing Governance

In 2019, plastics made up 57% of total debris from Jakarta by abundance [15:2]. As shown on Figure 4, styrofoam accounted for most of this at 11.47%. Another study found that most emmitted plastics were bags and foils [3:8], possibly explained by the categories “thin plastic wrap” and “thick plastic wrap, sack” which amount to 13.65% on Figure 4. With this, it is important for the government of Jakarta to focus on the management of styrofoam, plastic sacks, and plastic wraps.

Plastics categories	Jakarta Abundance (%)
Ball, Tires, Balloons, Pieces	0.09
Plastic bottles	6.96
Plastic cups	9.17
Plastic cover	4.28
Plastic match, tips, cigarettes	4.24
Thin plastic wrap	7.24
Thick plastic wrap, sack	6.41
Rubber bands, rubber pieces	5.65
Masking tape, duct tape, plastic pieces	3.02
Medicine wrap	5.60
Straw, pieces	6.23
Food boxes, plastic utensil, etc.	5.80
Shoes, sandals, gloves, cuts	4.85
Styrofoam	*11.47
Rope, fishing line, fishing rod	3.81
Plastic rope/small net pieces	4.06
Pipe, hoses, pieces	3.72
Another plastic fault	3.02
Wrap cosmetics, toiletries, etc.	4.37

Figure 4. Table of percentages of debris collected at Jakarta’s river outlets under plastic categories by abundance. The highest percentage is noted with an asterisk. [15:3]

The Governor Regulation Number 142 of 2019 introduced a ban on single-use plastic bags, while still allowing single-use plastic food containers where there is no better alternative [16:6]. Although this addresses plastic sack waste, it does not tackle the other dominant plastic categories: styrofoams and plastic wraps. Besides, the government’s decision to make an exception for food containers means that it is still far from confronting plastic cups and bottles, which amount to 16.13% on Figure 4. Furthermore, nearly 50% of the microplastics found in Muara Angke Wildlife Reserve,

Jakarta, were polystyrenes, which is commonly used for food packaging [17:1]. This reflects the need for more emphasis on the waste management of plastic food containers. Aside from that, the regulation was realized at quite an unforunate time mid-2020 [16] in the midst of Jakarta's Large Scale Social Restriction due to the COVID-19 pandemic [18]. This added even more burden towards Micro, Small, and Medium Enterprises (MSMEs), as they were forced to adjust to the additional costs of obtaining plastic alternatives [19] in the midst of difficult times. Furthermore, even though the regulation mentioned tax cuts for physical markets who have adhered to it, it required them to write an application letter to the government for it [16:13]. This makes the process difficult and does not necessarily motivate individual tenants to comply.

Years prior, Local Regulation Number 3 of 2013 introduced an extensive list of waste management regulations encouraging households, area managers/developers, and producers to reduce, reuse, and recycle (3R) [20], with some revisions made in 2019 [21]. Nonetheless, the fact that Jakarta's plastic debris is still prevalent today [22] shows that this regulation, or more precisely, its enforcement, is insufficient. In the district of Kelapa Gading, for instance, the reduction of waste has yet to be fully implemented due to the lack of the district managers' awareness of their responsibility to independently manage waste [23]. Furthermore, individuals in Kelapa Gading do not actively sort nor recycle waste and rely excessively on hygiene workers instead [23]. This lack of participation from both sides in the northern area of Jakarta is detrimental as they reside by the lower-stream section of the rivers near the sea.

It is also worth noting the government's program of naturalizing Jakarta rivers [24], which involves river-cleanups in its efforts to reduce flooding. However, even with this program in place, the macroplastic transport in Jakarta is still abundant at about 20 times greater than the national average [3:7]. As with the previous point, this calls for better citizen participation in ensuring that waste, especially plastic, do not enter waterways in the first place.

Governance Recommendations

The government of Jakarta needs to disincentivise the use of plastics, mainly styrofoams, plastic sacks, wraps, as well as cups and bottles, including those used for food packaging. This does not necessarily mean more bans in the near future, however. As the COVID-19 pandemic increases demand for hygienic single-use containers for food and toiletries [25], a sudden introduction of strict bans would be harmful for both consumers and producers. This risks Jakarta's social sustainability, as it threatens one's health, comfort, economic wellbeing, and thus quality of life [26]. Instead, the government needs to consider investing in supply-side policies for plastic alternatives which would substitute plastic containers to meet this increased demand. One potential alternative would be Cassava. Cassava bags are currently the cheapest alternative to plastic ones, but it is still six times the cost [27]. Besides, this would improve the demand for Cassava, thus improving the market price of Cassava and therefore the livelihoods of its farmers [28]. Another potential plastic substitute may be derived from food waste such as seeds and fruit peels, which would also help reduce Jakarta's food waste [29]. Among other supply-side policies, the government could encourage research and development in plastic alternatives through grants, trainings, and other forms of research facilitation. A potential source of funds for this expenditure would be a form of plastic taxation, which is already being planned by the Ministry of Finance [30]. This way, the economic loss from plastic taxation could hopefully be restored through the subsidies injected into the market for its alternatives.

Next, the government needs to review the effectiveness of Local Regulation Number 3 of 2013 about Waste Management, and ensure that all its regulations are first known and understood, and second followed by the public, including households, area managers/developers, and producers. This may involve campaigns around the 3R which should raise awareness of the dangers of mismanaged plastic waste and also provide information on how to reduce, reuse, and recycle them. Aside from that, it may also entail increasing the number of civil servant investigators (*PPNS*) [23] and training them in order to improve the regulation's enforcement. At the very least, the government must ensure that plastic waste do not end up in water bodies. This way, there would be a better collaboration between the government and the citizens in halting plastic flow, as the government continues to perform river clean-ups for

naturalization. Besides, there is little point in the naturalization program which seeks to reduce floods [24] if plastic waste continue to accumulate in river sediments and clog hydraulic infrastructure [31]. Furthermore, plastic debris is significantly detrimental to the issue of flooding as they lead to a more rapid rise in water levels than organic debris [32].

As mentioned, Jakarta's rivers are the final sites where plastic waste may be removed before they are pushed into the ocean and enter a larger ecosystem. This means that Jakarta should reduce, not add, the plastic load in rivers. While upstream waste may pose negative externalities on Jakarta, Jakarta's failure to halt the plastic flow poses harm principally on no other region but itself.

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