

Institute of Developing Economies (IDE-JETRO), The World Bank, The Asahi Shimbun Company  
Marine Plastic Debris and its Countermeasures in Asia: Impact on Ecosystems and International  
Cooperation

# **Marine Plastic Debris and its Countermeasures in Asia**

Michikazu Kojima  
Chief Senior Researcher, Inter-disciplinary Studies Center  
Director-General, ERIA Support Office,  
IDE-JETRO

# Leakage of Plastics to the Environment



↑ Plastic waste in the Pasig river close to Manila bay. Right hand side is residential area, close to squatter. February 2020, Photo by M. Kojima



↑ Bamboo fence to prevent marine plastics entering mangrove forest in Jakarta Bay, Indonesia. November 2022, Indonesia, photo by M. Kojima.

# Why we tackle on Marine Plastic Debris?

- Marine plastics affect marine eco-system.
  - After 2018, many death of marine life due to plastics have been reported in Southeast Countries: Whale, Dolphine, Turte, Dugon and others
- Conventional program for nature conservation, such as restricting human activity in designated area, is not effective for plastic pollution
- In addition, most of plastics are not biodegradable. Plastics are accumulated in the environment.
- Impact of plastics to human health is uncertain.
  - Plastics may be an agent to deliver hazardous substance into human body, but compared with other route, the volume of delivering hazardous substances into human body may be lower than other routes.
- Collecting plastics form the environment might be costly.
- Although there are uncertainty, due to irreversibility of possible future consequences (it is costly to collect plastics in the environment), precautionary principles should be applied.
- Microplastic are found in high mountain also.

# Increase of International Concern on Marine Plastic Debris ( 1 )

- Even in 1970s, Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter adopted in 1972, and MALPOL Convention adopted in 1978 prohibit the dumping plastic waste to the ocean. But leakage of plastic waste through rivers, or leakage of fishing gear were not regulated.
- Scientific and Technical Advisory Group (for the Global Environmental Facility) made a report titled “Maine Debris as a Global Environmental Problem: Introducing a Solutions Based Framework Focused on Plastic”, in 2011. Conventional measures to protect ecosystem, such as setting sanctuary and preventing human activities in specific area, is not effective to plastic pollution
- At the Rio+20 in 2012, Global Partnership on Marine Litter was started.
  - Decision XI/18 of Convention on Biodiversity in 2012 cited STAP report and decided to tackle marine debris issue.
- In all meetings of United Nations Environmental Assembly since 2014 has argue marine plastic debris.

# Growing concern on Marine Plastics (2)

- Jambeck, Jenna et.al (2015) “Plastic Waste Inputs from Land into the Ocean” was published in *Science*.
- World Economy Forum(2016) . “The best research currently available estimates that there are over 150 million tonnes of plastics in the ocean today. In a business-as-usual scenario, the ocean is expected to contain 1 tonne of plastic for every 3 tonnes of fish by 2025, and by 2050, more plastics than fish (by weight)”.
- In March 2022, UNEA 5 decided to have Intergovernmental Negotiating Committee on Plastic Pollution.
  - Plastic particles are found in top of mountain and human blood. New international treaty deal with not only marine plastic debris but also cover other plastic pollution on land and air.
- The first Intergovernmental Negotiating Committee was held between November 28 to December 2 in 2022.

# Estimation of Plastic Leakage to the Ocean (1)

**Jambeck et al.(2015)**

**海への流出（対象年：2010年）**

- Estimated from population within 50km from the ocean, per capita waste generation, rate of mismanaged waste, share of plastics.
  - The estimation on leakage from Sri Lanka might be error, because per capita waste generation is 4 to 5 times of other countries.

	Country	Leakage (million ton)
1	<b>China</b>	1.32 - 3.53
2	<b>Indonesia</b>	0.48 - 1.29
3	<b>Philippines</b>	0.28 - 0.75
4	<b>Vietnam</b>	0.28 - 0.73
5	<b>Sri Lanka</b>	0.24 - 0.64
6	<b>Thailand</b>	0.15 - 0.41
7	Egypt	0.15 - 0.39
8	<b>Malaysia</b>	0.14 - 0.37
9	Nigeria	0.13 - 0.34
10	<b>Bangladesh</b>	0.12 - 0.31
11	South Africa	0.9 - 0.25
12	<b>India</b>	0.9 - 0.24
13	Algeria	0.8 - 0.21
14	<b>Turkey</b>	0.7 - 0.19
15	<b>Pakistan</b>	0.7 - 0.19
30	Japan	0.2 - 0.6

# Estimation of Plastic Leakage to the Ocean(2)

## Meijer et al.(2021)

- Estimated leakage from each rivers by using correlation of monitoring result and explanatory variables such as population, rate of mismanaged waste, rainfalls and others.
- The estimated volume of plastic leakage by Meijer et al. (2021) is about one tenth of Jambeck et al.(2015),
- To improve accuracy, it is important to have more monitoring data on leakages from rivers, more detail data on waste generation and disposal, and plastic leakage not covered in waste statistics such as fishing gear, microbeads, fiber from textile and others.

.	国名	流出量 (万トン)
1	<b>Philippines</b>	0.356
2	<b>India</b>	0.126
3	<b>Malaysia</b>	0.073
4	<b>China</b>	0.070
5	<b>Indonesia</b>	0.056
6	<b>Myanmar</b>	0.040
7	Brazil	0.037
8	<b>Vietnam</b>	0.028
9	<b>Bangladesh</b>	0.024
10	<b>Thailand</b>	0.022
11位	Nigeria	0.018
12位	<b>Turkey</b>	0.014
13位	Cameroon	0.010
14位	<b>Sri Lanka</b>	0.0096
15位	Guatemala	0.0071
37位	Japan	0.0018

# Impacts to Marine Ecosystem(1): From News in Southeast Asia

When	Where	
June, 2018	Songkhla, Thailand	A male short-finned <b>pilot whale</b> found stranded in Songkhla Province was died in June 2018. 80 pieces, 8 kg of plastics was found from the stomach, while the weight of whale was 500kg. (Bangkok Post, June 3, 2018)
August 2018	Mindanao Philippines	A <b>whale shark</b> was found dead in the shores of Tagum City, Davao. The large plastic cup and jello plastic blocking the gills. The plastics inside the stomach blocked the fine filters of the intestines. (CNN Philippines, August 8, 2018)
Nov. 2018	South Sulawesi, Indonesia	5.9 kg of garbage was found from a dead <b>Sperm Whale</b> beached on Kapota Island. From the stomach, 115 plastic cups, 19 hard plastic pieces, 4 plastic bottles, 25 plastic bags, six wood splinters, two rubber sandals, on nylon sack, and more than 1,000 pieces of plastic rope were found. (Jakarta Post, November 18, 2018.)
March 2019	Mindanao, Philippines	Young <b>whale</b> died with 40 kg of plastics in its stomach in Davao Gulf of the Philippines (National Geographic, March 19, 2019),
June 2019	Pattaya, Thailand	A dead hawksbill <b>sea turtle</b> was found washed ashore Pattaya's Na Jomtien Beach. An autopsy reveals that the turtle's stomach was full of plastic trash and bits of fishing net. (Nation, July 1, 2019 )
August 2019	Krabi beach, Thailand	An 8-month-old <b>dugon</b> was died. Several pieces of plastics were found from intestine. (Bangkok Post August 17, 2019)
Nov. 2019	Kratie Cambodia	An illegal fishing net caused the death of an endangered <b>Irrawaddy dolphin</b> in Kratie Province. (The Phnom Peng Post, Nov. 14, 2019)
May 2020	Phuket Thailand	A small <b>turtle</b> trapped in a discarded fishing net was rescued by local residents at Yanui Beach in Rawai earlier today (May 29, 2020).
Feb. 2021	Quang Nam, Vietnam	A fisherman found a turtle entangled by fishing net and brought the turtle to the committee for marine conservation in Cham island. The committee release turtle to the ocean after healing injuries.
Nov.2022	Chonburi, Thailand	Dead turtle which was washed ashore. An autopsy revealed that the stomach and intestines were full of nylon threads and fibers derived from fishing nets, as well as waste plastic.



# Impacts to Marine Ecosystem(2)

- Marine mammals and fish tend to be the focus, but other adverse effects on ecosystems have also been observed.
- Coral reef
  - A study of 159 coral reefs in the Asia-Pacific region found that contact with plastic increases the chances of reef disease from 4% to 89%. (Lamb et al. 2018).
- Mangrove forest
  - Growth of mangrove is suppressed by covering the aerial roots with plastic. Mangroves have a large amount of carbon storage per area and are thought to contribute to adaptation and mitigation of climate change problems.

# Countermeasures

# Countermeasures

## Reduce Use of Plastics

- Mandatory charge or ban on single use plastics(ex: plastic shopping bag)
- Using alternative materials such as biodegradable plastics and biomass.
- Refill business

## Recycling of Plastics

- Applying Extended Producer Responsibility
- Design for Recycling
- Promoting recycling industry, Involvement of other industries
- Investment to reduce transportation cost of recyclable waste to recycling industries

## Appropriate Disposal of Plastic Waste

- Preventing littering
- Expand waste collection
- Collecting plastics in the environment
- Proper waste disposal
  - Sanitary landfill
- Wastewater treatment including grey water

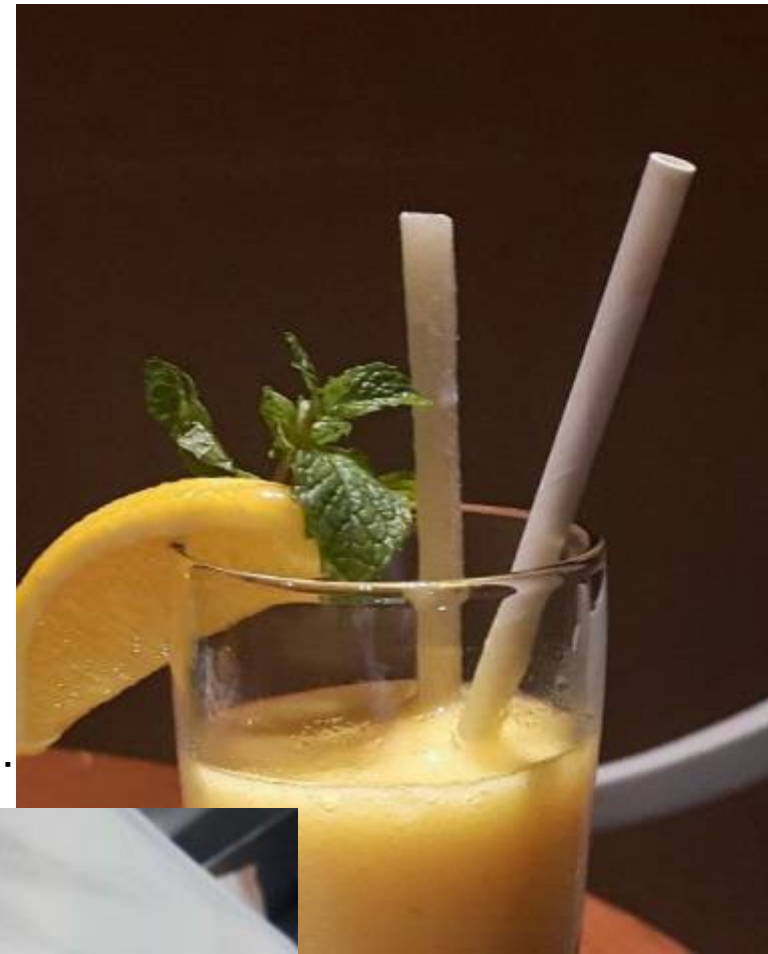
# Reduce Use of Plastics (1)

## Voluntary Initiative

The use of leaves and stem to tie the vegetables in Vietnam, April 2019, photo by M. Kojima.



The use of paper straw and sugarcane stiller in Indonesia, 2019, Photo by M. Kojima.



Wooden spoon and folk for in-flight meal by Singapore Airline, August, 2022, photo by M. Kojima.



Biodegradable plastic bag in Vietnam, April, 2019, Photo by M. Kojima

# Reduce Use of Plastics(2)

## Refill business

- Refill business
  - Consumer bring the bottles buying only contents without packaging and container.
- Challenge
  - In some country, by the regulation on food safety, refill is not allowed to refill of drinks or foods.



Refill shop in HCMC, Vietnam, Oct. 2022, photo by M. Kojima)

# Reduce Use of Plastics(3) Ban and Charge

- China
  - Proposal to Reduce Single Use Plastics (2008)
  - Proposal to Ban Single Use Plastics (2020)
    - Ban on plastic bag with less than 0.025mm thickness, vinyl for agriculture with less than 0.01mm thickness. microbeads in daily necessities
- India
  - State governments issue ban on plastic shopping bag.
- Thailand “Action Plan on Plastic Waste Management Phase I (2020-2022) ”
  - Ban on Plastic bag less than 36  $\mu$  m thickness, Plastic cup less than 100  $\mu$  m thickness, Styrofoam container for food, plastic straw
- Indonesia Regulation of the Minister of Environment and Forestry regarding Road Map to Waste Reduction by Producers
  - Producer and retailer should have a plan to reduce packaging and container and submit the report to the government.

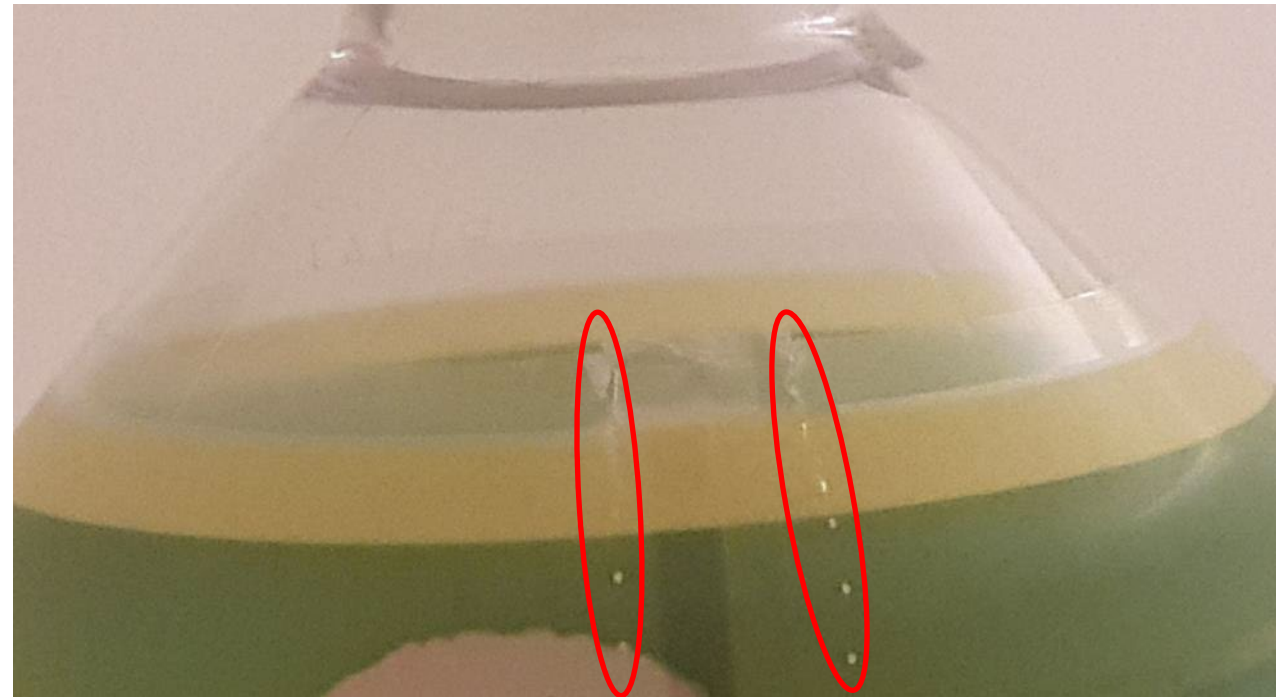
# Plastic Recycling ( 1 ) Applying EPR

- In the 1990s, Japan and South Korea applied extended producer responsibility to packaging and containers, and home appliances, which require producers to implement physical responsibility for recycling (collection rate, recycling rate, etc.) and/or economic responsibility (bearing cost of recycling, etc.).
- Around 2010, countries such as Vietnam, Thailand, and Malaysia attempted to apply extended producer responsibility, but it was not implemented.
- But in recent years, many Asian countries try to introduce EPR.
  - Indonesia (previous page)
  - Vietnam: Environmental Protection Laws revised in 2021.
  - Philippines: Extended Producer Responsibility Act (2022)
  - Singapore: mandatory reporting on volume of packaging and container, for preparation to apply EPR.
  - India: Plastic Waste Management Rule (Amendment) (2022)

# Plastic Recycling (2) Design for Recycling

- A best practice on design for recycling is the voluntary guideline for the design of PET bottles developed by Japan's Council for PET Bottle Recycling. The first version was developed in 1992. The guideline has been revised several times.
  - PE or PP which gravity are less than 1 should be used for caps, in order to sort caps from PET.
  - Prohibit the coloring of PET, because waste PET with color has limited demand of recycling.
  - It is also recommended to have perforation on the labeling.
- You can access English version of voluntary standard here:
  - <https://www.petbottle-rec.gr.jp/english/design.html>
- In 2020, Japan's collection rate is 96.7%. Bottle to bottle recycling rate is about 32% of total recycling volume.

- PET bottle to bottle chemical recycling was approved by the Food Safety Committee in 2004.
- Bottle to bottle mechanical recycling of PET was also approved in 2012.



Perforation on the labeling of PET bottle.  
Photo by M. Kojima



# Plastic Recycling (3)

## Styrofoam

- Technology to reduce the volume is crucial to transport bulky expanded polystyrene (EPS) or Styrofoam waste efficiently to recycling factories.
  - Compressing machines: EPS to reduce the volume to one-fiftieth of the original size.
  - The first machine was installed in 1977 in Tsukiji Fish Market.

Video in English  
<https://youtu.be/Rjcp7fK8i2o>



↑ Machines compressing EPS Fish Boxes at Tsukiji Fish Market in 2004. Photo by M. Kojima

Compressed EPS from the machine. Photo by M. Kojima →



# Proper Waste Disposal ( 1 )

- Reason behind larger leakage of plastics to the ocean from developing countries is the improper waste management: not enough waste collection and proper disposal



Waste dumped along roadside, in Sihanoukville, Cambodia. (July 2022  
Photo by M. Kojima)

Waste disposed in open space in Semarang Indonesia, September 2016, photo by M. Kojima

# Proper Waste Disposal (2)

## Preventing Littering

- Eliminating scattered waste was one of the priorities of the governments before Tokyo Olympic in 1964.
  - Many trash bins were located in load side. Waste are scattered around the waste bins.
- A video made by JICA shows littering by children in Tokyo in 1950s
- JICA “Technical Expertise of Japan in Solid Waste”, <https://www.youtube.com/watch?v=jeVcms5XwZs&t=16s>
- Before Tokyo Olympic in 1964, Tokyo Metropolitan Government had removed half million waste bins located in street since 1961.
- Tokyo Metropolitan government urged people to use plastic trash bins and collect wastes at fixed time from 1961.

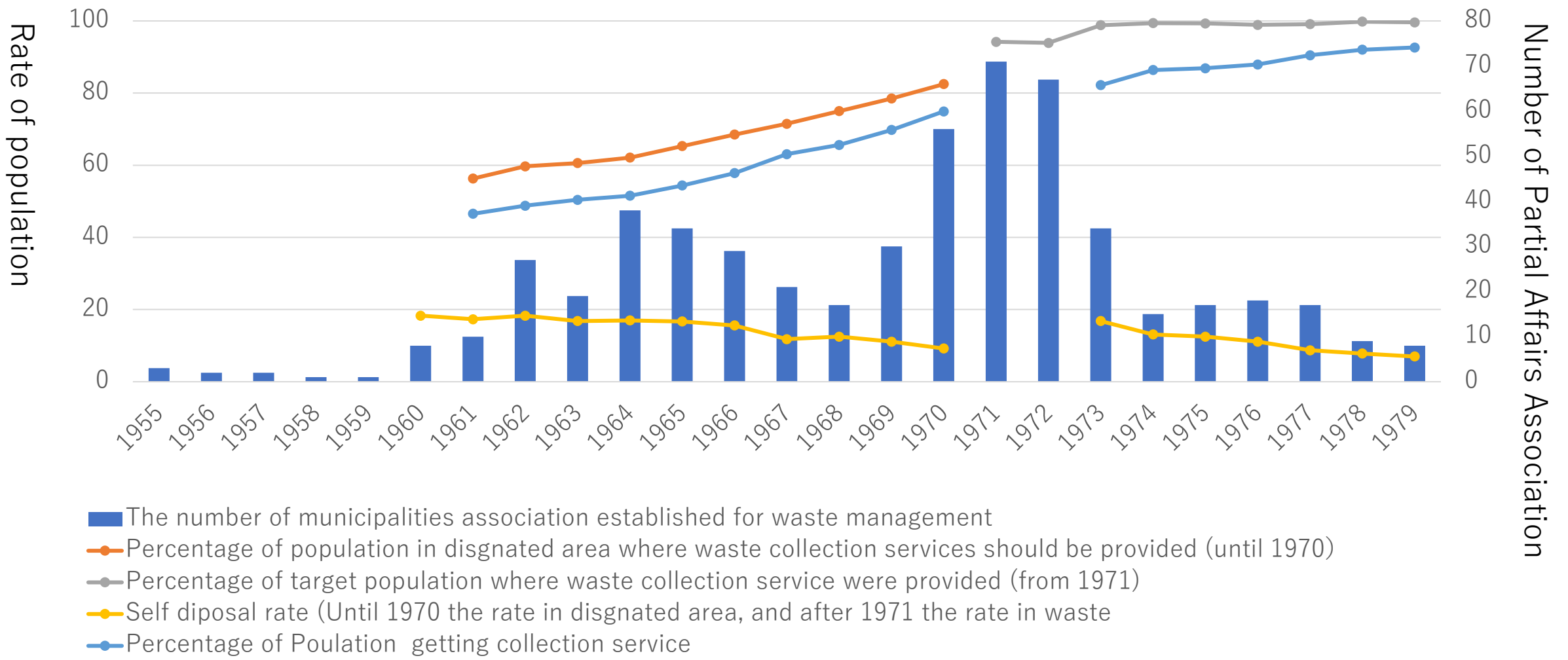
# Proper Waste Disposal(3) The fate of Indonesia's plastic waste

	Mega Cities	Medium & Small Cites	Rural	Remote	Total
Total Generation	1.6Mt	1.8Mt	2.5Mt	0.9Mt	6.8Mt
Leakage into Sea, Lakes and Rivers	4%	8%	12%	15%	10%
Dumping on Land	1%	3%	8%	8%	5%
Open Burning	21%	45%	61%	64%	48%
Official dumpsites	3%	3%	14%	15%	9%
Managed Disposal	51%	29%	0%	0%	20%
Recycling	20%	12%	5 %	0%	9%

Among mismanaged waste, 15.9% is leaked into sea, lakes and rivers.

Looking at the amount of runoff into the sea, rivers, and lakes, rural areas accounted for the largest amount of runoff, accounting for 46.7% of the total amount of runoff. Rural areas and small and medium-sized cities together account for 69% of the total outflow. Facilities such as sanitary landfill and waste to energy plant have economies of scale. The construction cost for landfill and waste-to-energy plant can be saved by inter-municipal cooperation.

# Proper Waste Disposal (4) Number of Establishment of Partial Affairs Association concerning Waste Management in Japan



Compiled by M. Kojima from various sources.

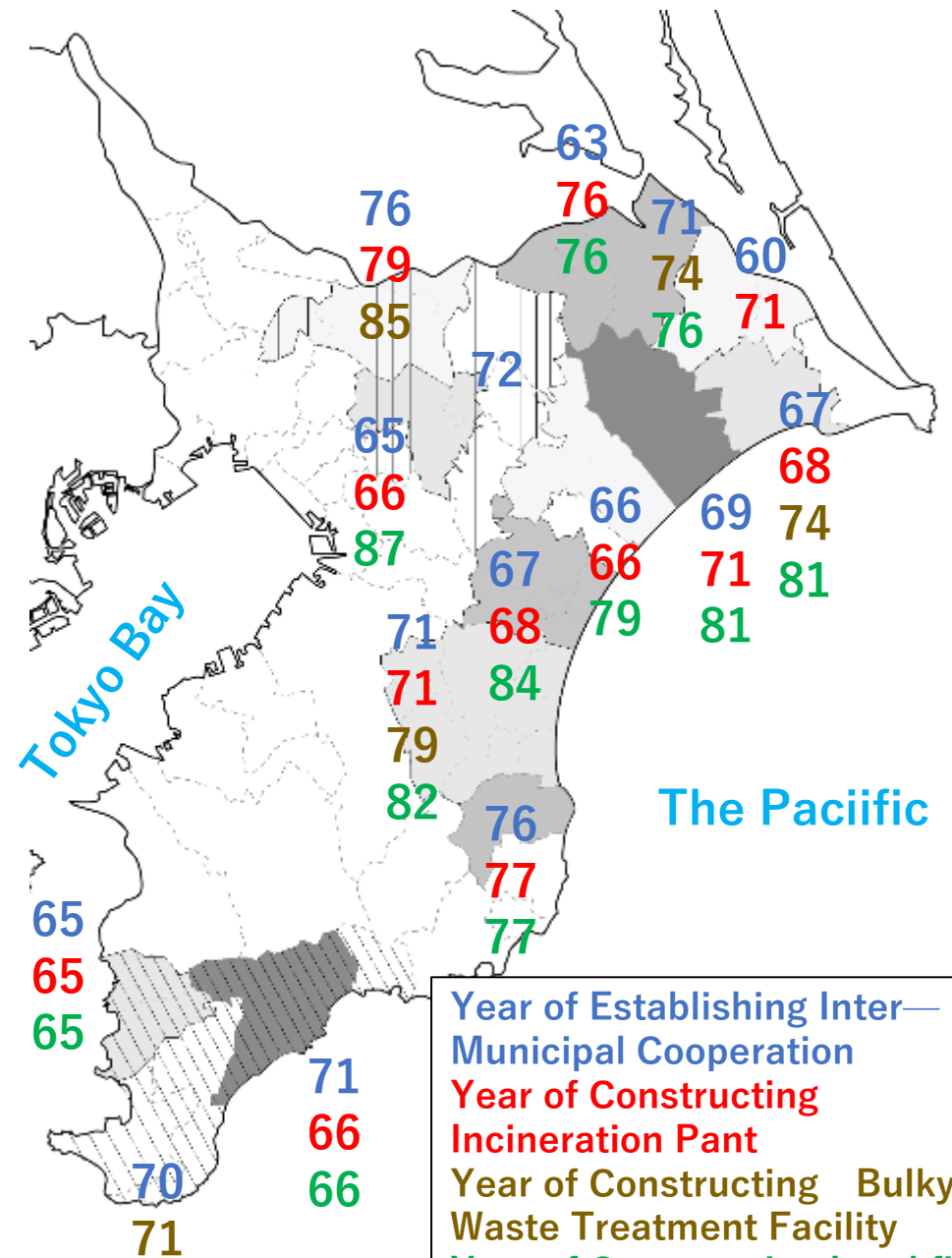
# Proper Waste Disposal(5)

## Case in Chiba Prefecture

- Until 1964, there was no waste treatment facility serving to multiple municipalities in Chiba.
- Municipalities have formulated associations for managing waste in in 1960s and 1970s, because economy of scale works in waste incineration plant and landfill site.

### Number of local government associations with waste management

	1960-	1965-	1970-	1975-
No. of Association	0	6	5	3



Source : Compiled by M. Kojima from documents of Chiba prefecture.

# The Proper Disposal of Waste(6)

## Collecting Waste from the Environment

- There are many efforts to collect waste from the environment.
  - Beach clean up
  - Collecting waste from rivers by using Boom and specific boat such as Interceptor.
  - Collecting waste at pumping up station to discharge water to the river or ocean.
  - Fishermen bring back to waste which were bycatch during fishing.



Interceptor made by Ocean Cleanup for collecting floating waste in the river in Indonesia. Installing boom at river for flowing waste into Interceptor. Nov. 2022, Photo by Kojima.

Fishermen bring back garbage which was bycatch during fishing, to fishing port. The waste was collected by local government, Kagawa, Japan in December 2019. Photo by Kojima.



# Various International Cooperation

- JICA and JST (SATREPS) “Formation of a Center of Excellence for Marine Plastic Pollution Studies in the Southeast Asian Seas”
- Ministry of Environment Japan : Support establishment of Regional Knowledge Centre for Marine Plastic Debris in Economic Research Institute for ASEAN and East Asia
- Some projects under Japan ASEAN Integrated Fund (JAIF)
- UNEP: CounterMEASURE
- UN-Habitat: Healthy Oceans and Clean City Initiative
- World Economic Forum : Global Plastic Action Partnership (GPAP) : Indonesia, Nigeria, Pakistan
- World Bank
  - Indonesia Rapid Assessment
  - ASEAN Regional Action Plan for Combating Marine Debris in the ASEAN Member States (2021-2025).



# Reference

- Jambeck, J.R. , R. Geyer, C. Wilcox, T. R. Siegler, M. Perryman, A. Andrady, R. Narayan, and K. L. Law, (2015) “Plastic waste inputs from land into the ocean,” *Science*, Vol. 347, No. 6223, pp. 768–771.
- Meijer, Lourens J. J. et al. (2021) “More Than 1000 Rivers Account for 80% of Global Riverine Plastic Emissions into the Ocean” *Science Advances* 7, eaaz5803.
- STAP (2011). *Marine Debris as a Global Environmental Problem: Introducing a solutions based framework focused on plastic*. A STAP Information Document. Global Environment Facility
- World Economy Forum (2020) *Radically Reducing Plastic Pollution in Indonesia: A Multistakeholder Action Plan: National Plastic Action Partnership*.