2026 Great Lakes Microplastics Summit




# Plastic Pellet Spills:

## Environmental Impacts and Remediation Challenges

**Mala C. Hettiarachchi, PhD, PE**

Senior Engineer, Environmental Resources Group (ERG), Novi, MI

**Meththika S. Vithanage, PhD**

Professor, Department of Geochemistry, Geological Survey of Denmark and Greenland

Professor, University of Jayewardenepura, Sri Lanka

# Content

1. Key references
2. Definitions
3. Plastic pellet spills - Case studies
    - Marine spill in Sri Lanka
    - Overland spill in Michigan
4. Regulatory gaps
5. Conclusions

Contacts:

Mala C. Hettiarachchi:
mala.Hettiarachchi@ergrp.net

Meththika S. Vithanage:
metvi@geus.dk

# Key References


1. **Sewwandi, M., Hettithanthri, O., Egodage, S.M., Amarathunga, A.A.D., Vithanage, M. (2022). Unprecedented marine microplastic contamination from the X-Press Pearl container vessel disaster.** ***Science of the Total Environment, 828, 154374***
2. **Madushika Sewwandi, Oshadi Hettithanthri, S.M. Egodage, A.A.D. Amarathunga, Meththika Vithanage, Unprecedented marine microplastic contamination from the X-Press Pearl container vessel disaster, Science of The Total Environment, Volume 828, 2022, 154374, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2022.154374**
3. **Meththika Vithanage, Fate of the Pearl Unprecedented microplastic contamination from the Xpress Pearl maritime disaster; presentation slides**
4. UN Environmental Advisory Mission, X-Press Pearl Maritime Disaster Report (2021)
5. Sri Lanka Supreme Court ruling on X-Press Pearl compensation (July 2025)
6. Michigan EGLE / local reporting on the Kalamazoo River nurdle spill (Jan 2026)
7. IMO, Resolution A.1184(33) - Guidelines on Places of Refuge for Ships in Need of Assistance (Dec 2023)
8. IMO, MEPC.1/Circ.909 (MEPC 81, March 2024) and MEPC 84 outcomes (April 2026) - imo.org
9. Erandi Gayesha, Gayithri Niluka Kuruppu, Nimila Dushyantha, Sandun M. Dassanayake (2026). Post-disaster assessment of the socio-economic and environmental impacts of the MV X-Press Pearl on coastal communities in Sri Lanka, Marine Pollution Bulletin, Volume 222, Part 3, 2026, 118853
10. Regulation (EU) 2025/2365 -pellet loss prevention regulation

# Definitions

## Microplastics:

- Plastics particles less than 5 mm in size

## Types of Microplastics

- **Primary**: Purposefully manufactured (e.g., plastic pellets; microbeads)
- **Secondary**: Unintentionally formed from the breakdown of larger plastic debris (e.g., microfibers; fragments, and films)

## Plastic Pellets (AKA nurdles)

- They are preproduction plastic pellets
- Use as the raw feedstock for manufactured plastic products
- Typically, 2–5 mm in size
- They are produced, transported, and handled in large volumes

## Types of Plastic Pellet Spills

- Industrial: Spills at manufacturing and recycling facilities
- Transport: vessel, rail, and truck incidents (this is the focus of today's case studies)



Plastic Pellets
(Photo Source: Amazon)

Plastic pellet spills during transport represent a concentrated release of primary microplastics into the environment (marine or freshwater)

CASE STUDY 1

# X-Press Pearl Disaster

UN environment programme Knowledge repository

About Collections Explore Statistics

Home > Supplementary resources > Communication materials > X-Press Pearl Maritime Di...

## X-Press Pearl Maritime Disaster: Sri Lanka - Report of the UN Environmental Advisory Mission



**Download**

English (4.59 MB)

**Date**

2021-07

### Abstract

The X-Press Pearl incident is the worst maritime disaster to have struck Sri Lanka. It has had a significant impact on Sri Lanka's sensitive coastal environment, local communities and the economy. Moreover, the event continues to unfold, and its active pollution generation phase will only come to closure with the elimination of the risks from the wreck and containers lost at sea. Along with uncertainties of cascading environmental damage, the incident's complexity stems from the range of pollutants involved - oil, hazardous chemicals and plastics – and the lack of clarity regarding the nature and status of a substantial part of the vessel's cargo. Moreover, the growing geographic extent of the plastic spill - the largest on record - is expected to have transboundary impacts further compounding the problem.

*Sources: Seatrade Maritime News; OSRL Spill Journal*

CASE STUDY 1

# Background



Her Journey:
Singapore →Malaysia → UAE → Qatar → India → Sri Lanka → Malaysia → Singapore

| | |
|---|---|
| **Flag** | **Singapore** |
| **Built** | **2021** |
| **Capacity** | **2,756, 20-foot shipping containers** |
| **Length** | **186 m** |
| **Beam** | **34.8 m** |
| **Operator** | **X-Press Feeders** |
| **Content** | **Various (including plastics)** |

**May 10, 2021**
**Jebel Ali, UAE**
Nitric acid container loaded; departs for Qatar

**May 11, 2021**
**Hamad Port, Qatar**
Nitric acid leak discovered; request to offload refused; departs for Hazira

**May 15, 2021**
**Hazira, India**
Offload refused again; departs for Colombo, Sri Lanka






*Colombo: 20th busiest container port in the world*
*Photo Source: Sri Lanka Port Authority*

*Sources: Seatrade Maritime News; OSRL Spill Journal*

CASE STUDY 1

# Background

**May 20, 2021**
Fire breaks out; Sri Lanka receives Mayday call from the ship anchored 9.5 nautical miles off its coast

**May 20-25, 2021**
Personnel evacuated; Explosions onboard the ship; fire engulfs ship; multiple containers fall overboard; Tier II oil spill warnings; fishing ban

**June 2, 2021**
Vessel begins sinking under tow

**June 17, 2021**
Wreck fully settles on the seabed (21 m depth; about 69 feet)



Photo Source: Reference #1

*Sources: Seatrade Maritime News; OSRL Spill Journal*

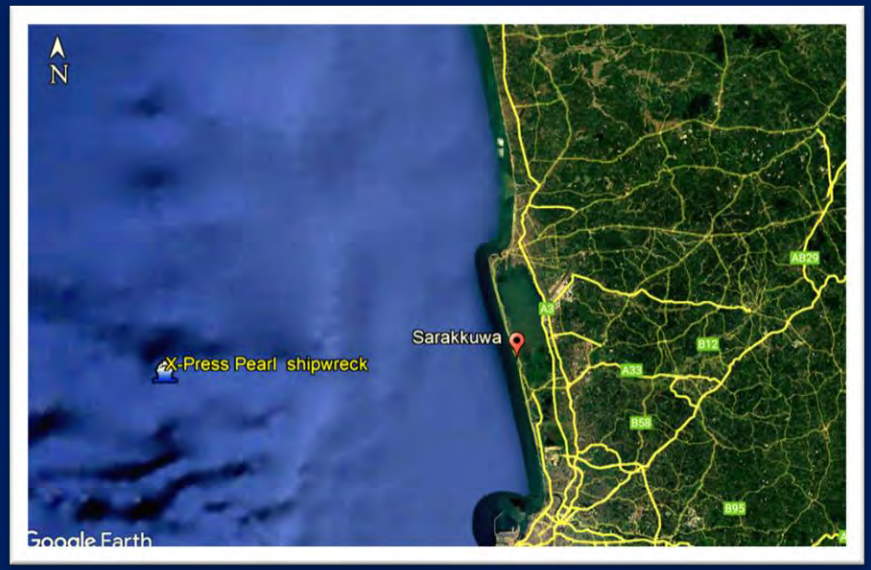
CASE STUDY 1

# Epicenter






View of X-Press Pearl shipwreck at Sarakkuwa beach




## Sarakkuwa Beach

- 9.5 nautical miles from the wreck
- 9 miles from Negombo (a major a commercial and tourism hub)
- This is the beach where the research team's field sampling was based.

Photo Source: Reference #1, 2, 3

CASE STUDY 1

# Pollutants Released

**1,680 MT**
Polyethylene nurdles released

**9,700 MT**
Epoxy resin on board
(~1/3 of cargo)

**>8,000 MT**
Other chemicals including nitric acid

Source: Reference #1, 2, 3

**Quantities of the content belong to each category in MT (Total)**

| Cargo detail in brief | Plastics and Polymers | Cargo detail in brief | Chemicals | Cargo detail in brief | Metals | Cargo detail in brief | Food items | Cargo detail in brief | Other |
|---|---|---|---|---|---|---|---|---|---|
| Epoxy resins | 9700.8 | Urea (Dust, Prilled, ..) | 1843.3 | Aluminium stuffs | 2202.2 | Fish, Dry fish, Sprats | 1288.6 | Paper/Wastepaper items | 1705.9 |
| Synthetic resins | 177.3 | Inorganic Chemicals, nos | 495.3 | Copper stuffs | 474.6 | Chicken | 370.6 | Used items (Vehicle parts, | 263.9 |
| HDPE | 747.8 | Caustic Soda | 1126.9 | Iron and steel stuffs | 74.8 | Shrimp | 252 | Cartons | 105.1 |
| LLDPE | 245.4 | Chemical products, nos | 160.2 | Lead | 187 | Cuttlefish | 33.6 | Fabrics, wadding, thread, | 1297.1 |
| LDPE | 574 | Nitric Acid | 28.7 | Metal scraps | 142.7 | Dates | 194.6 | Tyres (New) | 22.8 |
| Packages of PS pellets | 31.9 | Perfumery products | 8 | | | Raisin | 88 | Furniture | 11.1 |
| Bare foam pig | 1.9 | Assorted perfumes | 16.8 | | | Alchoholic | 34.4 | Waterproof materials | 23.4 |
| Packaging materials | 22.8 | Quicklime lumps | 1196.4 | | | Chocolates | 24.5 | Pharmaceutical packing | 16.5 |
| Polycarbonate | 60.9 | Sodium Methylate | 57.3 | | | Honey | 11.1 | Carpets | 46.2 |
| Plastic pellets | 81.3 | Methanol | 235.6 | | | Fruit Juice | 29.1 | Aseptic pack | 29.5 |
| Polymeric beads | 19.3 | Bright Yellow Sulphur | 562.4 | | | Fresh Orange | 120.6 | Personal cargo, effects, .. | 310 |
| Polymers of propylene | 57.3 | Molybdic Oxide | 48 | | | Jam and Pistachio | 48.9 | Scoured Goat hair | 22 |
| PVC film | 20.4 | Env. Hazardous subs. | 10.6 | | | Oats | 26 | Crushed Stone | 22.5 |
| ALKYD resin | 19.5 | Pharmaceutical stuffs | 7.5 | | | Other food stuffs | 259.5 | Fire Protective Equipment | 109.3 |
| Unsat. Polyester resin | 21 | Paints | 21.2 | | | | | Automotive, vehicle parts (New) | 126.3 |
| Vinyl copolymer | 18.6 | Colors for ceremic ware | 15 | | | | | Wagon Models | 28.9 |
| Vinyl Acetate | 46.3 | Shampoo | 16.3 | | | | | Exhaust stack anchor bolts, nuts, .. | 16.1 |
| Polybutadiene | 92.7 | Cement conforming | 1154.8 | | | | | Consol Cargo | 43.6 |
| | | Modified Asphault | 205.2 | | | | | Mobile and Stationary Accessories | 26.7 |
| | | Silicon sealant | 12.5 | | | | | Empty | 1114.3 |
| | | Engine coolant and grease | 16.9 | | | | | | |
| | | Liquid Paraffin | 130.2 | | | | | | |
| | | Brake fluid | 34.7 | | | | | | |
| | | Lubricating oil | 387.8 | | | | | | |
| | | Base Oil | 47.6 | | | | | | |
| | | Pails of lubricants | 145.9 | | | | | | |
| Total : Plastics | 11939.2 | Total : Chemicals | 7985.1 | Total : Metals | 3081.3 | Total : Food items | 2781.5 | Total:other | 5341.2 |

CASE STUDY 1

# Scale of Contamination

- Released debris and plastic pellets to the sea
- Plastic pellets lodged in coral reefs, mangroves, lagoons, beach sand, and sediments
- Massive quantities of nurdles washed up on the pristine beaches
- Threatened marine life
- Damaged coral reefs
- Contaminated the seabed
- Made dramatic impacts on coastal communities and local economy

Photo Source: Reference #1, 2, 3






CASE STUDY 1

# Scale of Contamination



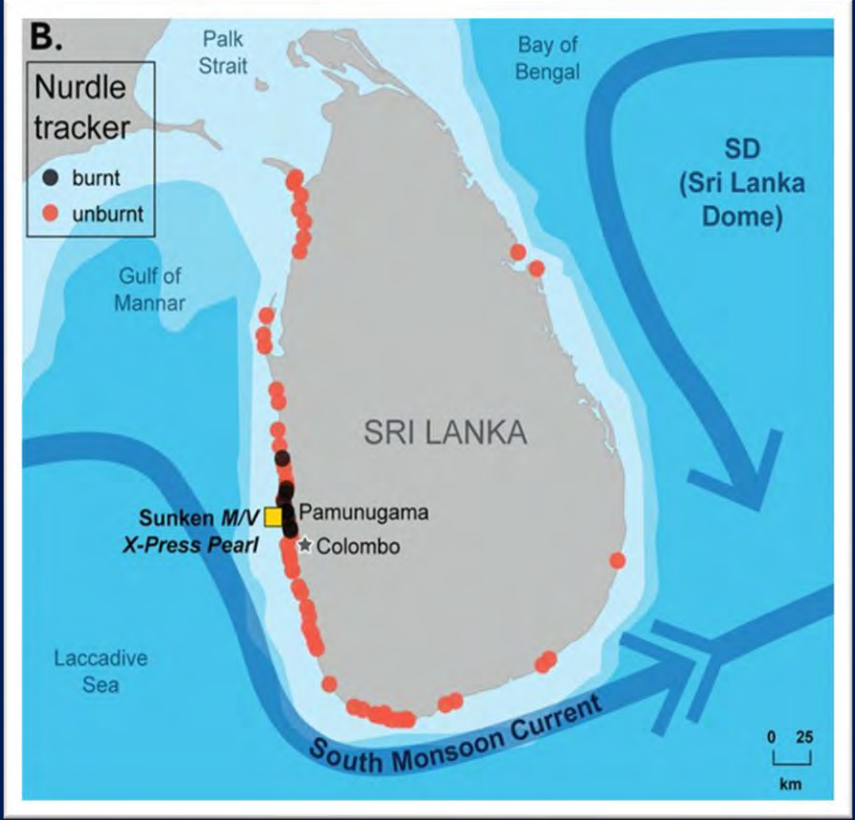


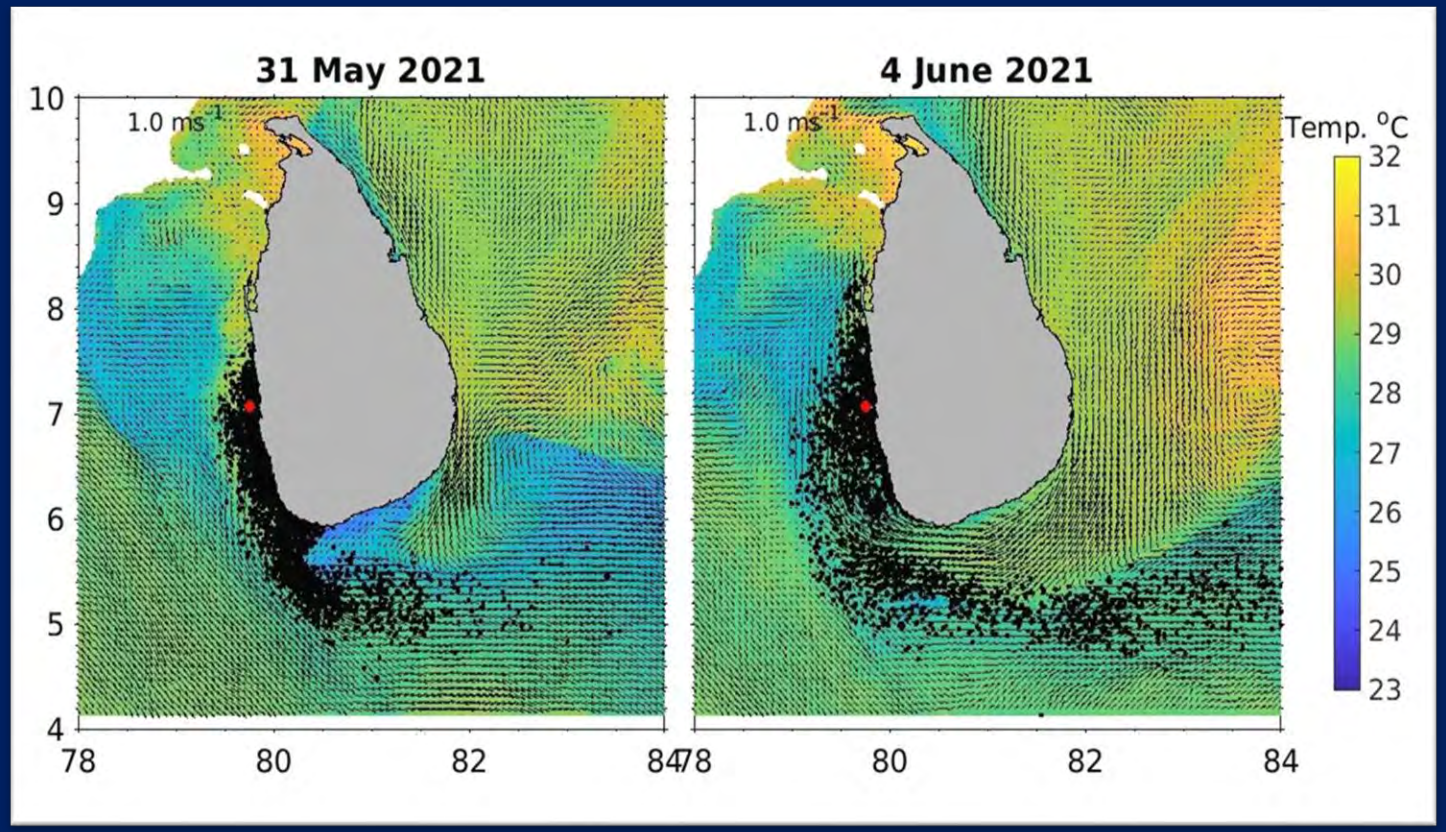
- Strong winds and high waves resulted in the onshore movement of the plastic pellets
- High accumulation of nurdles at Sarakkuwa beach
- Onboard explosions complicated the pollutant distribution. For example, a container drifted over 100 km south, stranded on an island near the coastline, and released unburnt plastic pallets

Photo Source: Reference #1, 2, 3

CASE STUDY 1

# Scale of Contamination




Nurdles blanketed over **200 km** (about 125 miles) of Sri Lanka's coastline within days

Source: Reference #1, 2, 3

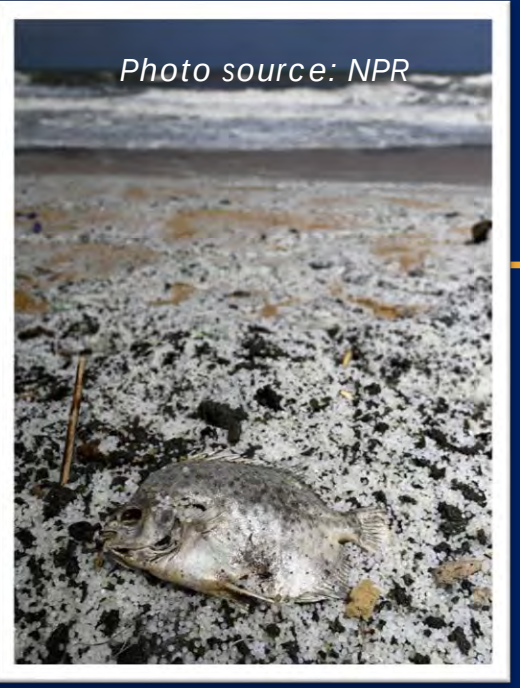
CASE STUDY 1

# Immediate Ecological Impact

| 258 | 43 | 6 |
|---|---|---|
| SEA TURTLES | DOLPHINS | WHALES |

- Mortalities among sea turtles, dolphins, whales, and fish
- Measurable disruption to marine plankton communities
- Nurdles in the gills and guts of fish













Source: Reference #1, 2, 3

CASE STUDY 1

# Emergency Response & Shoreline Cleanup

**Mechanical sieving**
Sieves, trommel screens & vacuum systems separated nurdles from sand

**Water separation**
Flotation tanks processed excavated beach sand

**Aerial & GIS mapping**
Drones directed cleanup crews to the most heavily impacted zones

**Marine recovery**
Dynamic-positioning vessels & diver-operated suction pumps cleaned the seafloor












Photo Source: Reference #1, 2, 3











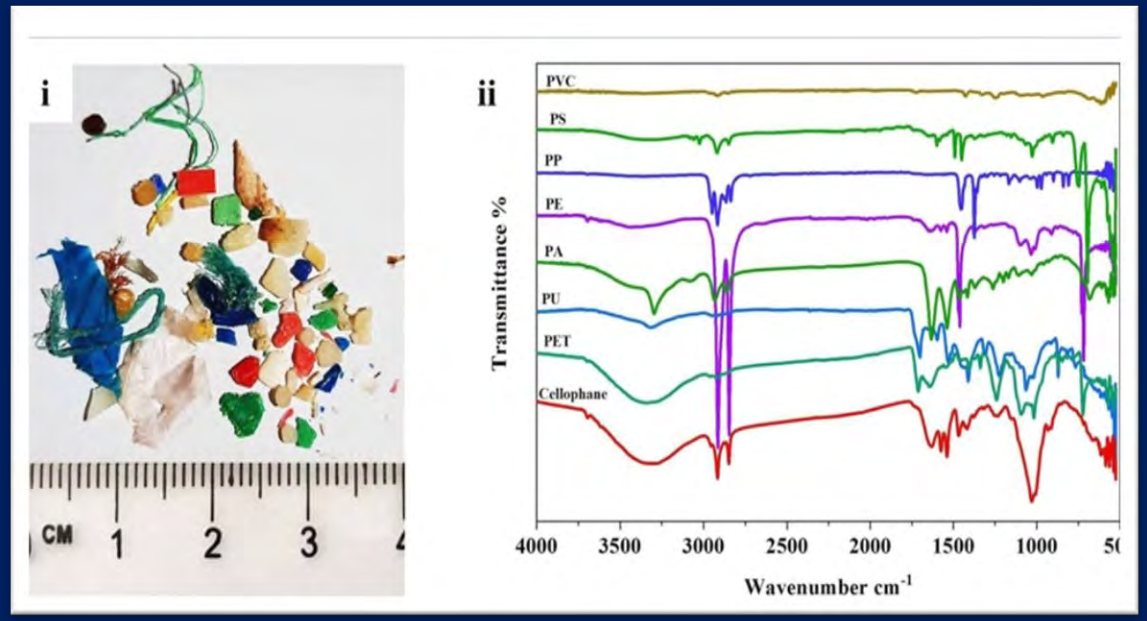


- Mobilized Sri Lankan military and authorities for clean up
- Utilized local and international contractors
- Reported 18,973 participants in 385 clean-up events as of 14 June 2021

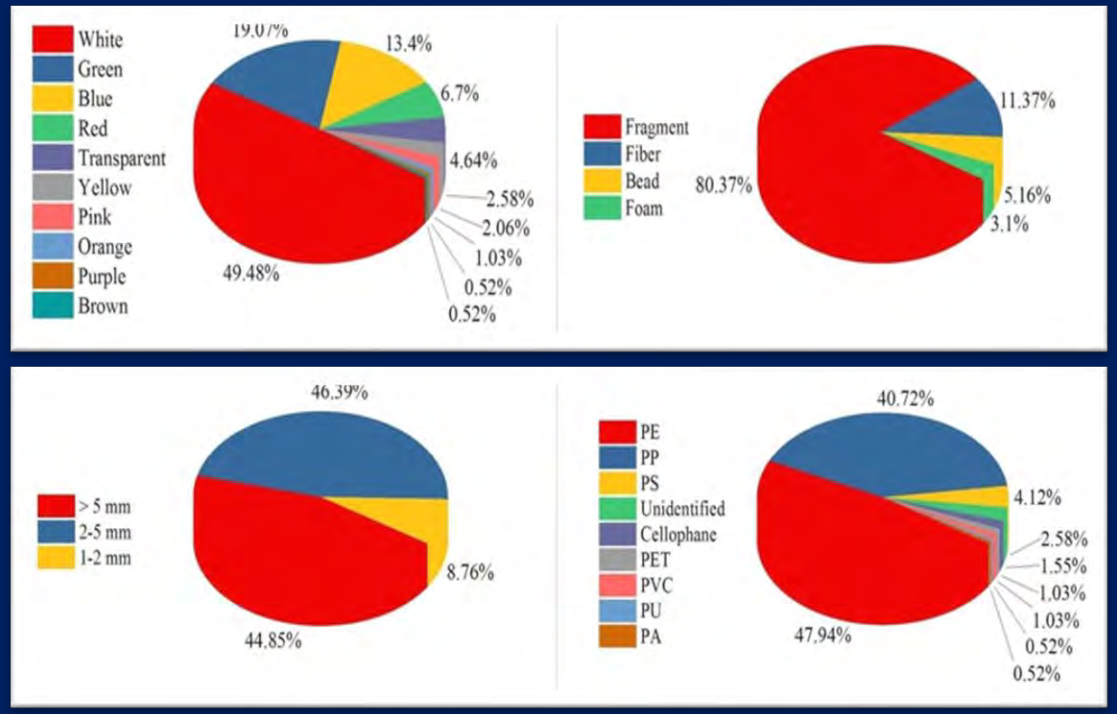
Photo Source/Reference #1, 2, 3

CASE STUDY 1

# Research: Pre-disaster Samples at Sarakkuwa Beach




Date collected in March 2020 (before the disaster)

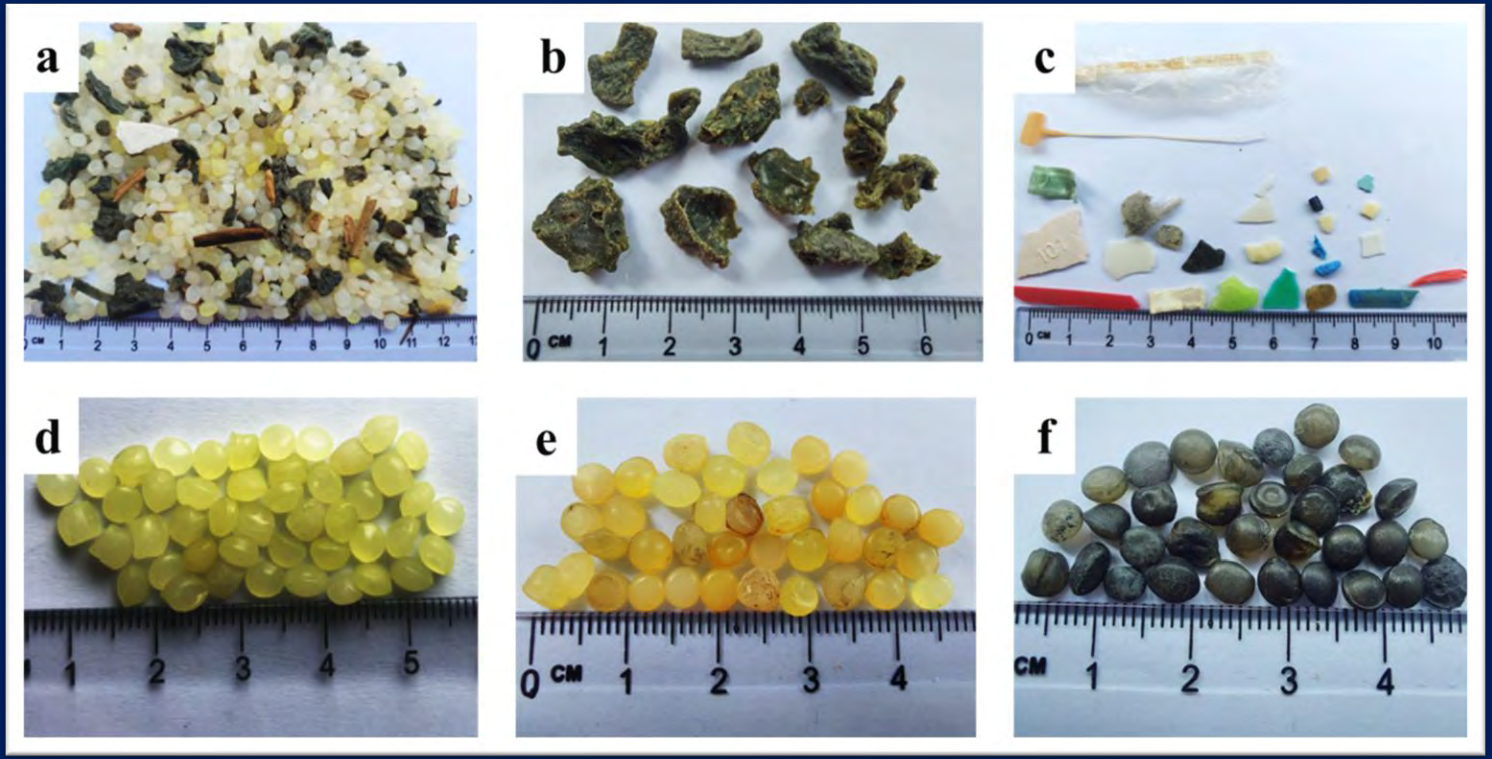



Source/Reference #1, 2, 3

CASE STUDY 1

# Post-Disaster Samples at Sarakkuwa Beach

- Color of some nurdles was different from the pristine nurdles
- Color change could be due to fire exposure, weathering, oxidation, and contaminant binding
- Spilled nurdle type per Fourier-transform infrared spectroscopy (FTIR) analysis: Low-Density Polyethylene (LDPE) and Linear LDPE (LLDPE)



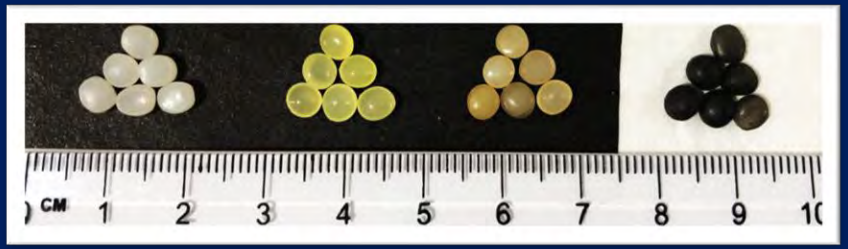



Figure 1: White, yellow, brown, and black color nurdles

a) A visually inspected sample
b) Partially burnt debris
c) Mix of plastics (could be from anthropogenic pollution)

d, e, f): Colored pellets

Photo Source/Reference #1, 2, 3

CASE STUDY 1

# Post-Disaster Samples at Sarakkuwa Beach

- Exposure to combustion, heat, and chemicals led to agglomeration, fragmentation, charring, and chemical modification of the plastics

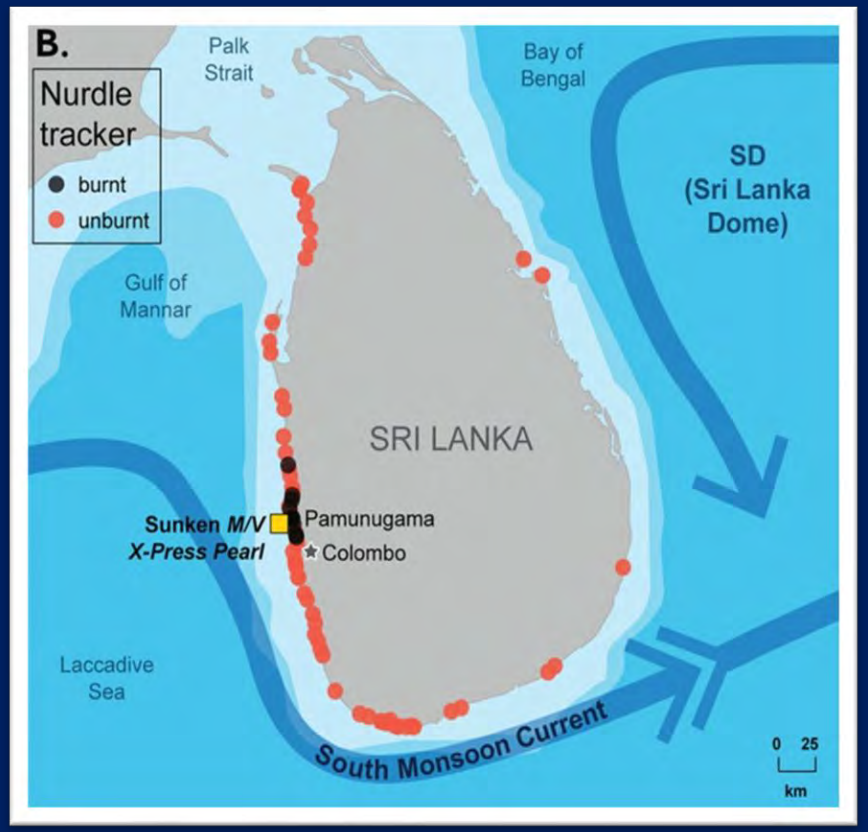


> 5 mm | 2 mm – 1 mm | 1 mm – 500 µm

Figure 1: Burnt Fragmented Nurdles



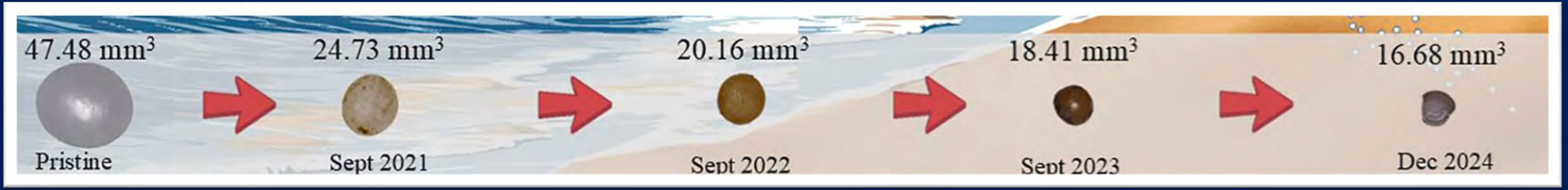
Figure 2: Agglomerated Nurdles




Source/Reference #1, 2, 3

CASE STUDY 1

# Long-term Weathering and Volume loss




Diameter = 4.49 mm

Diameter = 3.61 mm

Diameter = 3.37 mm

Diameter = 3.27 mm

Diameter = 3.17 mm

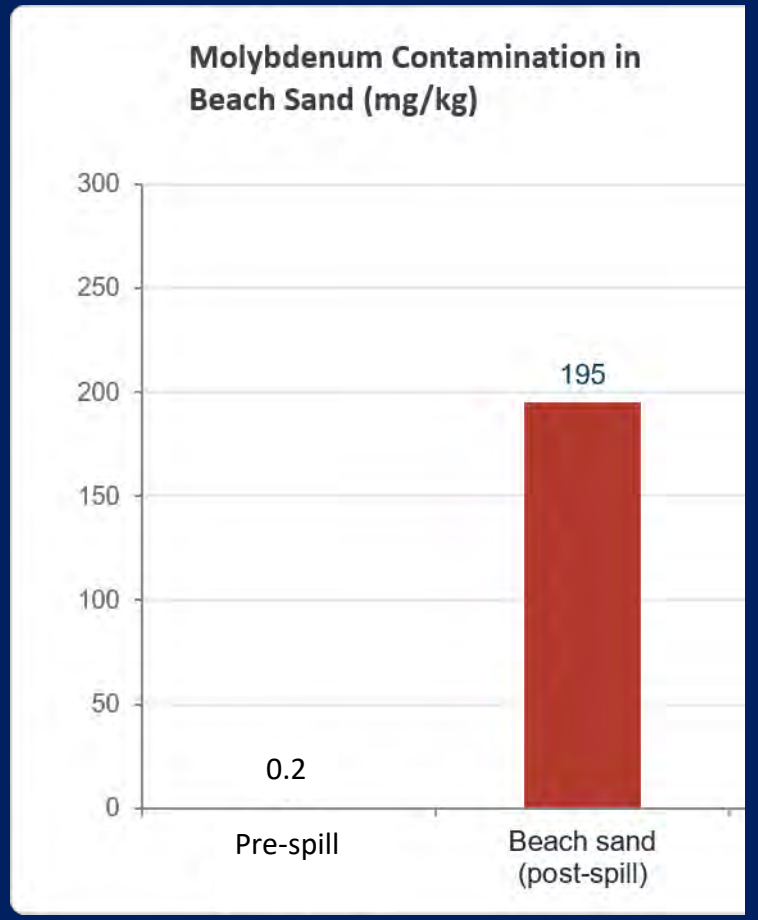
* Approximate diameter calculated assuming the pellets to maintain spherical shape

Source/Reference #1, 2, 3

CASE STUDY 1

# Metal Co-Contamination (Sarakkuwa Beach)

- Microplastics adsorb contaminants from their environment
- Associated sand pollution was investigated by determining the microplastics bound metals
- Molybdenum (Mo) was elevated in all sand samples collected after shipwreck. Note: 48 tons of molybdic oxide were on board
- Burnt and weathered plastic nurdles had more heavy metals than fresh nurdles
- Plastic pellets may have transported adsorbed contaminants far away from the source of contamination




Source/Reference #1, 2, 3

CASE STUDY 1

# Effectiveness of Beach Cleanup




Sarakkuwa Beach



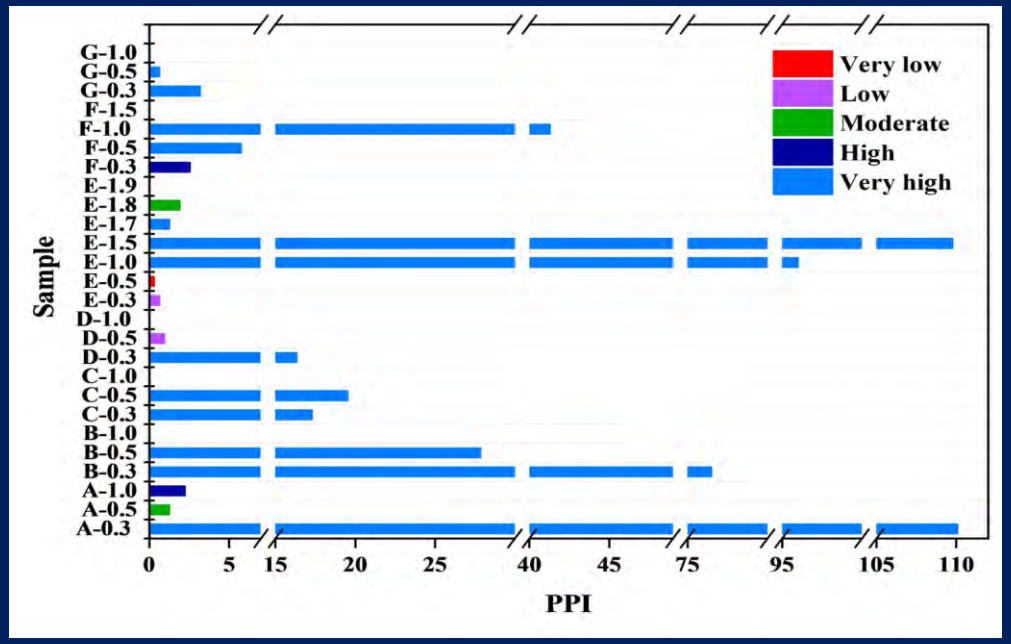

Kepungoda Beach
(about 1 km from Sarakkuwa Beach)

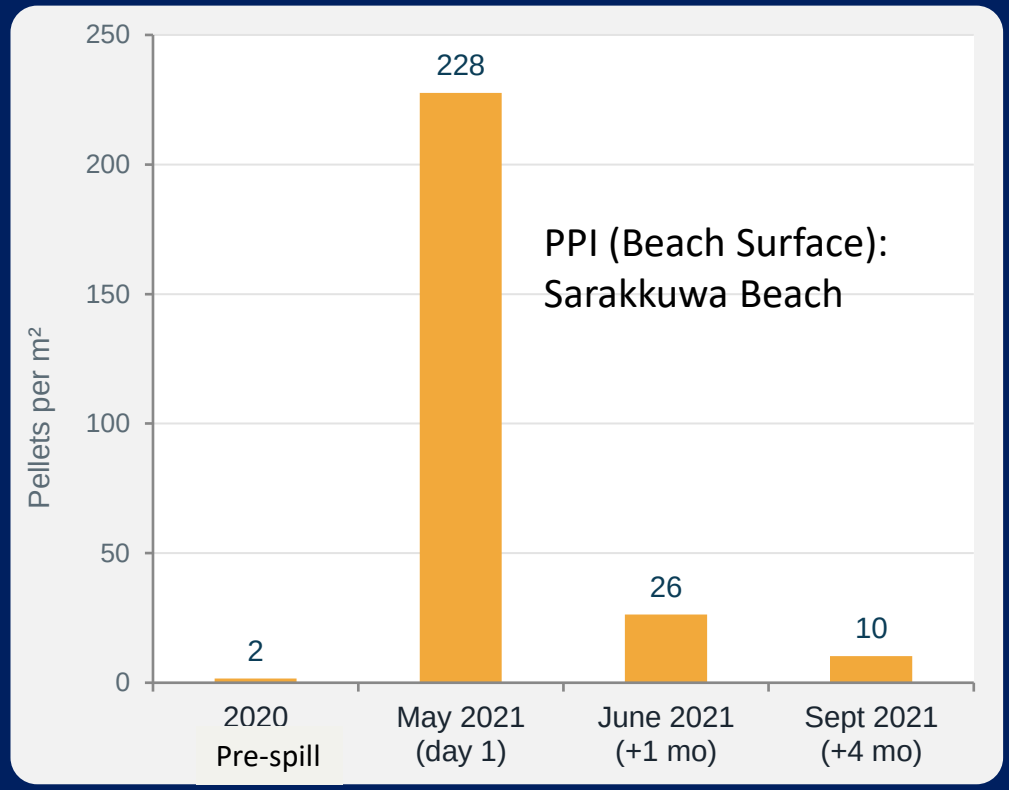
Photo Source: “Hard work brings results” – The Sunday Times, Sri Lanka; June 18, 2021

CASE STUDY 1

# Effectiveness of Beach Cleanup

- Decrease in Pellet Pollution Index (PPI) of beach surface is mainly due to cleanup activities
- High PPI at the depth of 0.3 and 0.5 m indicating long-term re-exposure of buried nurdles




Source/Reference #1, 2, 3

CASE STUDY 1

# Cleanup Challenges

## Buoyant and mobile

- Wind, waves, and currents carry nurdles far from the release point
- Pellets were found along ~ 40% of Sri Lanka's coastline 6 weeks from the disaster

## Deep burial

- Wave and current action bury pellets below surface cleanup reach
- Buried pellets found ~1 m (3.3 feet) depth in Sarakkuwa beach sand

## Habitat infiltration

- Lodge in vegetation, coral reefs, and lagoons

## Alterations

- Heat, chemicals, etc. alter pellets complicating the identification and recovery

## Continuous re-contamination

- Waves and storms re-deposit nurdles onto already-cleaned beaches
- Cleanup has no fixed endpoint

## Size limits effectiveness of conventional sieving

- Conventional tools are ineffective for smaller particles below ~2 mm




Photo source: Meththika S. Vithanage
Taken on: 09th September 2021
Location: Sarakkuwa Beach

Source/Reference #1, 2, 3

CASE STUDY 1

# Impacts on the Coastal Communities

- More than 16,000 local fishers lost their income due to the 80 km fishing ban along Sri Lanka's western coast
- Residents and workers in several tourist zones experienced severe disruptions, dealing with contaminated beaches, public mistrust in seafood safety



Beaches and coastal attractions



Centuries-old fishing towns



Livelihood

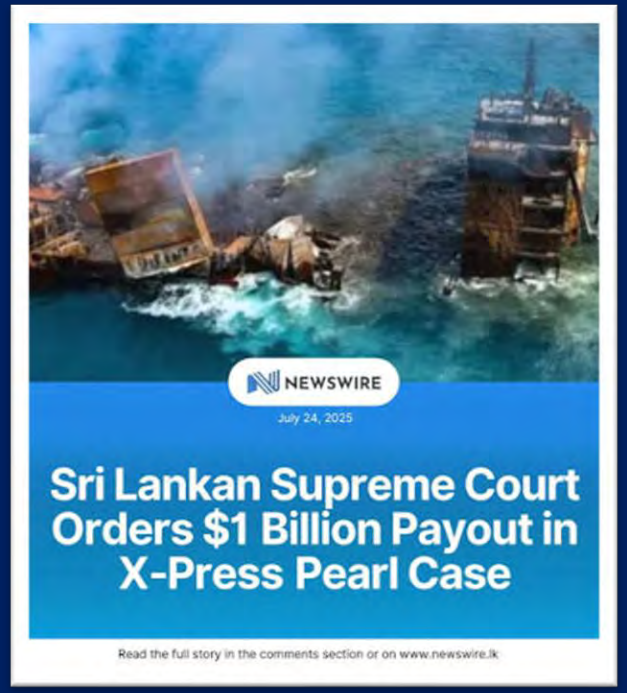
Photo Source: KAYAK; Audley Travel; Xinhua

CASE STUDY 1

# Court Ruling and Challenges

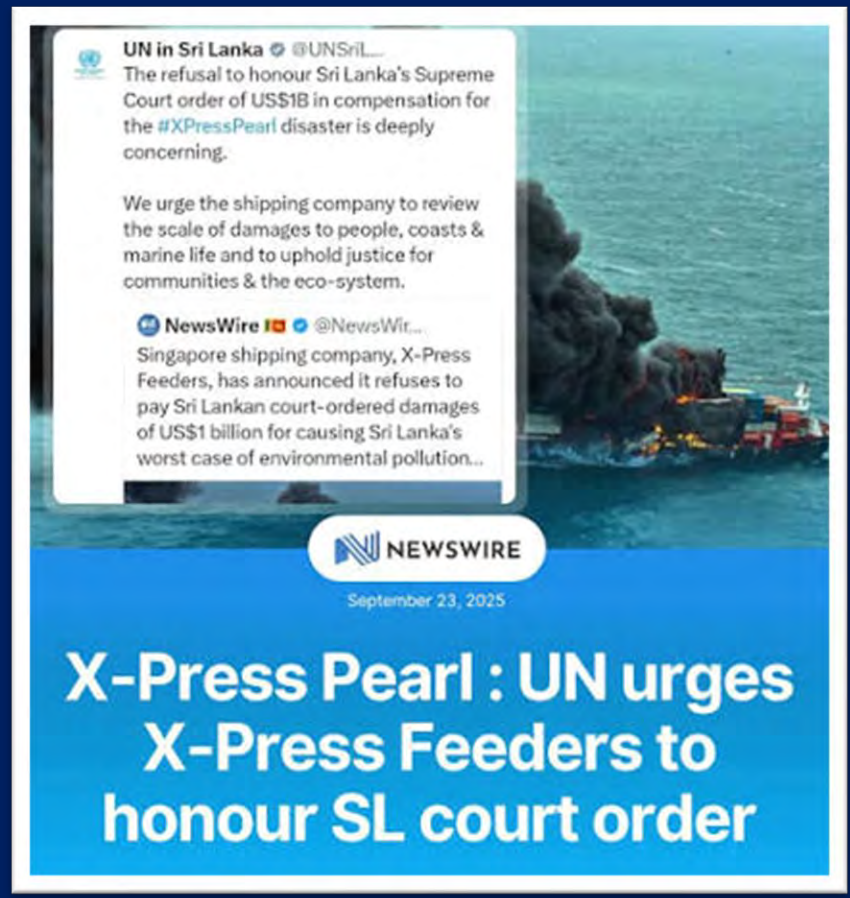
- No existing regulations on plastic pellet spills

- **1 Billion USD Ruling (via Multiple Fundamental Rights Petitions):** In July 2025, Sri Lanka's Supreme Court (five-judge bench, Trial-at-Bar) ordered the vessel's owner to pay compensation for environmental and economic damage









CASE STUDY 2

# Saugatuck, Allegan County, MI, January 27, 2026

- Pellet spills are not a marine-only hazard
- Transport corridors near the Great Lakes carry the same risk seen in Sri Lanka
- A truck crash near the I-196 bridge over the Kalamazoo River
- Released polystyrene nurdles along the freeway corridor
- Subsequent towing and snow plowing spread the pellets
- Some pellets entered the Kalamazoo River and adjacent wetlands



*Photo source: EGLE/WWMT*



**12 MT**
polystyrene nurdles spilled in a truck crash

**4 Miles**
of freeway shoulder and roadside affected

**4 Miles**
upstream from Lake Michigan

Reference: EGLE

CASE STUDY 2

# Saugatuck, Allegan County, MI, January 27, 2026

- Trucking company informed MDOT immediately
- EGLE was notified of the plastic pellet spill on February 19, 2026
- MDOT closed part of northbound I-196 on February 26, 2026 to perform a cleanup.
- EGLE issued a Violation Notice on February 26, 2026 ordering the company (Quest Liner) to:
  - provide a full accounting of the total material hauled and spilled
  - implement mitigation steps
  - execute a comprehensive cleanup plan accounting for river sediments and wetlands
- Violation: Company violated the State Water Quality Standards by discharging floating solids and settleable solids into state waterways



*Photo source: EGLE/Michigan Public www.michiganpublic.org*

Reference: EGLE

# Regulatory Similarities: Case 1 vs Case 2

| | Sri Lanka | Michigan |
|---|---|---|
| **Classification gap** | Nurdles not IMDG-classified (IMDG = International Maritime Dangerous Goods) | Not hazardous under Clean Water Act / CERCLA |
| **Reporting delay** | No reporting requirement for pellet cargo | MDOT notified immediately; EGLE notified 23 days later |
| **Enforcement via non-plastic rules** | • Indirect<br>• Fundamental Rights petitions<br>• $1B ruling issued | • Indirect<br>• WQSs - for floating/settleable solids discharge<br>• Violation Notice issued |

# Are Pellet Spills Uncommon?

- Spills are not isolated incidents. They are a frequent environmental issue.
- River Tyne, England incident dubbed as Europe's worst ever nurdle pollution incident (July 29, 2026)

  Spilled nurdle/pellet mass = 25 tons
  Pellets per ton = 40 million to 50 million
  Estimated number of nurdles = 1 - 1.25 billions

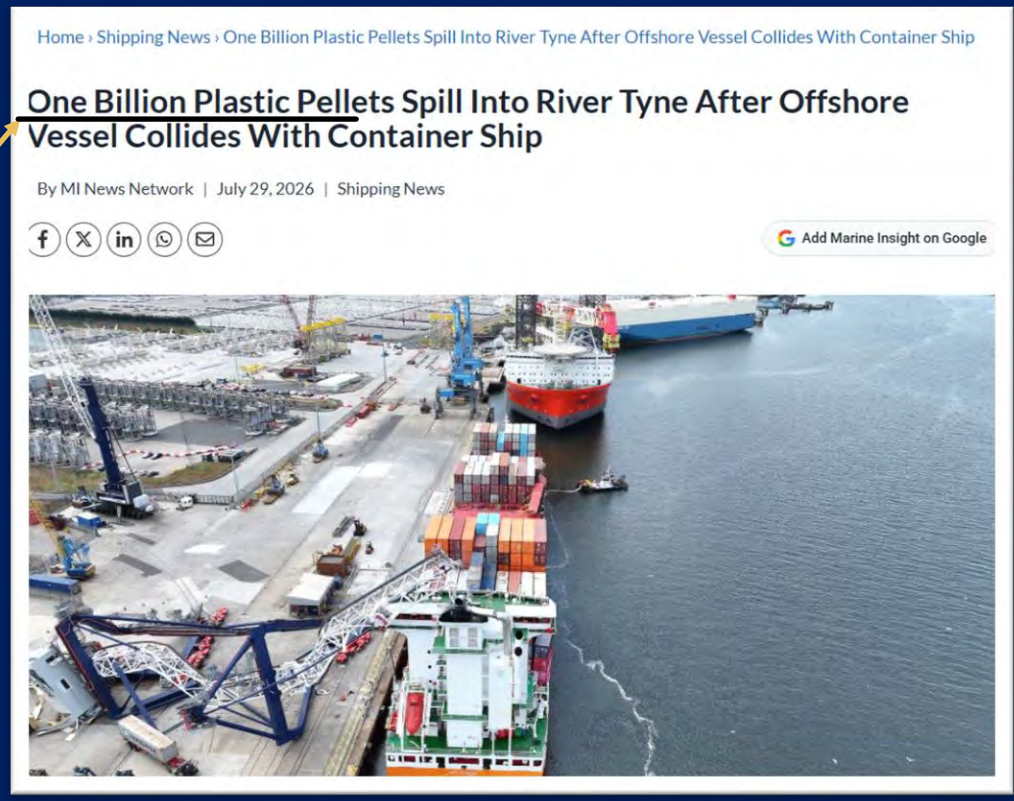
- Not every spill is reported as there is no globally binding reporting requirement on pellet spills



Mirror > News > UK News > Environment Agency

'Environmental disaster' fears after one billion plastic pellets enter River Tyne

The incident has been dubbed Europe's worst ever nurdle pollution incident. On 19 July tonnes of tiny beads, known as nurdles, entered the River Tyne when a vessel struck a shipping container in South Shields



Home › Shipping News › One Billion Plastic Pellets Spill Into River Tyne After Offshore Vessel Collides With Container Ship

One Billion Plastic Pellets Spill Into River Tyne After Offshore Vessel Collides With Container Ship

By MI News Network | July 29, 2026 | Shipping News

Add Marine Insight on Google

# The Regulatory Gaps

## United States

- No binding federal rule yet
- Plastic Pellet Free Waters Act (H.R. 7543 / S. 4181, 119th Congress) introduced in February 2026. This would direct the EPA to set effluent limitations prohibiting pellet discharges into US waters. Still in committee, not law.
- Colorado: Adopted a state law in 2026 explicitly making pellet discharge illegal, ahead of federal action.
- Illinois: The first Great Lakes State to officially designate industrial plastic pellets as a pollutant (signed House Bill 4418 into law in August 2026)

## European Union

- Regulation (EU) 2025/2365 (published in November 2025; in force since December 16, 2025.): The strongest pellet-specific law targeting "zero plastic pellet loss" in entire supply chain (production, conversion, transport, storage, and cleaning) for both EU and non-EU operators.
    - Rollout is staged: most obligations phase in by December 2027, with an extended timeline to December 2028 for maritime transport.
    - Large operators (>1,000 – 1,500 tons/year) need independent third-party certification
    - Small companies have an option for self-declaration of compliance.
    - *Criticism: Small companies make up most of the plastics supply chain and are largely exempted from independent oversight*.

# The International Maritime Organization (IMO): Regulatory Gaps

- IMO is the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships.
- IMO's Pollution Prevention and Response Sub-Committee has been the main forum since the X-Press Pearl disaster made this an unavoidable issue.
- March 2024: IMO’s Marine Environment Protection Committee (MEPC) approved voluntary recommendations covering packaging strength, stowage (below deck or in sheltered areas), and clear shipping documentation identifying pellet-carrying containers.
- April 2026: MEPC agreed to develop a mandatory code governing pellet transport in freight containers.
- **There is currently no binding global requirement for plastic pellets**

INTERNATIONAL MARITIME ORGANIZATION

19 February 2026

**IMO sharpens plans to achieve zero plastic pollution from ships by 2030**

# Needs

## Mandatory containment standards

- Packaging and handling protocols for pellet shipments including rail and truck routes near waterways

## Spill-response protocols

- Treating pellet spills like other hazardous-cargo incidents, with pre-staged sieving/vacuum equipment and rapid-notification requirements

## Extended producer responsibility

- Assign cleanup and monitoring costs to resin producers and shippers, not solely to state and local responders

## Long-term monitoring

- Track recovery of impacted sites over years, not just the initial response window



# Conclusions

- Pellet spills are a concentrated, persistent, and increasingly common source of primary microplastic contamination in marine and freshwater systems alike.
- Spill incidents pose technical challenges: buoyant, sub-visible particles that outlast conventional cleanup.
- Extremely limited binding requirement to contain pellets in transit or fund their recovery when they escape.



# Thank You

**“Pellets kill marine life: Don't let nurdles escape”**



## Questions & Discussion

Mala C. Hettiarachchi:
mala.Hettiarachchi@ergrp.net

Meththika S. Vithanage:
metvi@geus.dk