OECD’S GLOBAL PLASTIC OUTLOOKS: MODELLING PLASTICS PRODUCTION & POLLUTION

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Workshop on Data and Harmonization to Improve the Circularity of Plastics
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The Global Plastics Outlooks in a nutshell

First **comprehensive mapping of the lifecycle of plastics globally**

**High-level of granularity**: primary and secondary production, 14 polymer categories, various applications

**Domestic plastics policy landscape** covering 50 countries

**Forward-looking** to 2060 with a multi-regional, multi-sectoral dynamic model

Presents **scenarios** projecting future plastics use, waste and leakage

**Quantifies costs** of policy packages towards eliminating leakage at regional level

Investigates synergies between plastics and **climate policies**
OVERVIEW OF THE MAIN RESULTS
The plastic lifecycle in 2019

PLASTICS PRODUCTION & WASTE
- Fossil-based plastics: 429Mt
- Primary plastics: 431Mt
- Bio-based plastics: 2Mt
- Secondary plastics: 29Mt
- Plastics use: 460Mt
- Accumulated stock of plastics in economy: 3120Mt

PLASTIC WASTE
- Process losses: 4Mt
- Plastic scrap: 33Mt
- Recycling residues: 22Mt
- Collected for recycling: 55Mt
- Incinerated: 67Mt
- Landfilled: 174Mt
- Mismanaged & littered: 82Mt
- Litter clean-up: 3Mt
- Leaks from landfills: 0.3Mt
- Open-pit burning: 26Mt
- Dumpsites: 34Mt
- Aquatic leakage: 6Mt
- Terrestrial leakage: 13Mt
- Microplastics leakage: 2.7Mt

IN THE ENVIRONMENT
Rivers are a key pathway and sink for aquatic leakage today
Global plastics use is on course to almost triple by 2060

All polymers are projected to increase…
…in all applications

Packaging, construction and vehicles will be 2/3 of all use
Plastic waste will also triple, half will still be landfilled and unmanaged keeps increasing.
How far would we be in 2060 from zero plastic pollution?

- Doubling from 2019 levels
  - 493 Mt by 2060
  - 115 Mt/year
  - 44 Mt/year

The circularity of the plastics lifecycle only increases from 8% to 14%

Other lifecycle impacts (e.g. land use, human toxicity)
Present situation:
Current circumstances and policy landscape

How to achieve better environmental outcomes?

Gradually increasing stringency of measures

Regional Action

Co-ordinated policy action

How do we get there?

Global Goal: Eliminate leakage

Global Ambition
Both policy packages target the entire plastics lifecycle

Restrain plastics demand and enhance circularity

Enhance recycling

Close leakage pathways
Combining policies that target different lifecycle stages can drastically reduce plastics leakage.

In 2060, million tonnes

Plastic use

Baseline: 1231 (-17%)

Regional Action: 1018 (-33%)

Global Ambition: 1014 (-33%)

Plastic waste

Baseline: 460

Regional Action: 353 (-33%)

Global Ambition: 283 (-33%)

Mismanaged plastic waste

Baseline: 827 (-17%)

Regional Action: 837 (-17%)

Global Ambition: 863 (-17%)

Plastic leakage

Baseline: 460

Regional Action: 353 (-62%)

Global Ambition: 59 (-96%)

Stocks in rivers and oceans

Baseline: 493 Mt

Regional Action: 140 Mt (-55%)

Global Ambition: 300 Mt

Share of recycled plastics

Baseline: 6% (2019), 6% (2060)

Regional Action: 12% (2019), 29% (2060)

Global Ambition: 41% (2019), 41% (2060)

In 2019, million tonnes

Only unmanaged sources of waste remain.

In 2060, million tonnes
MODELLING AND DATA
Modelling methodology

- Global assessment with ENV-Linkages

  - Macros model: ENV-Growth
    - Demographics
    - Labour
    - Capital accumulation
    - Total factor productivity

  - Multisectoral model: ENV-Linkages
    - Plastic use data
    - Structural change assumptions on demand and production

  - Economic projections
  - Plastics projections

COVID-19 impact
Overview of the methodology to model plastic flows

1. DRIVERS OF PLASTIC USE
   - Project sectoral and regional economic developments using a global CGE model (15 world regions)

2. PLASTIC VOLUMES
   - Associate plastic volumes to sectoral demand in CGE

3. PLASTIC WASTE
   - Calculate waste flows, based on product lifetimes

4. PLASTIC WASTE MANAGEMENT
   - Break down waste by waste management (recycled, incinerated, landfilled, mismanaged)

5. ENVIRONMENTAL IMPACTS
   - Estimate environmental impacts: plastic leakage to the environment, greenhouse gas emissions, lifecycle impacts
### Modelling plastics flows

<table>
<thead>
<tr>
<th>Input sectors</th>
<th>Applications</th>
<th>Output sectors</th>
<th>Polymers*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building &amp; construction</td>
<td>Construction</td>
<td></td>
<td>ABS, ASA, SAN; bioplastics; HDPE, LDPE, LLDPE; PP; PS; PUR; PVC; other</td>
</tr>
<tr>
<td>Consumer &amp; institutional products</td>
<td>Accommodation and food service activities; air transport; education; health; insurance; lumber; non-metallic minerals; Business services; other manufacturing; public services; land transport; pulp; paper and publishing; real estate; textile; water transport</td>
<td></td>
<td>ABS, ASA, SAN; bioplastics; HDPE, LDPE, LLDPE; PP; PS; PUR; PVC; other</td>
</tr>
<tr>
<td>Plastic products</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical/electronic</td>
<td>Electrical equipment; electronics</td>
<td></td>
<td>ABS, ASA, SAN; bioplastics; HDPE, LDPE, LLDPE; PP; PS; PUR; PVC; other</td>
</tr>
<tr>
<td>Industrial/machinery</td>
<td>Fabricated metal products; iron and steel; nonferrous metal; Machinery and equipment</td>
<td></td>
<td>HDPE, LDPE, LLDPE; PP; PUR</td>
</tr>
<tr>
<td>Packaging</td>
<td>Food products; chemical products</td>
<td></td>
<td>Bioplastics; HDPE, LDPE, LLDPE; PET; PP; PS; PUR; PVC; other</td>
</tr>
<tr>
<td>Personal care products</td>
<td>Chemical products</td>
<td></td>
<td>HDPE, PET</td>
</tr>
<tr>
<td>Transportation - other</td>
<td>Motor vehicles; public services; other transport equipment</td>
<td></td>
<td>ABS, ASA, SAN; bioplastics; Fibres; HDPE, LDPE, LLDPE; PP; PUR; PVC; other</td>
</tr>
<tr>
<td>Other</td>
<td>Other sectors</td>
<td></td>
<td>Other</td>
</tr>
<tr>
<td>Chemicals</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Marine coatings</td>
<td>Other manufacturing, other transport equipment</td>
<td></td>
<td>Marine coatings</td>
</tr>
<tr>
<td>Road markings</td>
<td>Construction</td>
<td></td>
<td>Road markings</td>
</tr>
<tr>
<td>Textile sector - clothing</td>
<td>Textiles</td>
<td></td>
<td>Bioplastics; Fibres</td>
</tr>
<tr>
<td>Textile sector - others</td>
<td>Textiles</td>
<td></td>
<td>Fibres</td>
</tr>
<tr>
<td>Transportation - tyres</td>
<td>Plastic products</td>
<td></td>
<td>Elastomers (tyres)</td>
</tr>
</tbody>
</table>
Modelling waste: a lifetime distribution approach

Source: adapted from Geyer, Jambeck and Law (2017[1]).
Modelling primary and secondary plastics – calibration of economic databases

- Two production technologies producing one good
- Shares applied to GTAP sectors (rpp → plp + pls)
- Cost shares from Exiobase
  - Primary uses most of the fossil fuels
  - Secondary uses about half of chemical sector inputs

<table>
<thead>
<tr>
<th>Region</th>
<th>Share of secondary technology in 2015 (in tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OECD America</td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>3.9%</td>
</tr>
<tr>
<td>Canada</td>
<td>4.6%</td>
</tr>
<tr>
<td>Other OECD America</td>
<td>6.8%</td>
</tr>
<tr>
<td>OECD Europe</td>
<td></td>
</tr>
<tr>
<td>OECD EU countries</td>
<td>9.0%</td>
</tr>
<tr>
<td>OECD Non-EU countries</td>
<td>5.9%</td>
</tr>
<tr>
<td>OECD Pacific</td>
<td></td>
</tr>
<tr>
<td>OECD Asia</td>
<td>6.3%</td>
</tr>
<tr>
<td>OECD Oceania</td>
<td>2.4%</td>
</tr>
<tr>
<td>Other America</td>
<td></td>
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<tr>
<td>Latin America</td>
<td>7.5%</td>
</tr>
<tr>
<td>Eurasia</td>
<td></td>
</tr>
<tr>
<td>Other EU</td>
<td>4.9%</td>
</tr>
<tr>
<td>Other Eurasia</td>
<td>3.5%</td>
</tr>
<tr>
<td>Middle East and Africa</td>
<td></td>
</tr>
<tr>
<td>Middle East &amp; North Africa</td>
<td>3.5%</td>
</tr>
<tr>
<td>Other Africa</td>
<td>4.5%</td>
</tr>
<tr>
<td>Other Asia</td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>7.3%</td>
</tr>
<tr>
<td>India</td>
<td>6.5%</td>
</tr>
<tr>
<td>Other non-OECD Asia</td>
<td>4.8%</td>
</tr>
</tbody>
</table>
Modelling primary and secondary plastics – volumes & dynamics

• Calibrated coefficient at base year applied to growth of overall demand for plastics (rpp/chm inputs to other sectors)

• Secondary production grows with secondary economic flows (as processed scrap is assumed to be used)
  – Calibration of initial volumes: waste collected for recycling + loss rates → fixed point methodology
  – Check ex post of scrap availability
### Input data: plastic production

<table>
<thead>
<tr>
<th>Category</th>
<th>Variable</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>Primary and secondary economic split</td>
<td>OECD ENV-Linkages model, based on GTAP10 (Aguiar et al., 2019) split using Exiobase for cost structure (Stadler et al., 2018), Grand View Research (2020) data for total shares (in tons).</td>
</tr>
<tr>
<td></td>
<td>Plastic sectors</td>
<td>OECD ENV-Linkages model projections, resulting from mapping of sectoral/polymer flows to economic baseline. Secondary plastics incorporates recycling loss rates from the literature (Cottam et al., 2022; Chruszcz and Reeve, 2018; Roosen et al., 2020; VinylPlus, 2019).</td>
</tr>
<tr>
<td>Use by region, application and polymer</td>
<td></td>
<td>For the calibration year (2015), primary plastics use by polymer and application from Ryberg et al. (2019) has been associated to different sectors and regions in the OECD ENV-Linkages model. Secondary plastics use stems from waste generation (derived in the model), recycling rates (see below) and recycling loss rates from the literature (Cottam et al., 2022; Chruszcz and Reeve, 2018; Roosen et al., 2020; VinylPlus, 2019). For future years, OECD ENV-Linkages model projections result from the mapping of sectoral/polymer flows to economic baseline.</td>
</tr>
</tbody>
</table>
Input data: plastic waste

<table>
<thead>
<tr>
<th>Category</th>
<th>Variable</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sanitary landfilling</td>
<td>Cross country regression (residual) based on What a Waste 2.0 (Kaza et al., 2018) (*) Rates for non-MSW assumed to match MSW, when excluding littering.</td>
</tr>
<tr>
<td></td>
<td>Littering share</td>
<td>(Jambeck et al., 2015) for share in MSW and zero for non-MSW.</td>
</tr>
<tr>
<td></td>
<td>Mismanaged share</td>
<td>Cross-country regression based on Kaza et al. (2018) (*) Rates for non-MSW assumed to match MSW, when excluding littering.</td>
</tr>
</tbody>
</table>
Input data: plastic environmental impacts

<table>
<thead>
<tr>
<th>Category</th>
<th>Variable</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental impacts</td>
<td>Total leakage of macroplastics and microplastics to the environment by category</td>
<td>Based on plastic consumption, waste and waste management projections from OECD ENV-Linkages model, adapted from Ryberg et al. (2019) methodology. The central estimate for macroplastic leakage from mismanaged waste (the largest source of leakage) is equal to the average between the estimate provided with the methodology of Ryberg et al. (2019) and the estimate provided by Leeds University (Cottom et al., 2022[19]).</td>
</tr>
<tr>
<td></td>
<td>Plastic leakage and accumulation in aquatic environments</td>
<td>Based on waste management projections from OECD ENV-Linkages model, and the leakage estimates described above, adapted from the Lebreton and Andrady (2019) methodology.</td>
</tr>
<tr>
<td></td>
<td>Plastic leakage to air from terrestrial transport</td>
<td>Based on transport projections from OECD ENV-Linkages model, adapted from Evangelou et al., (2020) methodology.</td>
</tr>
<tr>
<td></td>
<td>GHG emissions for plastic lifecycle</td>
<td>Based on plastic consumption, waste and waste management projections from OECD ENV-Linkages model, based on Zheng and Suh (2019).</td>
</tr>
</tbody>
</table>
Trade in plastics waste

- Incorporated trade in plastic waste per application and polymer type
- Volumes of plastic waste exports and imports are calculated based on UN Comtrade data:
  - Total exports of plastic waste per country and polymer are estimated using the share of plastics exports (Comtrade) to plastic waste (output of ENV-Linkages).
  - Exports are split into partner countries and polymers using the country and polymer weights in 2019 for projections, and historical data for the years before
  - \( \text{Imports}(r,rr) = \text{Exports}(rr,r) \)
- The end-of-life fates of plastic waste traded flows differ from the domestically treated waste: 50% of traded plastic waste is recycled, and the remaining is distributed across the other waste streams following the same proportions of end-of-life fates as domestically treated waste excluding littering.
**Databases and linkages**

- Data is open and downloadable:
  - [https://www.oecd.org/environment/plastics/](https://www.oecd.org/environment/plastics/)

- The CGE model was soft-linked with several environmental models and methodologies:
  - DTU model of environmental leakage
  - Plastic leakage to terrestrial and aquatic environments (SPOT model, Leeds U)
  - Plastic leakage to aquatic environments (Laurent Lebreton)
  - Particulate matter emissions from tyre and brake wear (NILU)
  - Effects of higher penetration rates of biobased plastics (Neus Escobar and Wolfgang Britz)
  - Health and environment impacts from the life cycle of plastics (Ghent University)
Thank you

Find out more at: www.oecd.org/environment/plastics

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