



MICRO-CREDENTIAL

CIRCULAR ECONOMY FOR LAND AND WASTE MANAGEMENT

5.- Waste Prevention and Eco-Design

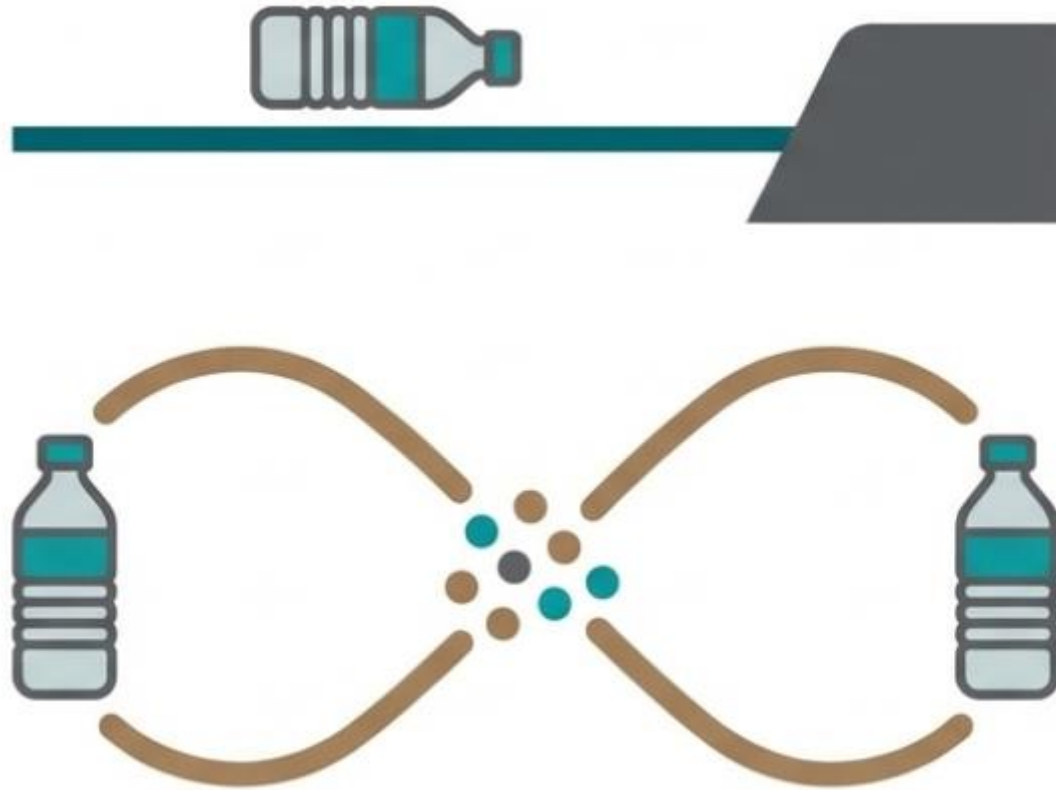
Packaging and Land Impacts

CELWS-W05-V03



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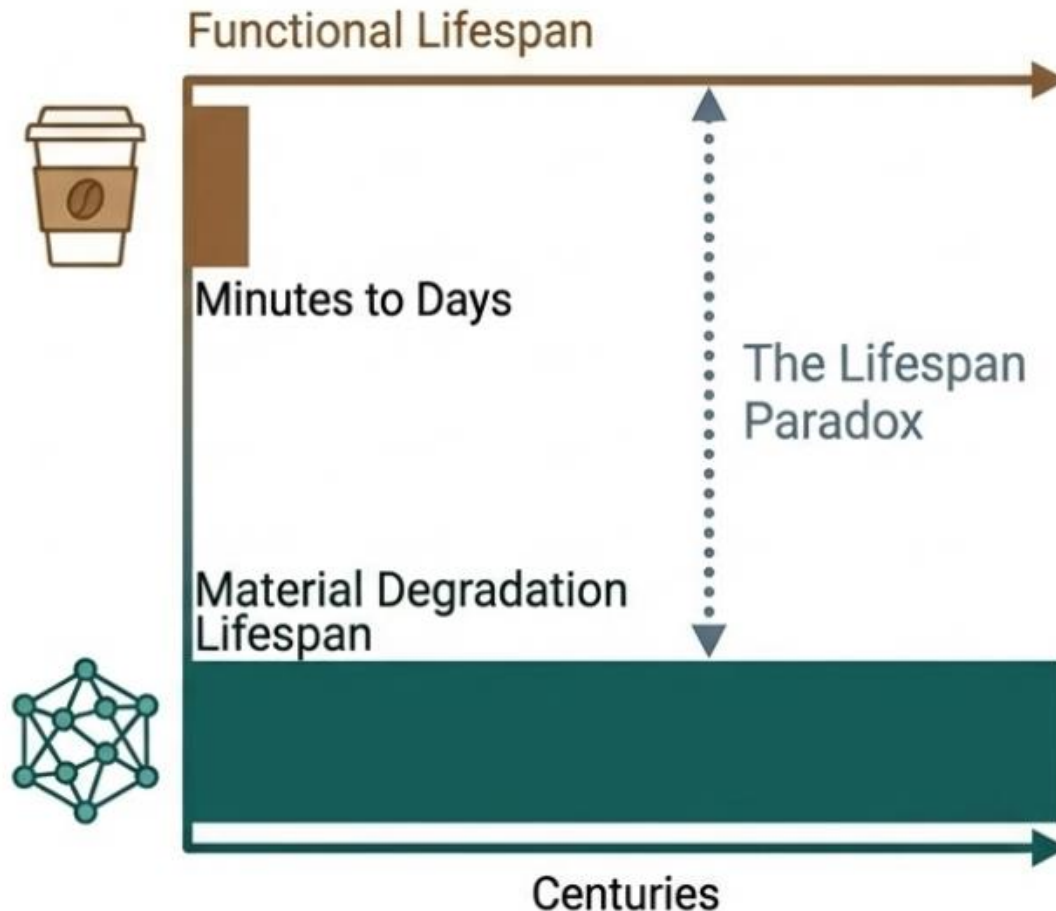


Mitigating the linear waste crisis through circular economy strategies.



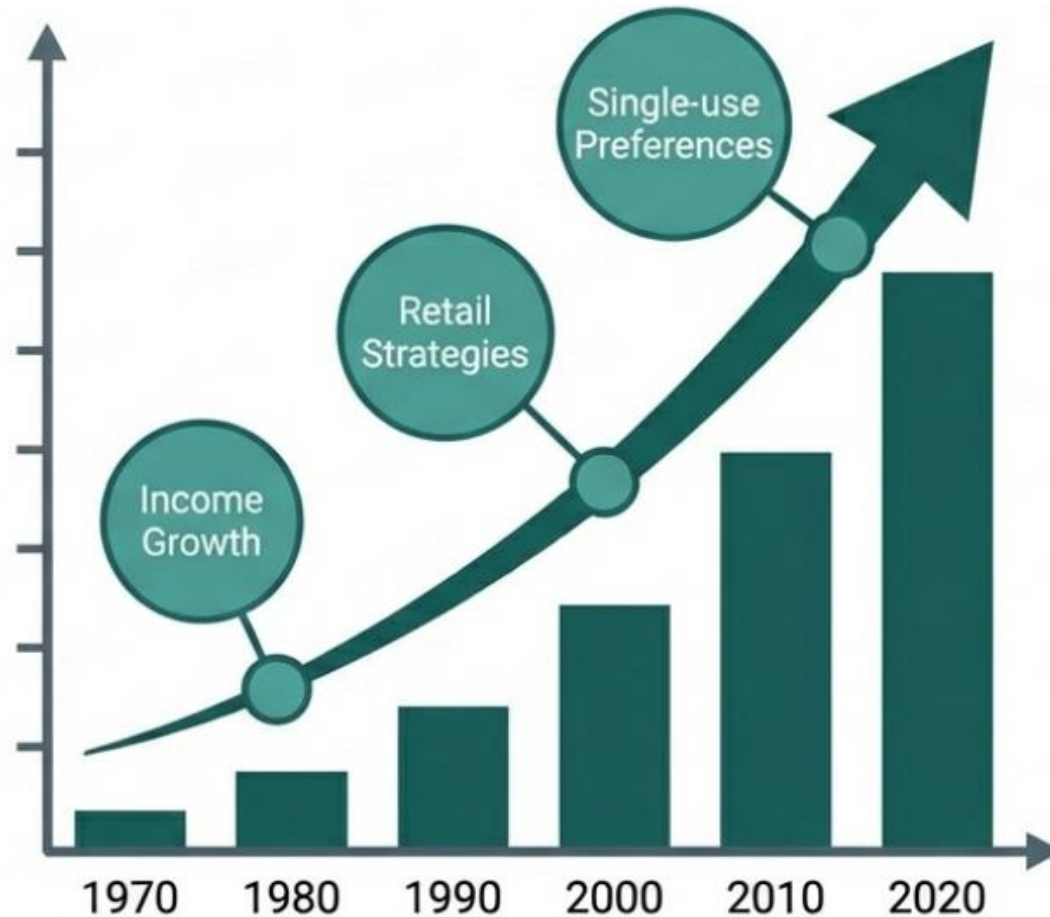
Packaging represents 10–25% of total product costs and provides essential services for global supply chains:

- **Protection:** Extends shelf life and prevents food loss.
- **Transport:** Enables efficient spatial logistics and handling.
- **Marketing:** Drives brand differentiation and consumer choice.
- **Information:** Delivers critical regulatory and safety data.



A critical design failure in modern linear consumption:

- **Short-term Use:** Single-use items provide only fleeting utility.
- **Long-term Impact:** Synthetic polymers endure in ecosystems for hundreds of years.
- **Result:** A rapid, continuous accumulation of persistent global waste.



Mass production and shifting habits have triggered unprecedented waste generation:

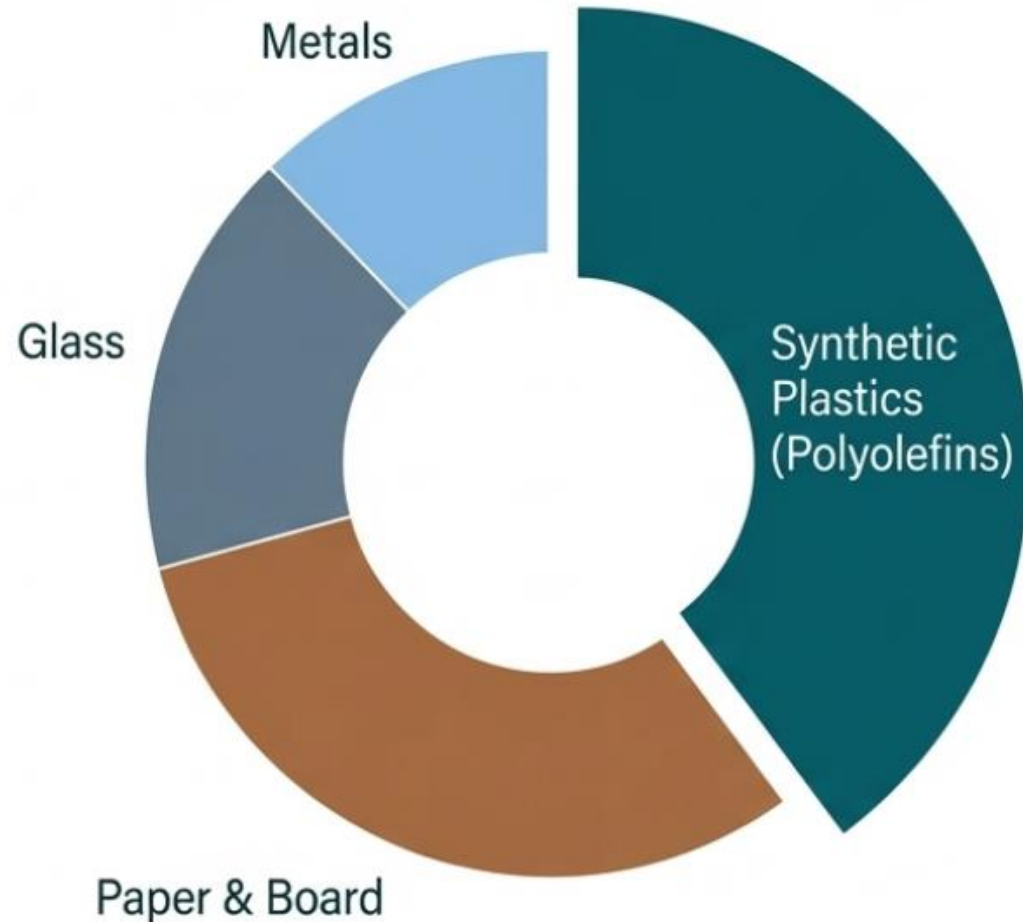
- **Demographics:** Driven by 1.8 billion new middle-class consumers.
- **Convenience:** A dramatic market shift to packaged, single-serving products.
- **Scale:** Globally, packaging consumes ~207 million tonnes of material annually and accounts for nearly 20% of all household waste.

Cities act as massive resource sinks with severe spatial limitations for waste:

- **Concentrated Intake:** Urban areas consume 75% of global natural resources.
- **Concentrated Output:** High-density populations yield localized, unmanageable daily waste volumes.
- **The Spatial Challenge:** The urgent need for removal to protect public health often forces linear disposal (landfilling/incineration) over recovery.

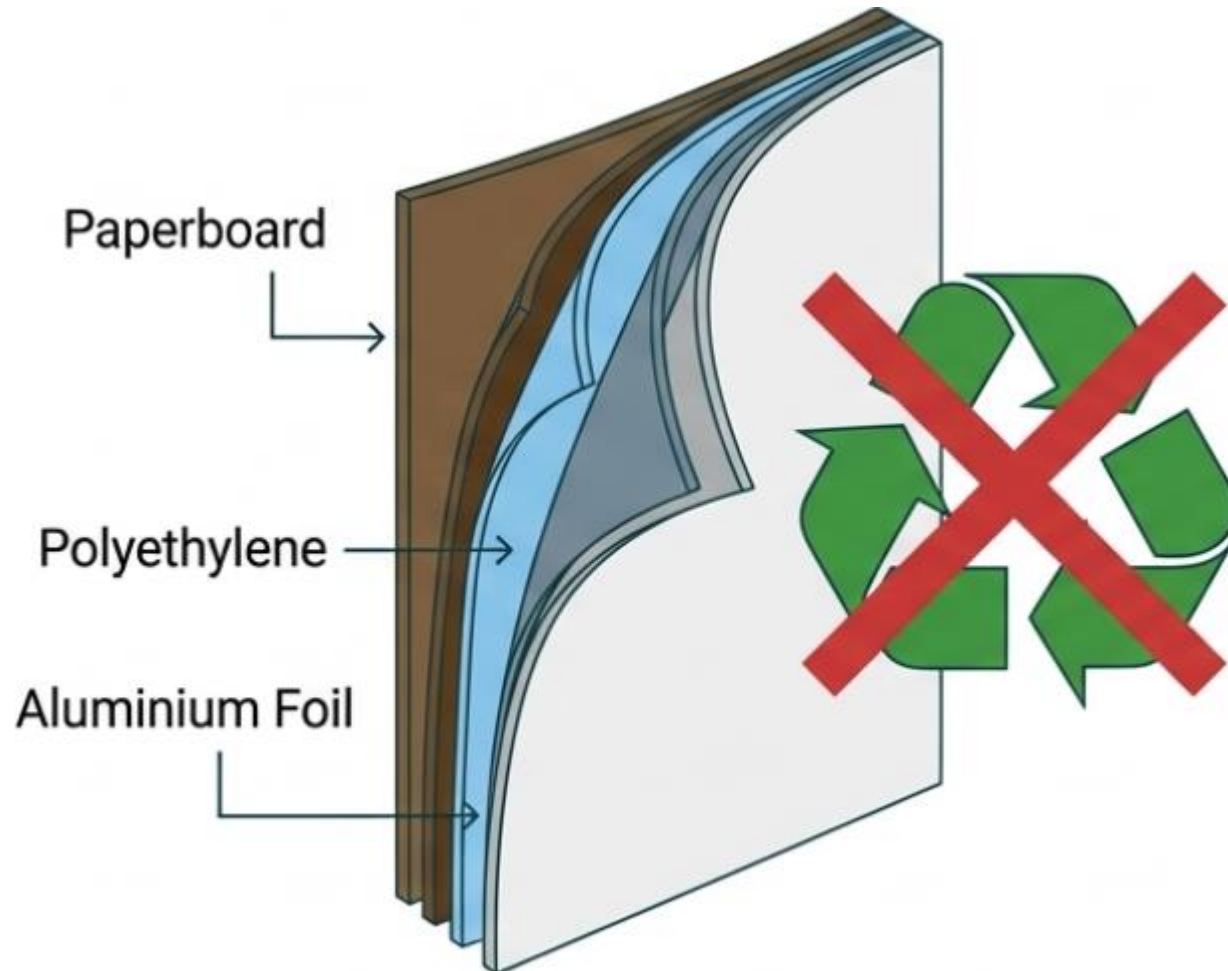


Types of Packaging Materials



Synthetic plastics dominate modern packaging due to low cost and functional versatility:

- **Plastics:** Packaging accounts for 40% of all global plastic production, predominantly engineered for single-use.
- **Paper/Cardboard:** High theoretical recovery rates, but frequently lost to food contamination.
- **Glass & Metals:** Highly recyclable, but heavy profiles increase transport emissions.

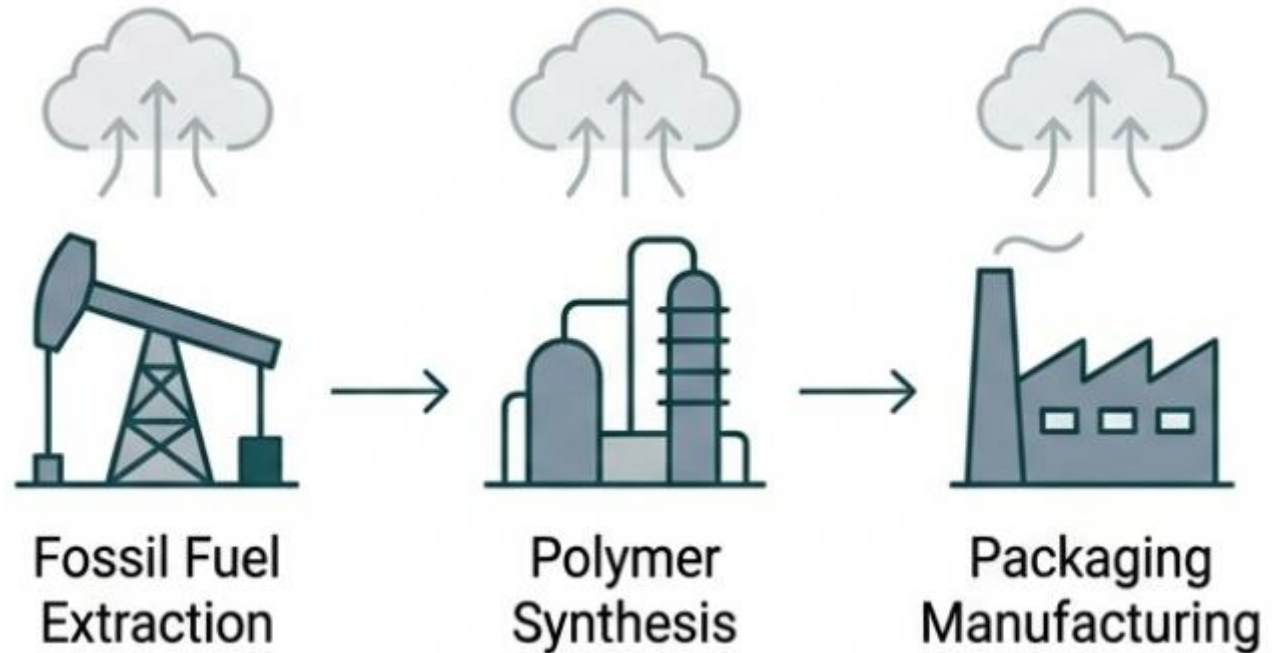


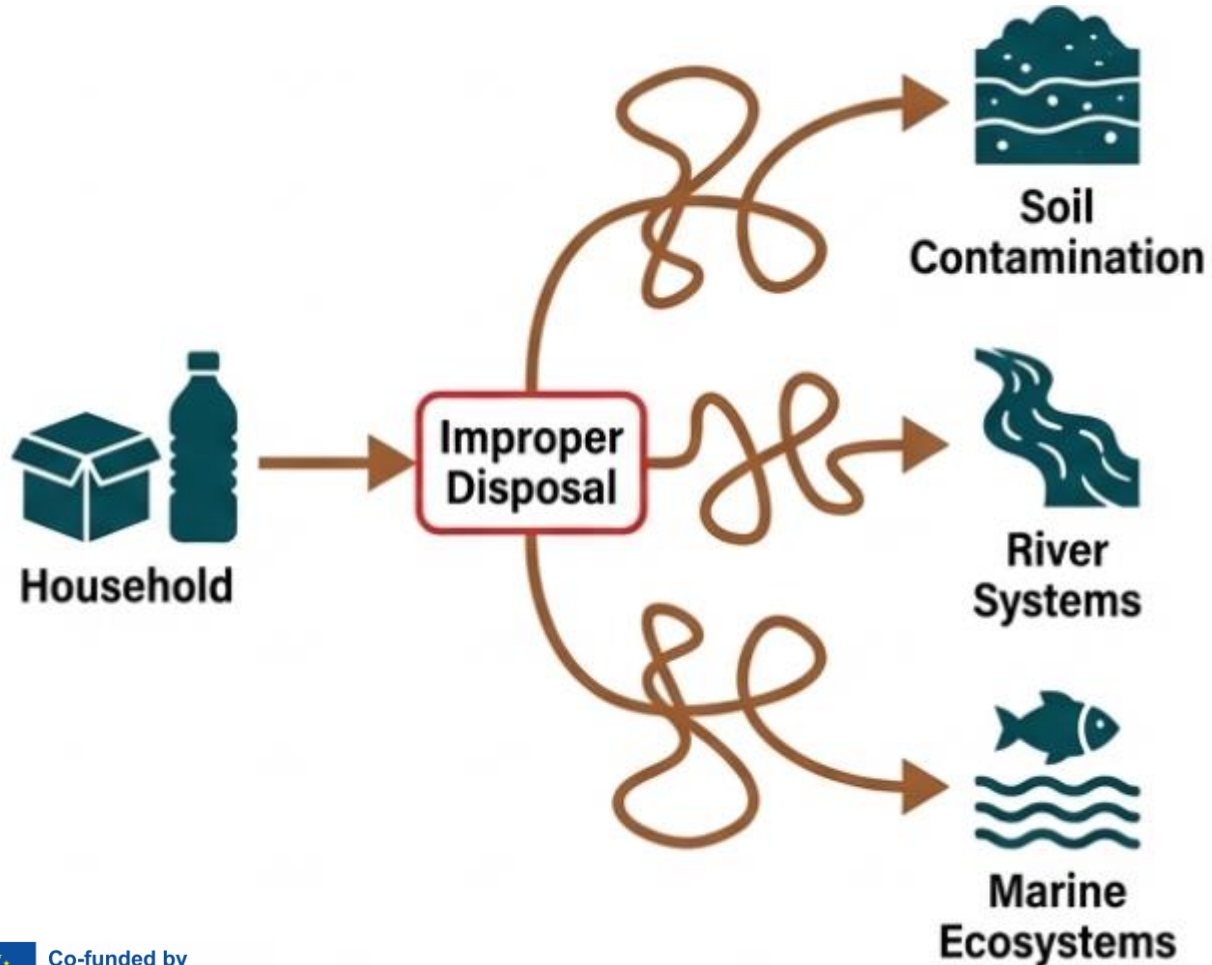
Superior packaging performance is often achieved by combining materials, which paralyzes circularity:

- **Chemical Bonding:** Different polymers and foils are fused to block moisture and oxygen.
- **Separation Cost:** Rendering multi-materials into pure fractions is technically difficult and economically unviable.
- **Outcome:** These materials face inevitable downgrading or thermal disposal.

The environmental toll of packaging begins long before it becomes waste:

- **Resource Depletion:** High reliance on finite fossil energy carriers.
- **Energy Intensity:** Polymer synthesis and material conversion require massive industrial energy inputs.
- **Emissions:** Continuous release of greenhouse gases at every extraction and manufacturing stage.



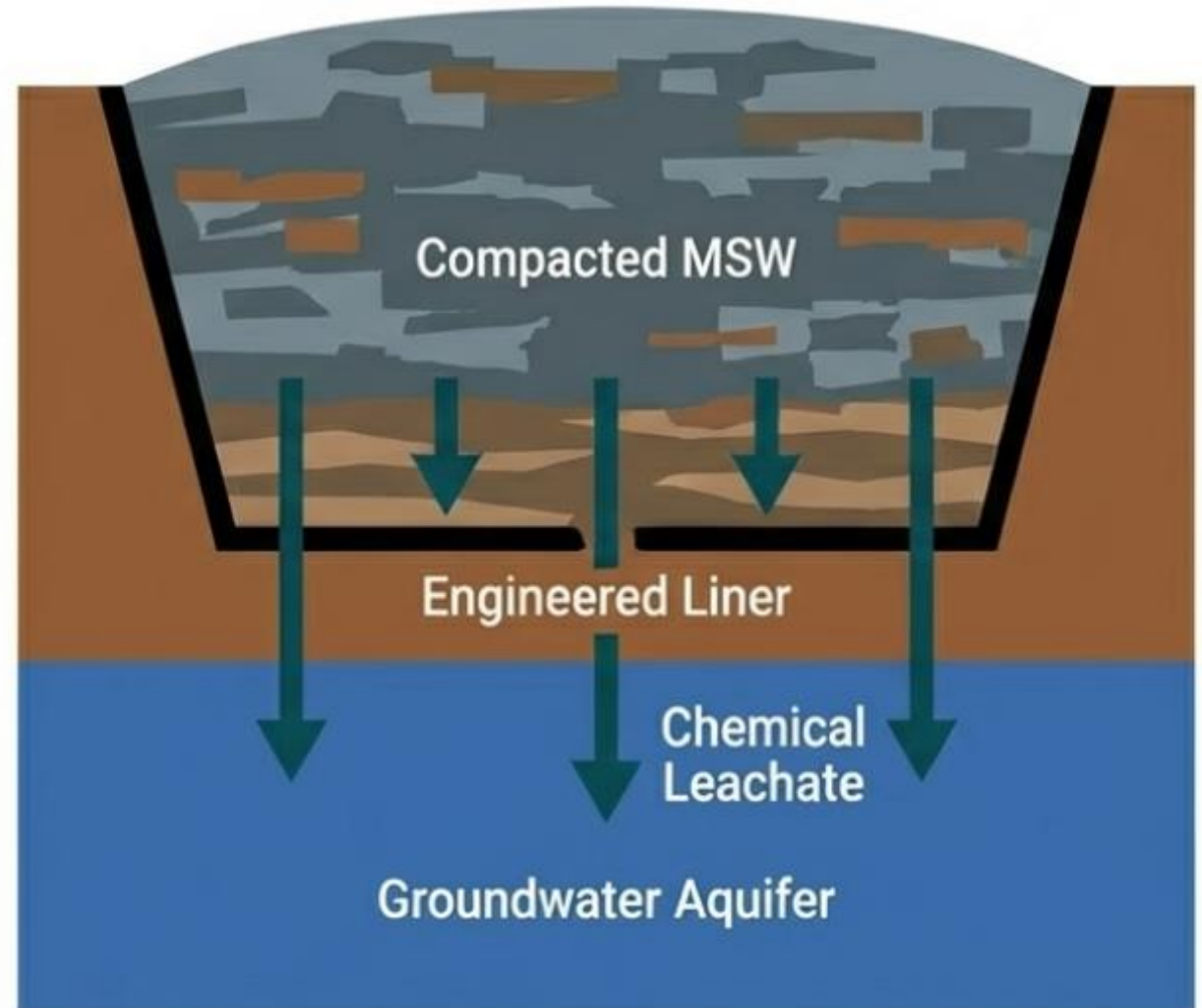


When formal waste management fails, linear packaging becomes an invasive pollutant:

- **Soil Contamination:** Alters soil chemistry and disrupts agricultural productivity.
- **River Systems:** Act as global transport arteries, carrying macro-debris across borders.
- **Marine Ecosystems:** Causes severe entanglement, ingestion, and systemic disruption of aquatic food webs.

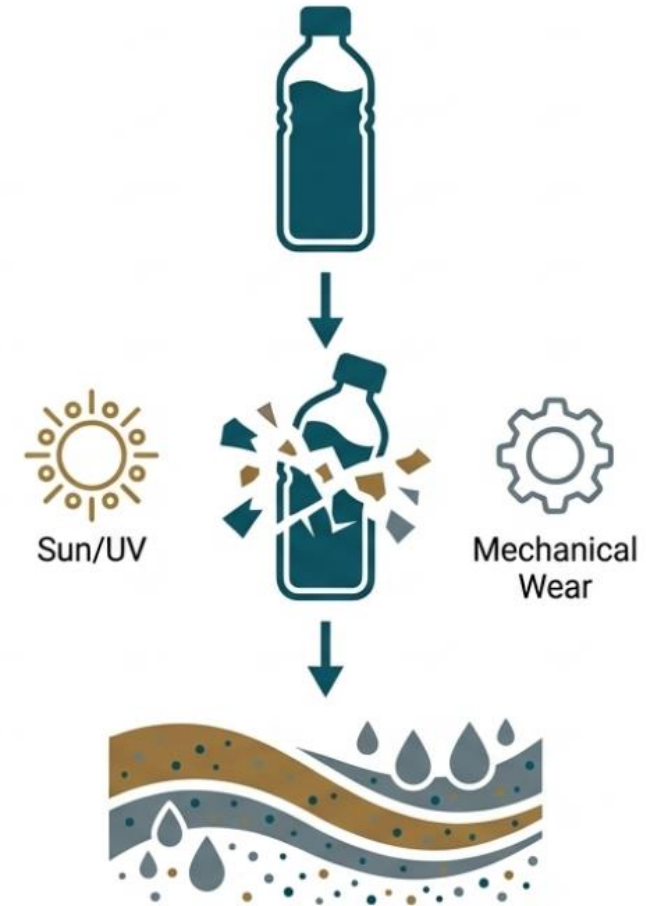
Landfilling is the indefinite storage of waste on land, creating long-term liabilities:

- **Spatial Consumption:** Vast geographic areas are locked away from ecological or agricultural use.
- **Leachate Risks:** Toxic liquid byproducts risk breaching engineered liners, contaminating local aquifers.
- **Methane Emissions:** The anaerobic breakdown of mixed organic and packaging waste produces potent GHGs.



Synthetic plastics do not safely biodegrade; they only physically fragment:

- **Weathering:** UV radiation and physical friction break macro-plastics into microscopic particles.
- **Pervasive Contamination:** Microplastics irreversibly infiltrate soil matrices and water tables.
- **Biological Transfer:** Particles are absorbed by flora and ingested by fauna, ultimately entering the human food chain.



Economic Costs of Packaging Waste

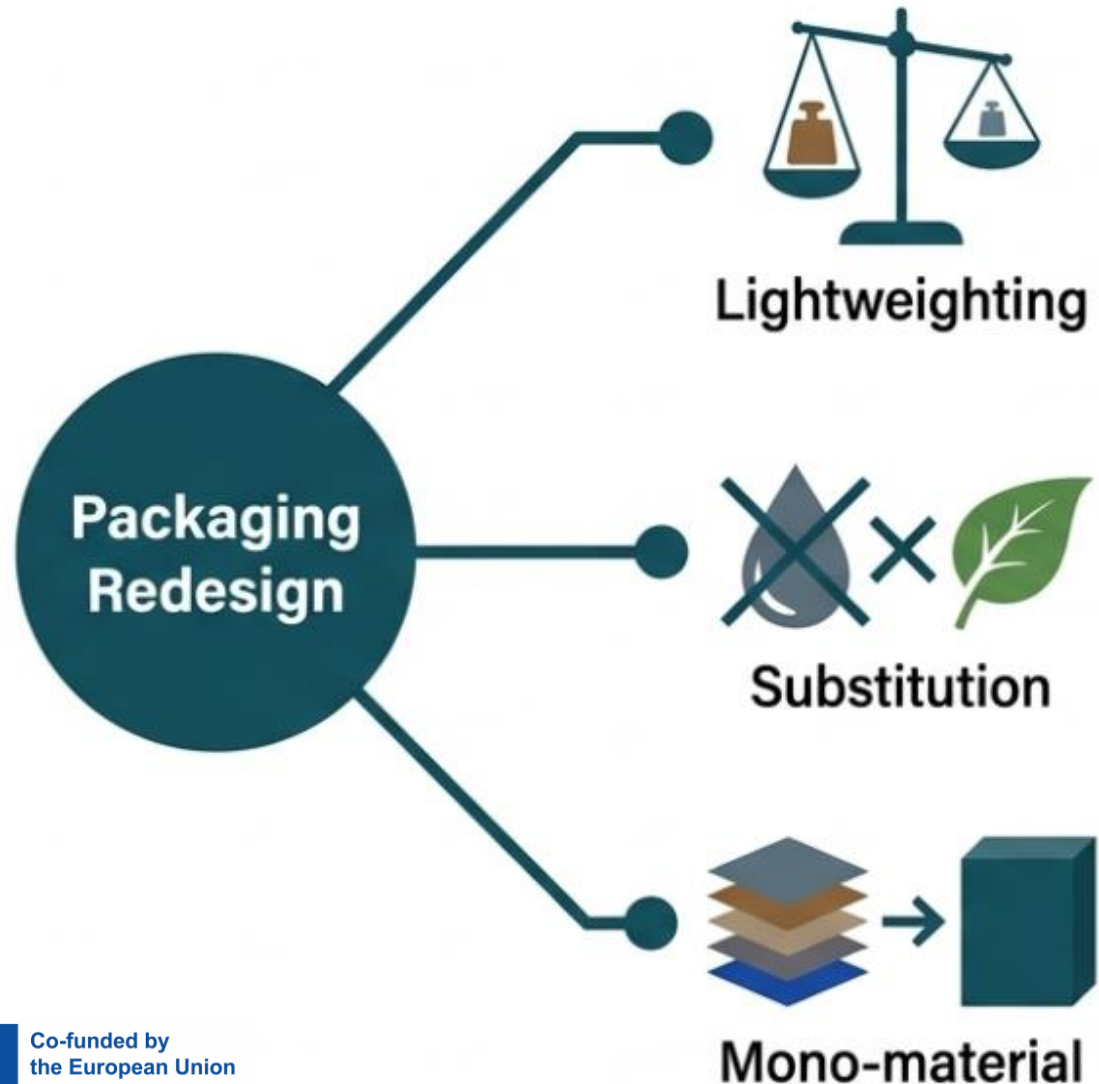
\$139 Billion
Annually



Cheap Cost of
Virgin Plastics

The linear packaging economy successfully internalizes profits while externalizing its damages:

- **Artificial Cheapness:** Virgin plastics appear inexpensive only because environmental damages are not priced into production.
- **The True Cost:** Ecosystem degradation, municipal cleanup, and resulting health impacts cost the global economy an estimated \$139 billion annually.



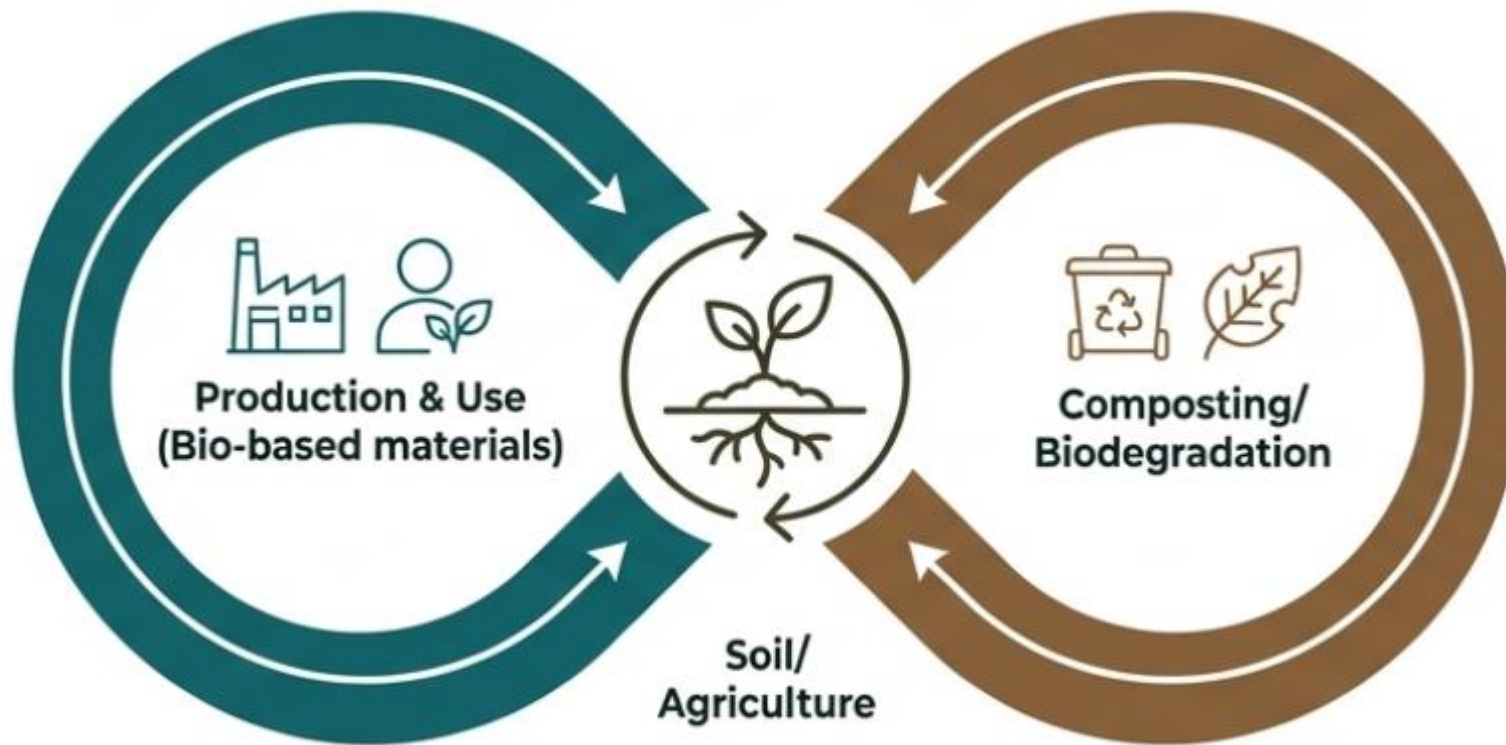
Mitigating land impacts requires intervening at the engineering phase before waste is created:

- **Lightweighting:** Delivering the exact same protective function with drastically less material volume.
- **Substitution:** Transitioning supply chains from fossil-based to renewable, bio-based materials.
- **Mono-materials:** Simplifying chemical structures to ensure economic viability for end-of-life recyclers.

Breaking the single-use habit requires business models that retain a package's value:

- **Durability:** Packaging is engineered as a long-term capital asset, not a daily consumable.
- **Reverse Logistics:** Dedicated infrastructure must be established to collect, clean, and return containers efficiently.
- **System Impact:** Drastically reduces virgin raw material extraction and eliminates zero-value end-of-life waste.





The ultimate goal of Sustainable Land Management in packaging systems:

- **Waste Equals Food:** Materials must be designed to be safely metabolised by nature.
- **Regenerative By Design:** Compostable packaging restores vital nutrients to the soil rather than consuming static landfill space.
- **Systemic Shift:** Moving entirely from a 'take-make-dispose' paradigm to an economy perfectly aligned with natural biological cycles.



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5.- Solid Waste Streams and Material Flows

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