ENVIRONMENTAL IMPACT OF GEOTEXTILES

Literature study – Chapter 6: Erosion control applications.

The report ***"Environmental Impact of Geotextiles – Chapter 6: Erosion control applications "*** was written by **Prof. Philippe Delmas** of SINTEF Community (Norway), at the request of the **European Association of Geosynthetic Product Manufacturers (EAGM)**.

The report is part of SINTEF's broader research series *"Environmental Impact of Geotextiles and Geotextile-related Products"* and complements *Chapter 1: Global Overview* by addressing **erosion control applications** such as **coastal protection, riverbanks, canals, and waterways**.

An **Advisory Group** guided the work, consisting of:

- 3 EAGM members (Anne-Laure Backes, Henning Ehrenberg, Fabrizia Trovato);
- 3 independent experts (Laetitia van Schoors, University Gustave Eiffel; Laurent Briançon, INSA Lyon; Philippe Delmas, SINTEF).

The chapter synthesizes results from **84 scientific publications (2020–2024)**, evaluating both **environmental and economic impacts** of geotextile applications in hydraulic and erosion-control structures

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1. Sustainability and Environmental Performance

1.1 Contribution to the UN Sustainable Development Goals

Geotextiles contribute directly or indirectly to several **UN Sustainable Development Goals (SDGs)**, notably:

- **SDG 6 (Clean Water and Sanitation)** – enabling cleaner waterways and improved filtration;
- **SDG 9 (Industry, Innovation, and Infrastructure)** and **SDG 11 (Sustainable Cities and Communities)** – through resource-efficient, resilient infrastructure;

- **SDG 12 (Responsible Consumption and Production)** and **SDG 13 (Climate Action)** – by reducing emissions and material use;
- **SDG 14 (Life Below Water)** and **SDG 15 (Life on Land)** – by protecting shorelines and habitats from erosion

1.2 Environmental and Resource Efficiency

From decades of research and recent LCAs:

- Geotextiles **replace several layers of gravel and sand filters**, reducing material use by 70–80%
- They are **lightweight**, which lowers **transport demand, energy use, and CO_2 emissions**, and simplifies logistics.
- The reduced need for quarried material helps conserve **non-renewable resources** and **natural landscapes**.
- For hydraulic works, this leads to **10–50% lower total environmental impacts** (including CO_2, energy use, acidification, eutrophication, and particulate matter) compared with conventional solutions

Key LCA comparisons (Frischknecht 2022; de Visser et al. 2022; Ferrara & Jayakrishnan 2024) show:

- **Global Warming Potential reduction:** 40–60% with geotextiles compared to shotcrete or gravel filters.
- **Cumulative Energy Demand (CED):** up to **50% lower**.
- **Sensitivity analysis:** Even when heavier geotextiles (up to 750 g/m^2) are used, they remain environmentally superior unless transport distances for natural materials are extremely short

1.3 Service Life and Durability

- Polypropylene (PP) is the dominant polymer (>90% of geotextile use).
- When properly installed and UV-protected, modern PP geotextiles demonstrate.
- Stabilizers such as **HALS** prevent degradation; field studies in the Azores and the Baltic Sea confirm that **weathering and UV** are the main degradation risks but can be mitigated through **design and covering**.
- Biodegradable options (e.g., jute or biopolymers) are being researched for **short-lived, low-risk applications**, though current European standards (EN 13253–13255) still exclude biodegradable raw materials

2. Microplastics and Environmental Risks

2.1 Potential Release

The report finds **no significant evidence** that geotextiles are a major source of microplastics.

- The **largest global sources** remain **tyre wear, packaging, and agriculture**, which in the Netherlands contribute **~800 t/year**, compared with only **~3 t/year from construction** (of which geosynthetics form a negligible share)
- Field investigations in the Baltic Sea (EI-GEO project, 2017–2022) identified isolated fragments of improperly installed materials, not properly covered or maintained. These cases were linked to **installation errors and storm damage**, not to material failure

2.2 Scientific Evidence and Standards

- Laboratory and field studies (Scholz et al., 2021; 2024) confirm **no harmful leaching or ecotoxicological effects** from properly stabilized PP geotextiles.
- Misleading studies suggesting high emission rates (e.g., Bai et al., 2022) were **debunked** for flawed methodology and unrealistic assumptions (Gustavsson 2022; Fontana 2023; EU 2023)
- Ongoing EU standardization work under **CEN TC189/WG7 Project Group "Potential Release of Microplastics"** is developing a **risk matrix** covering degradation factors (UV, mechanical, chemical) to identify high-risk use cases

2.3 Key Conclusion

When **correctly designed, installed, and maintained**, geotextiles in hydraulic and erosion control works pose **negligible microplastic risk**.
Observed pollution cases stem from **poor design or lack of maintenance**, not from intrinsic material degradation

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3. Economic and Environmental Cost Aspects

3.1 Cost Efficiency

Geotextiles yield major financial advantages:

- Up to **70–80% total cost savings** compared to conventional rock or concrete-based systems
- Savings arise from **reduced excavation and transport**, smaller construction volumes, and faster installation.
- Case data (de Visser et al., 2022):

    - Polymeric geotextile filter = **€27,700 MKI**;
    - Granular closed filter = **€46,900 MKI**;
    - Jute filter = **€193,900 MKI** (mainly due to short lifespan requiring multiple replacements)

3.2 Environmental Cost Indicator (MKI/ECI) Integration

- The **Dutch MKI** (Milieu Kosten Indicator) translates environmental impact into a monetary value.
- Combined cost–environmental assessments show that **PP geotextiles** have the **lowest overall MKI and lifecycle cost**, despite a theoretical (minor) microplastic risk.
- The MKI framework supports **circular and climate-neutral infrastructure goals**, aligning financial and ecological evaluation criteria

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4. Conclusions and Perspectives

Sustainability

Geotextiles significantly **reduce resource use, CO_2 emissions, and energy demand** while promoting **durability, circularity, and sustainable infrastructure** development.

Microplastics

They are **not a major pollution source**; emissions occur only from **improperly handled installations**. EU efforts under **CEN TC189/WG7** are establishing harmonized evaluation standards.

Costs and Efficiency

Geotextiles combine **economic savings with ecological benefits**, achieving up to **50% lower environmental impacts** and **70% lower construction costs**.

Policy Outlook

Integrating environmental costs into procurement (via MKI/ECI) and emphasizing proper design and maintenance are key to ensuring **sustainable, long-lived erosion control systems**.

Overall Conclusion

The SINTEF study confirms that **geotextiles in erosion control and hydraulic works** are a **sustainable, low-impact, and cost-efficient alternative** to traditional mineral solutions.

They contribute directly to the **UN SDGs**, exhibit **lifetimes beyond 100 years**, and—when properly installed—pose **minimal microplastic risk**.
These findings reinforce geotextiles as a **core enabler of Europe's climate-neutral and circular construction transition**.