The role of geosynthetics in sustainable development and the circular economy

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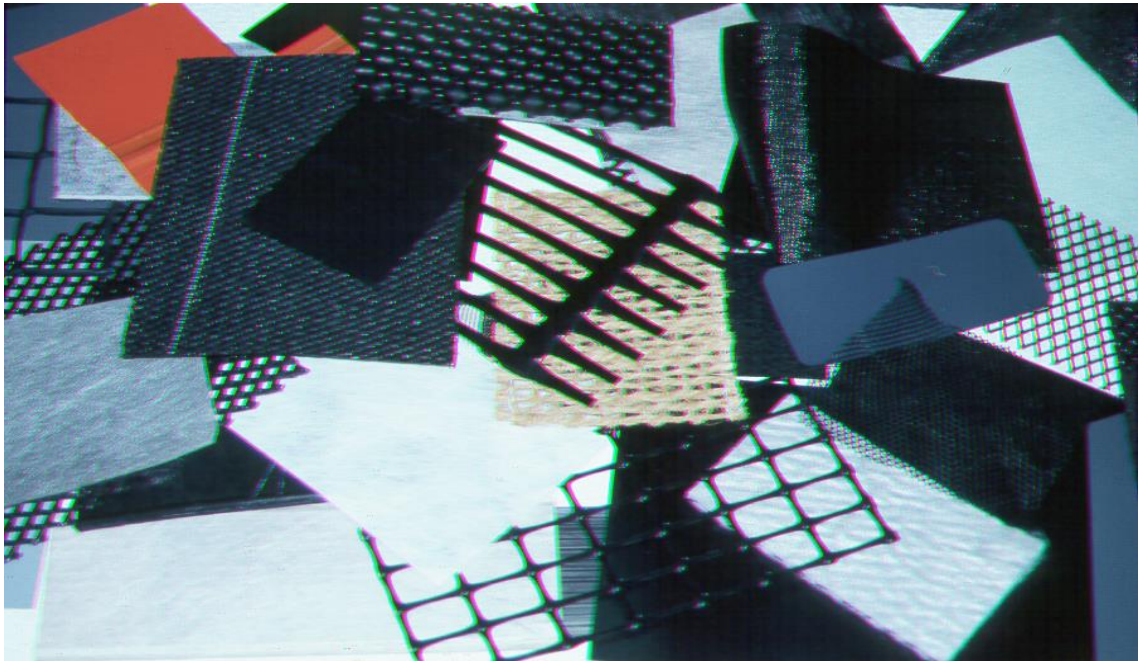
Geosynthetics (EN ISO 10318-1)

Product,at least one of whose components is made from a synthetic or natural polymer, in the form of a sheet, a strip, or a three-dimensional structure, used in contact with soil and/or other materials in geotechnical and civil engineering applications



To learn more on terminology and functions: https://growwithtml.website

Geosynthetic Functions – IGS University Online Lecture Series

In this 55-minute lecture, renowned geotechnical engineering professor Dr. Erol Guler (Bogazici University, George Mason University) describes the essential functions of geosynthetics and how they

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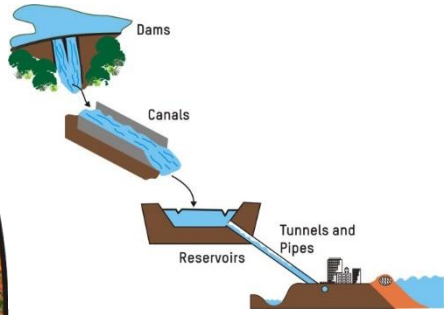
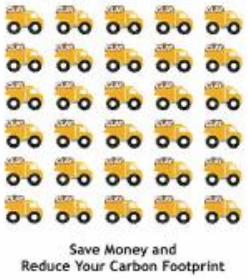
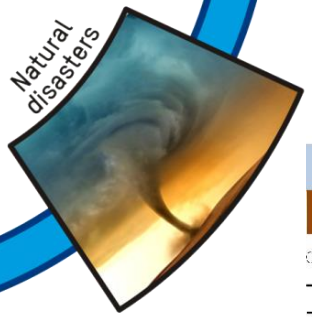
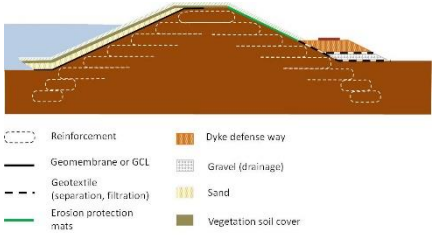
Where are geosynthetics used ?

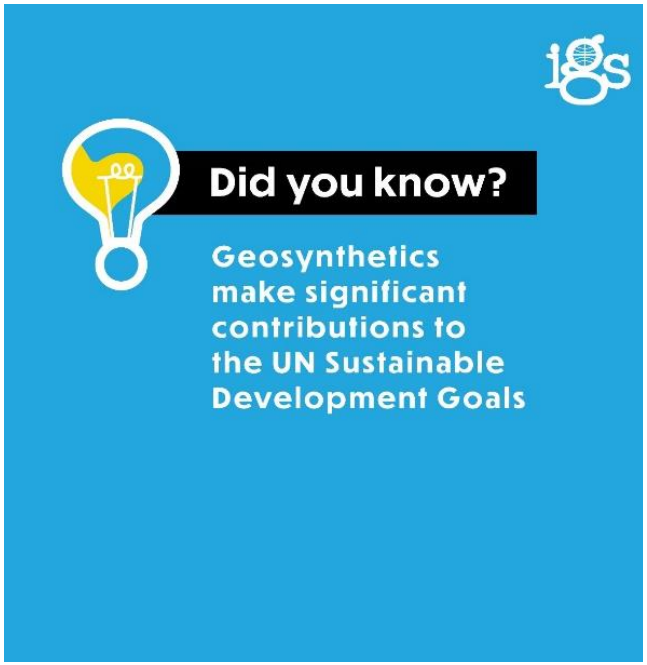








Geosynthetics and the sustainable development goals



https://www.geosyntheticssociety.org/sustainability/

International Geosynthetics Society

Did you know?

Did You Know… geosynthetics make significant contributions to the UN Sustainable Development Goals?

- Unequalled solutions are possible
- Surface and groundwater is preserved and safeguarded from contamination
- Sustainable techniques ensure the reduction in energy consumption and emission
- Other construction materials can be replaced or reduced
- Environmental protection and resilience is achievable
- Economic growth and welfare is enabled

The role of geosynthetics in sustainable development and the circular economy

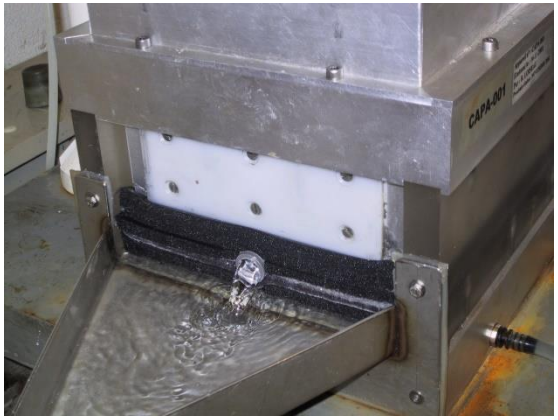
- Geosynthetics and the UN SDGs
- Unequalled solutions are possible
- Environmental and Economic benefits
- Societal benefits
- The geosynthetics’contribution to the Circular Economy
- Summary

Unequalled solutions are possible

Geosynthetics are manufactured materials

Geosynthetics work better than the geotechnical materials they replace

The performance improvement is gained by using manufactured materials with known properties



Effectiveness of canals after 10 years in service

Defined as the reduction of seepage losses compared to unlined canals (Giroud and Plusquellec, 2017)

Type of canal	Percentage
Lined with concrete	70
Lined with geomembrane	95

Courtesy H. Plusquellec

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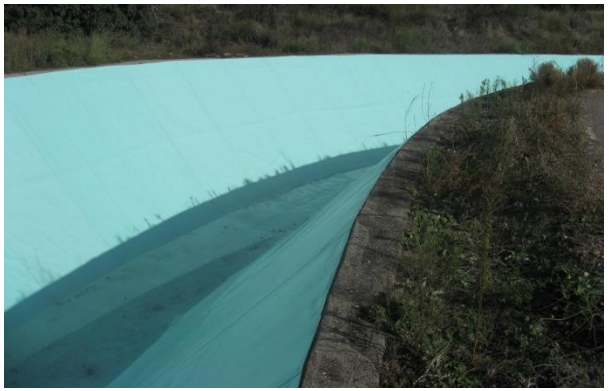

Courtesy P. Guinard

Joint environmental and economic benefits

Joint environmental and economic benefits : basics

Common misconception that sustainable solutions for infrastructure will cost more, but:

Geosynthetics solutions were developed to provide financial benefits

* Easier and or accelerated construction
* Immediate usability
* Long term savings in relation with extending life by increasing volume (reduced thickness, increased stability on slope)

* Reduction in energy consumption
* Reduction of the quantity or need for select soil material
* Less long-term maintenance associated with significant contribution to the lifespan

Energy savings and environmental benefits then became obvious

* Reduction in emissions

Joint environmental and economic benefits : basics

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Reduction in emissions and in non-renewable energy consumption

Mitigation of climate change by use of geosynthetics

EPDM Geomembrane temporary landfill cover used over a twenty year span, IGS photo contest 2014 (W. Johnson)

From agriculture waste to energy

Anaerobic digester lined and capped with EPDM Geomembrane, IGS photo contest 2010 (S. Murray)

Reduction in energy consumption: renewable energy

Solar growing from grass
IGS photo contest 2010
(N. Barba)

Solar cells installed on an exposed Geomembrane cap at the Hickory Ridge landfill (courtesy Carlisle Energy)

Work underway to demonstrate that these systems contribute to energy independance and to reduce the unsustainable dependance on fossil fuels

Reduction in energy consumption : renewable energy

Covers for reservoirs

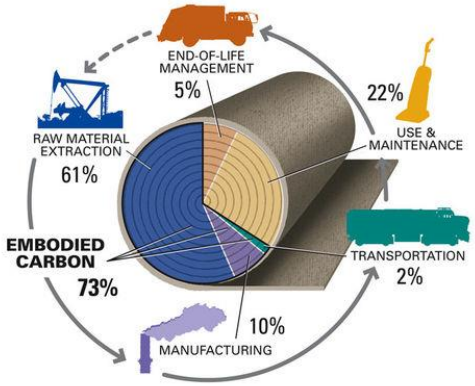
Floating photovoltaic covers reduce the use of land and constitute a renewable source of electricity

Floating photovoltaic cover (courtesy M. Redón-Santafé)

Mitigation of climate change by use of geosynthetics

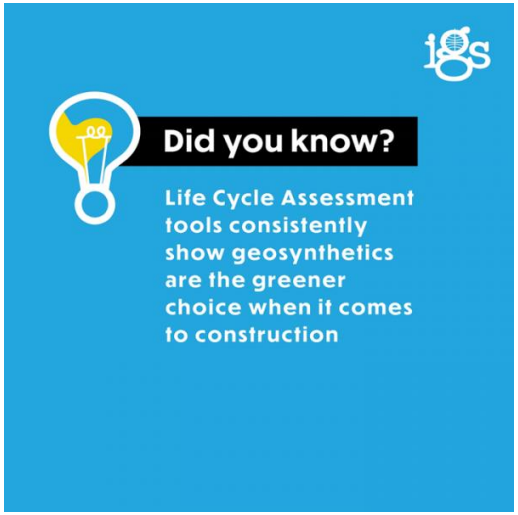
- Collection of methane induces reduction of GHG emission from operating infrastructures
- Geosynthetics also contribute to a reduction of GHG emissions from construction compared to soils

Carbon footprint is a measure of total GHG emissions that can cover emissions over the whole life of a product or service



Embodied carbon (EC) is an indicator of cumulative carbon emissions used in the solution adopted

All published studies to date conclude geosynthetic solutions are more sustainable based on embodied carbon



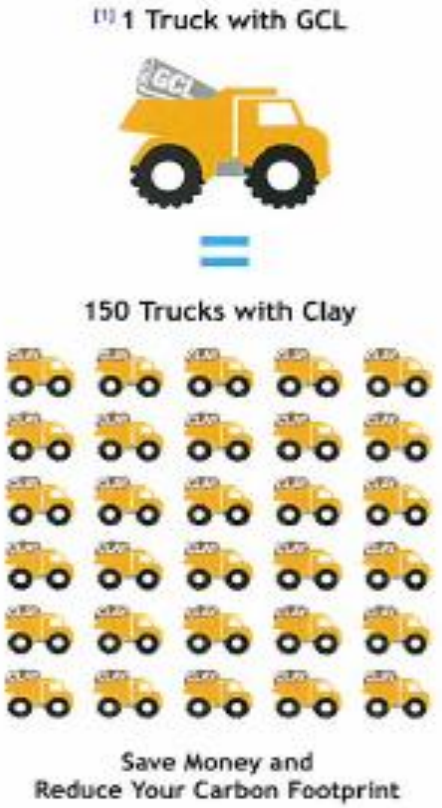
Reduction of the quantity or need for select soil material

The case of barrier materials used in landfills

Limit contaminant migration:

- Several types of lining systems
- Associated to drainage systems

The Honk Kong landfill, winner CFG photo contest 2015 (T. Gisbert)



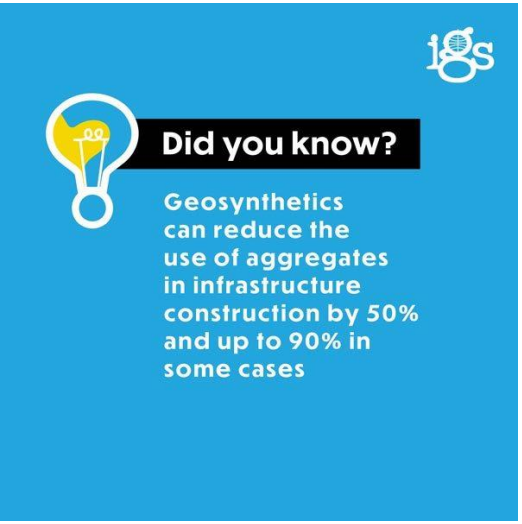
IGS leaflet: Geosynthetic barriers

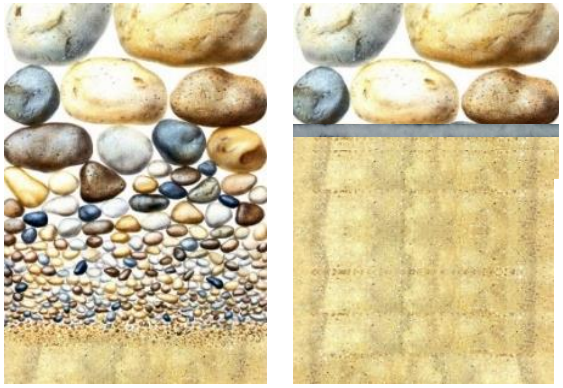
The case of geotextile filters in drainage applications

Geotexiles used to wrap an edge drain trench allow for a reduction of the size of the trench

- No granular filter around the open graded drainage aggregate required
- No need to use a well graded material to act as a filter and provide drainage

Cost savings arising from the reduction in volume of excavation and volume of filter material required (Christopher, 2014) and reduction in energy and resource consumption





Rock only vs rock and geosynthetic (courtesy D. Shercliff)

Courtesy Veylon

Less long-term maintenance associated with significant contribution to the lifespan

Geosynthetics are designed for long-term use

Geomembranes in Dam Construction

Concrete Dam Leaking!

Lining a Concrete Dam

Lined Earth Fill Dam: Before Rip-Rap

Courtesy: Geosynthetic Institute (GSI)

Completed Concrete Dam Lining

IGS University Online Lecture Series

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From the IGS digital library

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Durability of exposed geomembranes

Linked to the safety, can facilitate avoiding economic and human damages

Cignana dam
(Courtesy D. Cazzuffi)

In dams, the service life of PVC-P composite geomembranes exceeds 50 years

Camposecco dam (Courtesy D. Cazzuffi)

Durability of exposed geomembranes

HDPE geomembrane, La Mericana reservoir (courtesy M. Blanco)

EPDM geomembrane, Torrealta-1 reservoir (courtesy M. Blanco)

- Good behavior of exposed HDPE, PVC-P, EPDM geomembranes in climatic conditions representative of the Canary Islands 20 to 30 years after installation
- Good behaviour of exposed elastomeric bituminous geomembranes and covered oxidized bituminous 30 years after installation

Societal benefits

Mitigation of natural disasters

Protection against water gains importance as population density increases in parallel to climate change

Reinforcing coastal defence: geotextile units provide a safe, injury-free environment and attract an abundance of marine plants and life

Coastal protection, Cancun, Mexico, IGS photo contest 2010 (S. Lothspeich)

Sei Samboja Groin, East Kalimantan IGS photo contest 2014 (H. Sumantri)

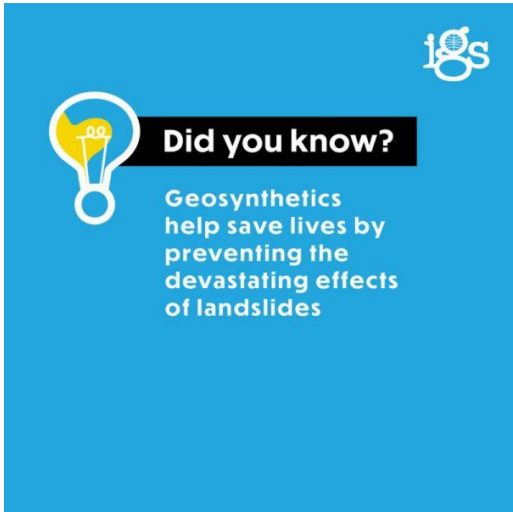
Landslide prevention and soil reinforcement

Landslide control: improve drainage conditions, grow more vegetation, provide proper retaining structures

Landlslide prevention by using Geosynthetics for erosion control, French Chapter photo contest 2017 (S. Pavlesk)

Large reinforced soil just completed, IGS photo contest 2010 (P. Assinder)

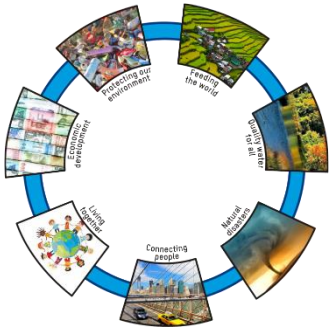
The IGS has engaged in the 2020 Kyoto commitment for global promotion of understanding and reducing landslide disaster risk



Economic growth and welfare is enabled

Positive impact on climate change and use of resources

Use of geosynthetics

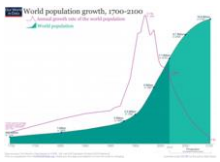


Financial benefits

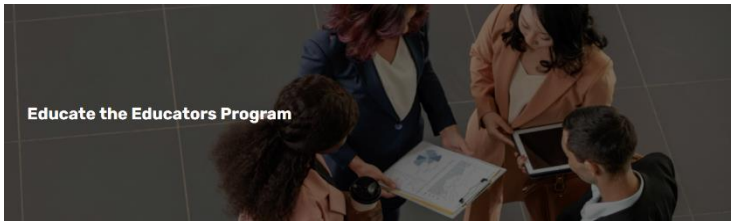
More money available

Infrastructure, Healthcare, education

Healthier better educated and efficient people



Reduction in population (Norberg, 2017)



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The geosynthetics contribution to the Circular Economy

What is the link between the SDGs and the Circular Economy?

The Circular Economy = tool which presents solution to some of the world's most pressing cross-cutting sustainable development challenges.

By addressing root causes, the concept of a circular economy provides much promise to accelerate implementation of the 2030 Agenda (The Netherlands Entreprise Agency, 2020).

An economy in which :
- waste and pollution do not exist by design,
- products and materials are kept in use,
- natural systems are regenerated.

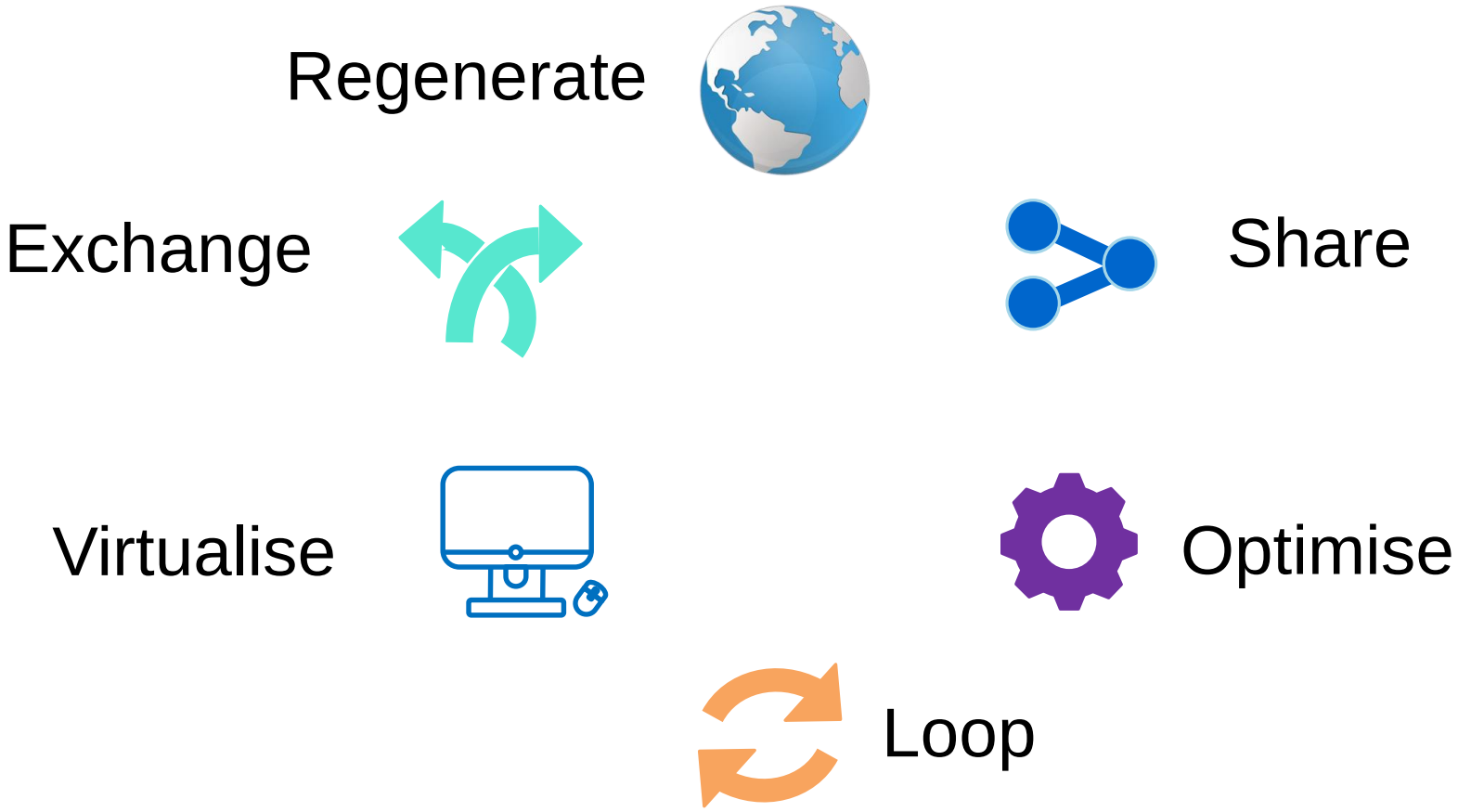
Instead of destroying value after the use phase, value is retained through cycles of reusing, repairing, remanufacturing or recycling.

What is the IGS contribution to the circular economy?

https://hub.beesmart.city/hubfs/blogposts/circular-economy/circular-economy-unido-blog.jpg

The ReSOLVE framework

the ReSOLVE framework takes the core principles of circularity and applies them to six actions: Regenerate, Share, Optimise, Loop, Virtualise, and Exchange that represent a major circular business opportunity



Regenerate

Shift to renewable energy and materials; reclaim, retain, and regenerate health of ecosystems; return recovered biological resources to the biosphere

- Reduction of the impact on ecosystems compared to other techniques like the use of concrete
- Used in remediation of polluted sites and prevents additional pollution
- Soil decontamination or dewatering of fluid fine tailings with electrokinetic geosynthetics
- Potential of CO_2 emission is returned to the soil

Bourrassin et al. 1999

Share

Keep product loop speed low and maximise utilisation of products by sharing them among users, reusing them throughout their technical lifetime, and prolonging their life through maintenance, repair, and design for durability,

Publino dam rehabilitation
(courtesy D. Cazzuffi)

Geosynthetics (original design rehabilitation of works) allow maintenance, repair, and as they are designed for durability, prolonge lifetime.

Optimise

Increase performance/efficiency of a product; remove waste in production and the supply chain (from sourcing and logistics to production, use, and end-of-use collection); leverage big data, automation, remote sensing, and steering

https://www.geosyntheticssociety.org/spotlight-on-sustainable-initiatives-in-geosynthetics/

- Optimisation process ensured in the production chain of geosynthetics: reuse the heat produced along the manufacturing chain, recycling and reusing water wherever possible.
- Possible collection of gosynthetics at the end-of-use and recycling (economic and ecological costs to evaluate first)

Loop

Keep components and materials in closed loops and prioritise inner loops. For finite materials, this means remanufacturing products or components and as a last resort recycling materials

- Take back programs for packaging, overwraps, slings and other materials supplied with the geosynthetic materials for identification and transport (Ramsey, 2022)
- More use of recycled materials for the production of geosynthetics is possible, to be promoted if and when it is appropriate and useful to our environmental goals (Fontana, 2022)
- Collection of plastic bottles from which some geosynthetics are manufactured creates a significant number of income-generating opportunities for the people involved.

Virtualize

Deliver utility virtually

INTERNATIONAL GEOSYNTHETICS SOCIETY Digital Library

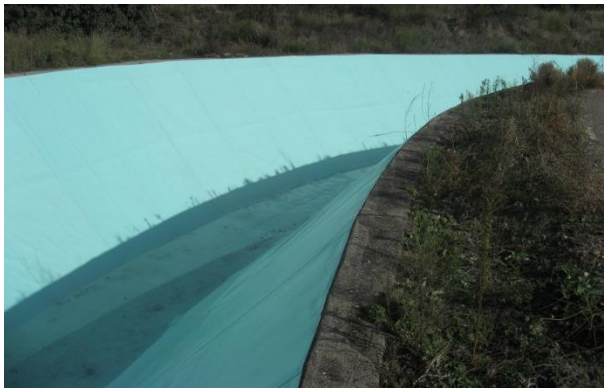
The library resources include:

- Educational leaflets
- Chapter lectures and webinars
- Journals
- Procedures
- Manuals and reports
- PhD dissertations
- Videos
- An image gallery

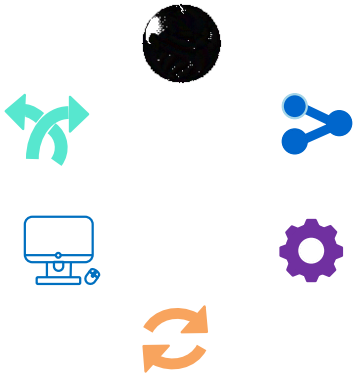
Exchange

Replace old materials with advanced materials; apply new technologies

Geosynthetics have, by definition, and taking into account of the various advantages they offer compared to older technologies, the potential to be the Exchange resource to replace for example concrete in various applications allowing significant cost savings and environmental benefits



Summary



- Geosynthetics make significant contributions to the 17 SDGs of the United Nations by their use in applications that serve in food production, environmental protection, infrastructure, mitigation of natural disasters, etc
- Geosynthetics solutions also contribute to make significant economic savings thus impact positively the economic growth and the reduction of inequalities
- Geosynthetic solutions minimize resource and energy consumption and emissions, in relation with their unequalled performance whether intrinsec to the products or to the transportation and installation processes
- Many initiatives exist along the manufacturing-design-installation chain that bring significant contribution of geosynthetics to the Circular Economy

Thank you for your attention

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