International Symposium on Geosynthetics and Sustainability
Environmental, Civil and Hydraulic Engineering

NGO IGS Netherlands

Sustainable use of geosynthetics in landfill and hydraulic applications world-wide

Boyd Ramsey

Boyd Ramsey Consulting LLC

Caveat and bona fides

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- **Caveats**
  - This presentation is my opinion and my opinion solely. It has not been sanctioned or approved by the IGS and/or the IGS Sustainability committee.
- **Sustainability bona fides**
- I am part of the population/community that has, and is, actively destroying our planet. Worst. Generation. Ever.
- I have chaired the IGS Sustainability committee.
- I am attempting to improve my personal sustainability contributions and performance and I have done the reading and the math.

Tell'em what your going to tell them….

- My concept of sustainability and more importantly, where I got most of my information/opinions.
- Many examples of geosynthetics making sustainability contributions to our planet.
- How sustainability contributions are being measured.
- What I suggest you do to make the world a better place.

Quran 96:5 (English translation)

He (Allah) made him possessor of knowledge which is the noblest attribute of creation, and He made him not only possessor of knowledge but also taught him the art of writing by the use of pen, which became the means of propagation, progress, dissemination and preservation of knowledge on a large scale.

"The test of a first-rate intelligence is the ability to hold two opposed ideas in mind at the same time and still retain the ability to function."

F. Scott Fitzgerald

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He (Allah) made him possessor of knowledge which is the noblest attribute of creation, and He made him not only possessor of knowledge but also taught him the art of writing by the use of pen, which became the means of propagation, progress, dissemination and preservation of knowledge on a large scale. Quran 96:5 (English translation)

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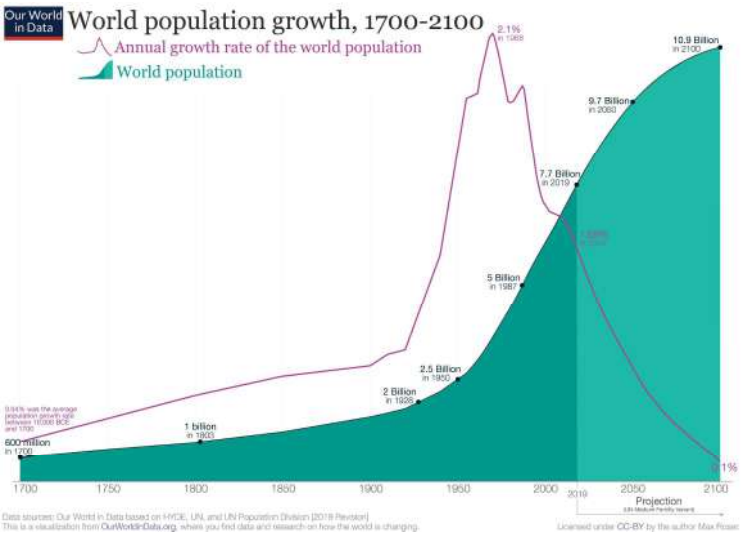
Earth's resources relative to the population



By Max Roser - https://ourworldindata.org/world-population-growth, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=87369360

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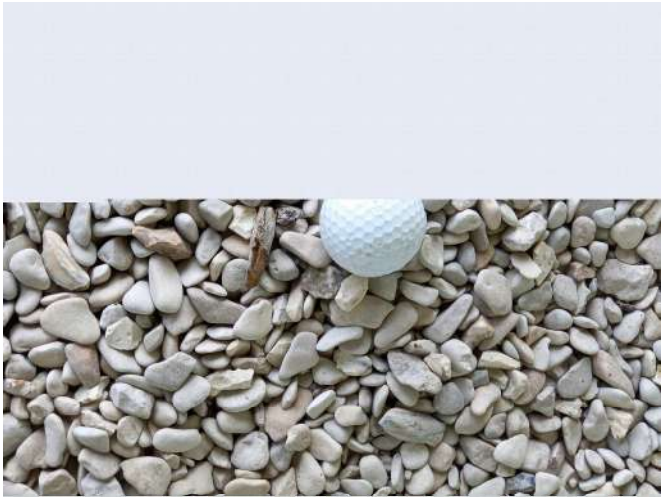
Rounded river rock



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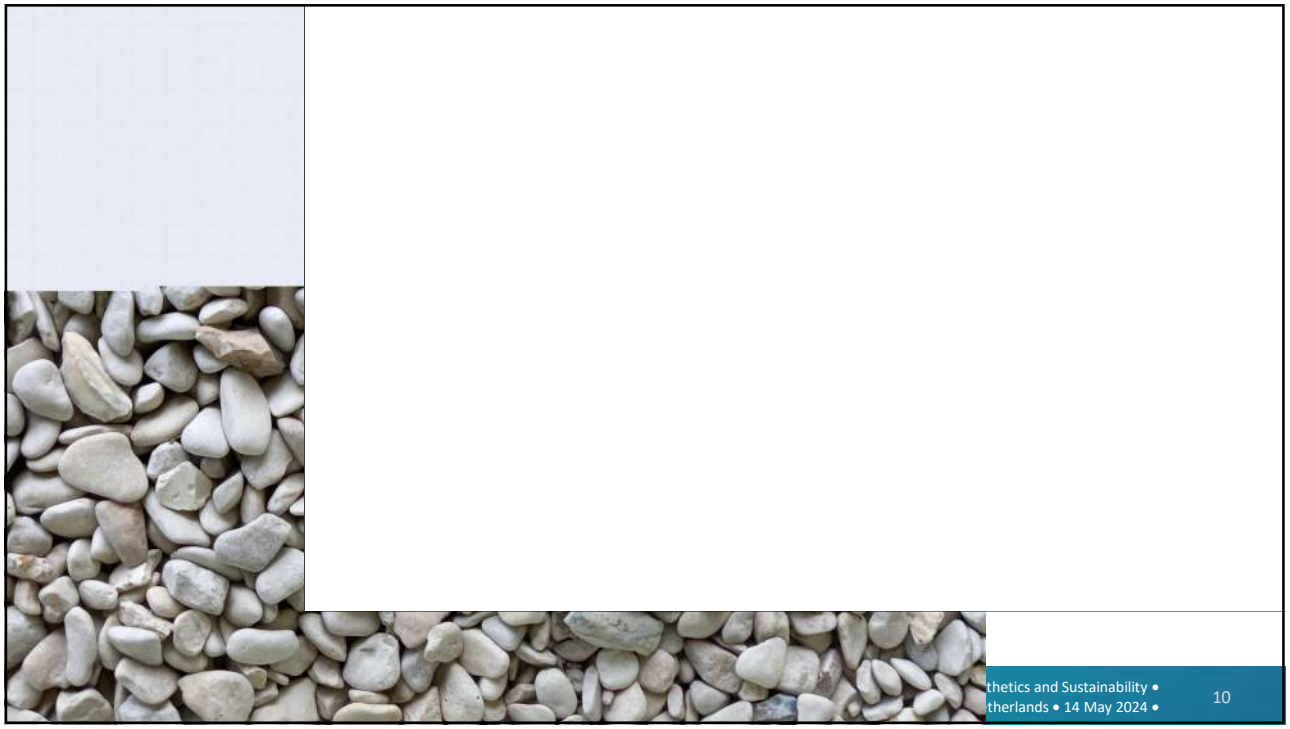

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12

He (Allah) made him possessor of knowledge…

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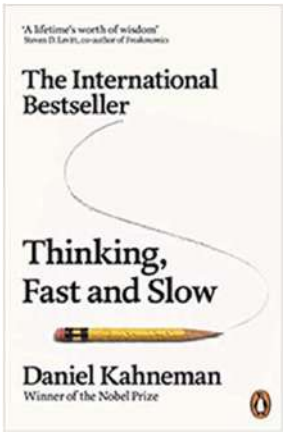

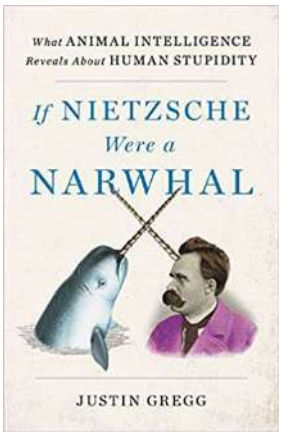

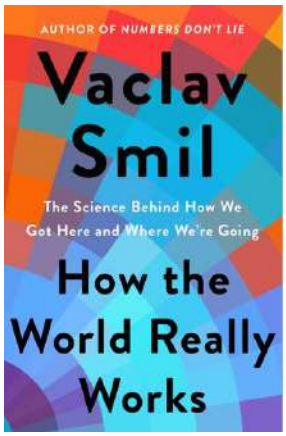

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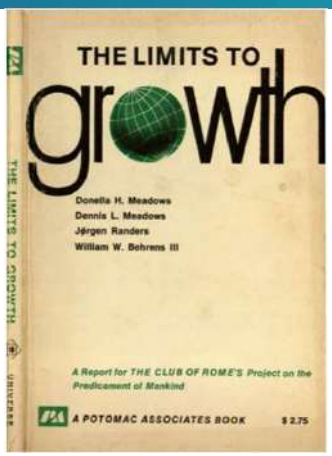

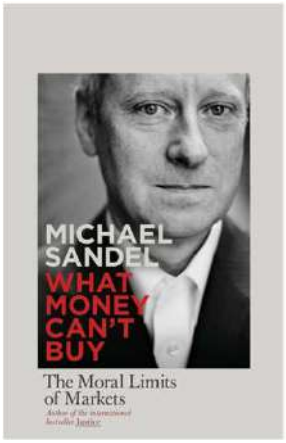

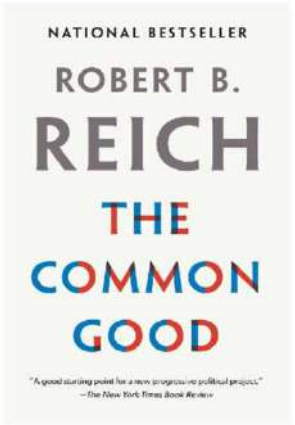

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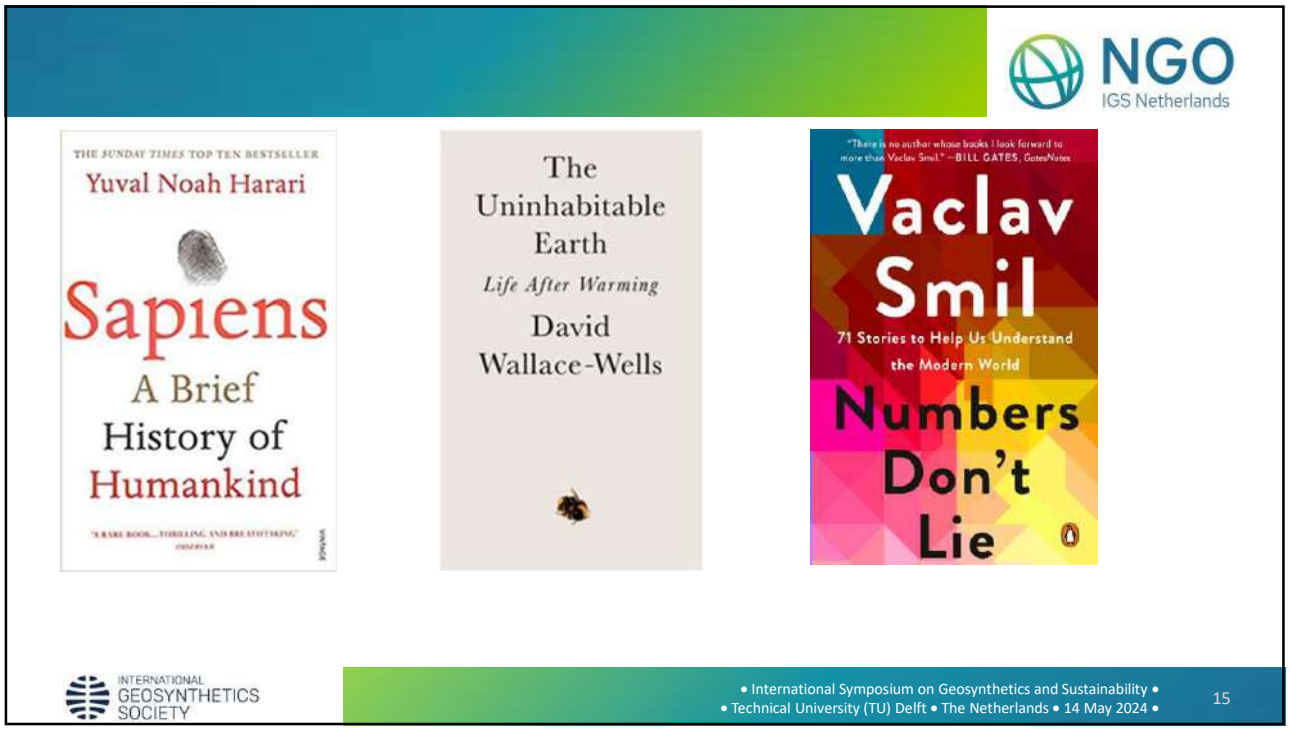

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- Water storage industrial
- Municipal solid waste
- Hazardous waste
- Potable water
- Irrigation and drainage
- Water storage / canal
- Pumped storage / electricity
- Dams and reservoirs
- Mining – solids/ore
- Mining - liquids / Lithium salts
- Coastal protection
- Erosion control
- Dredging/dewatering
- Landfill drainage

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Water storage industrial (layers)

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Reservoir: Potable water

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Potable water – floating cover

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Water storage industrial/power

Figure 2 from Eichelberger – Palo Verde Electrical Generating Station near Phoenix AZ. (For scale the three blue rectangular buildings are nuclear reactors.) All ponds pictured were lined with white materials totaling appx. 310 acres/1.25 square km.

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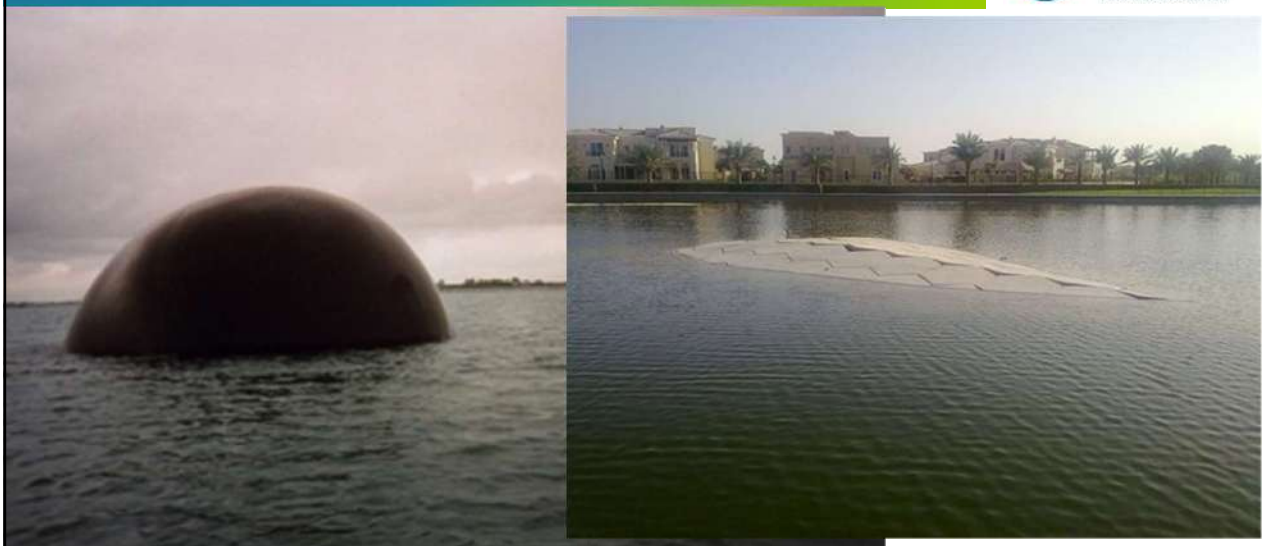
Venting of trapped gases - whales



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District Heating (Thermal storage)

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Pumped water storage (Electricity)

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Mining - liquids / Lithium salts

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Zoom of Mining - liquids / Lithium salts

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Landfill – someplace to put the garbage/waste

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MSW storage / landfill

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Canyon Landfill

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Hazardous waste landfill storage – night installation

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Mining – solid ore

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Dredging/dewatering

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Land creation

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Erosion control – drainage channels

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Erosion protection

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Coastal erosion protection (tides)

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Canals

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Canals

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Plastics in the ocean (improper disposal)

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Barrier integrity survey after soil placement (ELLS)

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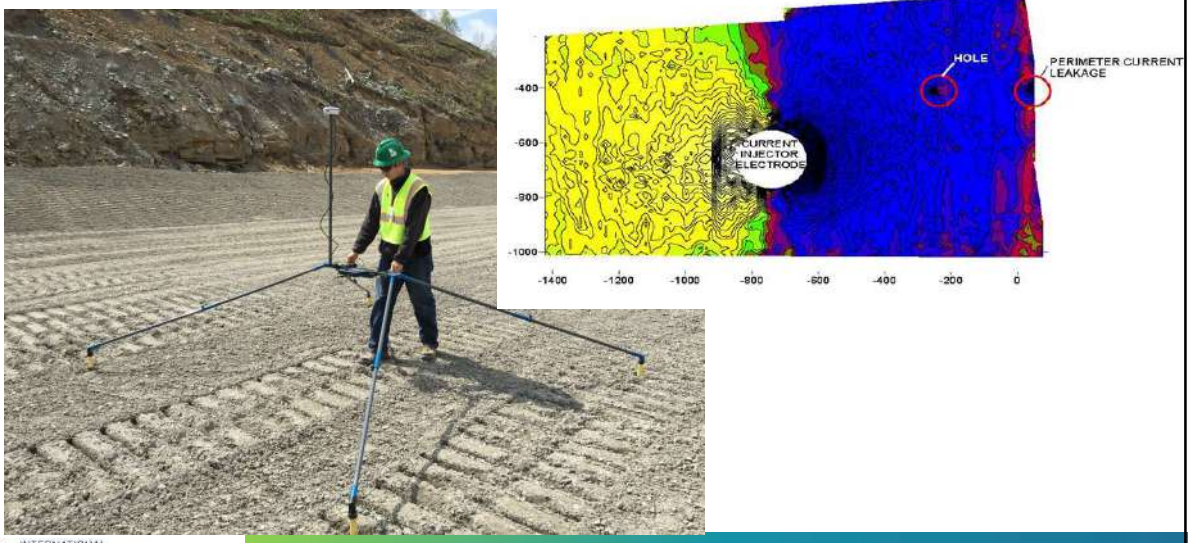

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Slides – interface friction failures

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Let's use our numbers, shall we?

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"*If you can't measure it, you can't manage it*." – Peter Drucker (1909-2005)

"*If you can't measure it, you can't improve it*." – Lord Kelvin (1824–1907)

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Advances in measurement

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Techniques and standardization (numbers!)

- ISO standards for evaluation and comparison of sustainability characteristics
- ISO 14001 to 14015 all relate to Environmental management systems (EMS), EMS performance evaluation is covered in ISO 14031.
- The ISO 14001-15 family provides guidelines on the implementation and incorporation of an EMS and how to assess physical sites and organizations.
- The ISO 14020 subfamily covers environmental labels and claims. ISO 14063 broadens the spectrum and provides guidelines and examples for environmental communication, internally and externally.
- ISO 14040 to 14049 outlines guidelines for life cycle assessment and goal setting.
- The ISO 14060 subfamily provides guidance for quantifying, reporting, and reducing greenhouse gas emissions as well as the processes around it

Environmental Product Declarations (EPDs)

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- Environmental Product Declarations (EPDs) are third-party verified product data sheets developed based on the requirements of ISO 14025, and are governed by Product Category Rules (PCRs)

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IGS actions

- Selection of OneClick LCA as initial platform
- Purchase of a multi-user license
- Engagement of teams from George Mason University (Washington D.C.) and Universitat Politècnica de Catalunya·BarcelonaTech (UPC) to prepare example templates
- Launch of a calculator at Rome ICG for any IGS member
- Promotion (such as this) and pending training as a component of the IGS Handbook

Geosynthetic benefits vs. traditional construction materials - Life cycle analysis using OneClick LCA

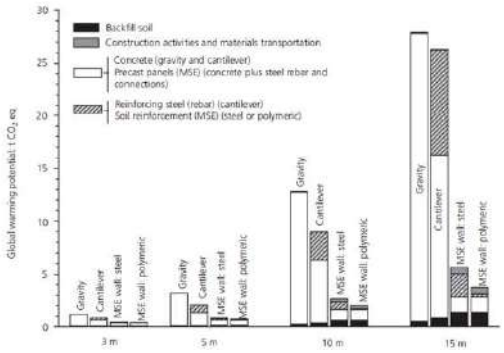
Cases 1 through 4

Aníbal Moncada, Ivan Puig Damians

Department of Civil and Environmental Engineering (DECA), Universitat Politècnica de Catalunya·BarcelonaTech (UPC)

Life cycle analysis

- Quantification and comparison of environmental impacts of comparable structures which serve a common purpose.
- Evidence the reduced impact of geosynthetic solutions. (Damians et al. 2017)
- Ample evidence in previous research for:
  - Retaining structures
  - Bridge abutments
  - Pavements
  - Landslide control
  - Many other geotechnical applications



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Standards and OneClick LCA - Stages

- A1: Raw material extraction
- A2: Transport to manufacturing site
- A3: Manufacturing

} Basic EDP information

- A4: Transport to construction site
- A5: Installation / Assembly

} Based on design requirements

- B1-B5: Use stages ➡ Not relevant for geotechnical structures, only repair stage (B3) could apply
- C1-C4: End of life stages ➡ Includes various types of reuse, recycle, and disposal

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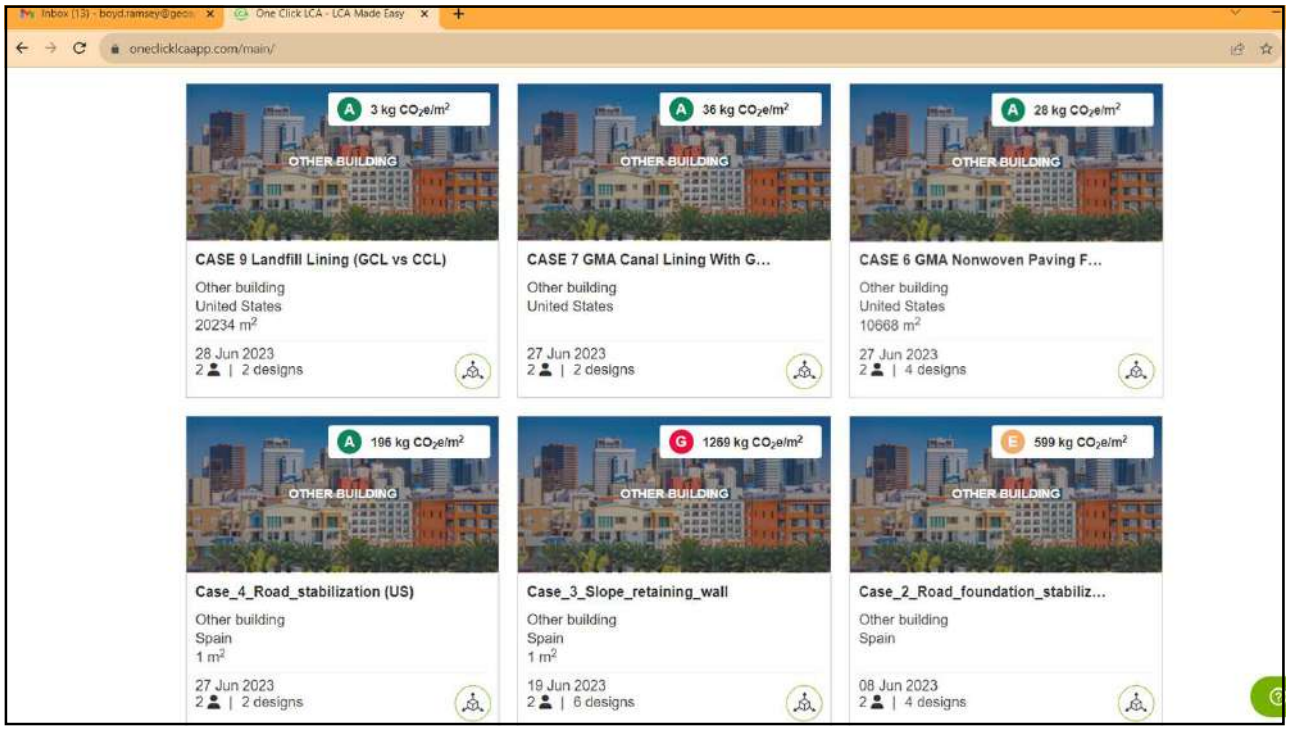
OneClick LCA

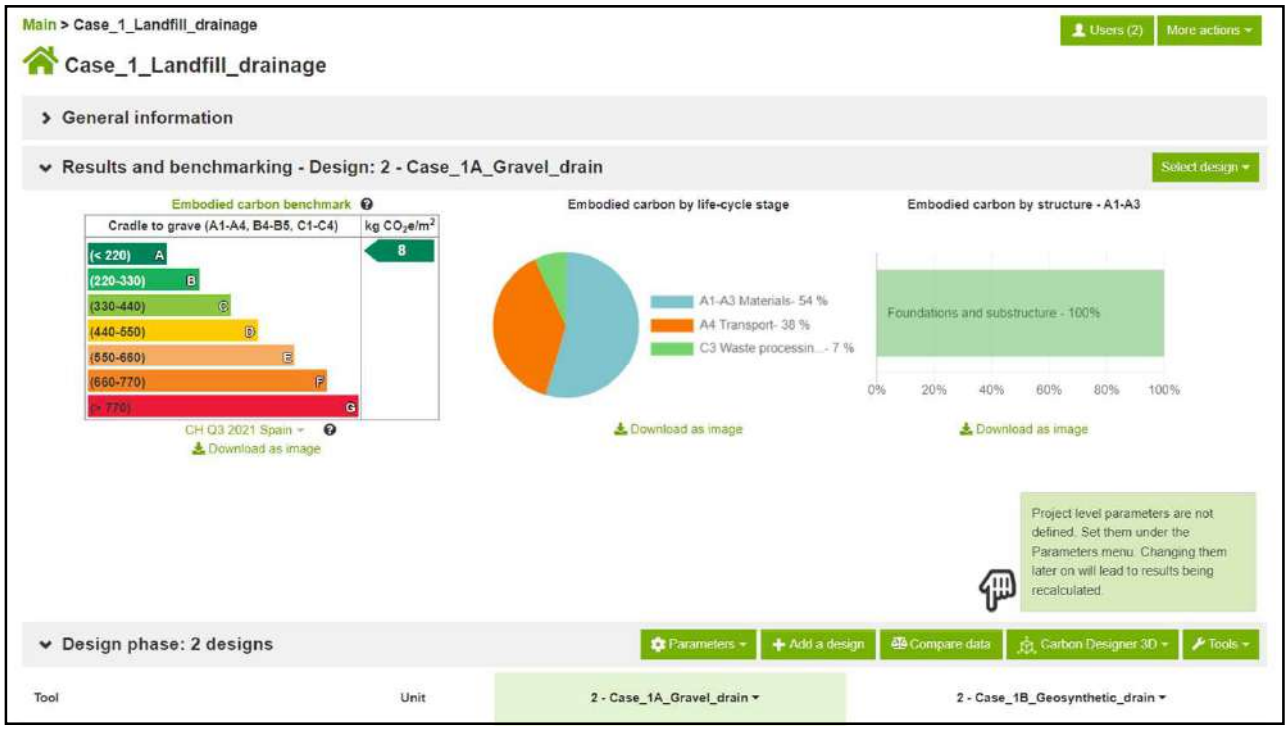
- Focused on building and infrastructure
- Assessments according to EN 15978
- Can use CML and/or TRACI
- Kg CO_2e ➡ Analyses were carried out using the "Life Cycle Carbon – Global" tool
- Compensation to local conditions ➡ Can recalculate impacts to a specific location using local energy matrix
- Wide array of EDPs (average, generic, and manufacturer specific)
- Intuitive interface

- **OneClickLCA**
- Materials
- Shipment modes distance segment
- Waste percentage
- Service life
- Repair and maintenance activity
- End of use disposal
- Multiple cases for comparison

- **EPD**
- Material used by type and emission classification data
- Packaging used, data for unit shipments – truck, container etc.
- Utilities used to make – electric, gas, etc, – plant operations
- Maintenance requirements, waste disposal data, fate of waste and end-of-life


oneclicklcaapp.com/main/
A 3 kg CO2e/m2
OTHER BUILDING
CASE 9 Landfill Lining (GCL vs CCL)
Other building
United States
20234 m2
28 Jun 2023
2 | 2 designs
A 36 kg CO2e/m2
OTHER BUILDING
CASE 7 GMA Canal Lining With G...
Other building
United States
27 Jun 2023
2 | 2 designs
A 28 kg CO2e/m2
OTHER BUILDING
CASE 6 GMA Nonwoven Paving F...
Other building
United States
10668 m2
27 Jun 2023
2 | 4 designs
A 196 kg CO2e/m2
OTHER BUILDING
Case_4_Road_stabilization (US)
Other building
Spain
1 m2
27 Jun 2023
2 | 2 designs
G 1269 kg CO2e/m2
OTHER BUILDING
Case_3_Slope_retaining_wall
Other building
Spain
1 m2
19 Jun 2023
2 | 6 designs
E 599 kg CO2e/m2
OTHER BUILDING
Case_2_Road_foundation_stabiliz...
Other building
Spain
08 Jun 2023
2 | 4 designs

53


Main > Case_1_Landfill_drainage
Users (2)
More actions
Case_1_Landfill_drainage
General information
Results and benchmarking - Design: 2 - Case_1A_Gravel_drain
Select design
Embodied carbon benchmark
Cradle to grave (A1-A4, B4-B5, C1-C4)
kg CO2e/m2
8
(< 220) A
(220-330) B
(330-440) C
(440-550) D
(550-660) E
(660-770) F
(> 770) G
CH Q3 2021 Spain
Download as image
Embodied carbon by life-cycle stage
A1-A3 Materials- 54 %
A4 Transport- 38 %
C3 Waste processin... - 7 %
Download as image
Embodied carbon by structure - A1-A3
Foundations and substructure - 100%
0%
20%
40%
60%
80%
100%
Download as image
Project level parameters are not defined. Set them under the Parameters menu. Changing them later on will lead to results being recalculated.
Design phase: 2 designs
Parameters
Add a design
Compare data
Carbon Designer 3D
Tools
Tool
Unit
2 - Case_1A_Gravel_drain
2 - Case_1B_Geosynthetic_drain

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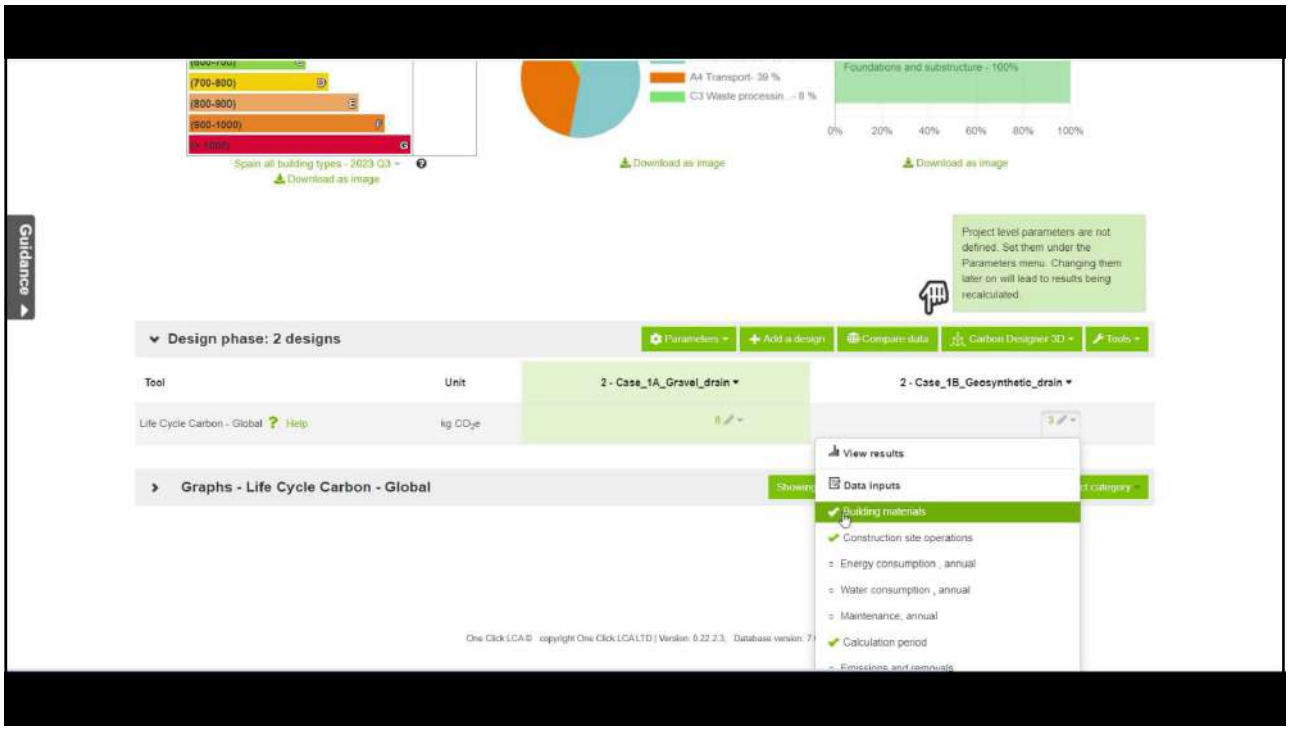
Guidance
Design phase: 2 designs
Parameters
Add a design
Compare data
Carbon Designer 3D
Tools
Tool
Unit
2 - Case_1A_Gravel_drain
2 - Case_1B_Geosynthetic_drain
Life Cycle Carbon - Global
Help
kg CO2e
Graphs - Life Cycle Carbon - Global
View results
Data inputs
Building materials
Construction site operations
Energy consumption , annual
Water consumption , annual
Maintenance, annual
Calculation period
Project level parameters are not defined. Set them under the Parameters menu. Changing them later on will lead to results being recalculated.
A4 Transport- 39 %
C3 Waste processin... - 8 %
Foundations and substructure - 100%
Download as image

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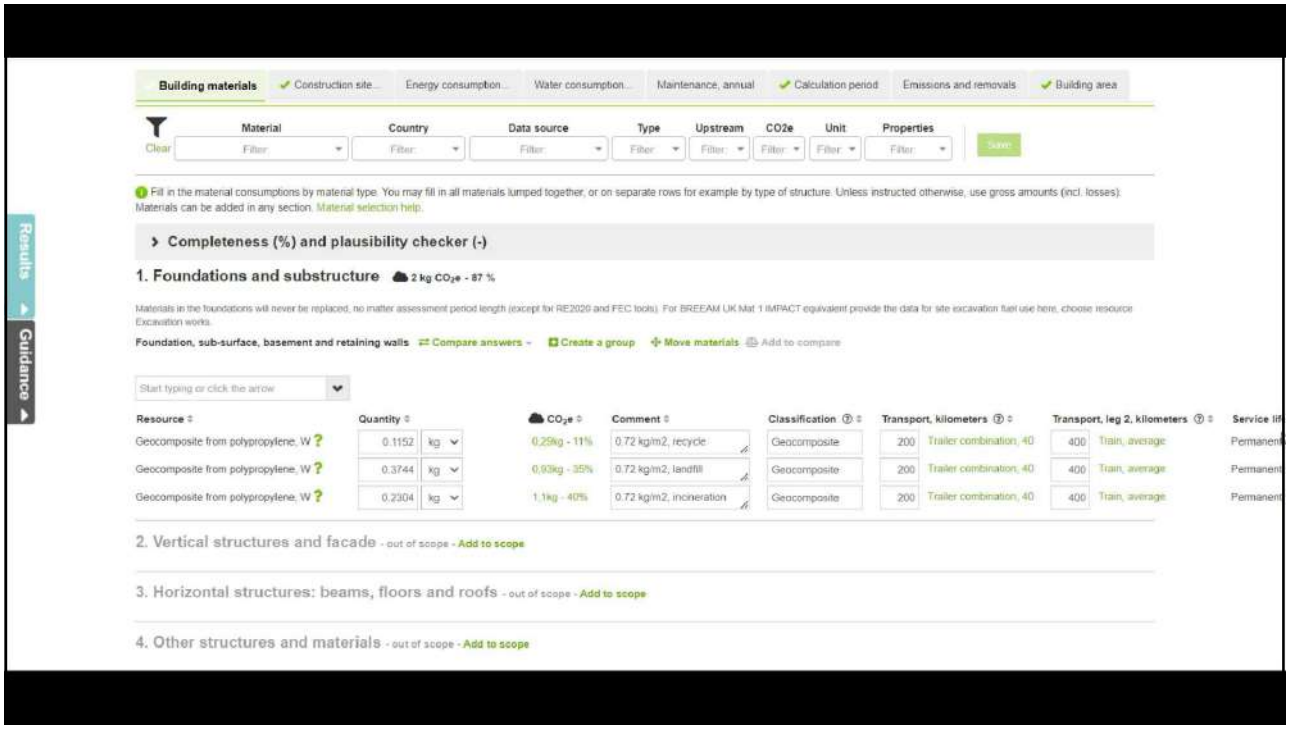
Results
Guidance
Building materials
Construction site...
Energy consumption...
Water consumption...
Maintenance, annual
Calculation period
Emissions and removals
Building area
Material
Country
Data source
Type
Upstream
CO2e
Unit
Properties
Clear
Save
Fill in the material consumptions by material type. You may fill in all materials lumped together, or on separate rows for example by type of structure. Unless instructed otherwise, use gross amounts (incl. losses). Materials can be added in any section. Material selection help.
Completeness (%) and plausibility checker (-)
1. Foundations and substructure
2 kg CO2e - 87 %
Foundation, sub-surface, basement and retaining walls
Compare answers
Create a group
Move materials
Add to compare
Resource
Quantity
Comment
Classification
Transport, kilometers
Transport, leg 2, kilometers
Geocomposite from polypropylene, W
0.1152
kg
0.25kg - 11%
0.72 kg/m2, recycle
Geocomposite
200
Trailer combination, 40
400
Train, average
Permanent
0.3744
0.93kg - 35%
0.72 kg/m2, landfill
0.2304
1.1kg - 40%
0.72 kg/m2, incineration
2. Vertical structures and facade - out of scope - Add to scope
3. Horizontal structures: beams, floors and roofs - out of scope - Add to scope
4. Other structures and materials - out of scope - Add to scope

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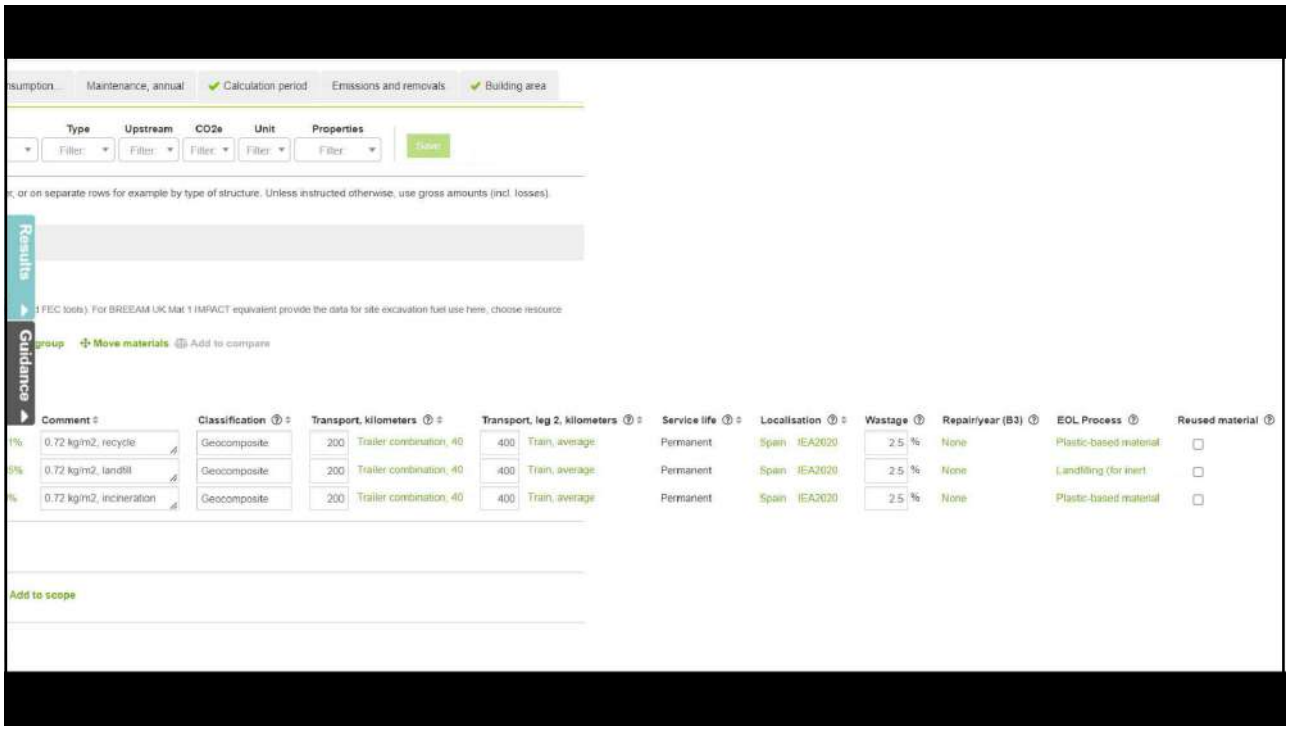
Maintenance, annual
Calculation period
Emissions and removals
Building area
Type
Upstream
CO2e
Unit
Properties
Results
Guidance
Move materials
Add to compare
Comment
Classification
Transport, kilometers
Transport, leg 2, kilometers
Service life
Localisation
Wastage
Repairlyear (B3)
EOL Process
Reused material
0.72 kg/m2, recycle
0.72 kg/m2, landfill
0.72 kg/m2, incineration
Geocomposite
Trailer combination, 40
Train, average
Permanent
Spain IEA2020
None
Plastic-based material
Landfilling (for inert
Add to scope

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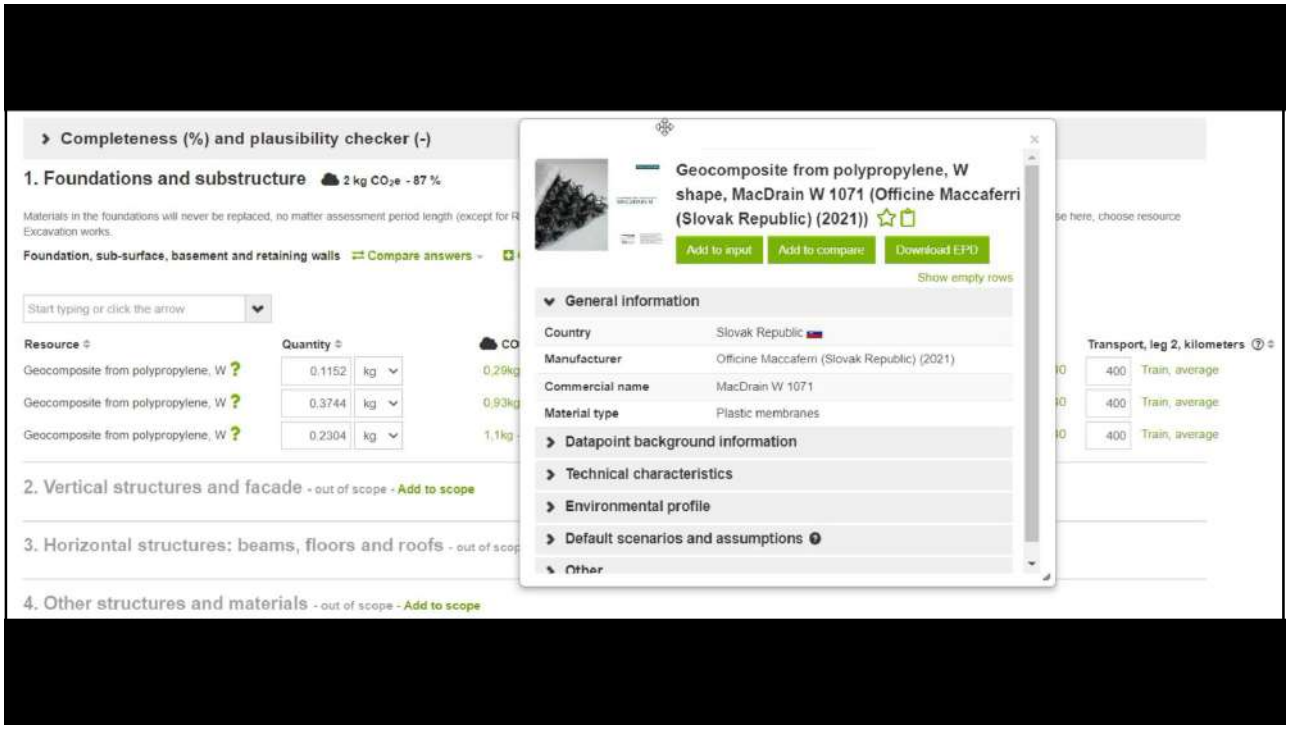
Completeness (%) and plausibility checker (-)
1. Foundations and substructure
2 kg CO2e - 87 %
Foundation, sub-surface, basement and retaining walls
Compare answers
Start typing or click the arrow
Resource
Quantity
Geocomposite from polypropylene, W
0.1152
0.3744
0.2304
kg
Transport, leg 2, kilometers
400
Train, average
2. Vertical structures and facade - out of scope - Add to scope
3. Horizontal structures: beams, floors and roofs - out of scop
4. Other structures and materials - out of scope - Add to scope
Geocomposite from polypropylene, W shape, MacDrain W 1071 (Officine Maccaferri (Slovak Republic) (2021))
Add to input
Add to compare
Download EPD
Show empty rows
General information
Country
Slovak Republic
Manufacturer
Officine Maccaferri (Slovak Republic) (2021)
Commercial name
MacDrain W 1071
Material type
Plastic membranes
Datapoint background information
Technical characteristics
Environmental profile
Default scenarios and assumptions
Other

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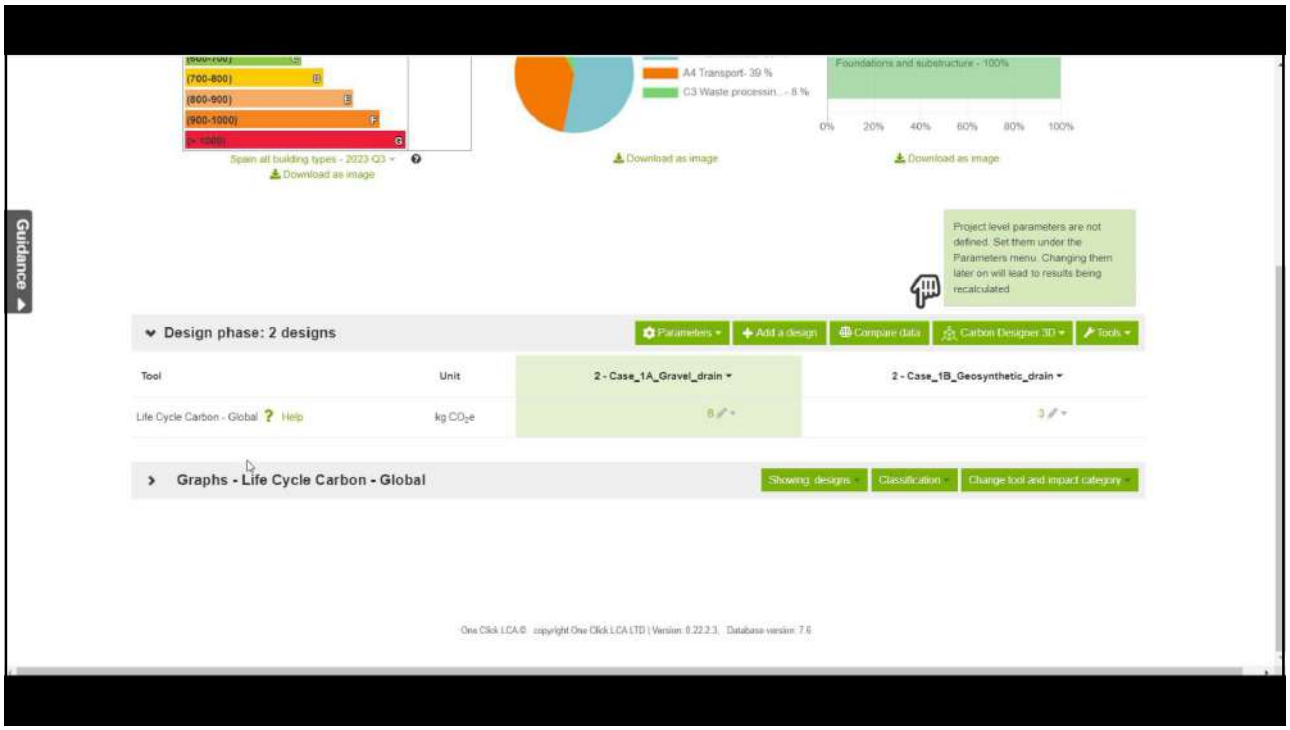
(700-800)
(800-900)
(900-1000)
Spain all building types - 2023 Q3
Download as image
A4 Transport- 39 %
C3 Waste processin... - 8 %
Download as image
Foundations and substructure - 100%
0%
20%
40%
60%
80%
100%
Download as image
Guidance
Project level parameters are not defined. Set them under the Parameters menu. Changing them later on will lead to results being recalculated
Design phase: 2 designs
Parameters
Add a design
Compare data
Carbon Designer 3D
Tools
Tool
Unit
2 - Case_1A_Gravel_drain
2 - Case_1B_Geosynthetic_drain
Life Cycle Carbon - Global
Help
kg CO2e
Graphs - Life Cycle Carbon - Global
Showing designs
Classification
Change tool and impact category
One Click LCA © copyright One Click LCA LTD | Version: 0.22.2.3, Database version: 7.6

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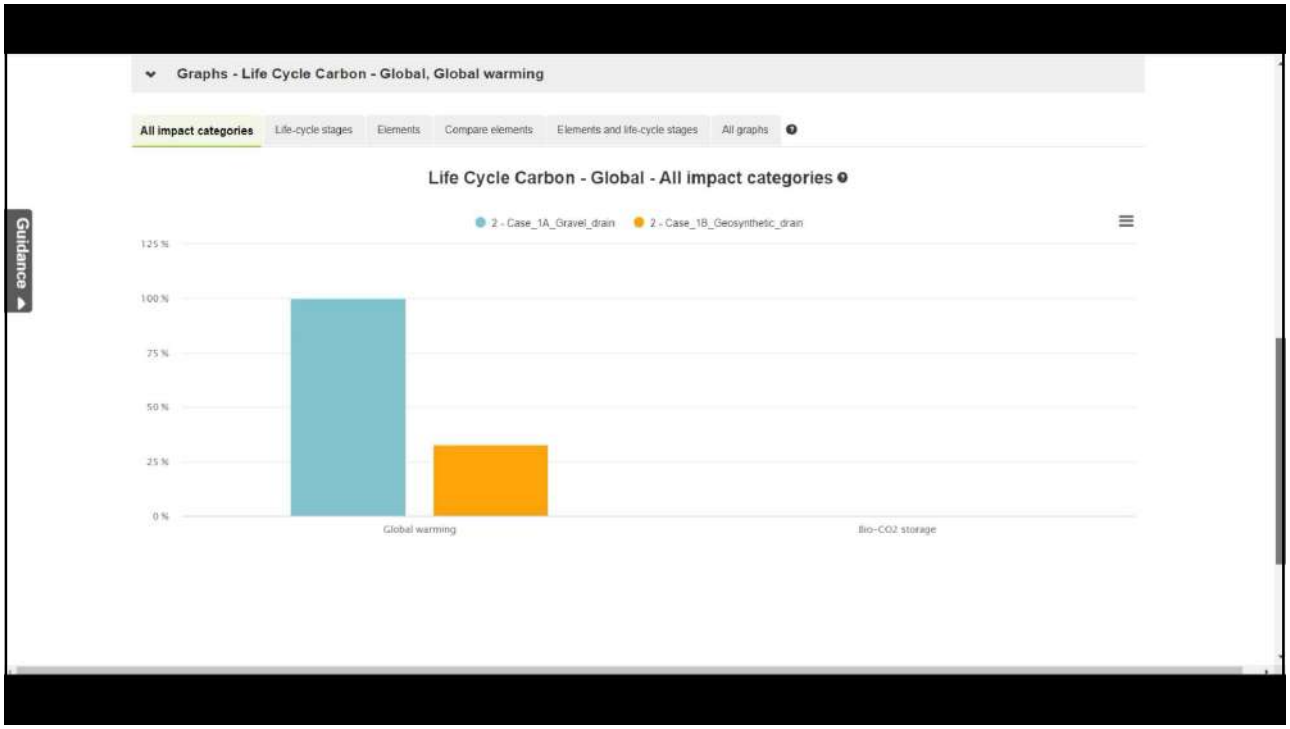
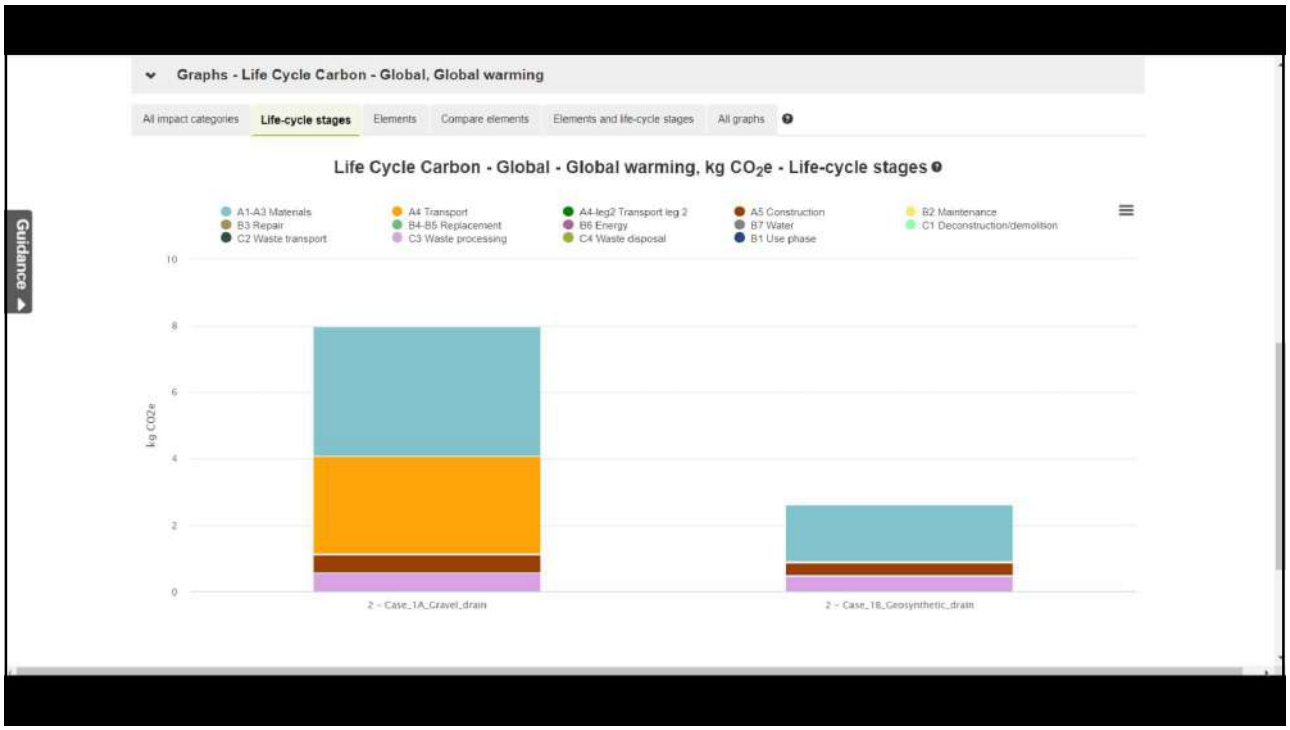

Graphs - Life Cycle Carbon - Global, Global warming
All impact categories
Life-cycle stages
Elements
Compare elements
Elements and life-cycle stages
All graphs
Life Cycle Carbon - Global - All impact categories
2 - Case_1A_Gravel_drain
2 - Case_1B_Geosynthetic_drain
Guidance
125 %
100 %
75 %
50 %
25 %
0 %
Global warming
Bio-CO2 storage

60


Graphs - Life Cycle Carbon - Global, Global warming
All impact categories
Life-cycle stages
Elements
Compare elements
Elements and life-cycle stages
All graphs
Life Cycle Carbon - Global - Global warming, kg CO2e - Life-cycle stages
A1-A3 Materials
A4 Transport
A4-leg2 Transport leg 2
A5 Construction
B2 Maintenance
B3 Repair
B4-B5 Replacement
B6 Energy
B7 Water
C1 Deconstruction/demolition
C2 Waste transport
C3 Waste processing
C4 Waste disposal
B1 Use phase
Guidance
kg CO2e
2 - Case_1A_Gravel_drain
2 - Case_1B_Geosynthetic_drain

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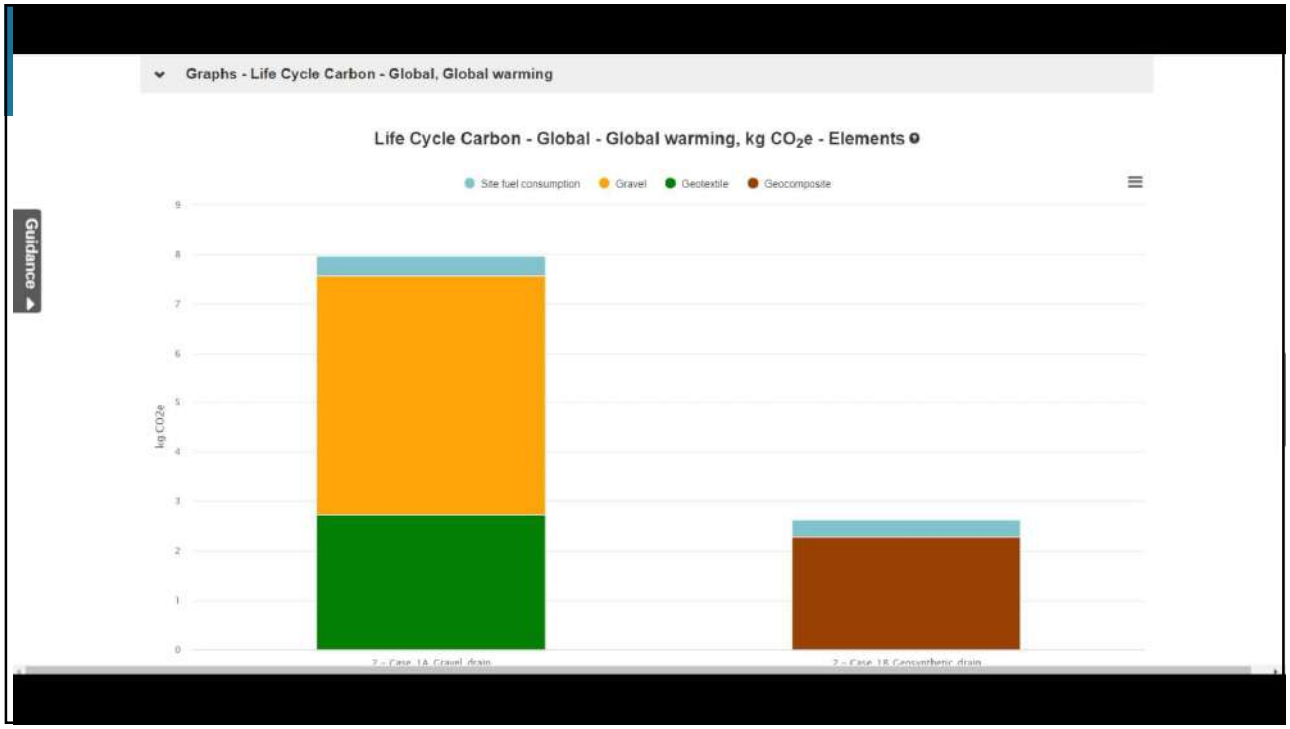
Graphs - Life Cycle Carbon - Global, Global warming
Life Cycle Carbon - Global - Global warming, kg CO2e - Elements
Site fuel consumption
Gravel
Geotextile
Geocomposite
Guidance
kg CO2e

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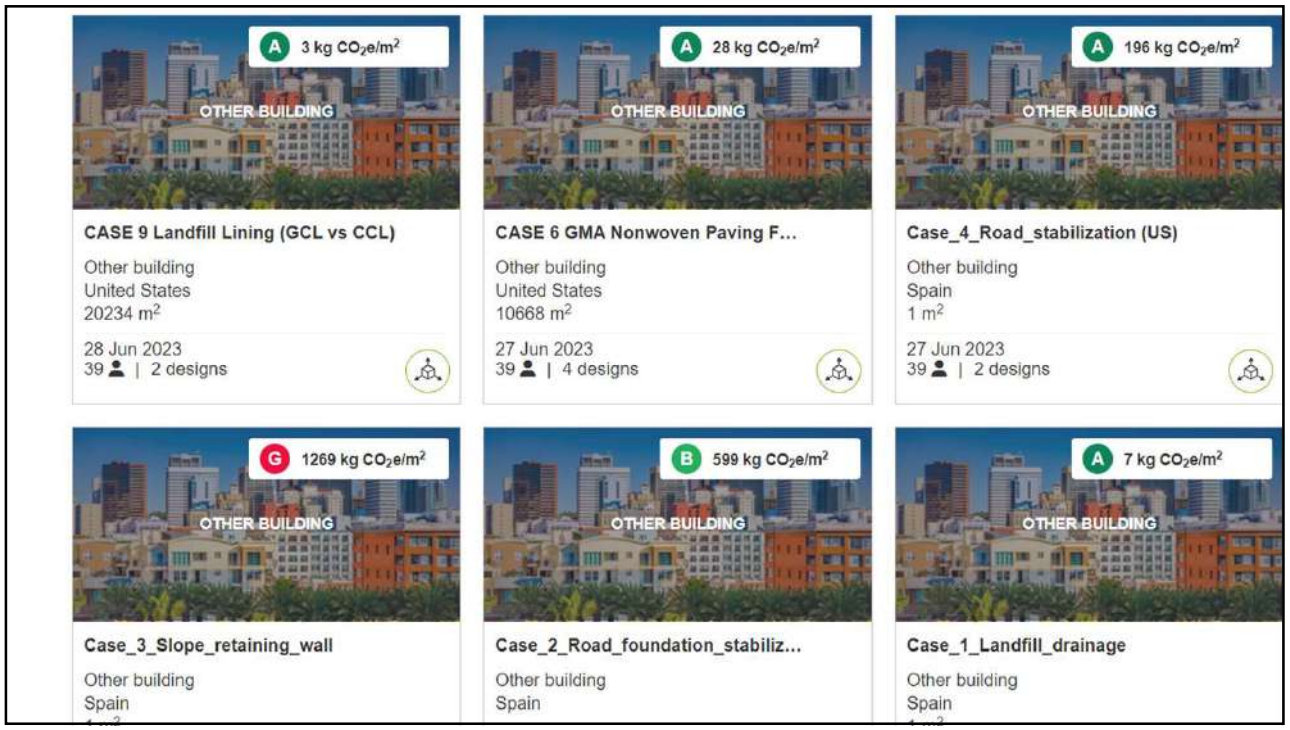

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The IGS Sustainability Calculator is available free of charge to IGS members.

Several templates are available demonstrating geosynthetic benefits as compared to older designs.

The system operates within OneClickLCA and user training is necessary and available.

This provides a measurement of geosynthetic benefits using current best practices and standards.

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So what do I want you to do?

Think

Read

Act

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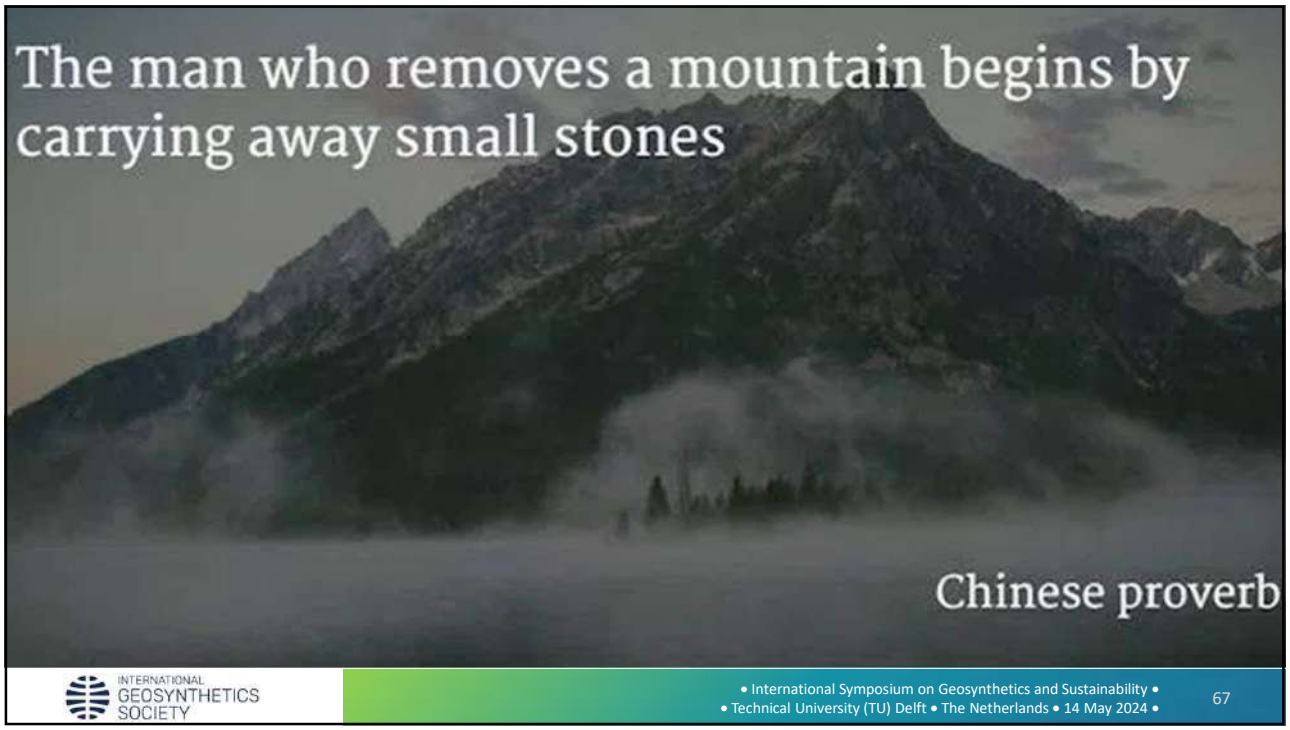

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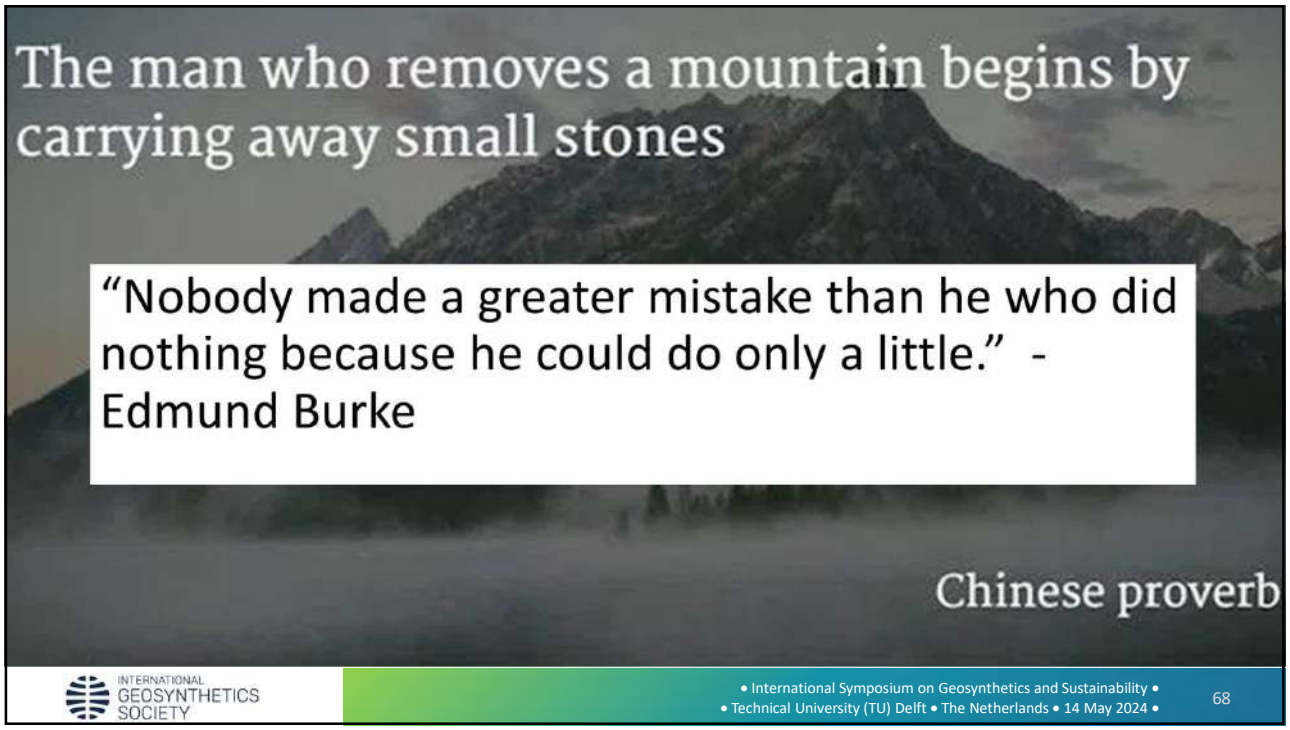

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What can you do?

- Make wise and informed individual consumer choices (transport, packaging, eliminate single use items)
- Use more public transport and less automobiles (don't fly)
- Recycle, recycle everything you can possibly recycle
- Think before breeding children, and not more than two!
- Engineer and design with sustainability in the forefront of decision making and measure it.
- Give economic factors proper consideration in design and decisions

Acknowledgments and photo credits

- Wikipedia
- The International Geosynthetics Society
- The International Geosynthetics Society ACIGS chapter
- The International Geosynthetics Society Young Members
- Solmax, Our World in Data, NASA, TRI Environmental
- Chris Eichelberger, J.P. Giroud, Ian Peggs, Francesco Fontana, Tim Rafter. Mark Harris

Don’t thank me….change your actions

NGO IGS Netherlands

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