Tom Sangster B. Sc., C.Eng., M.I.C.E.

Downley Consultants Ltd

UK & Switzerland

tom.sangster@downley.com

DOWNLEY CONSULTANTS

Impacts, Adaptation & Vulnerability

COP26

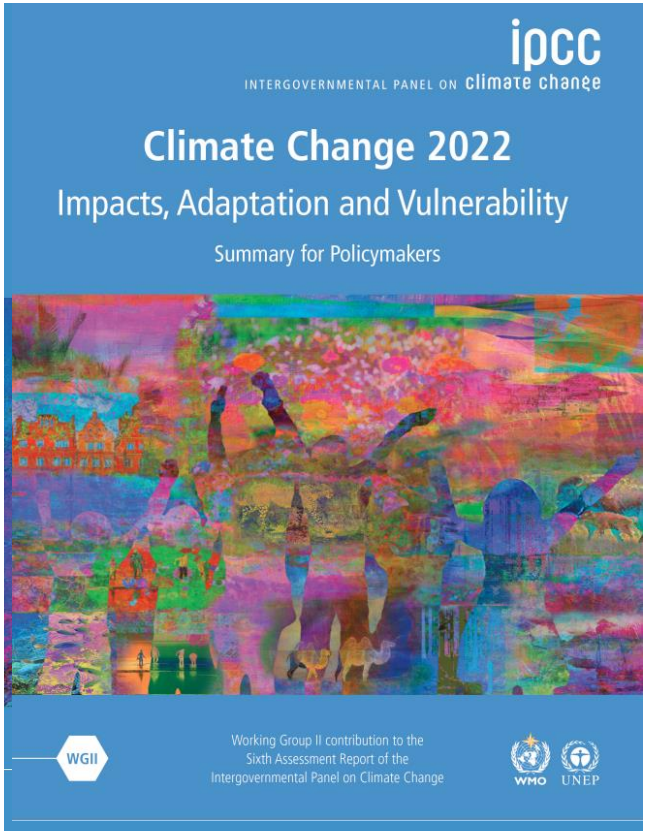
.... in/by 2035

.... in/by 2050

Already increases in:

- Extreme high temperatures
- Torrential rain
- Droughts
- Weather conditions conducive to wildfires

Efforts to adapt to a changing climate are imperative but…
Beware of maladaptation –when efforts to deal with the impacts of climate change do more harm than good



Impacts

Erftstadt, Germany
15 July 2021
196 dead (in all Germany)

Lytton, Canada
30 June 2021
49°C (120°F) previous day

California January 2023 (Source: Deseret News)

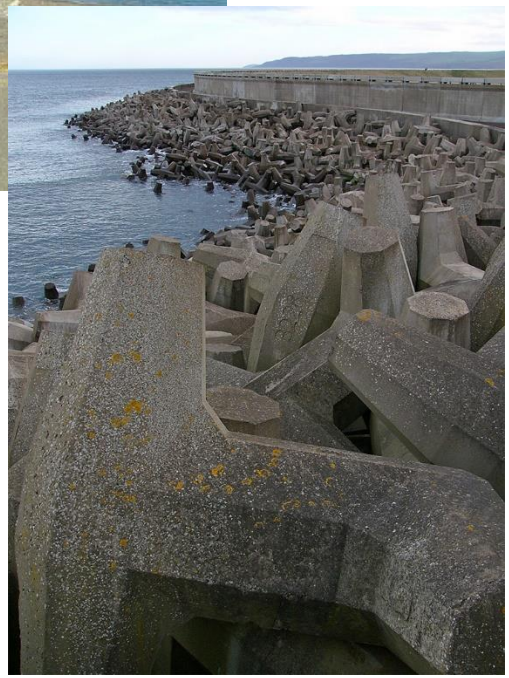
Zhengzhou, China
20 July 2021
12 dead

Australia 2020 (Source: REDUX Pictures)

Australia 2021 (Source: Univ. of Melbourne)

Brisbane Australia 28 February 2022
(Source: ABC News)

Water Management



Or take it away

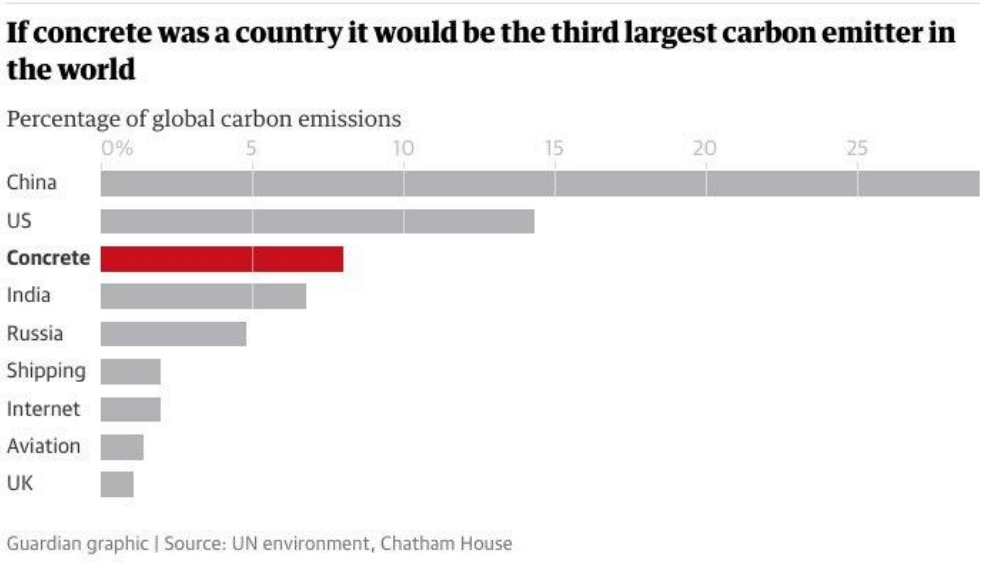
Keep it out

Water Management

Or store and use it

Water Management

LOTS OF CONCRETE



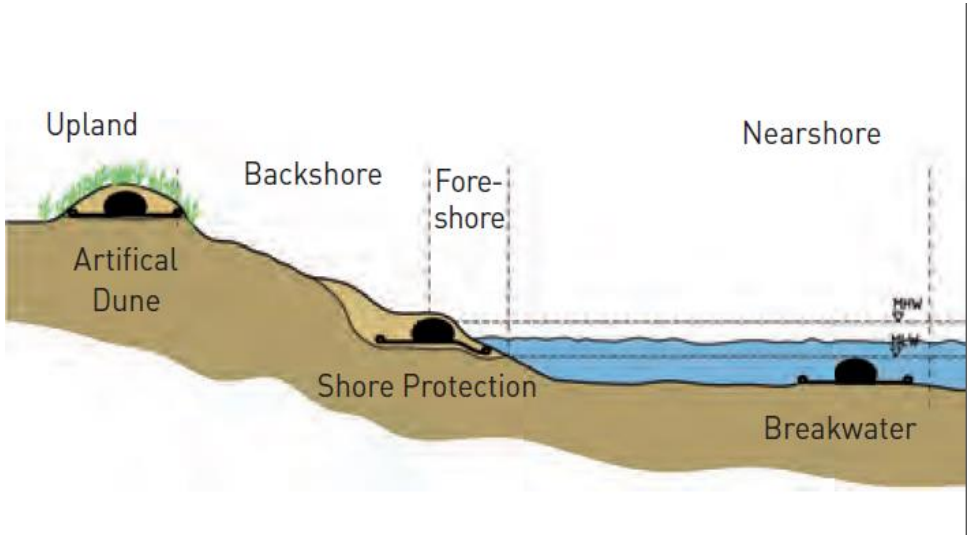
- **The construction industry is responsible for 11% of the world's man-made CO_2 emissions**
- **The industry's carbon footprint is not shrinking**
- **The solution makes the problem worse**
- **This is the opposite of sustainable**

Water Management

OR LOTS OF STONE

- **Depletion of natural resource**
- **Large number of truck journeys**
- **May travel long distance from source**
- **Very large carbon footprint**
- **Again not sustainable**

Water Management with Geosynthetics



Keep it out **Geocontainers**

Water Management with Geosynthetics

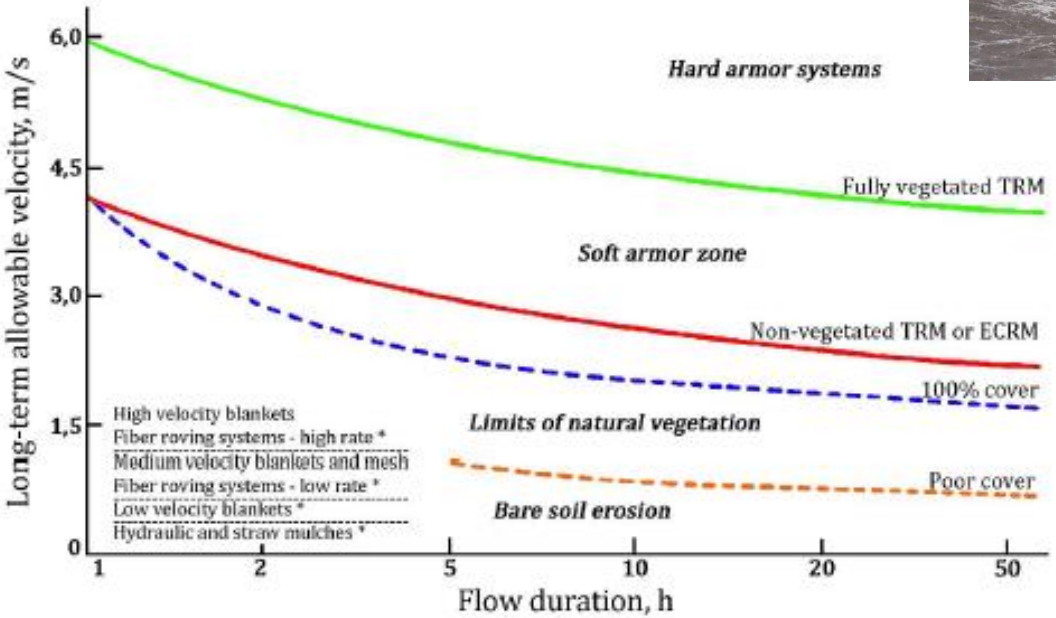
Take it away

Geomats, GCCM & turf reinforcement mats

Water Management with Geosynthetics

Take it away - Geomats, GCCM & turf reinforcement mats

But - limits to what we can do with geosynthetics



Source – ISO/TR18228-8 (in draft) adapted from Theisen (1992)

GCCMs – hybrid solution for hard armor locations?

Water Management with Geosynthetics

Store and use it -

Geomembranes

Irrigation & Aquaculture

Water Management with Geosynthetics

Geomats & geotextiles

Soft solutions & stormwater storage

Measuring the Environmental Benefits

Life Cycle Analysis (LCA)

LCA considers several aspects:

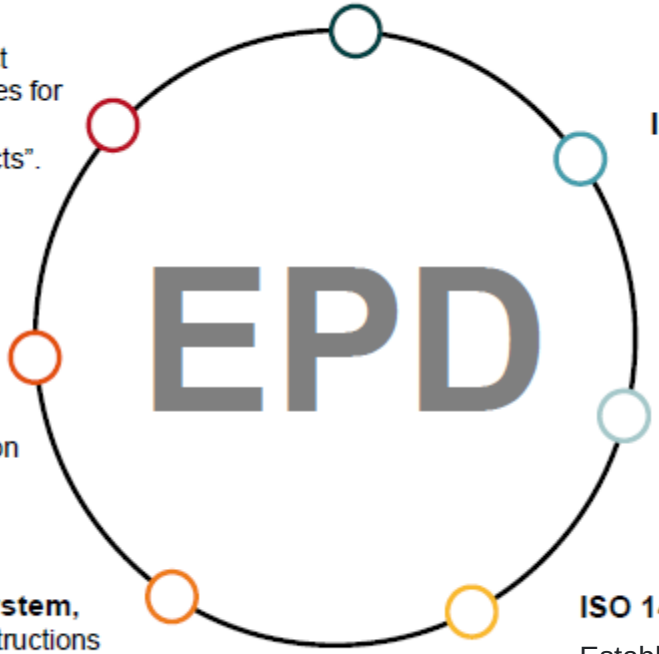
- **Greenhouse gas emissions/global warming potential**
- **Particulate matter formation**
- **Ozone Depletion**
- **Eutrophication**
- **Abiotic resource depletion**
- **Acidification**
- **Land use related impacts**
- **Cumulative energy demand**
  - non-renewable
  - & renewable

LCA is a central part of a larger sustainability analysis

Measuring the Environmental Benefits

- **Greenhouse gas emissions/global warming potential (GWP)**
  - CO_2 , Methane, etc.
- **Photochemical ozone creation potential (POCP)**
- **Ozone Depletion Potential (ODP)**
- **Eutrophication Potential (EP):**
  - the process by which a body of water becomes enriched in dissolved nutrients (such as phosphates) that stimulate the growth of aquatic plant life (algae) usually resulting in the depletion of dissolved oxygen
- **Abiotic resource depletion potential (ADP):**
  - depletion of non-living resources – fossil fuels, minerals, etc.
  - 2 categories: fossil fuels (ADP(f)) & non-fossil resources (ADP(e))
- **Acidification potential (AP)**
- **Land use related impacts**
- **Cumulative energy demand**
  - non-renewable (PERNT)
  - Renewable (PERT)

Environmental Product Declaration (EPD)



EN 15804:2012+A1:2013
"Sustainability of construction works, Environmental product declarations, Core rules for the product category of construction products".

ISO 14040: 2006

ISO 14044: 2006

International EPD System,
2012:01 Construction products and construction services, version 2.2

ILCD
International Reference Life Cycle Data System, Handbook. General Guidance for life cycle assessment. Detailed Guidance

International EPD System,
General Programme Instructions for the International EPD System vers. 2.5

ISO 14025:2006

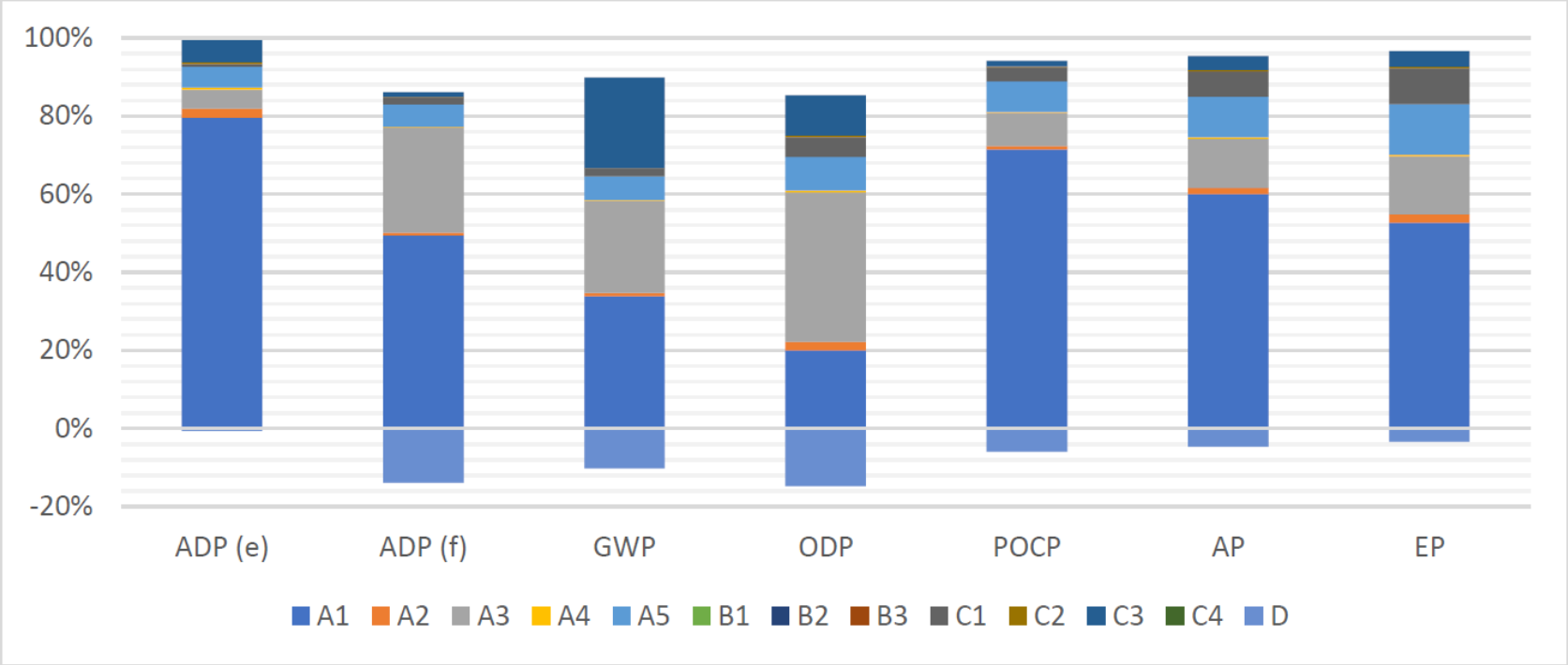
Establishes the principles and specifies the procedures for developing Type III environmental declaration programmes and Type III environmental declarations. It specifically establishes the use of the ISO 14040 series of standards in the development of Type III environmental declaration programmes and Type III environmental declarations.

Measuring the Environmental Benefits

Description of the system boundary																
Product stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundaries
Raw material supply	Transport	Manufacturing	Transport from manu-facturer to place of use	Construction-installation process	Use	Maintenance	Repair	Replacement	Refurbishmen	Operational energy use	Operational water use	De-construction / demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	X	X	X	X	X	MND	MND	MND	MND	X	X	X	X	X
X=Module declared | MND=Module not declared																

Measuring the Environmental Benefits

Influence of different life stages. For this product A1 & A3 are dominant



Product Grade	Unit	1	2	3	4	5	6	Scaling Function
Unit weight	**[g/m²]**	**185**	**240**	**320**	**350**	**440**	**530**	**x**
ADP(e)	[Kg Sb]	1,65E-06	2,17E-06	2,93E-06	3,59E-06	4,54E-06	5,37E-06	1,11E-08x - 4,49E-07
ADP(f)	[Kg Sb]	1,34E-02	1,55E-02	1,81E-02	1,93E-02	2,22E-02	2,44E-02	3,23E-05x + 7,69E-03
GWP	[Kg CO_2 Equiv.]	1,90E+00	2,24E+00	2,68E+00	2,87E+00	3,37E+00	3,73E+00	5,36E-03x + 9,54E-01
ODP	[Kg CFC-11 Equiv.]	1,43E-07	1,57E-07	1,69E-07	1,76E-07	1,90E-07	2,02E-07	1,68E-10x + 1,15E-07
POCP	[Kg Ethene Equiv.]	9,15E-04	1,13E-03	1,45E-03	1,67E-03	2,05E-03	2,36E-03	4,30E-06x + 1,15E-04
AP	[Kg SO_2 Equiv.]	4,53E-03	5,39E-03	6,59E-03	7,28E-03	8,69E-03	9,79E-03	1,56E-05x + 1,69E-03
EP	[Kg PO_4^{3-} Equiv.]	7,74E-04	8,97E-04	1,07E-03	1,19E-03	1,40E-03	1,57E-03	2,36E-06x + 3,38E-04

Environmental Product Declaration (EPD)

Environmental Product Declaration

as per ISO 14025 and EN 15804 +A1

Owner of the declaration:	HUESKER Synthetic GmbH
Publisher:	Kiwa BCS Öko-Garantie GmbH - Ecobility Experts
Programme holder:	Kiwa BCS Öko-Garantie GmbH - Ecobility Experts
Declaration number:	EPD-HUESKER-096-EN
Issue date:	15.12.2020
Valid to:	14.12.2025

Fortrac® T
Highly resilient, flexible geogrid with a prove
track record in soil reinforcement

Environmental Product Declaration (EPD)

PARAGRID

EPD
THE INTERNATIONAL EPD® SYSTEM
EPD in accordance with ISO 14025 and EN 15804+A1

PCR: 2012:01 Construction products and construction services version 2.2
Geographical scope: Global
EPD registration number: S-P-01461
Date of publication (issue): 2019-01-18
Date of validity: 2023-12-17 (5 years)

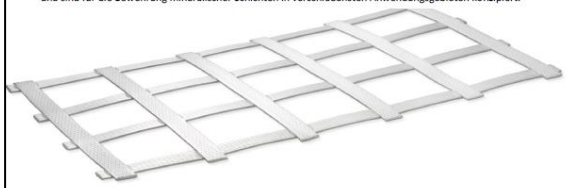
Umwelt-Produktdeklaration

nach ISO 14025 und EN 15804

Deklarationsinhaber:	Naue GmbH & Co. KG
Herausgeber:	Kiwa BCS Öko-Garantie GmbH - Ecobility Experts
Programmhalter:	Kiwa BCS Öko-Garantie GmbH - Ecobility Experts
Deklarationsnummer:	EPD-Naue-069-DE
Ausstellungsdatum:	12.04.2019
Gültig bis:	11.04.2024

Secugrid 40/40 Q1

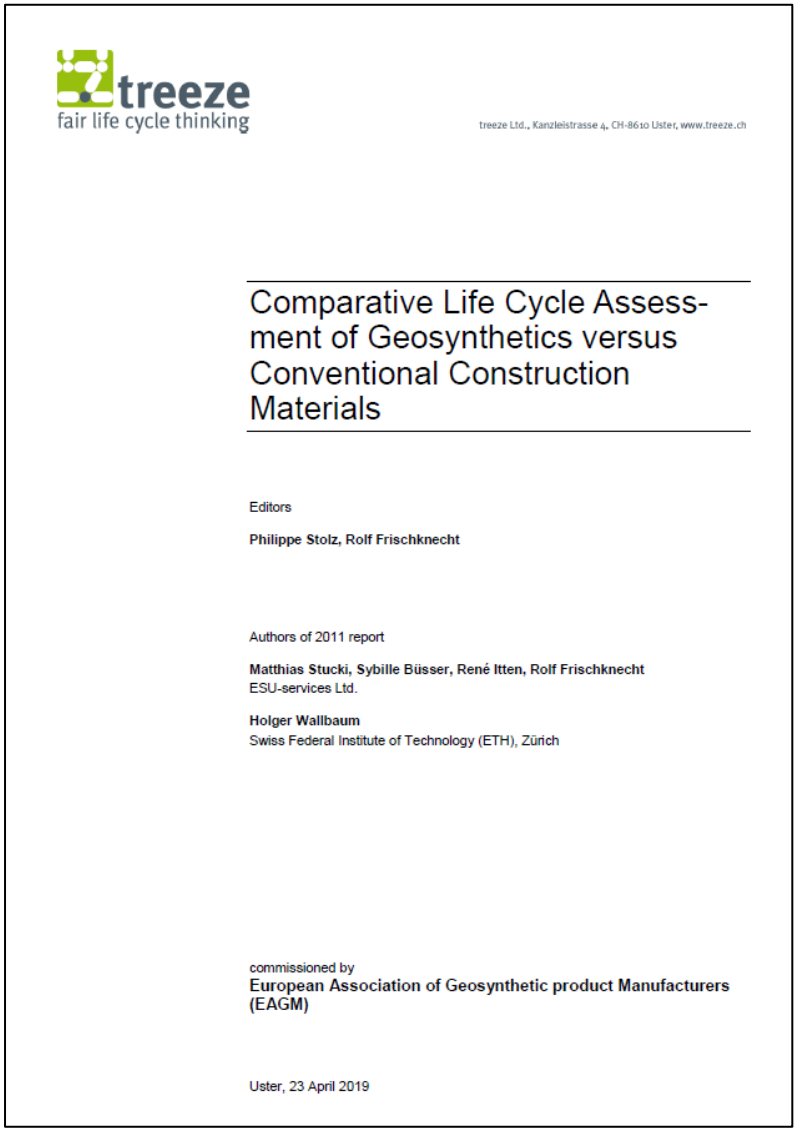
Diese Umwelt-Produktdeklaration (Environmental Product Declaration - EPD) bezieht sich auf 1 m^2 Secugrid 40/40 Q1 Geogitter der Naue GmbH & Co. KG. Die Geogitter werden aus Polypropylen gefertigt und sind für die Bewehrung mineralischer Schichten in verschiedensten Anwendungsgebieten konzipiert.



7. VERIFICATION AND REGISTRATION

CEN standard EN 15804 served as core PCR	
EPD Programme:	The International EPD® System. For more information · www.environdec.com
PCR:	PCR 2012:01 Construction products and construction services version 2.2
PCR review was conducted by:	The Technical Committee of the International EPD® System. Contact via info@environdec.com
EPD Registration no:	S-P-01461
EPD validity:	2023-12-17 (5 years)
EPD valid within the following geographical area:	International
Technical support:	Ecoinnovazione S.r.l. – spin-off ENEA - Via d'Azeglio 51, 40123 Bologna ecoinnovazione www.ecoinnovazione.it
Independent verification of the declaration and data according to ISO 14025:	EPD verification (external)
Third party verifier:	SGS SGS Italia S.p.A. Via Caldera 21, 20153 Milano.www.it.sgs.com
Accredited or approved by:	
Independent verification of the declaration and data according to ISO 14025:	EPD verification (external)
Third party verifier:	SGS
Accredited or approved by:	Accredia, certificate n.006H

Measuring the Environmental Benefits



treeze
fair life cycle thinking

treeze Ltd., Kanzleistrasse 4, CH-8610 Uster, www.treeze.ch

Comparative Life Cycle Assessment of Geosynthetics versus Conventional Construction Materials

Editors

Philippe Stolz, Rolf Frischknecht

Authors of 2011 report

Matthias Stucki, Sybille Büsser, René Itten, Rolf Frischknecht
ESU-services Ltd.

Holger Wallbaum
Swiss Federal Institute of Technology (ETH), Zürich

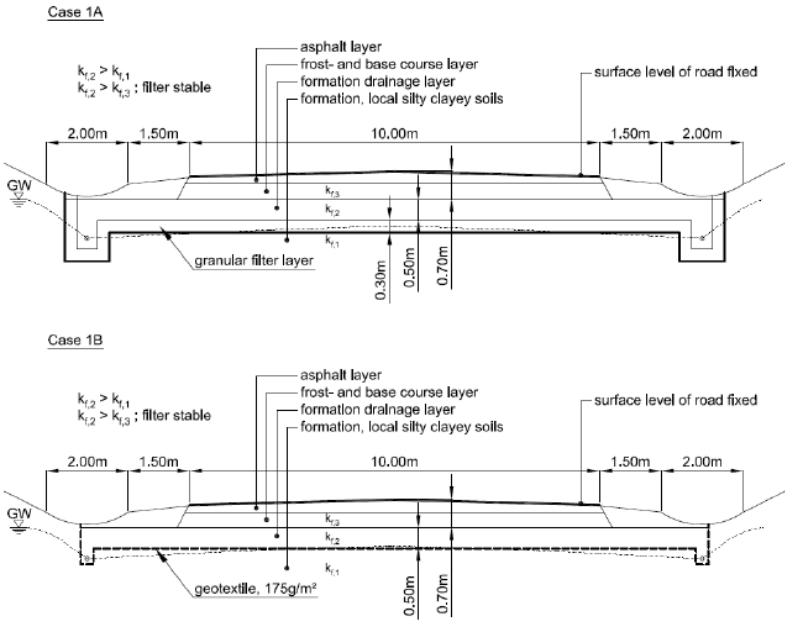
commissioned by
European Association of Geosynthetic product Manufacturers (EAGM)

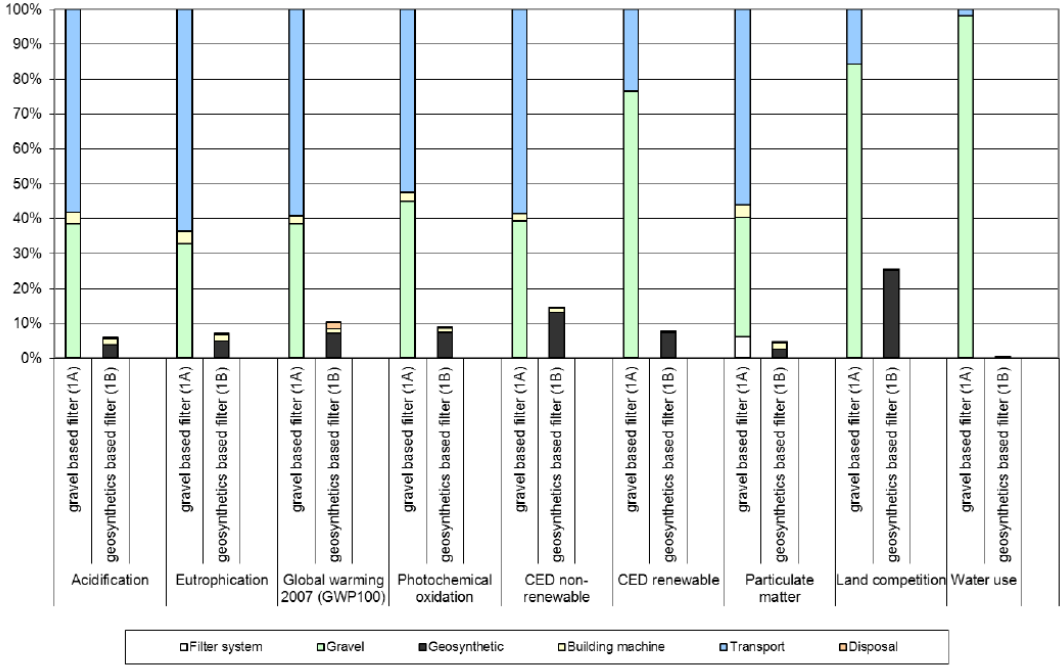
Uster, 23 April 2019

- Contains 4 detailed LCAs comparing geosynthetics with conventional solutions
- Reductions across all categories are significant in all cases
- Commissioned by:

EAGM European Association of Geosynthetic product Manufacturers

Case Study 1 – Filter Layer





Case Study 2 – Foundation Stabilisation

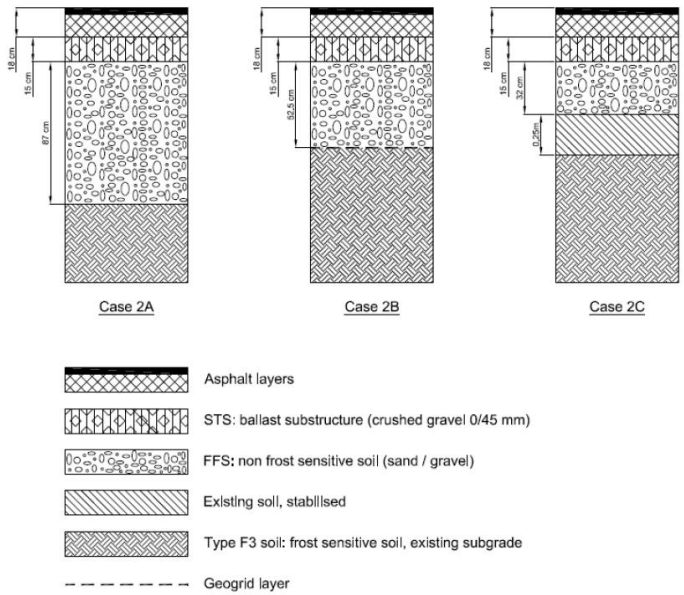
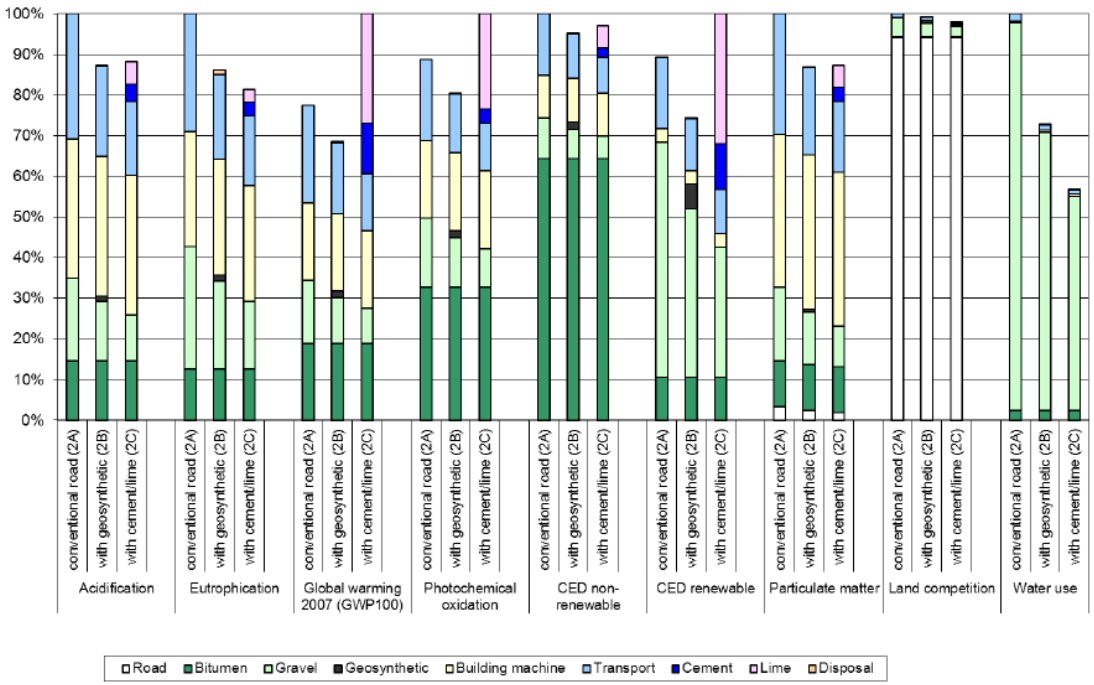
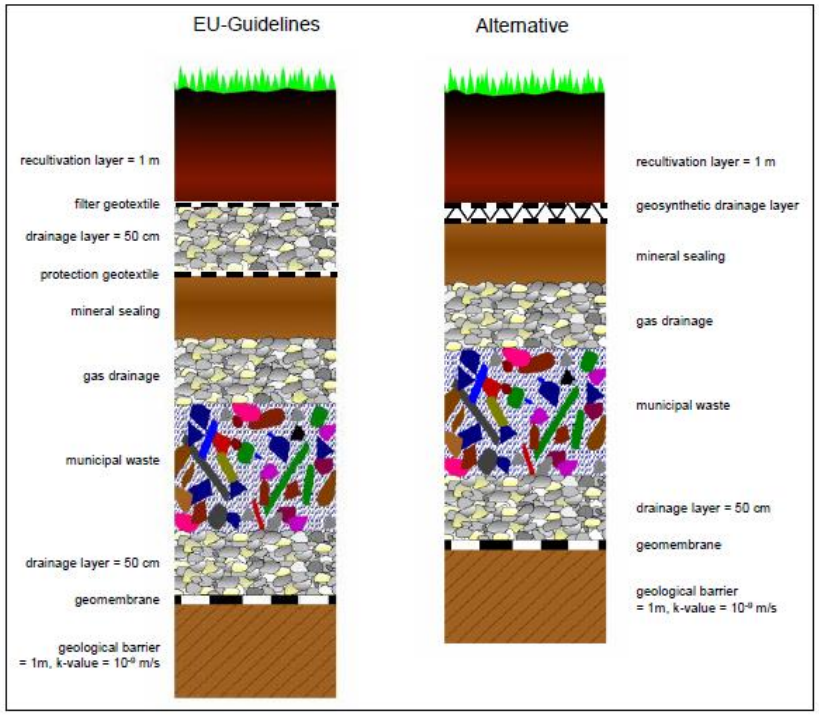


Fig. 3.1: Scheme of the road profiles of a standard road (case 2A, left), a road using reinforcement middle) and a road using soil improvement with lime/cement (case 2C, right).



Case Study3 – Landfill Capping



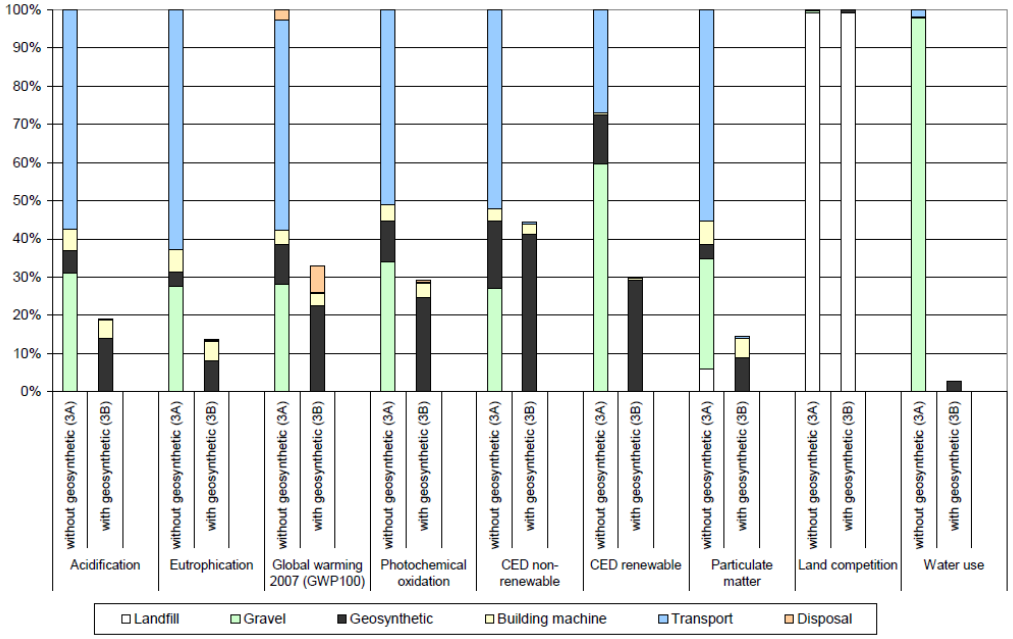


Fig. 4.1: **Scheme of the profile of waste landfill site class 2 according to EU guidelines (case 3A, left) and with a geosynthetic as an alternative drainage layer in the cap (case 3B, right)**

Case Study 4 – Retaining Wall

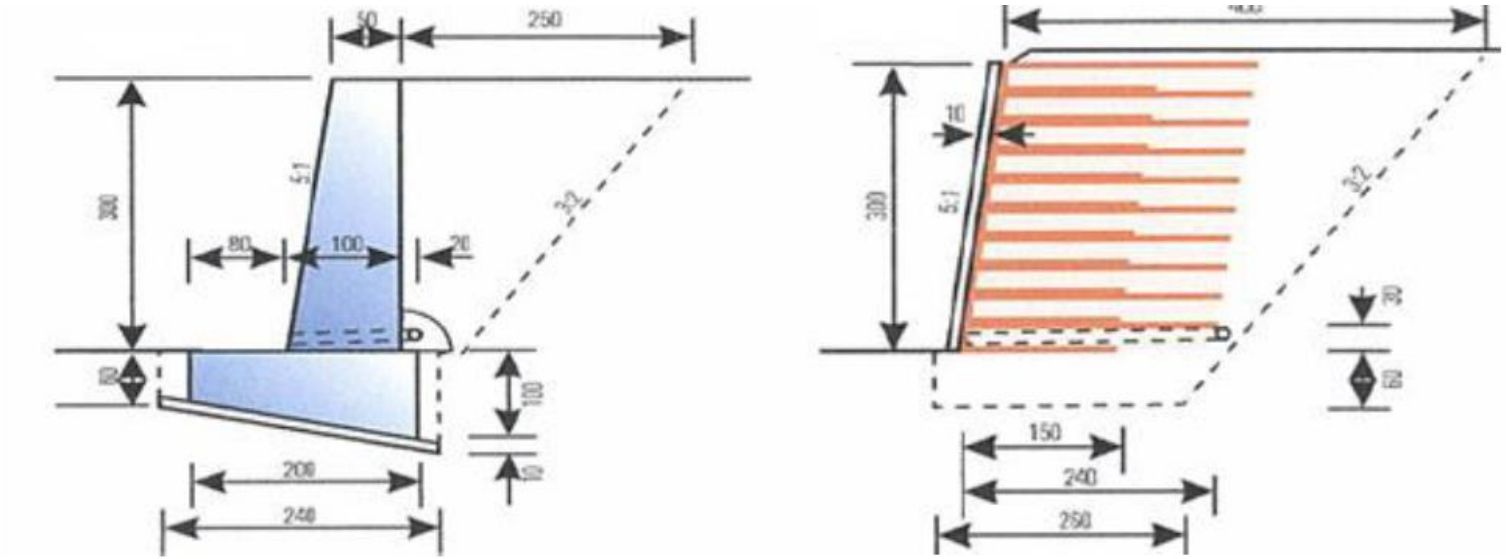
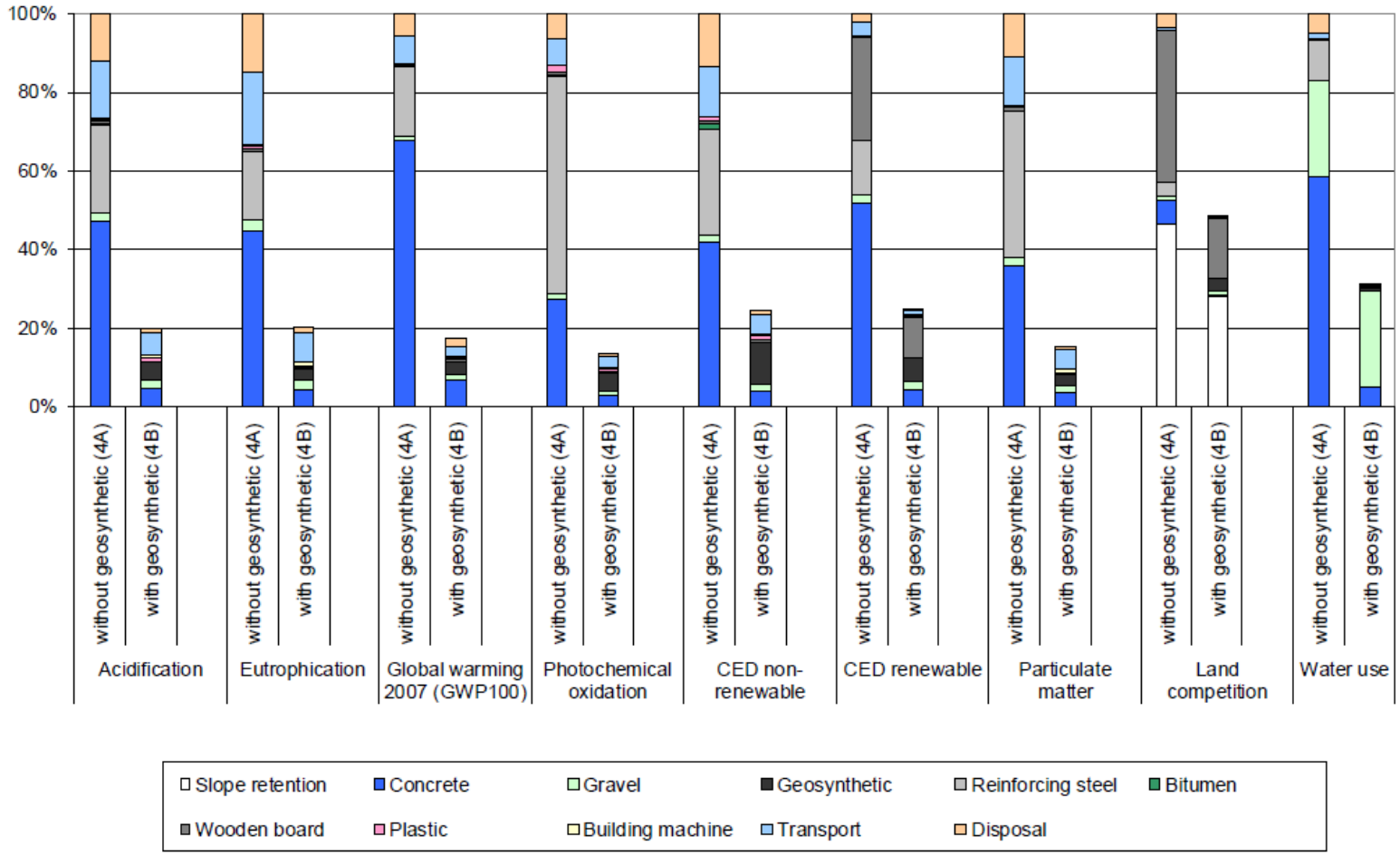


Fig. 5.1: Scheme of retaining walls: the concrete reinforced wall (case 4A, left) versus the geosynthetics reinforced wall (case 4B, right)

Case Study 4 – Retaining Wall



But it costs more! Doesn't it?

Cost Comparisons

Retzlaff (2022) undertook a cost comparison of Case Studies 3 & 4, comparing the costs of the conventional and geosynthetic solutions.

Case Study 3 – Landfill Capping

- Area 106,000 m^2
- Conventional Solution: $2,234,456
- Geosynthetics Solution: $ 969,055
- **Cost Reduction: 57%**

Case Study 4 – Retaining Wall

- Per linear metre of wall
- Conventional Solution: $83,375/m
- Geosynthetics Solution: $29,113/m
- **Cost Reduction: 65%**

Note: costs converted from Euros to Dollars at January 2023 exchange rate

Source: Retzlaff, J. (2012) Cost Comparison of geosynthetics versus conventional construction materials, a study on behalf oof EAGM. Case 3: landfill construction drainage layer & Case 4: soil retaining wall. EUROGEO 7, Warsaw, Poland.

Measuring the Environmental Benefits

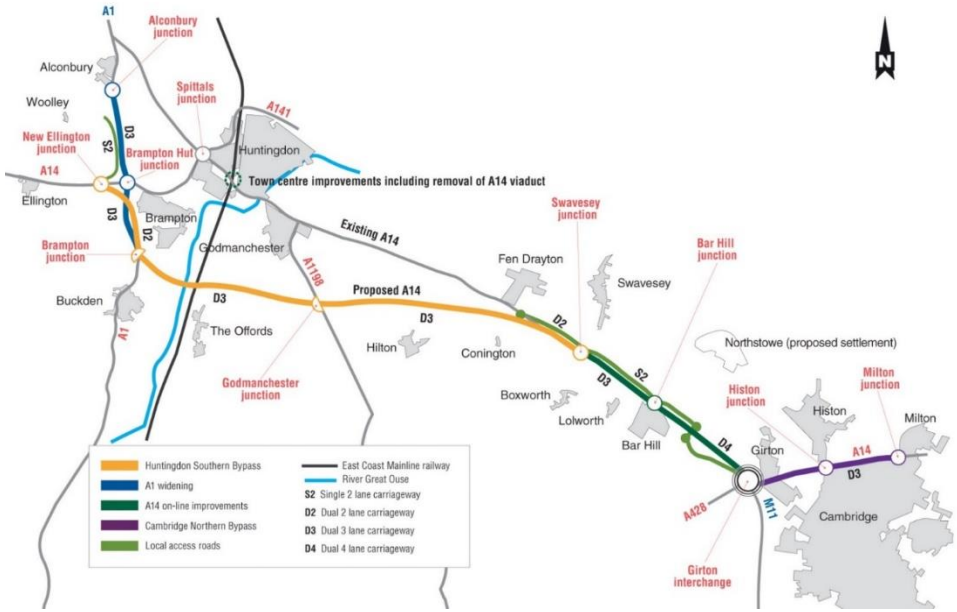
2 Additional Case Studies

- **£1.5 billion ($1.8 billion) road project – UK**
- **Offshore wind farm project – Germany**

A14 Huntingdon to Cambridge UK

Carbon reduction target for site from specification – 20%

3 main contractor JV all represented on each section
£1.5bn project
67 new bridges
750m long viaduct



Structural Drainage to Buried Structures

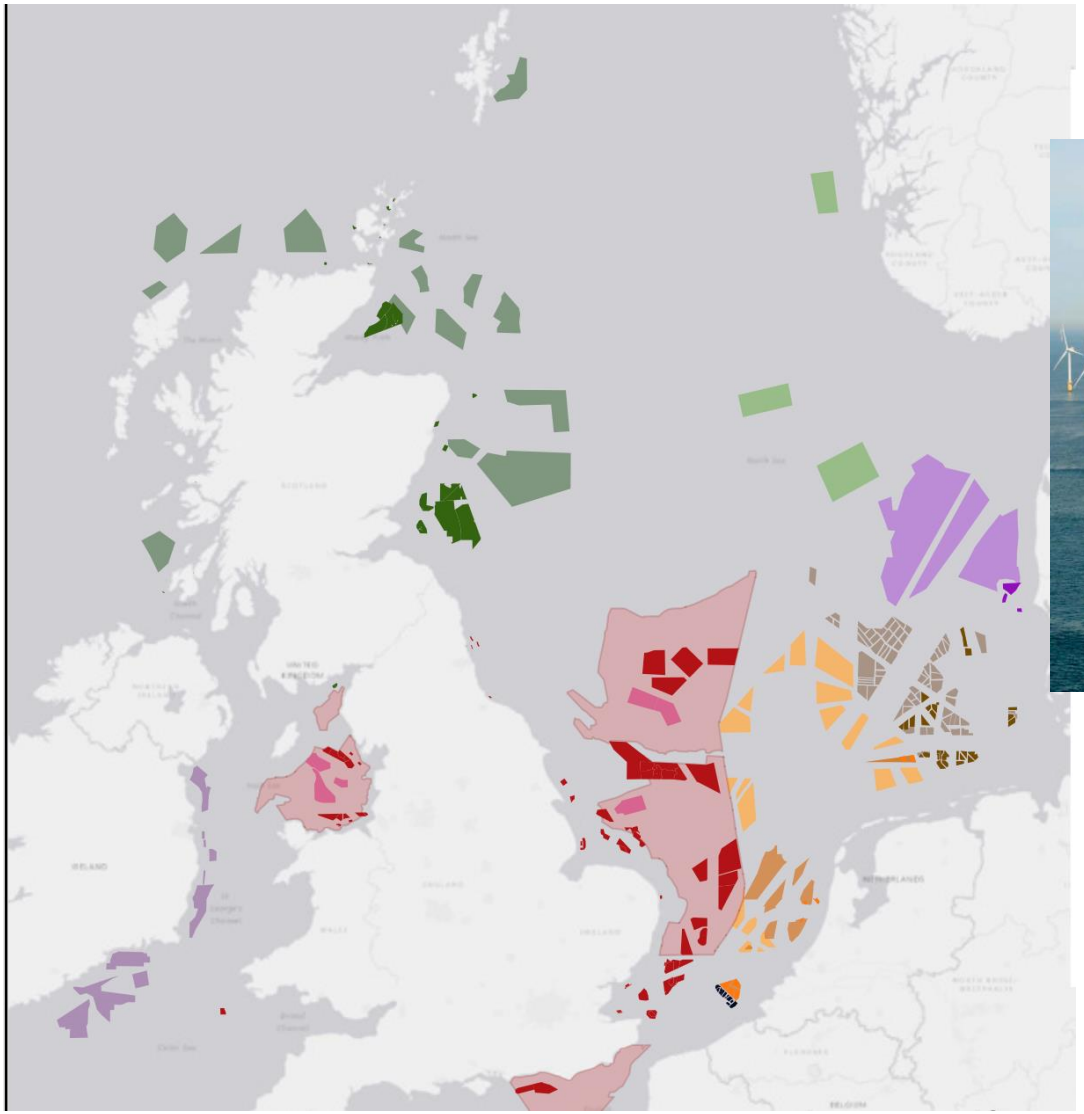
Comparison between three alternatives based on 55m^2 wall coverage (typical size of roll)

1. Geocomposite
2. Hollow concrete blocks filled with gravel
3. No-fines concrete

Output			
Construction Stage	**ABG Deckdrain**	**Hollow concrete blocks and gravel**	**No-fines concrete**
Part A - Removal of waste material	-	-	-
Part B - ECO_2e of imported materials	148 kg	1,220 kg	2,475 kg
Part C - CO_2e from transporting imported materials to site	2 kg	49 kg	524 kg
Part D - CO_2e emissions during Construction	-	520 kg	1,311 kg
Total CO_2e	**150 kg**	**1,789 kg**	**4,310 kg**
Replacing the Hollow concrete blocks and gravel with an ABG Deckdrain results in CO2e emissions being reduced by:		**92%** ✓	**97%** ✓

92% CO_2e reduction
Geocomposite v hollow concrete blocks
And it was lower cost $$$!

North Sea Offshore Wind



Current capacity ≈ 30GW
2050 target ≈180GW

Dogger Bank – 227 turbines
Capacity 3.6GW
1 turn of a turbine generates enough electricity to power a UK household for 2 days

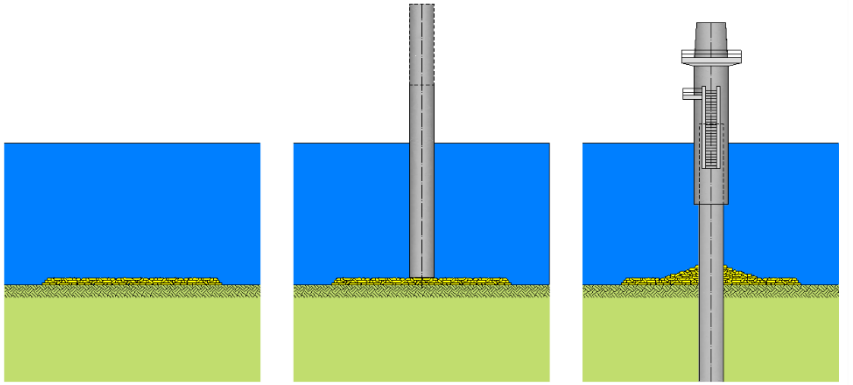
Amrumbank West Scour Protection

OWF Amrumbank: Solution and Experiences with Geotextile Sand Containers

Sellhorn INGENIEURGESELLSCHAFT

OWF Amrumbank West

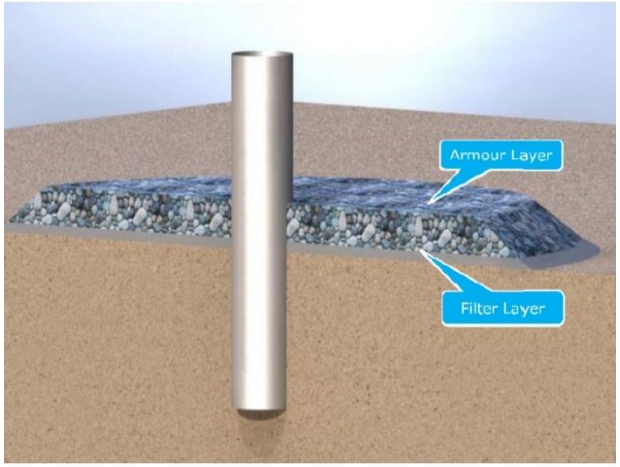
- Client: e.on Kraftwerke
- Location: North Sea
- Project Area: 32 km²
- Number of Turbines: 80
- Installed Capacity: 288 MW
- Distance to Shore: 33 km
- Start Offshore Activities: April 2012
- Completion: 2015

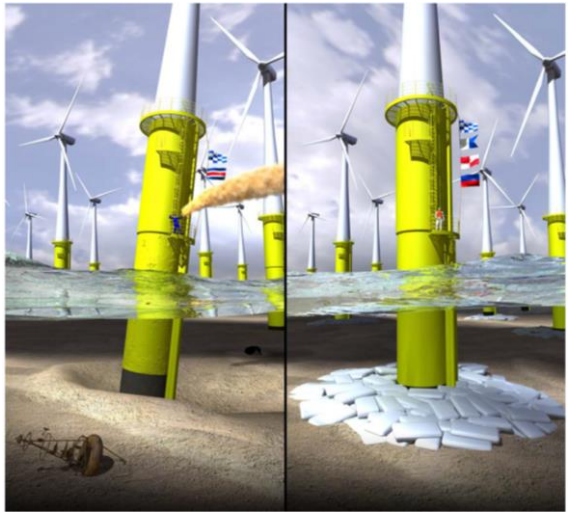


Step 1: 2 layers GSC as effective scour protection

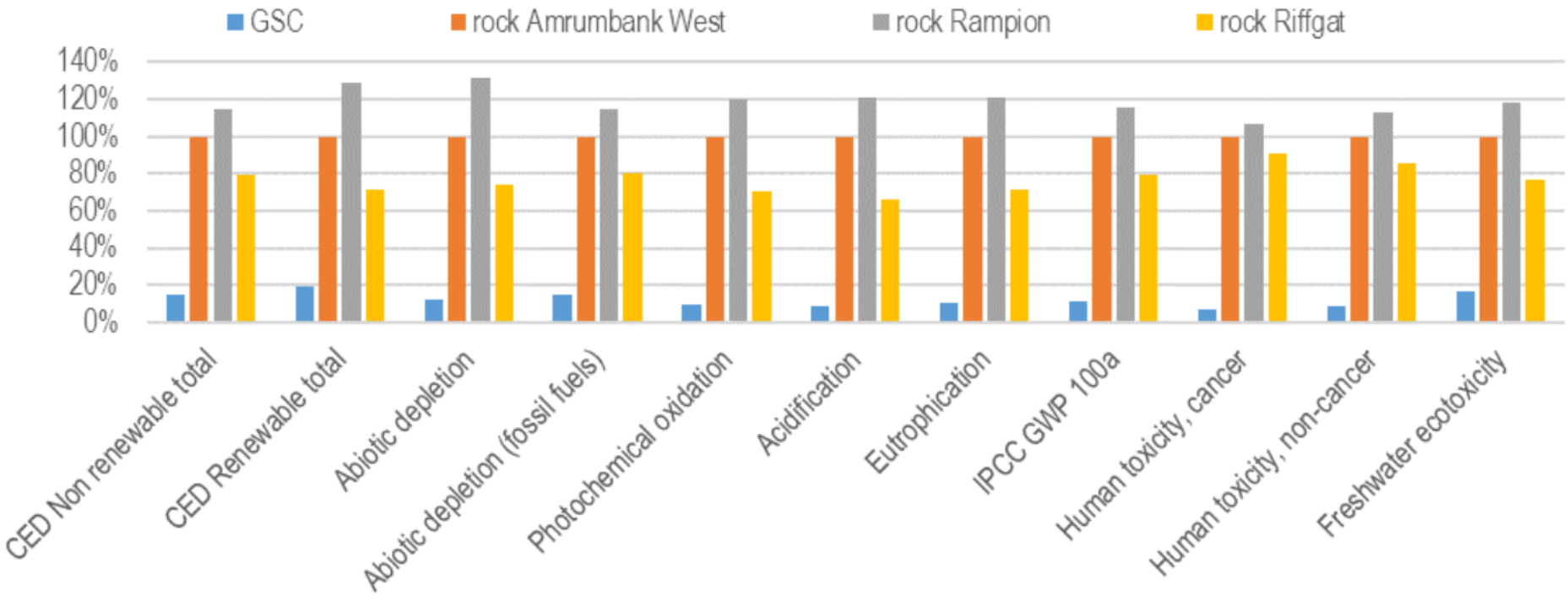
Step 2: Mono-Pile driving

Step 3: Adding singular GSC elements as "collar"





Offshore Wind Farm Germany



GSC = Geosynthetic Sand Containers

Reduction in every environmental impact category is >80%

In addition using geosynthetics resulted in significant construction cost savings compared with the conventional approach of rock armour

Conclusions

Examples have shown how construction with geosynthetics is able to:

- **reduce CO_2 and other emissions**
- **reduce natural resource depletion**
- **reduce energy demand (CED)**
- **reduce construction costs**
- **reduce the impacts for residents near construction**

while protecting people's lives from the effects of climate change

Conclusions

Geosynthetics contribute significantly to reducing the climate change impact of civil engineering works

The reductions in emissions and other environment impacts are huge – mainly greater than 80% and up to 95%

This does not entail higher costs – indeed quite the opposite, both cost AND environmental impact are reduced significantly

Geosynthetics are a key part of the solution – they enable the infrastructure needed to adapt to climate change to be created sustainably

But we must be realistic – geosynthetics cannot be used in ALL situations

To realise these benefits there needs to be a change in mindset at regulators, owners and designers, and in Standards – include environmental impact as a criterion and favour solutions with minimum impact in all categories of LCA

We acknowledge the resources and images provided by courtesy of:

EAGM European Association of Geosynthetic product Manufacturers

NAUE GmbH & Co KG

ABG Geosynthetics Ltd

Concrete Canvas Ltd

HUESKER Synthetic GmbH

Tensar International

Thank you for your attention!

Questions?

Thank You For Attending!

Tom Sangster
Downley Consultants Ltd
tom.sangster@downley.com
Mobile: +41 79 643 9395

Contact Information

Tom Sangster, B. Sc., C.Eng.
Downley Consultants
tom.sangster@downley.com

Timothy D. Stark, Ph.D., P.E.
Professor of Civil & Environmental Engineering
University of Illinois at Urbana-Champaign
Technical Director
Fabricated Geomembrane Institute
tstark@Illinois.edu

Jennifer Miller, M.S.
Coordinator
Fabricated Geomembrane Institute
University of Illinois at Urbana-Champaign
fabricatedgeomembrane@gmail.com

Next FGI Webinar

Geomembrane Damage During Oil and Gas Operations Part 1

Tuesday, March 14, 2023 at Noon CDT

Free to Industry Professionals

1.0 PDH

Presenter:

Timothy Stark, Ph.D., P.E.

Check out the FGI's Website

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- Audio and Video Podcasts
- Latest Specifications and Guidelines
- Installation Detail Drawings (PDF and DWG)
- Technical Papers and Journal Articles
- Webinar Library (available to view and download)
- ASTM Field and Laboratory Test Method Videos
- Pond Leakage Calculator
- Panel Weight Calculator
- Photo Gallery
- Member Directory
- Material and Equipment Guides
- Industry Events Calendar
- Women in Geosynthetics
- Spanish Webinars and Podcasts
- Geo-Engineering Pop Quizzes

www.fabricatedgeomembrane.com