



EROSION CONTROL: HOW TO PREVENT SOIL EROSION WHILE PROMOTING THE ESTABLISHMENT OF VEGETATION

Date April 7, 2022

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WEBINAR AGENDA

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- 5' *Introduction*
- 25' *Erosion control: research, solutions and design software*
- 15' *Environmental sustainability and Building Information Models*
- Live Q&A Session*

Speaker

*P. Pezzano – Technical Expertise Center of Excellence GSY
& MacRes Business Unit*



Soil is a precious
source of biodiversity,
fundamental in **storing
and releasing carbon**
and maintaining the
balance of gasses in
the air we breathe.



Plant roots hold the soil in position and **prevent it from being blown or washed away.**



Soil erosion refers to the wearing away of the field's **topsoil**, in which the high organic matter is contained. Wind and stormwater runoff are two common causes of soil erosion.

Urban gully in Kinshasa, Democratic Republic of Congo, May 2018. Credit: Matthias Vanmaercke.



We are all becoming more concerned about the loss of soil and, as engineers, we are called to **control the erosive force of wind and rainwater** to prevent the detachment of the topsoil, hence **promoting vegetation growth**.

Soil erosion in Lesotho, 2016. Photo credit: Lscheffa

WHO WE ARE

MACCAFERRI



Sales in
100+
countries



3,000+
employees



23
factories



60+
subsidiaries



A LONG LASTING COMMITMENT IN IMPROVING MATERIALS AND SOLUTIONS FOR CIVIL ENGINEERING

INNOVATION CENTER

MACCAFERRI



Maccaferri has a centre of excellence entirely dedicated to **research and development**, concentrating in a single place the capital of **knowledge** and **know-how**: in Bolzano (Italy) the Maccaferri Innovation Center (M.I.C.) is constantly working to innovate our products and solutions



FORWARD-LOOKING APPROACH

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Over the years Maccaferri has been working along with some of the most prominent universities at international level to develop **sustainable solutions** to **prevent the loss of soil** and to **enhance the re-vegetation**



UNIVERSITÀ
DEGLI STUDI
DI MILANO





**WE HELP
NATURE
GROW**





THE GROWTH OF VEGETATION

OPTIMISED EROSION CONTROL
SOLUTIONS

DESIGN SOFTWARE



THE STUDY CARRIED OUT BY UNIVERSITY OF MILAN

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We posed the question to **Prof. G. Bischetti**, Head of Department of Agricultural and Environmental Sciences at the **University of Milan**.

The study focuses on the relationship between erosion control solutions and vegetation growth.



UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI SCIENZE AGRARIE
E AMBIENTALI - PRODUZIONE,
TERRITORIO, AGROENERGIA

Relationships between Erosion Control
Products and vegetation growth

Prof. Gian Battista Bischetti

Report di ricerca – luglio 2021





YouTube

M

PROF. GIAN BATTISTA BISCHETTI

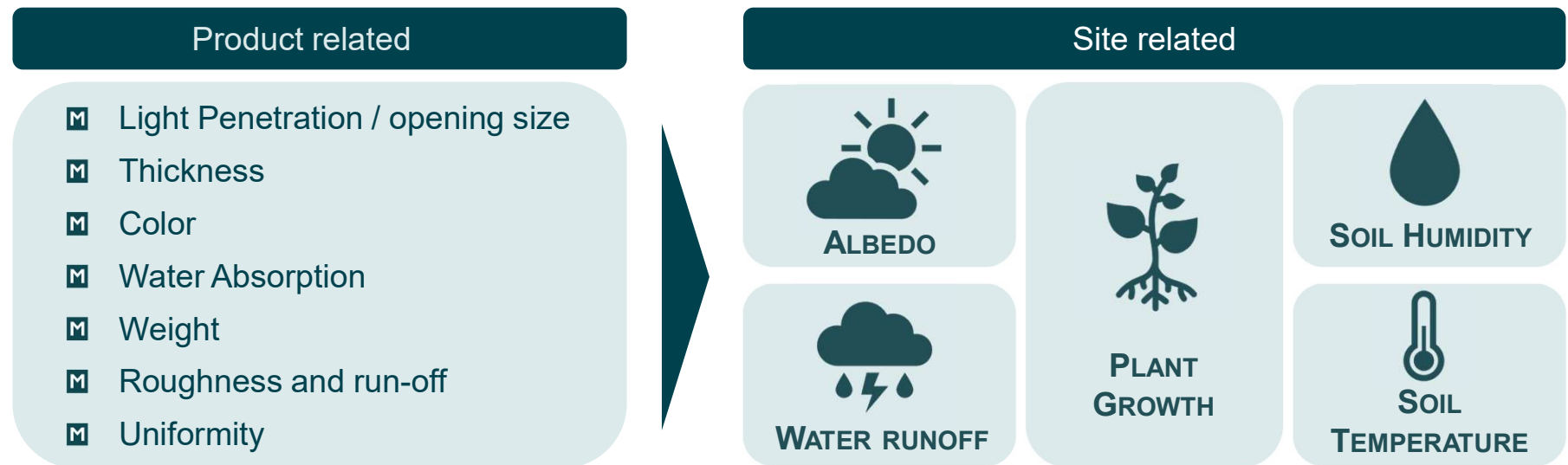
HEAD OF DEPARTMENT OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES
UNIVERSITY OF MILAN

What influence the growth of vegetation on slopes?

KEY ASPECTS FOR REVEGETATION SUCCESS

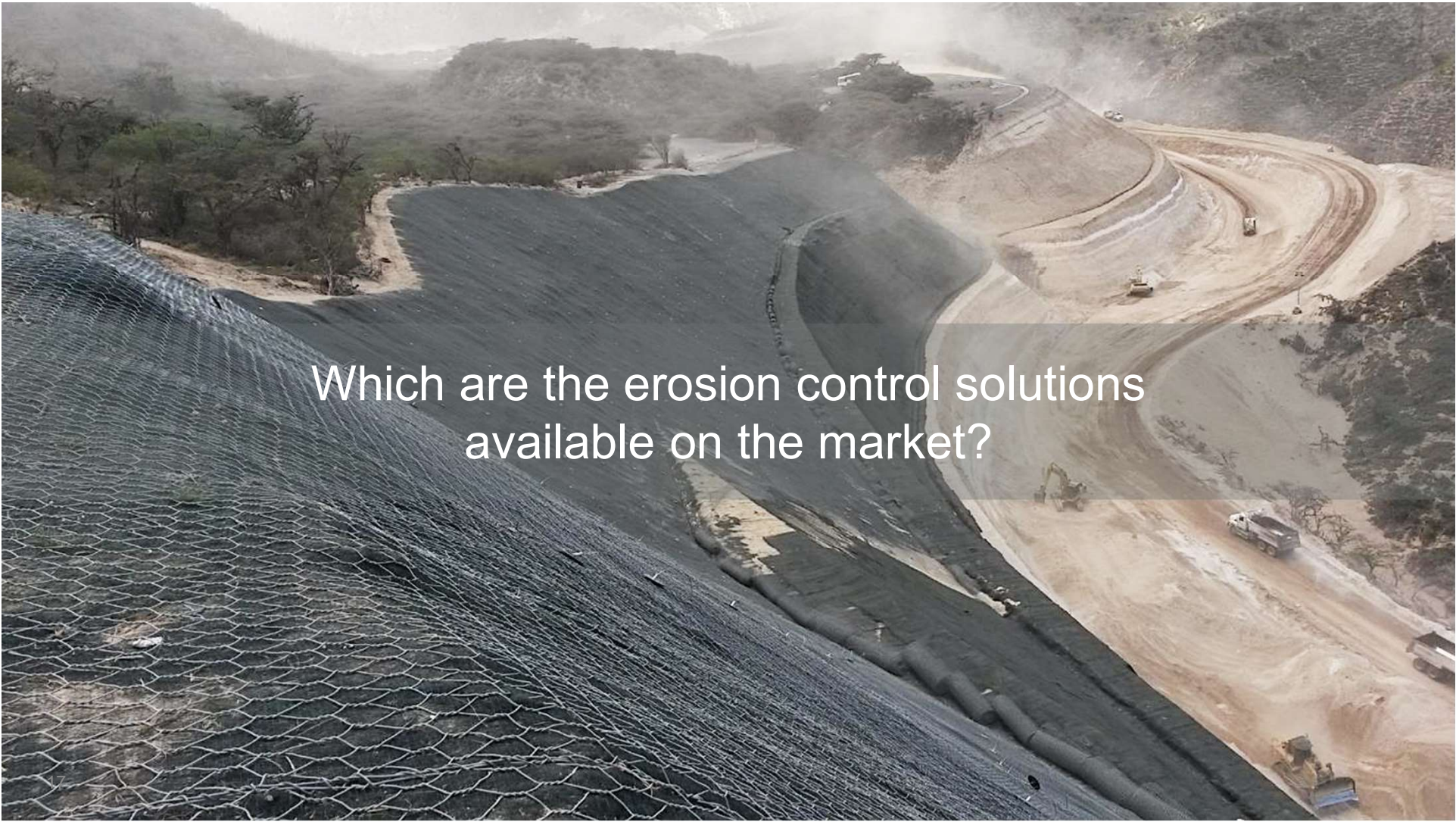
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How 7 key parameters affect revegetation and erosion control maximization



*"Relationships between Erosion Control
Products and vegetation growth"*
Prof. G.B. Bischetti et al, UniMi, 2021





Which are the erosion control solutions available on the market?

STATE OF THE ART

Main product categories for erosion control

Biomat

2D shape fabric made of biodegradable natural fiber, such as jute, straw, coconut, cellulose fiber felt.



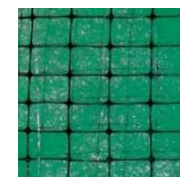
Geomat

3D shape mat made with polymeric filaments. The product could be reinforced with a geogrid.



Composite

Multi-layer 2D Geogrid coupled with a blanket in order to improve the soil coverage of the product.



Geotextile

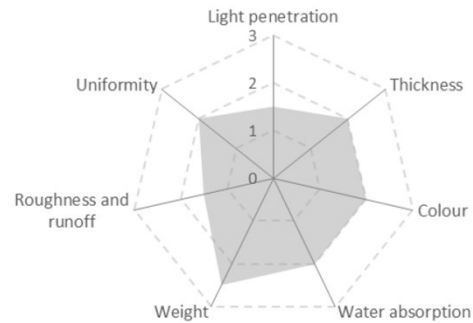
Woven planar geotextiles manufactured by weaving yarns in the warp and weft direction.



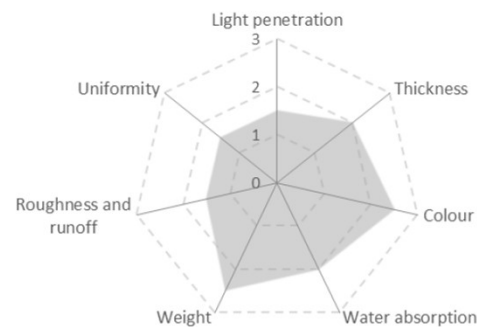
EXPECTED PERFORMANCE OF EROSION CONTROL SOLUTIONS

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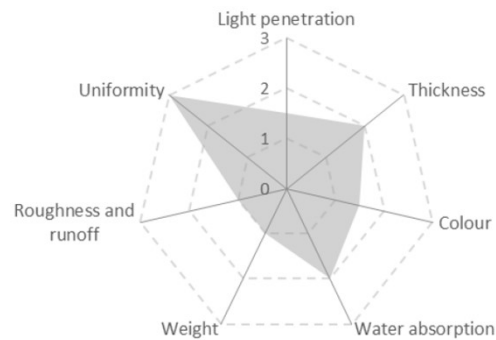
BIONETS



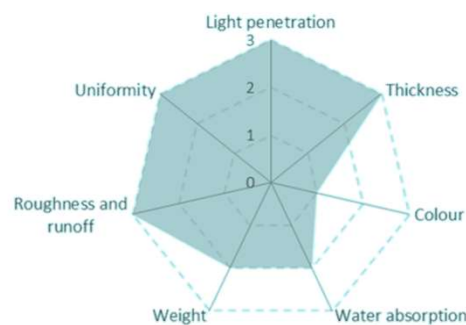
GEOBLANKETS



COMPOSITES



GEOMATS



Erosion Control solution **performance depends on complex processes** where different factors and features interact and those are not homogenous, quantitatively and qualitatively.

Considering all the interacting features, **Geomats globally show the best performance.**



"Relationships between Erosion Control Products and vegetation growth"
Prof. G.B. Bischetti et al, UniMi, 2021





THE GROWTH OF VEGETATION

**OPTIMISED EROSION CONTROL
SOLUTIONS**

DESIGN SOFTWARE





erosion CONTROL

sustainable durability



MACMAT: THE SUSTAINABLE SOLUTION FOR EROSION CONTROL

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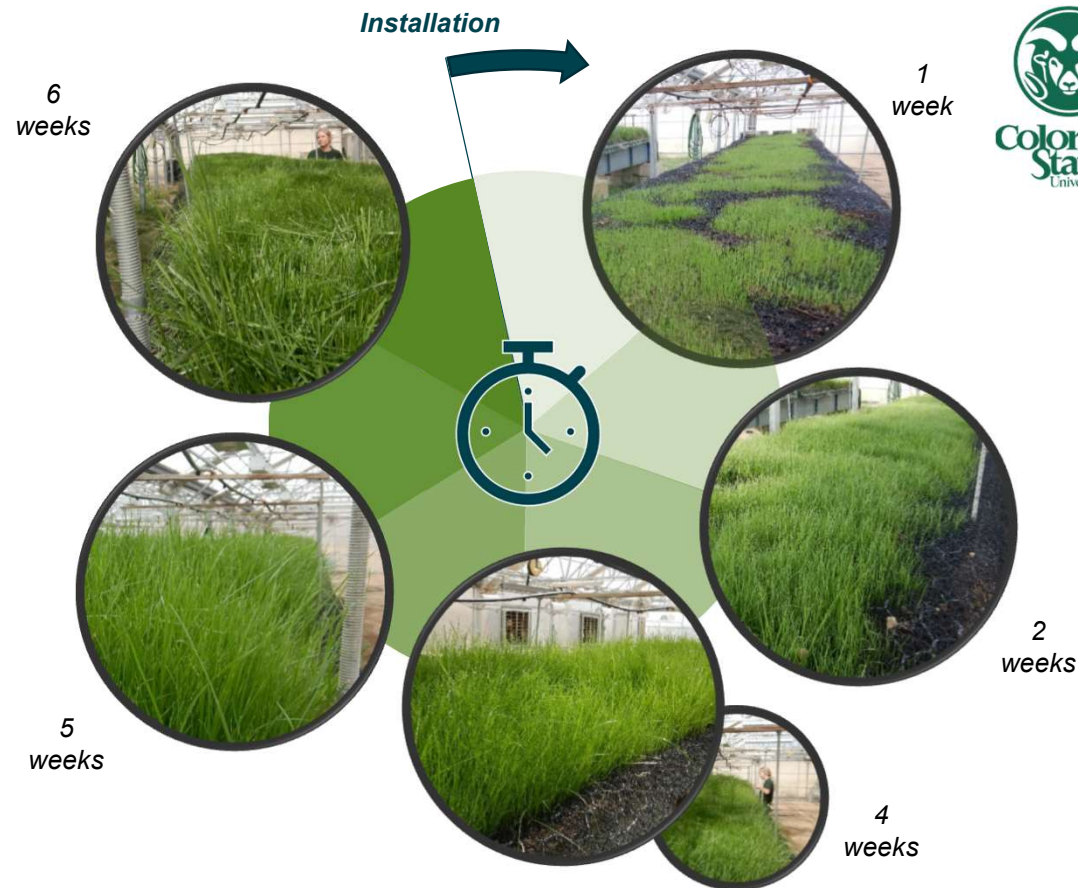
Geomat – MacMat® are made of synthetic material filaments, tangled together to form a highly deformable layer 10-20 mm thick, featured by a very high porosity (greater than 90% on average).

Perfectly suitable for slopes, along the banks of canals and river courses, or to convey liquids (drainage) in association with geotextiles and/or geomembranes.



MACMAT: THE FASTEST GROWTH ON THE MARKET

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Test conducted by
Colorado State University
between 2019 and 2020
on MacMat-R

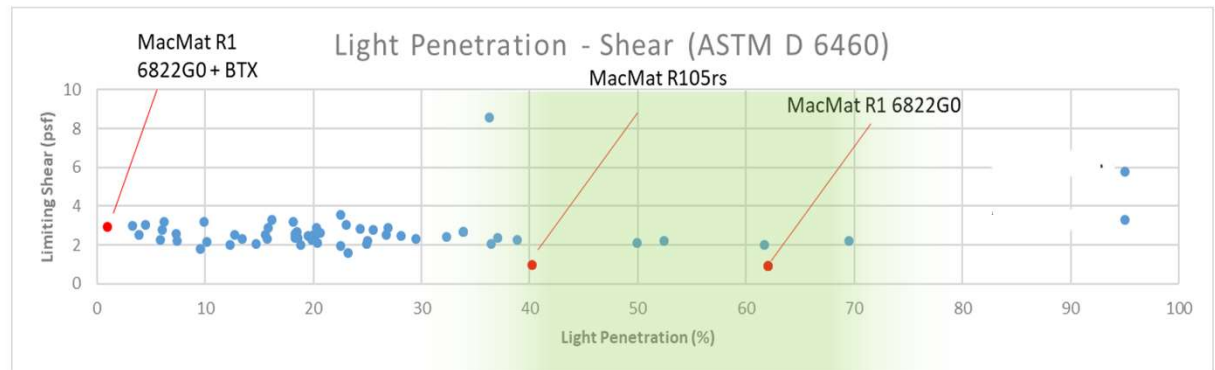
- Fully revegetation in only 6 week
- In 6 weeks performances reach what traditional EC solution achieve in 1 year (*Limit shear strength* and *Limit Velocity*)
- 6th week performance achieve 60% of 1 year measured strength



THE IMPORTANCE OF THE LIGHT

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Lab test and field experience evidence that a light penetration index between **40%** and **70%** is the optimum range for vegetation growth.



**Best light
penetration range for
vegetation growth**

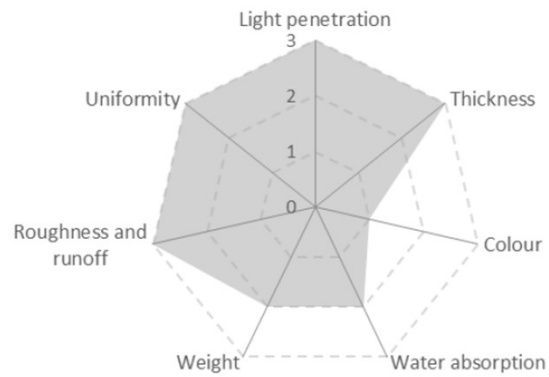


MACCAFERRI GEOMAT PERFORMANCE

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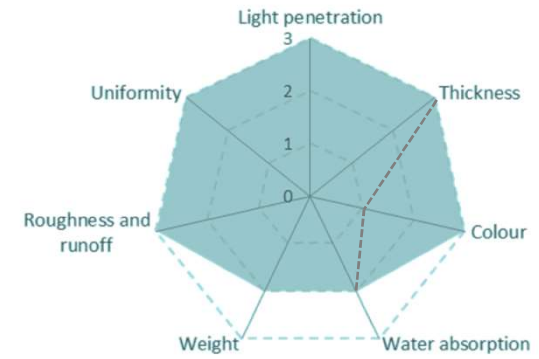
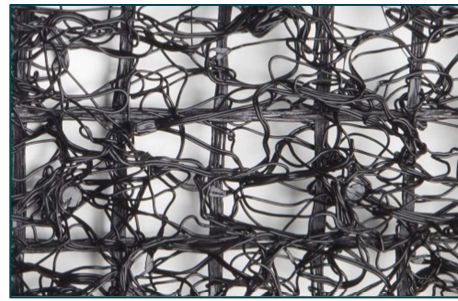
UniMi performance assessment on Maccaferri MacMat Geogrid & MacMat Steel

Erosion Control Geomats average performances

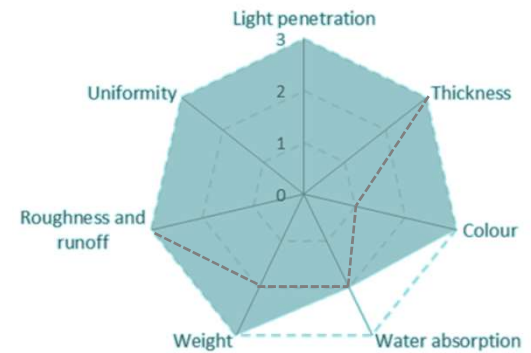
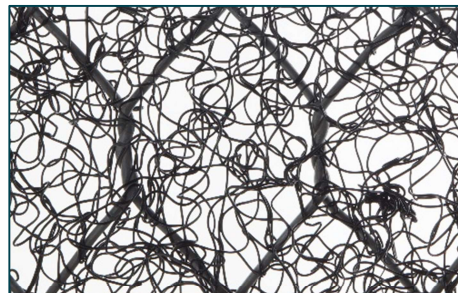


"Relationships between Erosion Control Products and vegetation growth"
Prof. G.B. Bischetti et al, UniMi, 2021

MacMat Geogrid



MacMat Steel

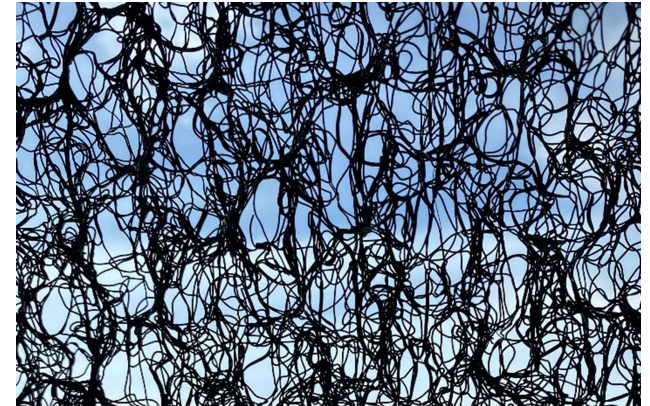


MACMAT: THE SUSTAINABLE SOLUTION FOR EROSION CONTROL

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MacMat

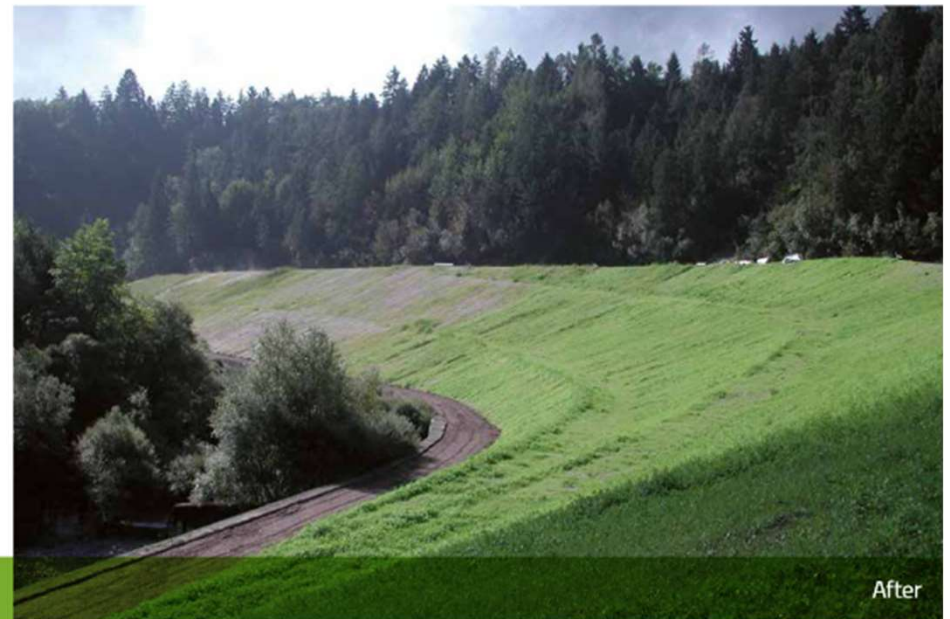
- M** Increases the **shear resistance** along the soil surface
- M** **Protects the topsoil** from washout
- M** Boosts the **growth of vegetation**
- M** Meets **specific project needs**: it comes either with **Geogrid** or **DT steel mesh**



OUR EXPERIENCE

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Naturally integrated into the surrounding environment



OUR EXPERIENCE

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Securing a connection between African countries and the access to the Indian Ocean

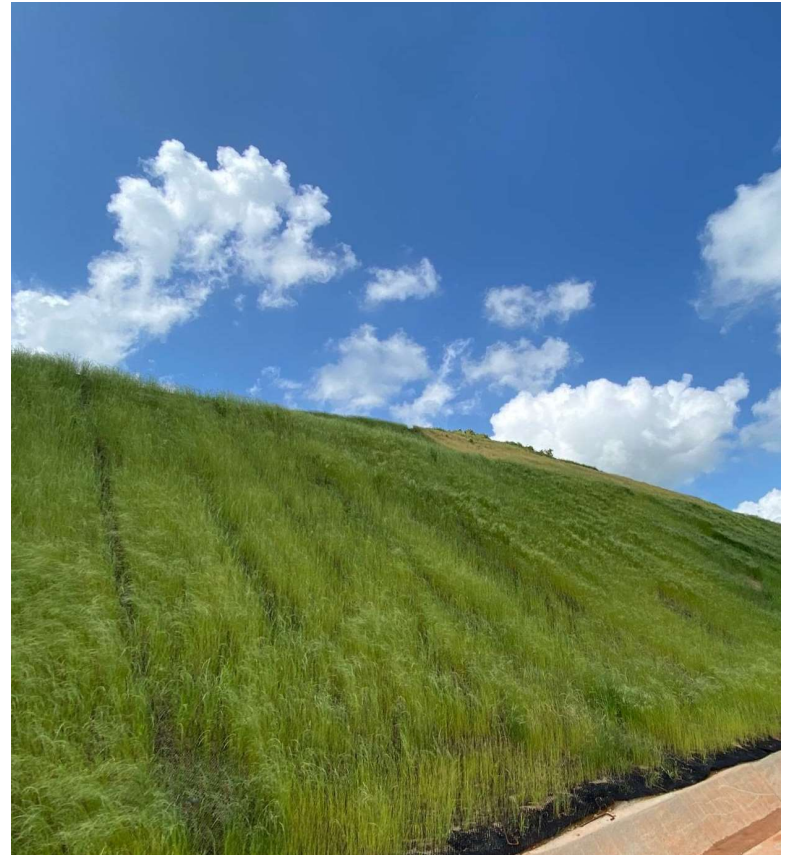


- 328.000 m² of **MacMat 12.1** and **MacMat R1** were used
- Successful revegetation



OUR EXPERIENCE

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THE GROWTH OF VEGETATION

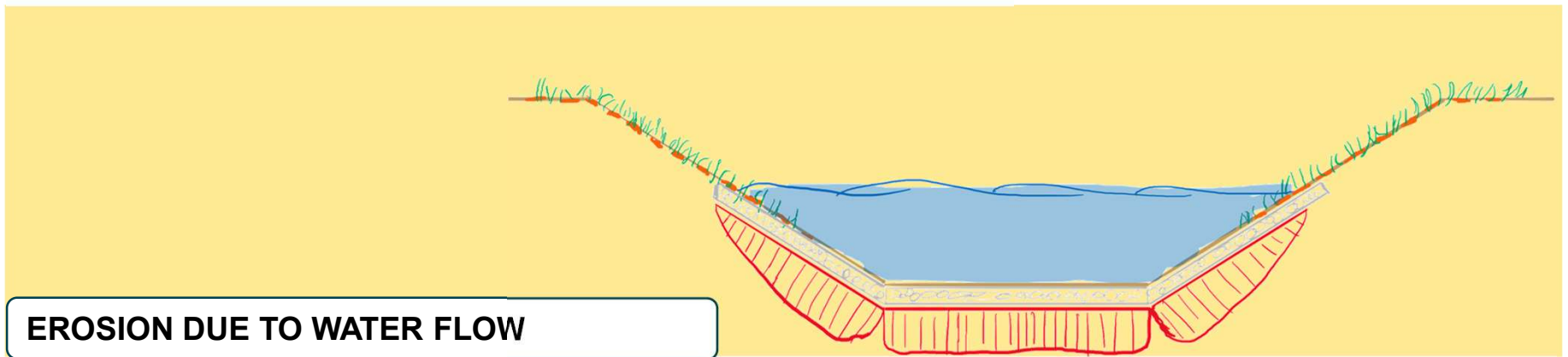
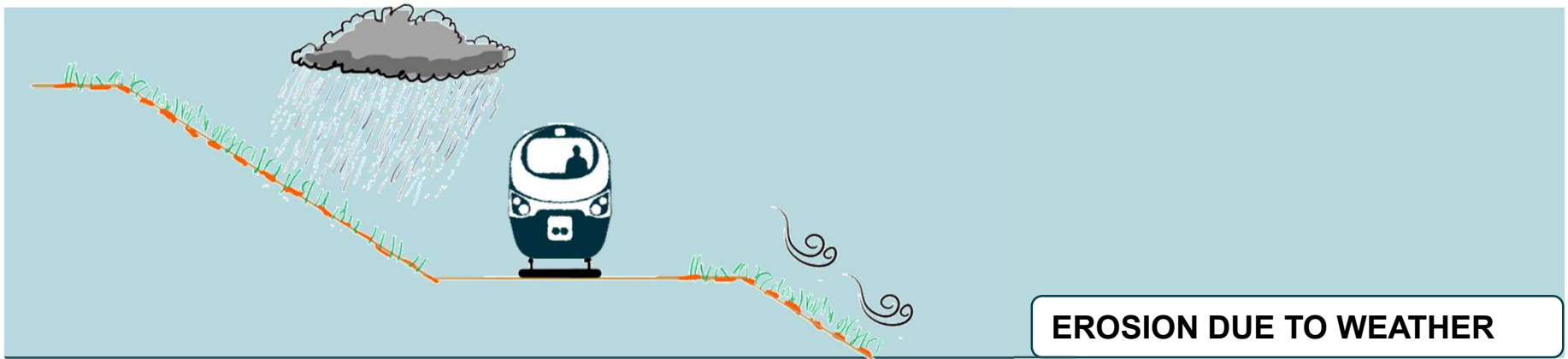
OPTIMISED EROSION CONTROL
SOLUTIONS

DESIGN SOFTWARE



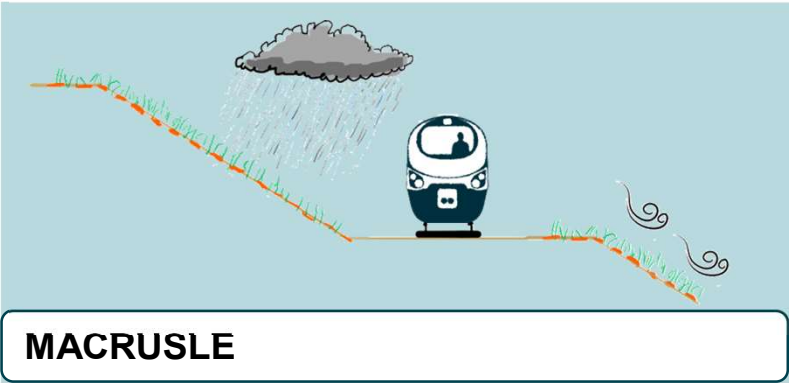
WHICH TYPE OF SOIL EROSION?

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MACCAFERRI SOFTWARE SUITE FOR EROSION CONTROL

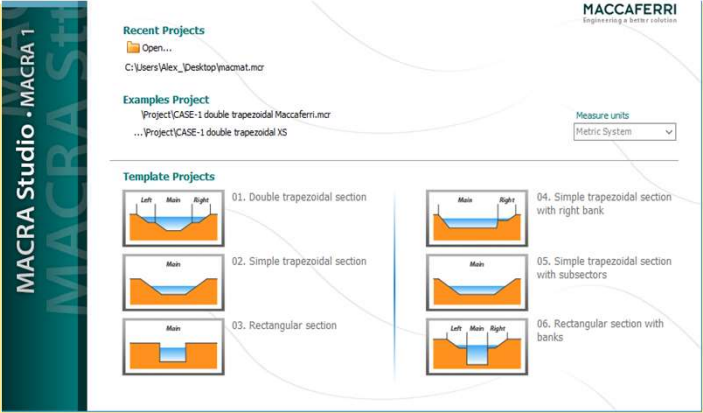
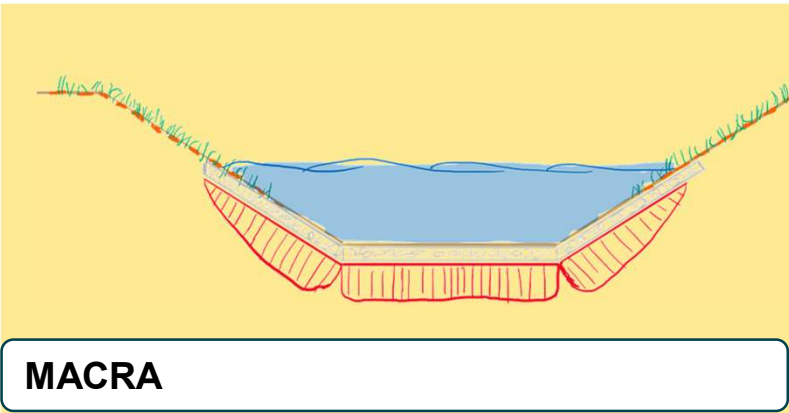
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DESIGN OF GEOSYNTHETICS FOR EROSION CONTROL ON SLOPES

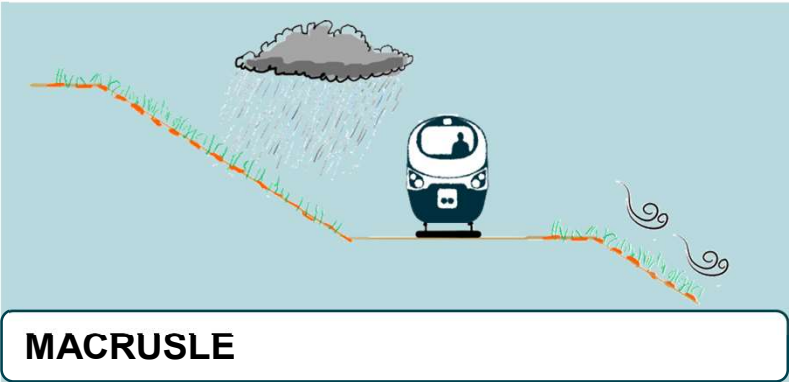
PROJECT AREA DATA		
SITE DESIGNATION	AREA DESCRIPTION	LAND AREA (m2)
1	GRUBH	1000
2	CHLWY	37200
3	ALUWYR	1400
4	GRAPFV SV	13700
5	CHWRH	840
6	CHWRH	1300
7	N CHWRH	1150
8	CHWRH	1000
9	FYUUL	5500
10	EDUCHE TH	2000
11	EDUCHE TH	9500
12	RAV77	3700
13	S	0
14	S	0
15	S	0
16	S	0
17	S	0
18	S	0
19	S	0
20	S	0

RULE METHOD		PROJECT CONSTRUCTION PERIOD WITHIN 1 SOLAR YEAR	
WORK PERIOD	FROM	TO	DURATION (DAYS)
	01/03/2017	31/03/2017	183
		% YEAR	50.1



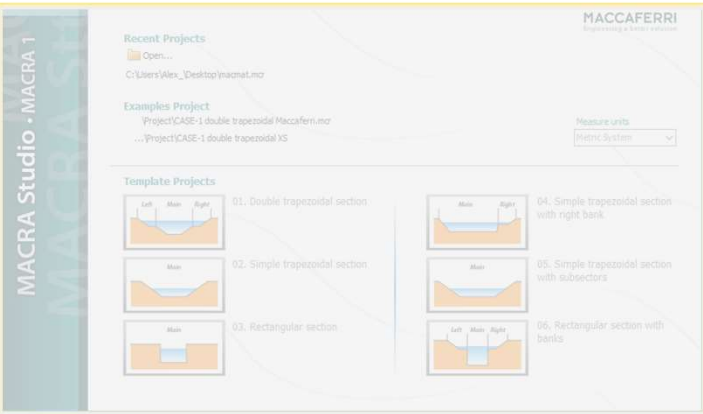
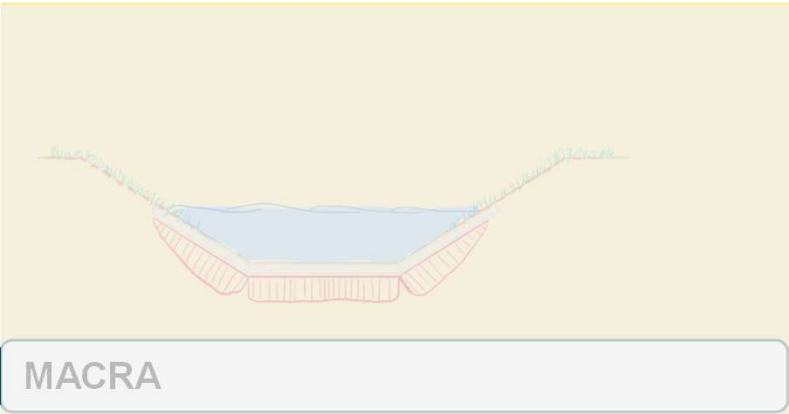
MACCAFERRI SOFTWARE SUITE FOR EROSION CONTROL

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DESIGN OF GEOSYNTHETICS FOR EROSION CONTROL ON SLOPES									
PROJECT AREA DATA			RUSLE METHOD						
SITE DESIGNATION	AREA DESCRIPTION	LAND AREA (m2)	PROJECT CONSTRUCTION PERIOD WITHIN 1 SOLAR YEAR				DURATION (DAYS)	183	
			WORK PERIOD	FROM	TO	% YEAR			
1	SRBSH	1500		01/03/2017	31/03/2017		80.1		
2	OTLST	1720							
3	RSUTPR	1400							
4	SRBSH 20	1170							
5	CHRT	840							
6	CHRT	3300							
7	NCHRT	1150							
8	RSUTPR	1000							
9	FYUL	500							
10	ESLUCE TR	2800							
11	ESTLW	800							
12	RY77	3700							
13		0							
14		0							
15		0							
16		0							
17		0							
18		0							
19		0							
20		0							

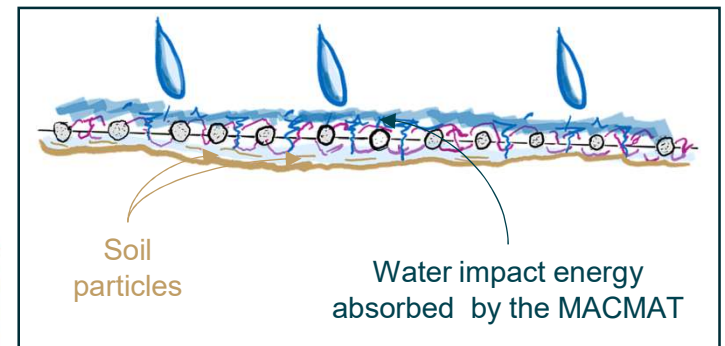
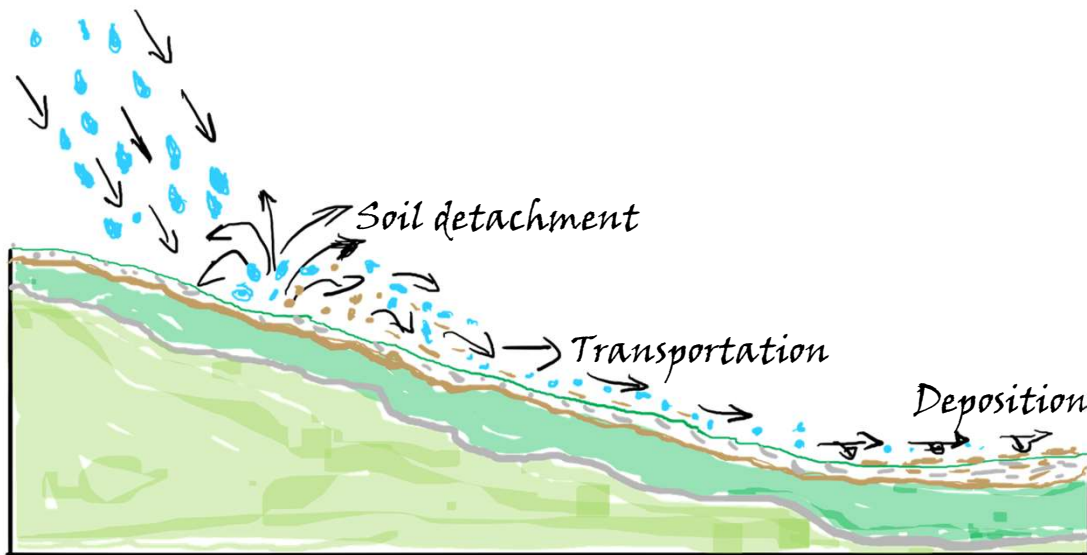
CALCULATION OF EROSION LOSS FOR THE PROJECT (SL UNITS)										
SITE DESIGNATION	AREA DESCRIPTION	LAND AREA (m2)	R factor	K factor	L factor	C factor	M factor	P factor	UNIT AREA SOIL LOSS (m3/m2) (unit: tonnage/acre)	TOTAL AREA SOIL LOSS (m3) (unit: tonnage/acre)
1	SRBSH	1500	198.5	0.1885	4.76871078	0.1	1	1	0.04401749	65.544086
2	OTLST	1720	198.5	0.04089709	6.02772878	0.2	1	1	43.5348701	75.7897168
3	RSUTPR	1400	198.5	0.017121	11.4300292	0.05	1	1	0.01779419	2.49418435
4	SRBSH 20	1170	198.5	0.09402	2.85300172	0.05	1	1	0.04401749	5.17795827
5	CHRT	840	198.5	0.044242	0.0057771	0.18	1	1	3.19917154	3.26466421
6	CHRT	3300	198.5	0.017121	8.41707387	0.05	1	1	39.7810384	131.247472
7	NCHRT	1150	198.5	0.0084	3.68341094	0.001	1	1	0.00909076	0.01106461
8	RSUTPR	1000	198.5	0.00508	10.0111882	0.05	1	1	0.04401749	1.0868195
9	FYUL	500	198.5	0.017121	10.3403833	0.008	1	1	0.04401749	0.05444566
10	ESLUCE TR	2800	198.5	0.0084	10.2048894	0.001	1	1	0.00909076	0.0101156
11	ESTLW	800	198.5	0.00048	2.18178434	0.001	1	1	0.00048	3.77620815
12	RY77	3700	198.5	0.017802	0.04012168	0.12	1	1	58.37142458	21.261959
TOTAL		108,350.8								335.6



MACRUSLE: EROSION CONTROL DESIGN SOFTWARE

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MACRUSLE is a design tool that gives an estimation of the **reduction of soil loss** based on **Revised Universal Soil Loss Equation**. It runs two simulations, without and with the erosion control product.



MACRUSLE: EROSION CONTROL DESIGN SOFTWARE

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DESIGN OF GEOSYNTHETICS FOR EROSION CONTROL ON SLOPES

PROJECT AREA DATA		
SITE DESIGNATION	AREA DESCRIPTION	LAND AREA (m ²)
1	SRGBH	15000
2	DTUKT	37200
3	24UJTYR	5400
4	GMHF3Y35Y	13700
5	OIGR7I	840
6	GNDTU	3300
7	N DHRTHU	1150
8	RH46U46	10500
9	FJYUJL	5500
10	EG.UOÐ	2600
11	EEYIL7WT	9500
12	R4Y77	3700
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0

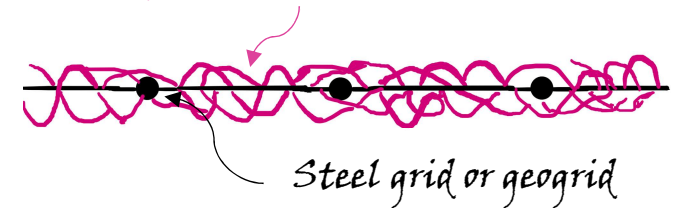
RUSLE METHOD

PROJECT CONSTRUCTION PERIOD WITHIN 1 SOLAR YEAR

WORK PERIOD	FROM	01/03/2017	DURATION (DAYS)	183
	TO	31/08/2017	% YEAR	50,1



Geomat
or
synthetic filaments



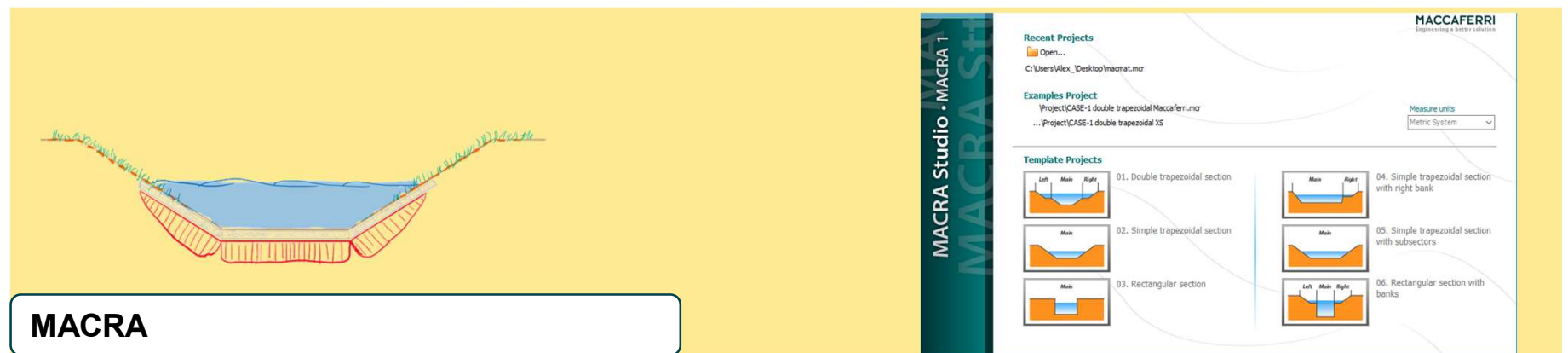
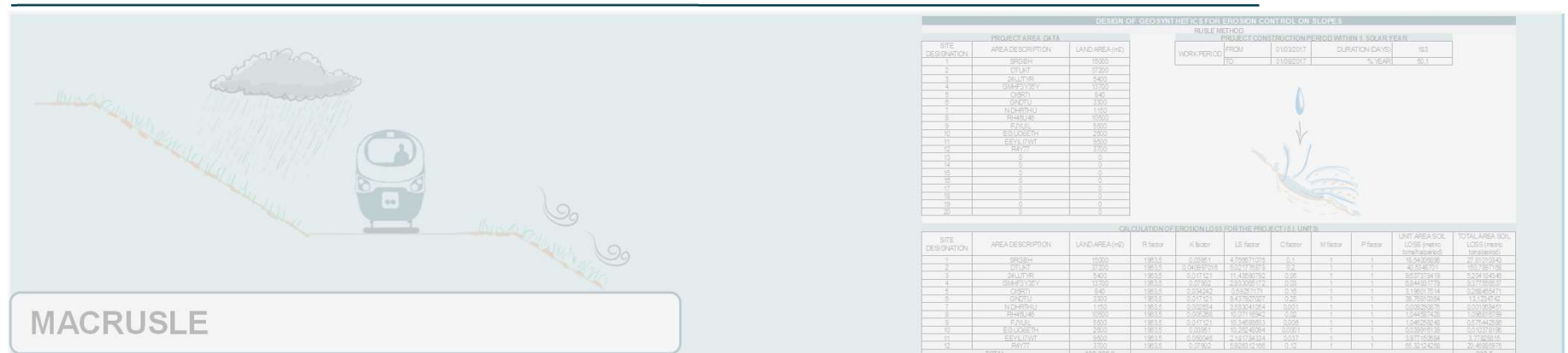
Steel grid or geogrid

CALCULATION OF EROSION LOSS FOR THE PROJECT (S.I. UNITS)										
SITE DESIGNATION	AREA DESCRIPTION	LAND AREA (m ²)	R factor	K factor	LS factor	C factor	M factor	P factor	UNIT AREA SOIL LOSS (metric tons/ha/period)	TOTAL AREA SOIL LOSS (metric tons/period)
1	SRGBH	15000	1963,5	0,03951	4,766671076	0,1	1	1	18,54006896	27,81010343
2	DTUKT	37200	1963,5	0,040997016	5,021776878	0,2	1	1	40,5348701	150,7897168
3	24UJTYR	5400	1963,5	0,017121	11,43590792	0,05	1	1	9,637378419	5,204184346
4	GMHF3Y35Y	13700	1963,5	0,07902	2,933065172	0,03	1	1	6,844931779	9,377556537
5	OIGR7I	840	1963,5	0,034242	0,59257171	0,16	1	1	3,196017514	0,268465471
6	GNDTU	3300	1963,5	0,017121	9,437927027	0,25	1	1	39,76810364	13,1234742
7	N DHRTHU	1150	1963,5	0,002634	3,583041054	0,001	1	1	0,009290876	0,001068451
8	RH46U46	10500	1963,5	0,005268	10,07116942	0,02	1	1	1,044587428	1,096816799
9	FJYUJL	5500	1963,5	0,017121	10,34593633	0,006	1	1	1,046259248	0,575442586
10	EG.UOÐ	2600	1963,5	0,03951	10,26248094	0,0001	1	1	0,039916139	0,010378196
11	EEYIL7WT	9500	1963,5	0,050046	2,181784334	0,037	1	1	3,977150684	3,77829315
12	R4Y77	3700	1963,5	0,07902	5,926312166	0,12	1	1	55,32124258	20,46885975
TOTAL		108.390,0								232,5



MACCAFERRI SOFTWARE SUITE FOR EROSION CONTROL

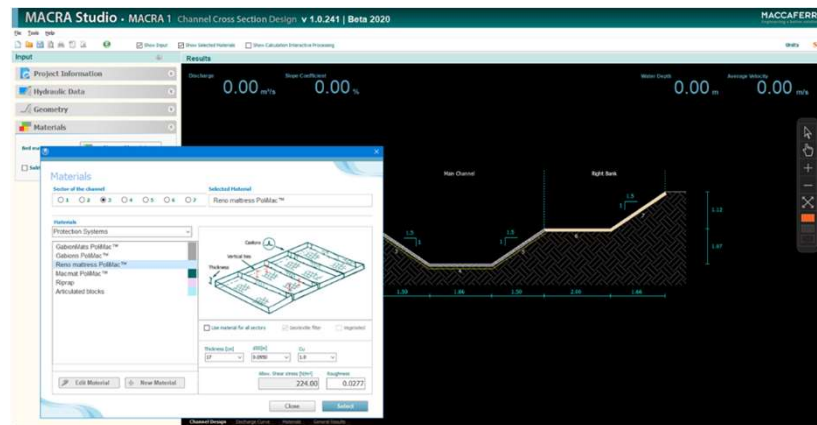
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MACRA SOFTWARE

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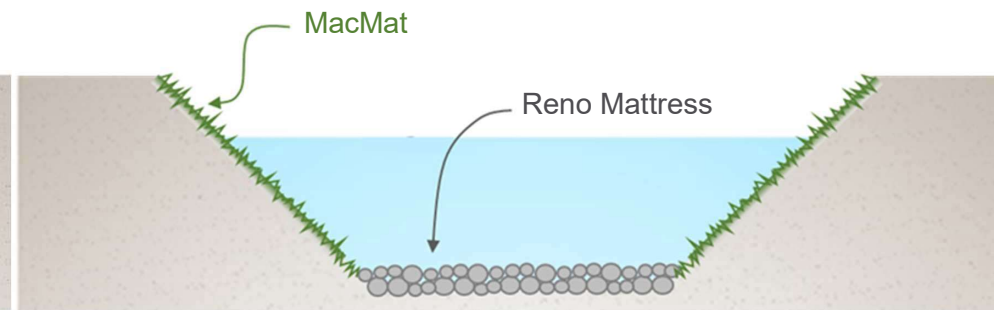
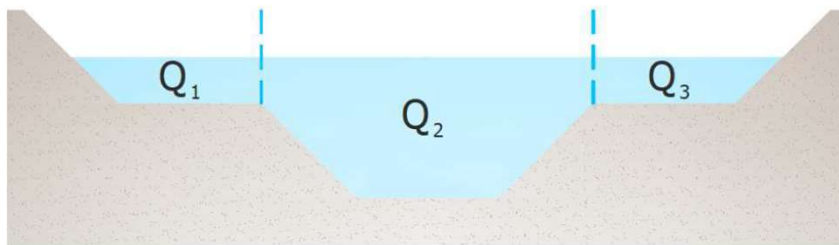
The design of River Analysis Solutions



MACRA is the software developed on the basis of experimental tests carried out at Colorado State University.

MACRA can model **complex geometries** and **multiple products combination** providing **accurate** and **realistic results**.

MACRA enable the user to design with MacMat in either **VEGETATED** and **UNVEGETATED** conditions.



THE TEST

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ASTM D6460



ASTM INTERNATIONAL
D6460

Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Earthen Channels from Stormwater-Induced Erosion

THIS TEST METHOD UTILIZES FULL-SCALE TESTING PROCEDURES



OBJECTIVE OF THE SOLUTION

Neutralize and absorb the hydraulic force of stormwater, thereby **reducing soil particle loosening** through “scour” mechanisms.



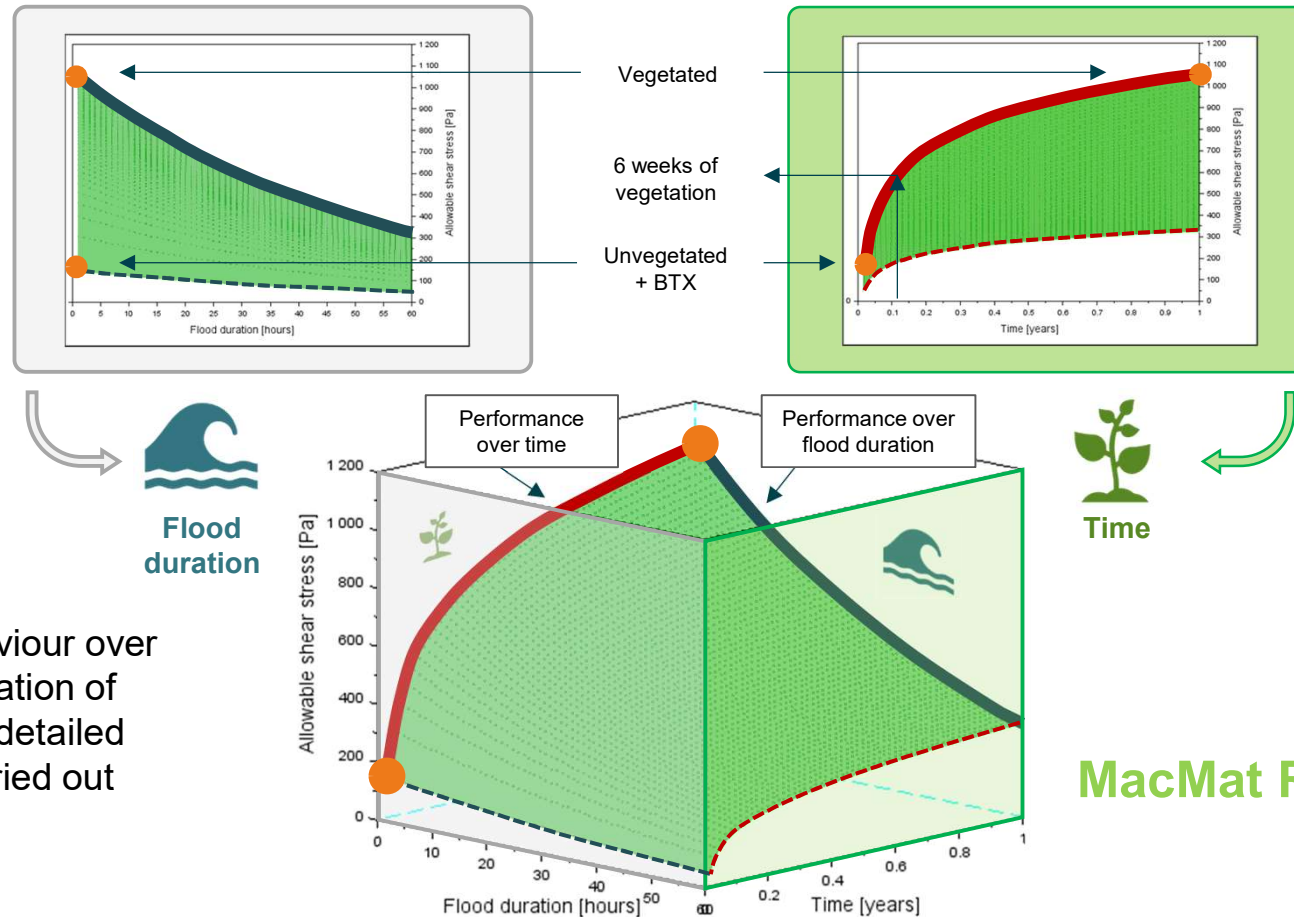
FAILURE CRITERION & TEST FOCUS

- M** The solution fails when the average loss of soil is equal or greater than 0.5 in
- M** The limit value at which failure occurs are assessed.
- M** The impact of vegetation on product performance is assessed



DESIGN OF MACMAT SOLUTIONS IN MACRA

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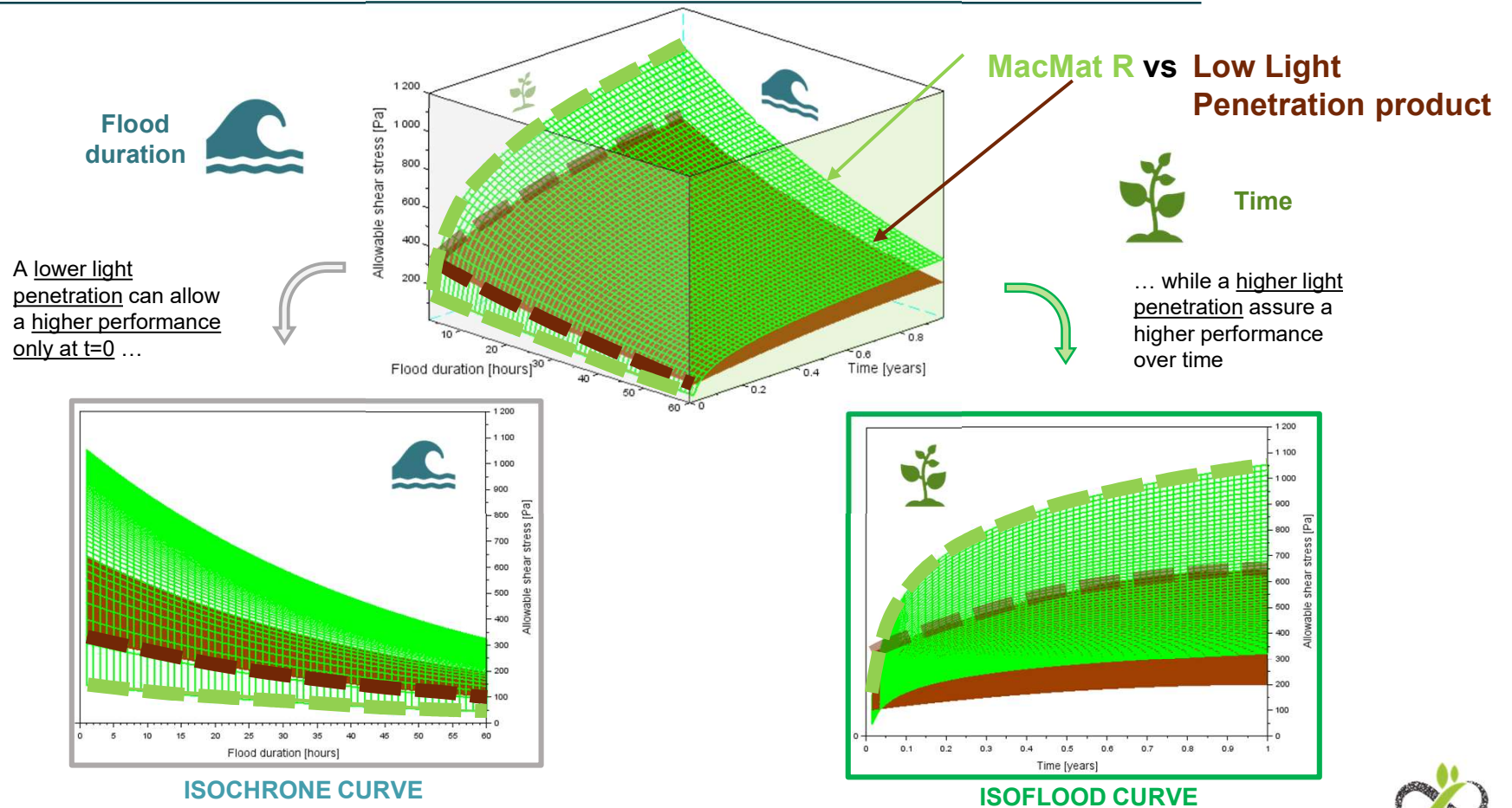


Knowing the behaviour over time and flood duration of MacMat R, a fully detailed design can be carried out



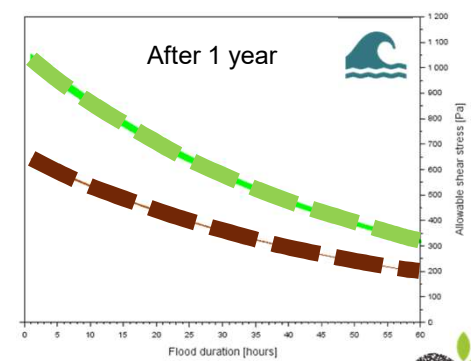
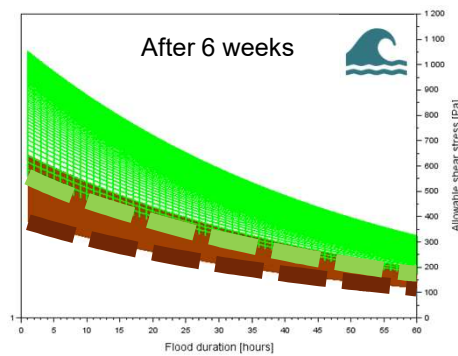
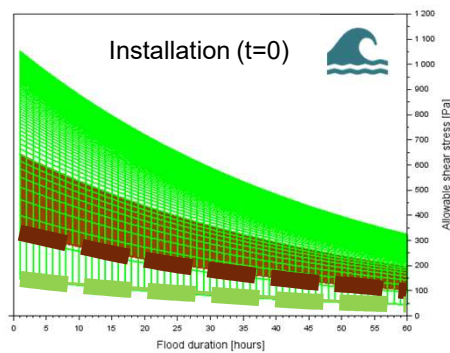
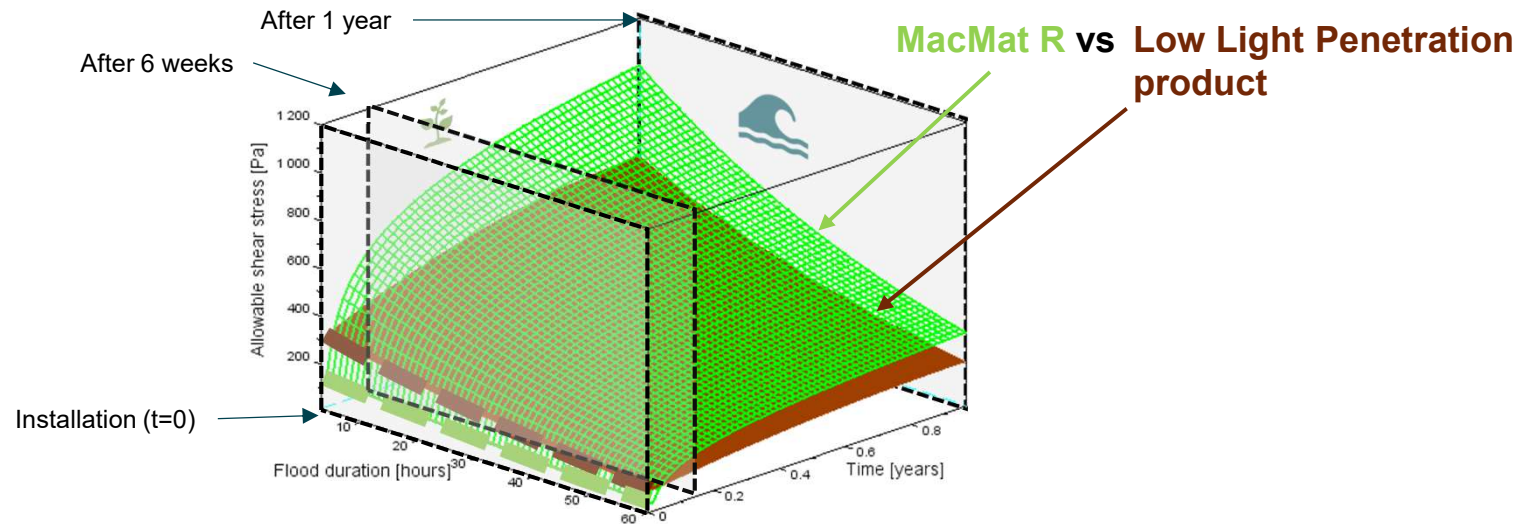
DESIGN OF MACMAT SOLUTIONS IN MACRA

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DESIGN OF MACMAT SOLUTIONS IN MACRA

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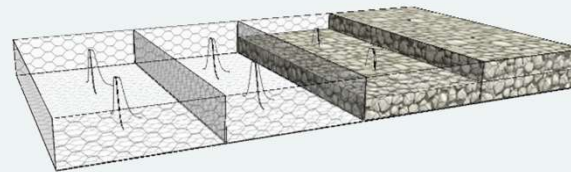


MACRA SOFTWARE

MACCAFERRI

The design of River Analysis Solutions

2 in 1



Reno Mattress Plus (base)



MacMat R (lid)

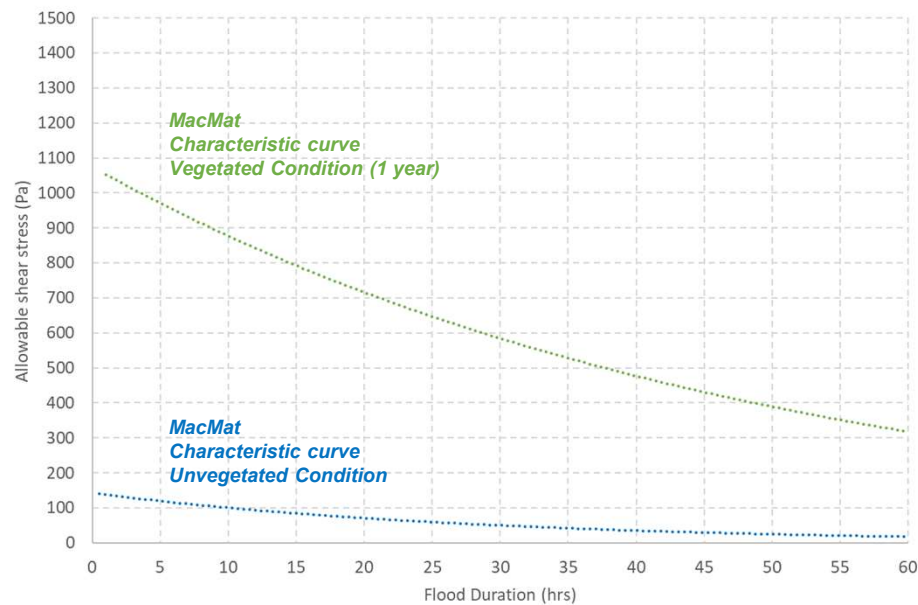
- Possible usage of deep anchor elements, thus guaranteeing an additional stabilizing effect on the embankment
- Possible coupled usage with mattresses and gabions, also facilitating a partial filling either with stones and topsoil or “vegetative pockets”



VEGETATED VS UNVEGETATED

MACCAFERRI

MacMat Performances



The characteristic curves must be considered as the reference performances for both the vegetated and unvegetated conditions.

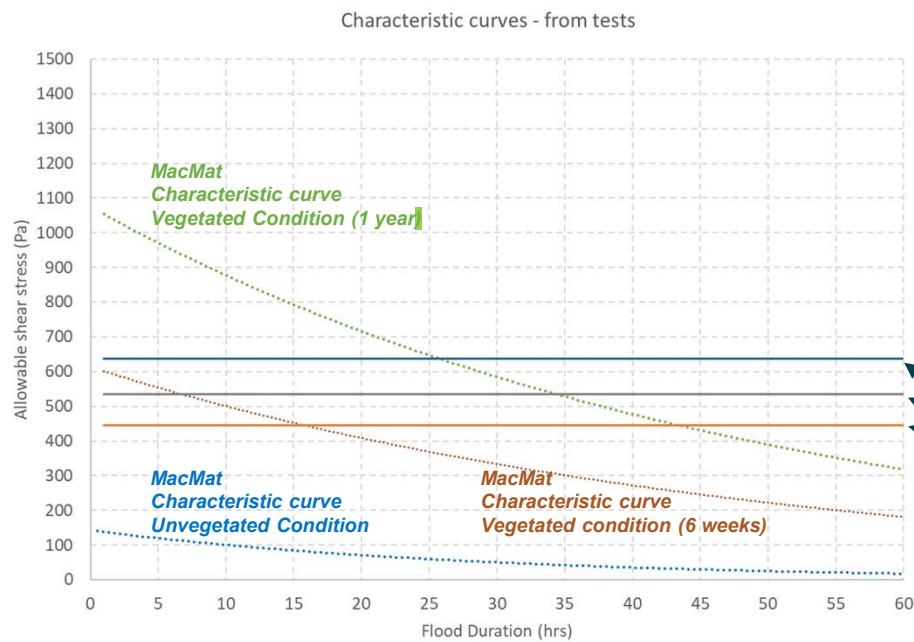
Neither Safety Factors nor Reduction Factors are applied to define them.



MACMAT VS RENO MATTRESS

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Performance comparison



Upper bound
Reno Mattresses Plus 30, 23, 17

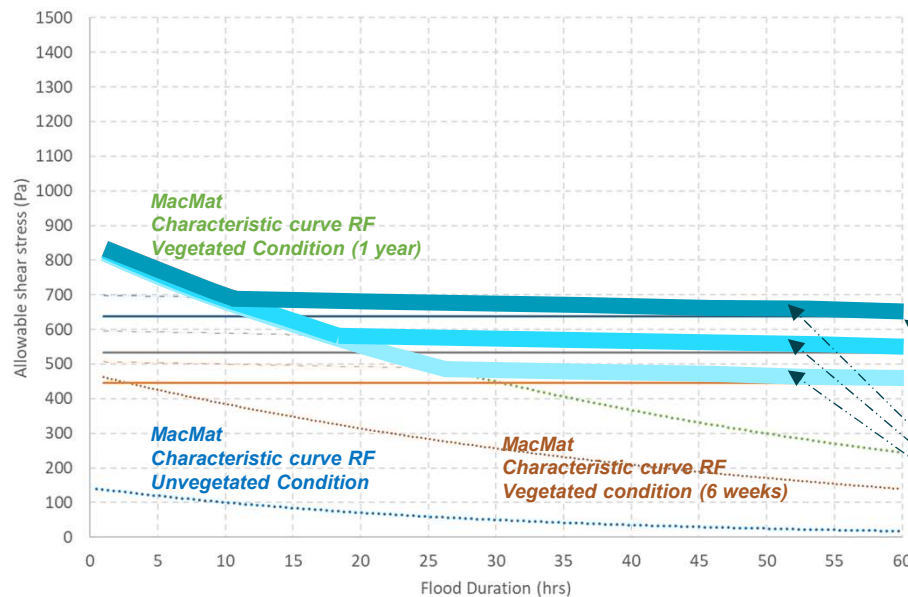


MACMAT AND RENO MATTRESS

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Performance increase for MacMat + Reno Mattres

Design curves (upper limit) when **fully vegetated**



The full vegetation can be faster achieved using:

- M mulch
- M **MacMat R**

In any case, **the vegetation period to reach the best performance widely depends on the actual site conditions** (environment, climate, etc.)

Upper bound RF
Reno Mattresses Plus 30, 23, 17

Characteristic curve
Combo Reno Mattresses Plus 30, 23, 17

The **best performance** can be achieved only when the solution is **fully vegetated**





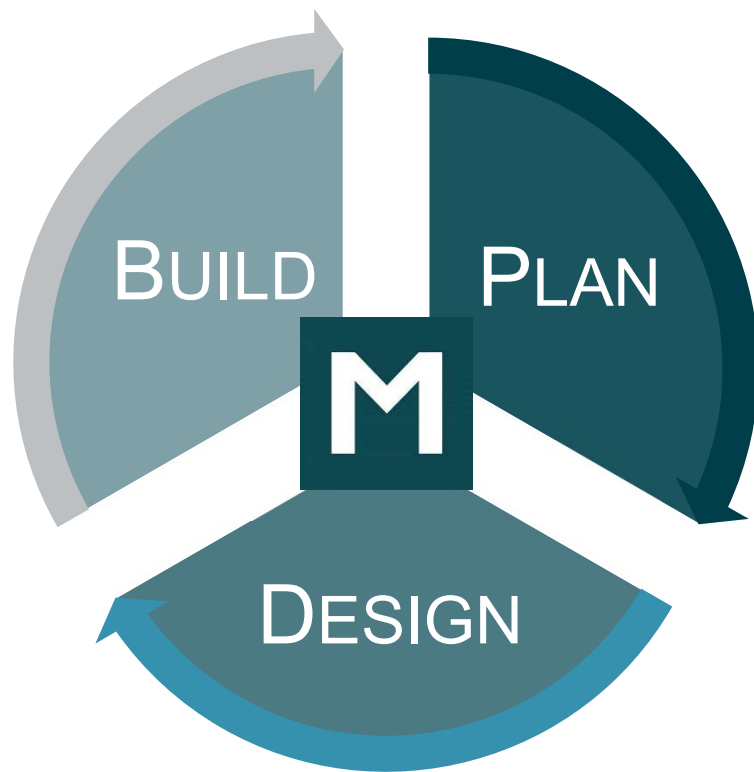
FINAL REMARKS



360° SUPPORT FOR YOUR PROJECT

MACCAFERRI

Maccaferri is always side by side with engineers, architects and builders



Our **experts** in **geotechnical, hydraulic & environmental engineering** can support through all the project phases.





Not only **performance** certification, but also **environmental** and **digital** ones.



We provide reliable and comparable information on the environmental impacts of the product life cycle **reducing energy** and **material consumption**

visit maccaferri.com/EPD



Our products are also available as BIM. Our BIM Object have been validated by the British Board Agreement (BBA) as being a true and fair representation of the physical product/system. BIM system **reduces design time and cost** and facilitates cooperation between project stakeholders

visit maccaferri.com/BIM



Any change in fragile ecosystems should be carefully considered, as **the value of biodiversity** extends far beyond the physical boundary of a project development.



ENVIRONMENTAL SUSTAINABILITY

MACCAFERRI

Life Cycle Assessment studies aims at weighing emissions and impacts of a solution, starting from the raw materials to the construction and delivery of the finished system.

We conducted a detailed LCA study on our MacMat Series in order provide reliable and comparable information on the environmental impacts of our solutions, reducing energy and material consumption.



Click on the link to find more information

[EPD MACMAT](#)

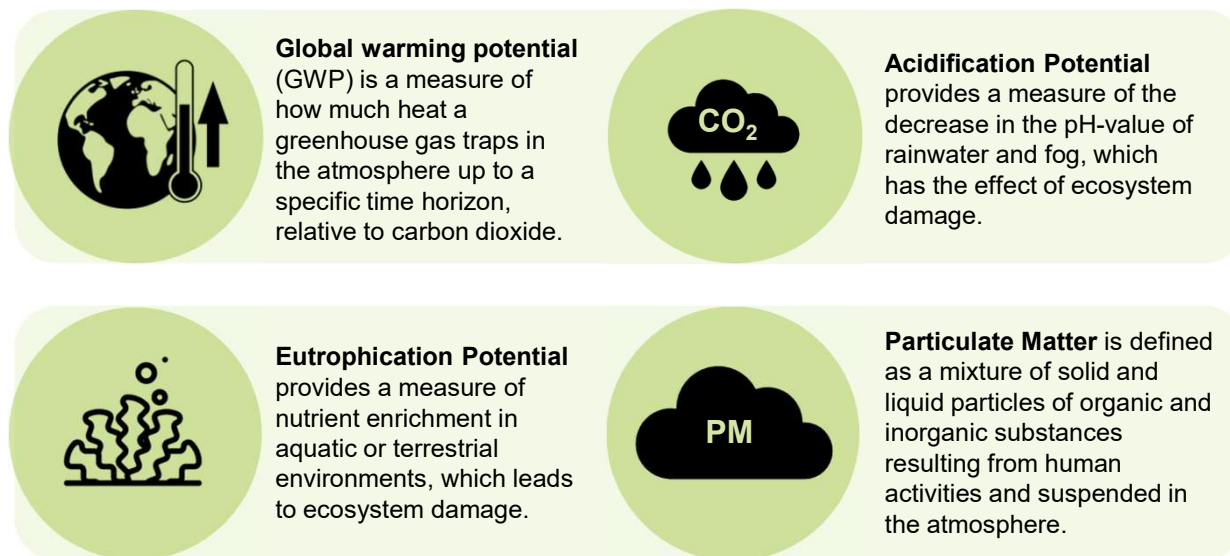
or use the QR code!



ENVIRONMENTAL SUSTAINABILITY

MACCAFERRI

The **environmental performance** is assessed with the following impact category indicators:



Click on the link to find more information

[EPD MACMAT](#)

or use the QR code!



An underwater photograph showing a clear blue ocean. In the center, a white and purple plastic cup floats upside down. Surrounding it are various pieces of debris, including yellow and brown leaves or small pieces of plastic. The background shows a blurred shoreline with green trees under a cloudy sky. The overall scene illustrates the problem of plastic pollution in the ocean.

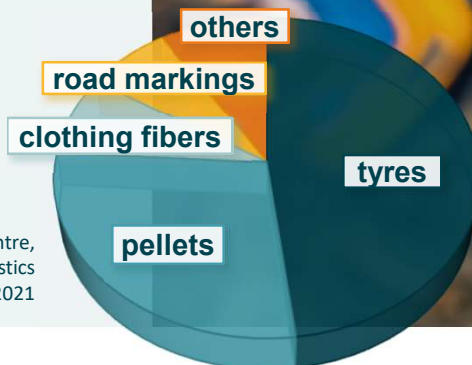
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“The issue of plastic waste in the ocean is one of growing magnitude and concern”

National Oceanography Centre

Microplastic is now a commonly used term that indicates plastic particles with size < 5 mm.

They are mostly produced by the fragmentation and degradation of larger plastic items during their use.



National Oceanography Centre,
Sources, amounts & pathways of plastics
entering the global ocean, 2021



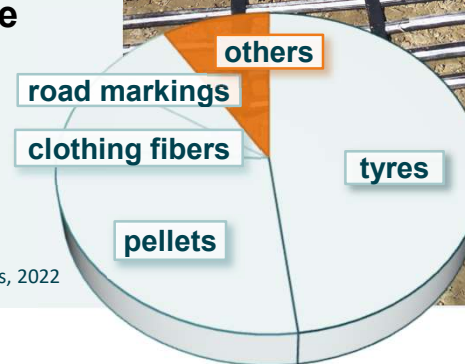
Photo credit: Water Europe

Can geosynthetics be a source of microplastics?

- most applications do not leave geosynthetics directly exposed to UV
- at the moment, they are **not recognized** as a relevant source of microplastics
- research shows that the **physical and chemical properties** of plastics determine the extent and rate of transformations. Our geosynthetics are produced with **high standards** and designed to face **extreme conditions**

Also, construction may also represent a possible future sink for plastic waste, with recycled plastic building materials.

Cost-benefit analysis of policy measures reducing unintentional release of microplastics, 2022



How do geosynthetics reduce environmental burden?

- ease of installation
- increased speed of construction
- improved performance by increased longevity or reduction of maintenance

These advantages all translate in **life cycle** savings.

Also, the application of geosynthetics in construction improves **sustainability** in terms of **conserving natural environments** as compared to alternative designs.

Simon et al., EI-GEO Environmental Impact of Geosynthetics in aquatic systems, 2020



OUR COMMITMENT TO ENVIRONMENTAL SUSTAINABILITY

MACCAFERRI



Research on microplastics is still relatively **limited** in number and content.

Even if we believe in our solutions, we are staying updated on research findings and we will make sure our geosynthetics respect **the highest standard** regarding **environmental protection**.



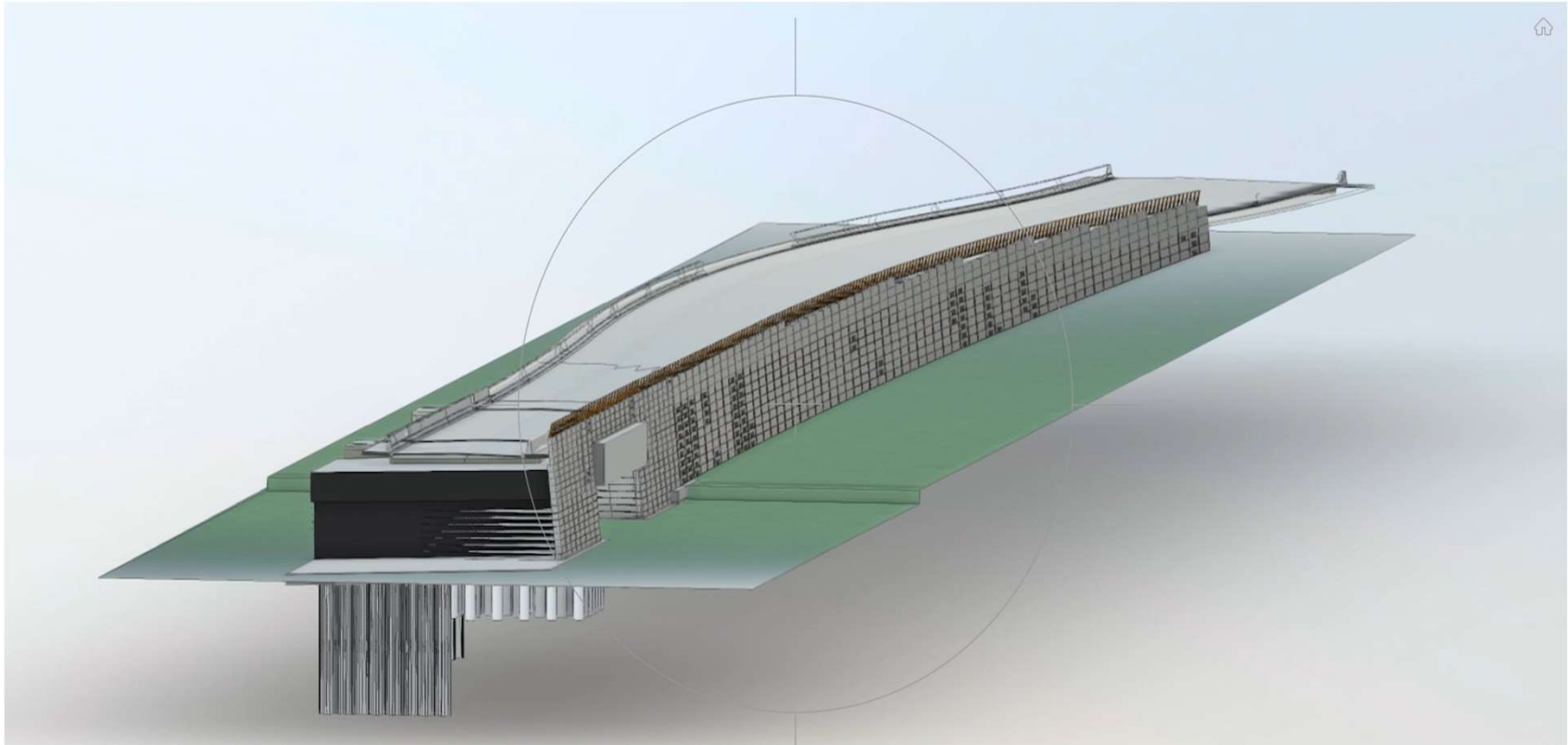


Building Information Modeling (BIM) is the foundation of digital transformation in the architecture, engineering, and construction industry.

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BIM – A NEW APPROACH TO THE DESIGN

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CONCLUSIONS

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- M** We promote an **holistic approach** to the selection of the most suitable Erosion Control Solution
- M** Our geosynthetics are among the **most tried and tested** in the world
- M** Thousands of reference cases available that prove the **cost effectiveness**



LIVE Q&A



erosion CONTROL
sustainable durability

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