



OPERANDUM

**OPEn-air laboRAtories for Nature based
solUtions to Manage hydro-meteo risks**



Nature Best Solutions

Soil & Water bioengineering techniques



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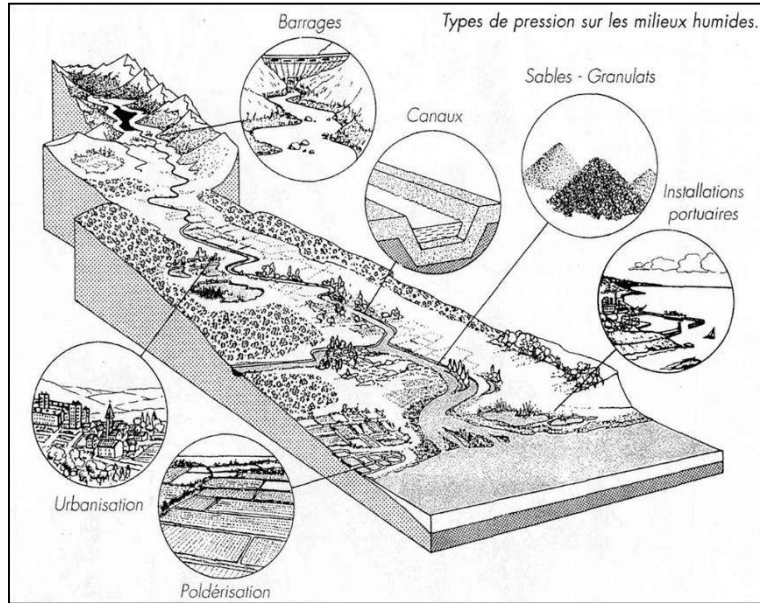


Naturalea is specialized in landscape restoration and it is a cutting-edge nationwide company in the field of implementation of bioengineering techniques, both traditional naturalistic engineering and biophysical or structural vegetable engineering. Created in 1996 with more than 1185 developed projects. Solve engineering problems creating landscape. Nature Conservation to improve quality of live.



“Salix provide sustainable, ecologically sound answers to the challenges found in soil and riverbank erosion, inland dredging, water based civil engineering, vegetation establishment, wetlands and habitat creation projects across the UK”

River management for improving morphology and regain river floodplain



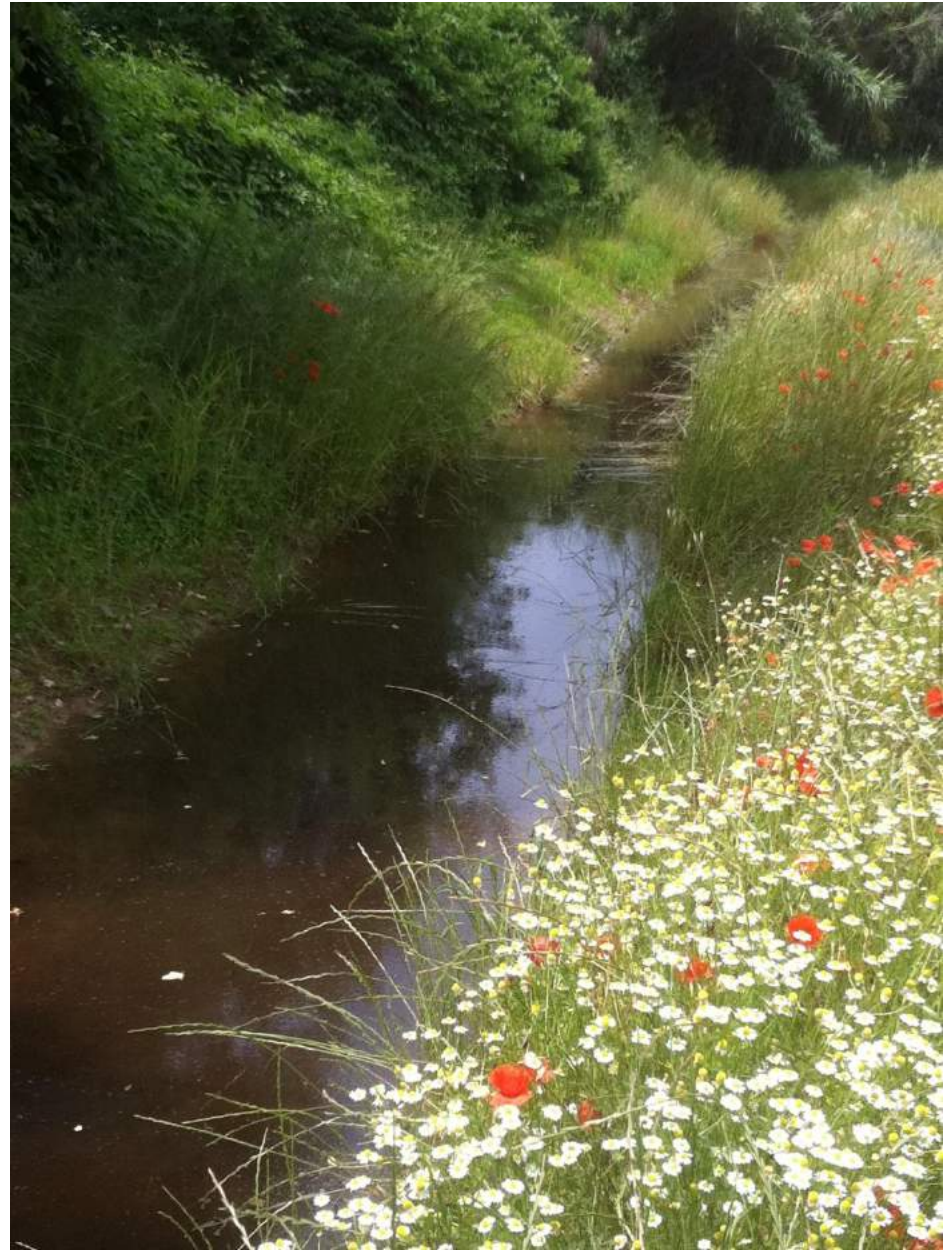




Smart citys involve green...Paris ideas ...involve rivers...Seul facts







SOIL AND WATER BIOENGINEERING TECHNIQUES, Practic NBS nature based solutions

Soil and water bioengineering is a discipline that combines technology and biology, making use of plants and plant communities to help protection land uses and infrastructures, and contribute to landscape development.

Typically, plants and part of the plants are used as living building materials, in such a way that, through their development in combination with soil and rock, they ensure a significant contribution to the long-term protection against all forms of erosion. In the initial phase, they often have to be combined with non-living building materials, which may, in some cases, ensure more or less temporarily, most of the supporting functions.

European Guidelines for Soil and Water Bioengineering EFIB, 2015



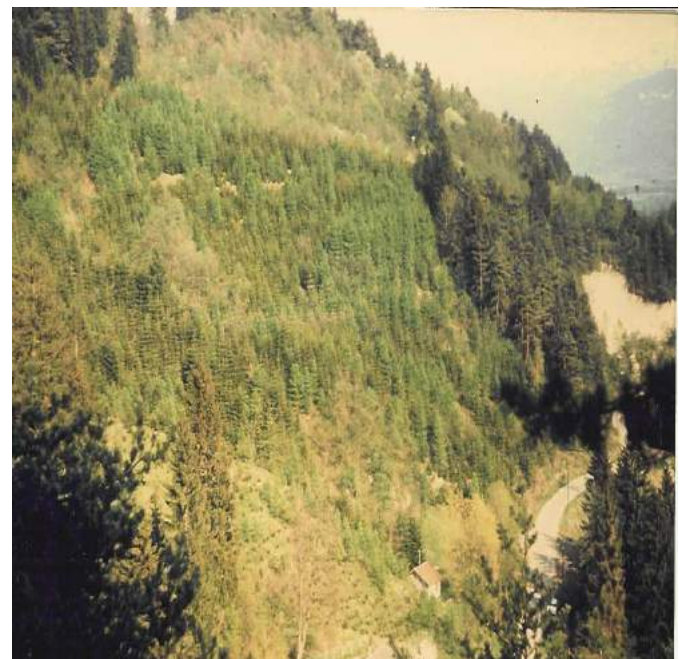
Soil bioengineering, modern discipline in the management of natural areas.

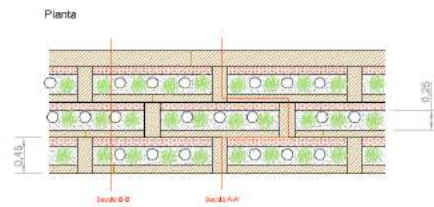
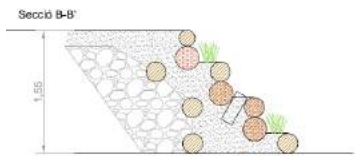
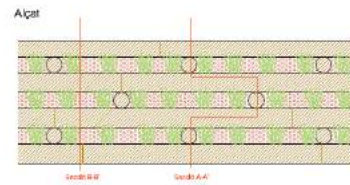
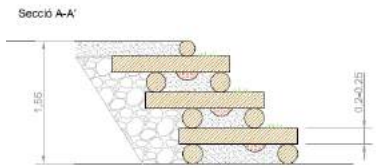
The roots of willows prevent the collapse of banks of canals and branches of willows that are placed in the margins and then cut each year and become dense and thus yields a margin of lives in one piece..

Léonardo da Vinci









NATURAL MATERIALS: HERBS, SHRUBS AND TREES

Physical Conditioners

Phytogeography

Weather

Land relief

Lithology

Edaphology

Hydraulics



Species

Selection criteria of the plant.

- Biological → List of suitable species
- Landscape
- Engineering



Introduction technique



Biotechnical characteristics:

A series of characteristics that make them especially interesting for stabilization

Faculty to colonize degraded lands (pioneer species);

Adventitious root emission capacity;

Rooting ability of stems and branches;

Mechanical tensile strength of roots and stems;

Resistance to falling stones;

Surface coverage capacity;

Survival capacity after planting

Resistance to watering

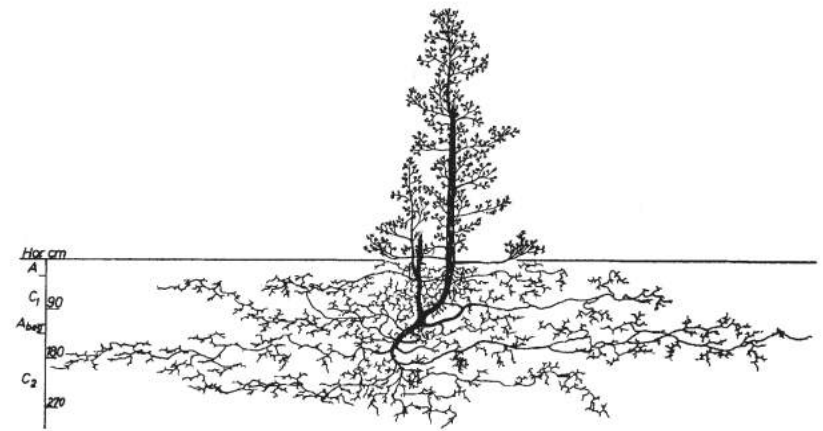


Figura 3.6: *Juniperus communis ssp. communis* (Kutschera –Sobot ik, 1997)

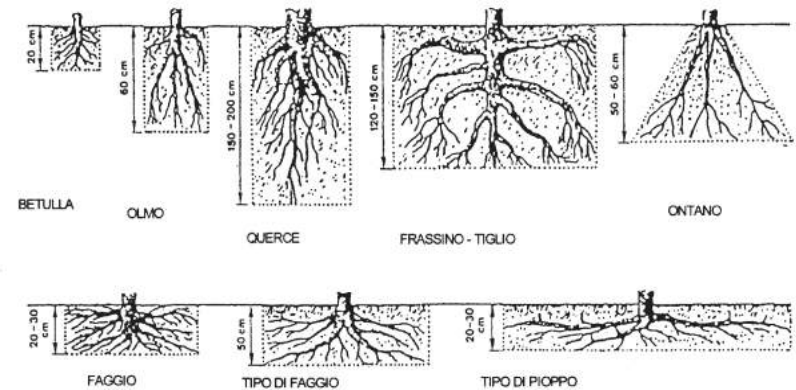


Figura 3.7: Confronto tra i diversi apparati radicali delle diverse specie di alberi (Mathey, 1929)

- Mechanical tensile strength

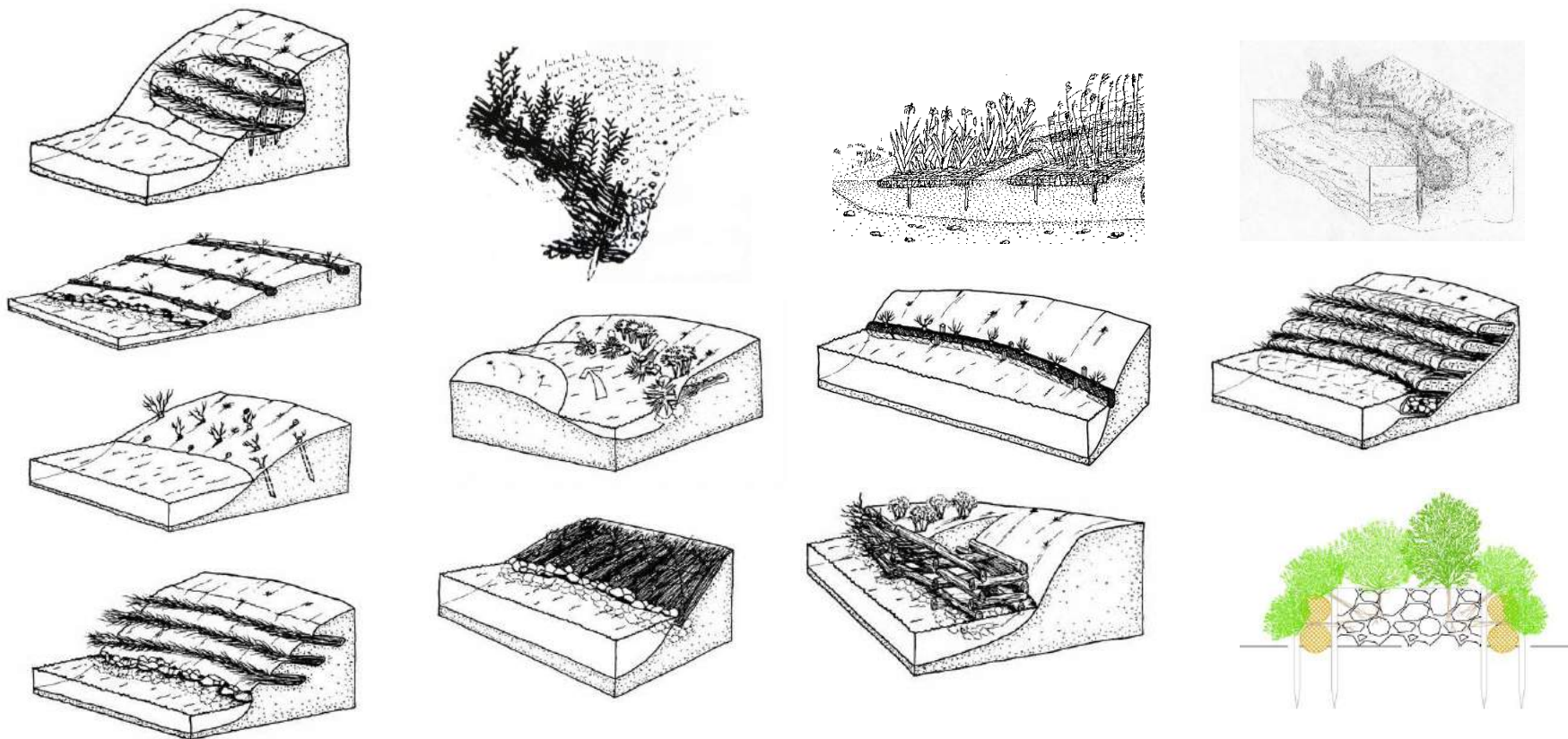
- Consolidating action of the soil: Depends on the shape of the root apparatus, rooting density and root mass

- Edaphology strength: the action of improvement of the land that allows through the succession to pass from the pioneer species to other stages of vegetation more evolved thanks to the climatic and soil improvement, thanks to either the root symbiosis for the fixation of Nitrogen (Legumes) or to the loss of leaves (Alnus)

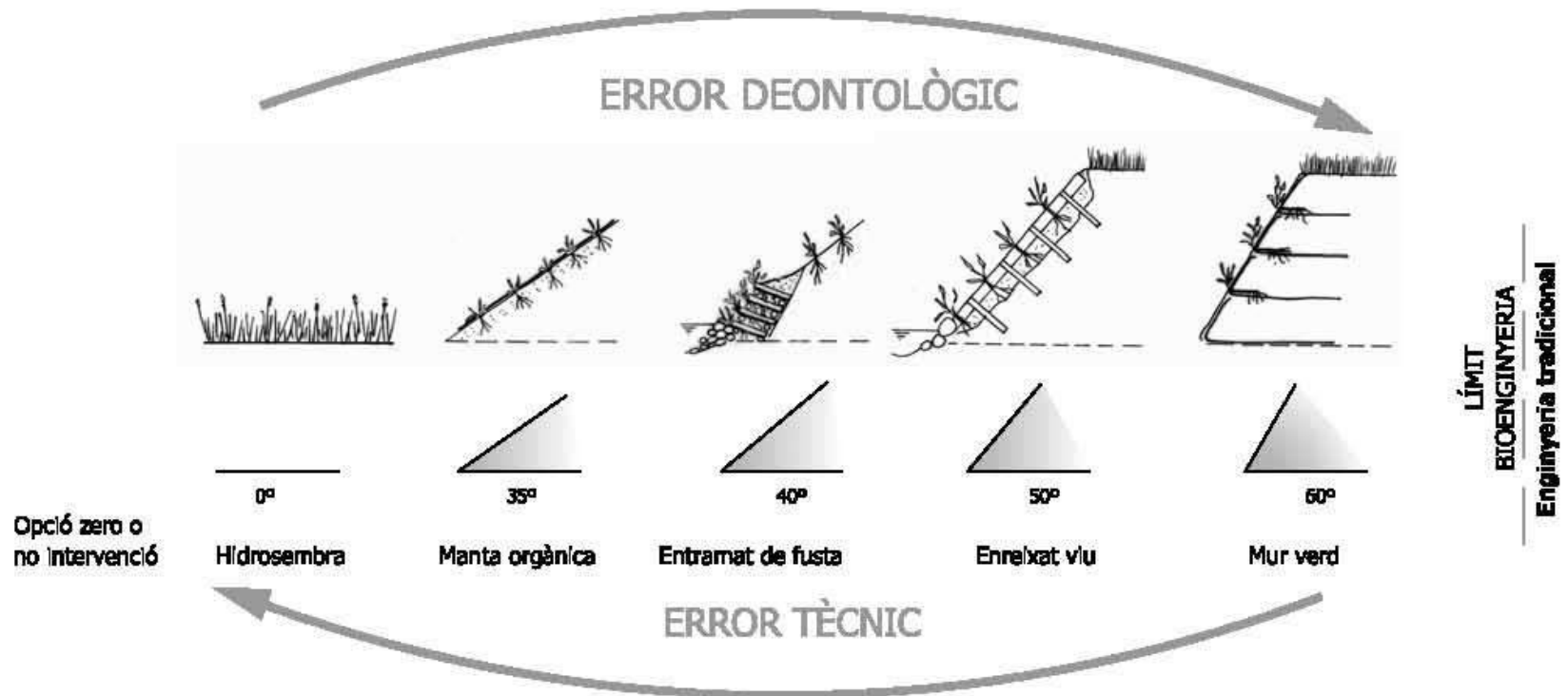
Importance of the relation between the volume of the radical part and the aerial part of several plants:

<i>Arbusti e alberi</i>		<i>Piante erbacee</i>	
<i>Salix glabra</i>	2,4	<i>Stipa species</i>	5-15
<i>Viburnum Lantana</i>	2,3	<i>Equisetum arvense</i>	5,5
<i>Erica carnea</i>	2,0	<i>Rumex scutatus</i>	5,5
<i>Salix eleagnos</i>	1,8	<i>Deschampsia caespitosa</i>	1,6
<i>Salix nigricans</i>	1,8	<i>Festuca ovina</i>	1,1
<i>Alnus viridis</i>	1,6	<i>Anthyllis vulneraria</i>	0,8
<i>Salix purpurea</i>	1,5	<i>Achillea millefolium</i>	0,7
<i>Fraxinus excelsior</i>	1,5	<i>Lotus corniculatus</i>	0,7
<i>Ligustrum vulgare</i>	1,2		
<i>Acer pseudoplatanus</i>	1,1		
<i>Hippophae rhamnoides</i>	1,0		
<i>Berberis vulgaris</i>	0,6		
<i>Salix alba</i>	0,5		

Fonte: da Schiechl, 1973



How should we act



From: NTJ 12S PART 5



2009 Sant Hilari Sacalm



2014 Talús Parc de la Serreta





Sils

River Conwy Flood Scheme, North Wales



- Highest Rainfall in the UK
- 10,000 m² Shear Stress Turf P
- Flows up to 7 m/s flows
- Largest Recorded Flood event after 2 months!
-





Salix

ESWEG
european Soil & Water engineering group

GROWING : KEY FACTS

- 30 different species grown
- Many of the plants grown from seed collected from the Park area before construction
- 23,000 metres of coir rolls and pallets were pre-established off site
- 350,000 native wetlands plants used in the North Park, South Park, Athletes Village
- 120 articulated deliveries to site from Salix's nurseries in Thetford



Riera de Vallvidrera. Parc de Collserola



2013 Río Sio





2015 Río Sio



Bioingeniería del paisaje

Red de coco/ Ret de coco / Coir netting



2012 Talud Nestlé Waters Viladrau

Red de coco/ Ret de coco / Coir netting



2012 Talud Nestlé Waters Viladrau

Vegetated coir pallet/ plant pallet



2016 Estabilización de canales de riego.Parque agrario del Llobregat. BCN



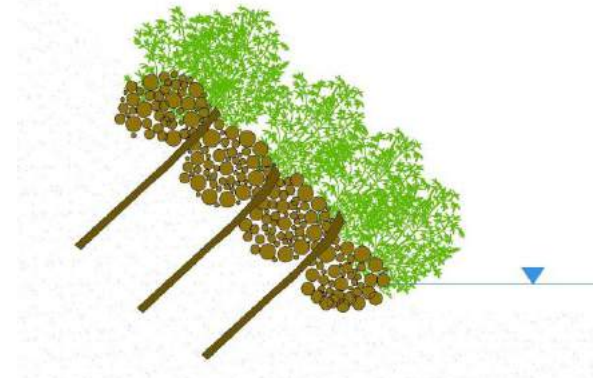






Execution on hillside and fishbone Vergara -Guipúzcoa

Ribalta



Enrejado / Slope grid / Enreixat viu



NATURAL MATERIALS: TRUNKS



NATURAL MATERIALS: TRUNKS





February 2010

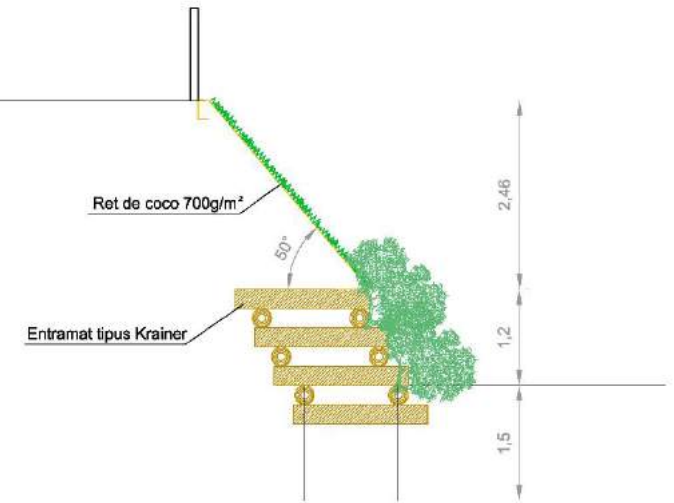
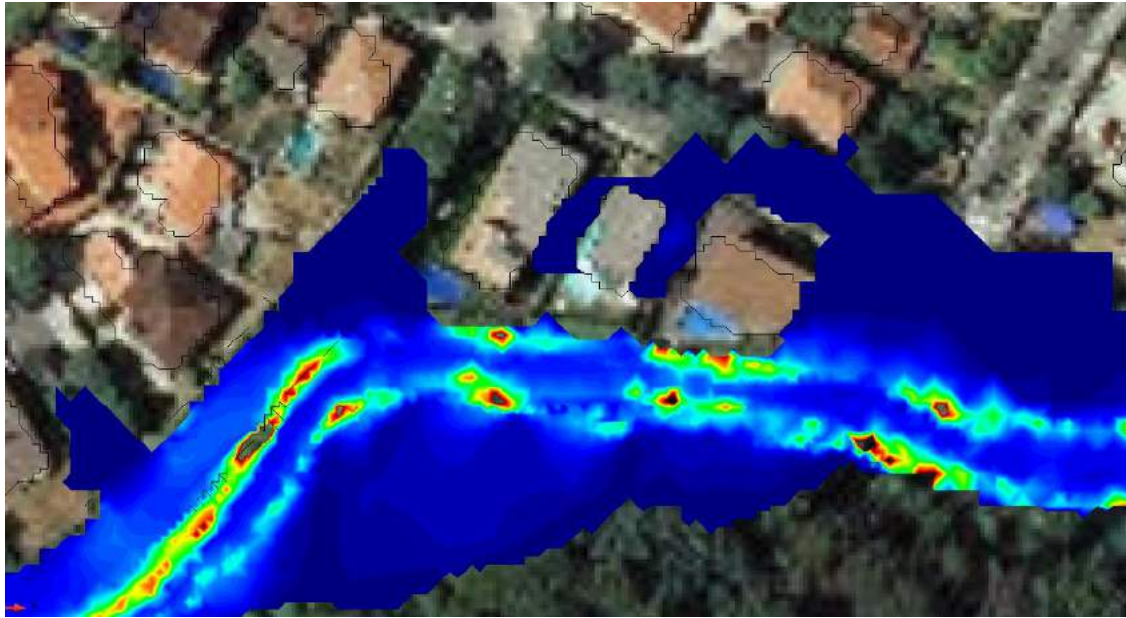


July 2010

NATURAL MATERIALS: TRUNKS



Riera de Can Cabassa. Sant Cugat 2016



2) Protecció de marges

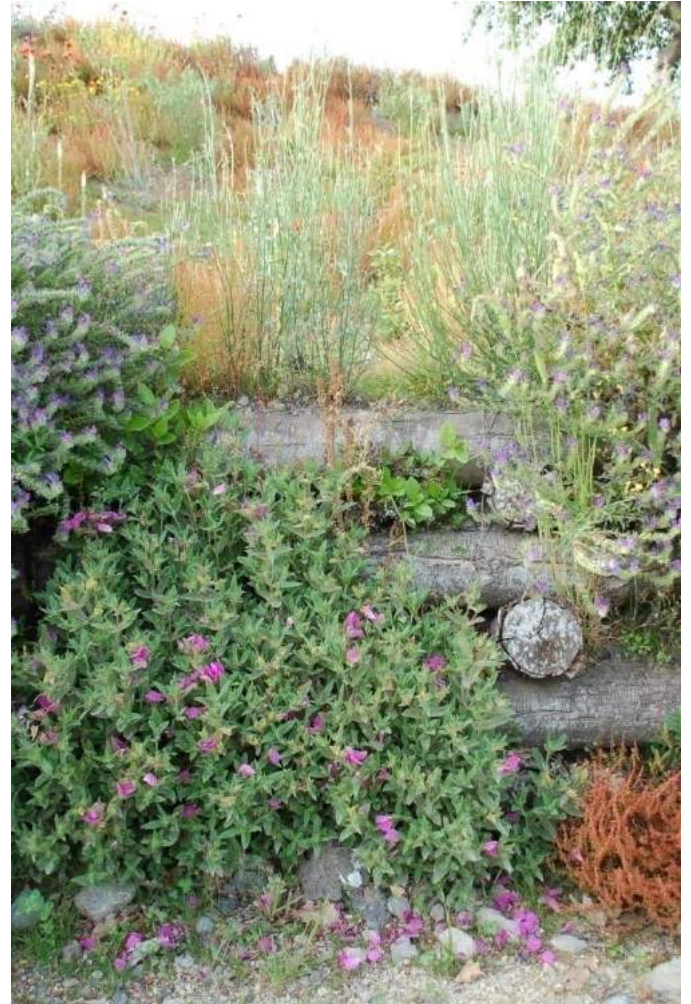
Cas 3: torrent de Can Cabassa
a Sant Cugat del Vallès

















Thank you !