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## Stabilization of soil aggregates on roadside embankments along a 70 years-old vegetation successional gradient

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## SBEE65 – Creating and Viewing 3D Models of Roots

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Vegetation plays a critical role in stabilizing natural slopes. For example, the canopy of trees and the leaves of grasses protect the soils on the ground from raindrop splashes, and the root of vegetation (particularly trees and bushes) reinforces soil and prevents mass sliding. In regards to roots, difference in the shapes and diameters of the roots will affect their tensile strength and change the effect of soil reinforcement. To study and compare reinforcement behaviors of different roots, it is important to be able to characterize individual roots by measuring not only the diameters of the roots, but also the overall shape and bend of the roots. To achieve this purpose, the authors studied new photogrammetric tools in this project to create virtual three-dimensional (3D) models of roots. The models looked realistic and had accurate dimensions. After the creation of the 3D models, the “virtual” roots can be viewed and examined on a computer screen in great details and shared instantly by researchers at different geophysical locations. Moreover, the original roots can be duplicated physically by 3D printers based on the 3D models. If proper material with equivalent mechanical properties of the roots can be found and used in printing, the 3D printed roots can further be used as subjects of laboratory testing.

## SBEE54 – Stabilization of soil aggregates on roadside embankments along a 70 years-old vegetation successional gradient

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The stabilization of roadside embankments is a major challenge for land managers worldwide. While most studies focused on the short-term influence of revegetation measures (such as planting or hydroseeding) on soil stabilization, little is known about the long-term effect of successional dynamics occurring along roadsides. Our aim is to explore the influence of a vegetation successional dynamic on the stabilization of soil aggregates, a proxy for soil stability, along a 70-years roadside chronosequence. We selected 24 plots (16 x 4 m) on embankments along roadsides in the Mediterranean region (South France), spread into 5 age-classes (0-10; 11-20; 21-30; 31-40 and >40 years-old, Fig.1).



Fig. 1 Pictures of the chronosequence of roadside embankments

We measured soil aggregate stability and several soil (soil organic carbon, soil nitrogen, soil texture, pH, CEC) and vegetation (root morphology, root mass density, plant community composition) characteristics. We found that soil aggregate stability varied significantly along the successional gradient, from unstable in early-successional plots (0-10 years-old) to very stable in late-successional plots (>40 years-old). More precisely, soil aggregates first appeared stable in the 31-40 years-old age class, reflecting that efficient stabilization of soil embankments by vegetation dynamics required about 3 decades (Fig.2). We notice that the most critical period for embankment stability is restricted to the

0-10 years-old class, characterized by unstable aggregates and thus high erosive risk, while moderate stability is reached from 11-20 years-old class.

This highlights the importance to invest in revegetation measures in the first decade after roadside construction. Along the gradient, the accumulation of soil organic carbon related to plant community dynamics appeared as the major factor driving the stabilization of soil aggregates. The increase in root density also enhanced soil aggregate stability. Remarkably, the replacement of herbs species by shrubs and tree species as the succession proceeded was not related to any destabilization of the soils, even though the direct soil coverage is usually reduced by encroachment. To conclude, vegetation successional dynamics are responsible for the long-term stabilization soil aggregates on roadside embankments.

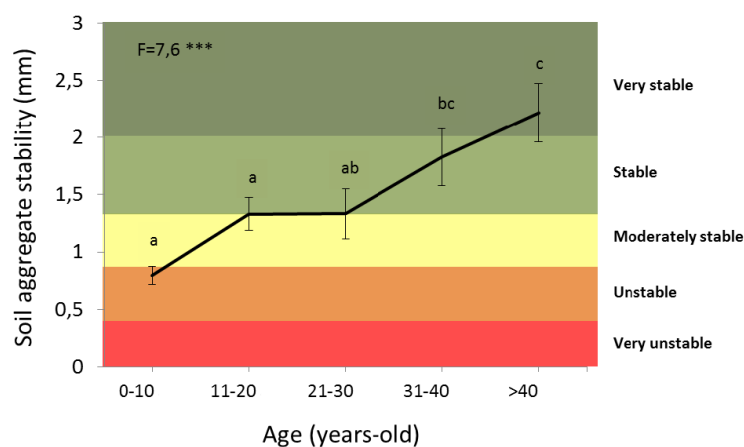


Fig. 2 Variations in soil aggregate stability along the roadside chronosequence

## SBEE27 – Post fire bioengineering remediation in *Pinus canariensis* forests

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Canary Islands pine (*Pinus canariensis*) is an endemic conifer species that regenerates both by seed and by epicormic shoots growing from the lower trunk after a perturbation like cutting or wildfire. Even though the ecological adaptation to fire allows for a relatively rapid regeneration of the soil cover, wildfire may cause disasters inducing abrupt ecological changes and soil losses. On Canary Islands, during the wildfire between 30 July and 2 August 2007, about 18.000 hectares of forest were destroyed.

In this work we describe the post-bioengineering techniques used to mitigate soil losses due to heavy rainfall during the Canary Islands wet season. A series of mixed dykes (wooden elements and stones with a core filled with forest residues) were built in the gullies created by the surface runoff and the soils susceptible to erosion. We analysed the soil properties and measured plant heights, diameters, land cover, litter, plant abundance and species richness indices near the mixed dykes in comparisons with surrounding areas.

Fire adaptations of the Canary Islands vegetation (pyrophyte plants) coupled with selected bioengineering techniques facilitated the seedling germination and allowed the restoration of the forest ecosystem while reducing the soil erosion rates.