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Root morphology of plant inlays used for biotechnical slope stabilisation

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Abstract

Root systems from hedge brush layers, live crib walls and live slope grids were excavated to gain an insight into rooting trends. The root characteristics of *Alnus incana* L. and *Prunus padus* L., grown from rooted plant inlays, and various *Salix* spp., grown from live cuttings, were studied. The poster presents the root development within layer constructions aged up to several decades which were applied for the stabilisation of former slope failures. A spatial sector analysis of the root biomass for *Salix daphnoides* Vill. and *Alnus incana* L. showed similar patterns. The spatial root biomass distribution was rather inhomogeneous, a concentration of biomass near the stem centre was observed. Cross-profile root analyses showed that the penetration of *Alnus incana* L. roots is more effective at depth than that of *Salix purpurea* L. Due to inter- and intraspecific root intergrowth within layer constructions, root bodies with diameters up to 8 m were found. Having considerable vertical and lateral effects, the root collectives enhanced soil stability.

Introduction

A variety of technical and biological properties of plants, such as asexual regeneration, root penetration, resistance against coarse sediment deposition, tolerance of submersion, elasticity, bending strength etc. represent the basic requirements for bioengineering purposes. The most important premise to use parts of plants as construction material is given by many species' capability of adventitious root growth. The hormonally controlled, often injury induced root development alongside stems or branches is not only beeing used for silvicultural and horticultural vegetative propagation but also for revegetation and stabilisation purposes. Layer constructions combine both rooted plants and branch or stem cuttings embedded horizontally in layers of slope fill. The live plant materials serve as mechanical elements and quarantee new plant growth.

Materials

Table 1: Soil bioengineering techniques investigated

technique		age of construction (years)	location	elevation [mNN]	geology
hedge brush layers	3	13/20/50	South Tyrol (I)/Tyrol (A)	1440/1220/1400	schist/porphyry/mica schist
vegetated crib walls	2	11/12	South Tyrol (I)	1220/1550	porphyry/gneiss
vegetated slope grids	1	25	South Tyrol (I)	1145	quartz phyllite

Table 2: Plant material investigated (number of plants per soil bioengineering technique)

	species	hedge brush layers	vegetated crib walls	vegetated slope grids
cuttings	*Populus tremula* L.		1	
	Salix appendiculata Vill.		4	
	Salix caprea L.	4		
	Salix daphnoides Vill.	7		
	Salix elaeagnos Scop.		6	
	Salix purpurea L.	20	1	
rooted plants	*Alnus incana* L.	13	18	
	Fraxinus excelsior L.	2	1	11
	Prunus padus L.		2	1

Methods

Root architecture: The root zones were either washed using a water pressure of two bar or excavated manually with brushes. From each individual all first order roots, their diameters and root lengths were measured and lengths and diameters of the former plant inlays were recorded.

Spatial sector analyses of root biomass: Root biomass was separated according to cubic units measuring 50x50x50 cm. All adventitious roots were isolated from the plant inlay or stem basis according to root classes <1 mm, 1-3 mm, 3-5 mm, 5-10 mm and >10 mm and ovendried at 105° for 24 hours.

Cross-profile root analysis: The root distribution was investigated in profiles of 200 cm length and 100 cm depth. The number of roots within 20x20cm sectors were mapped according to root classes 1-3 mm, 3-5 mm, 5-10 mm and >10 mm.

Results

Root architecture

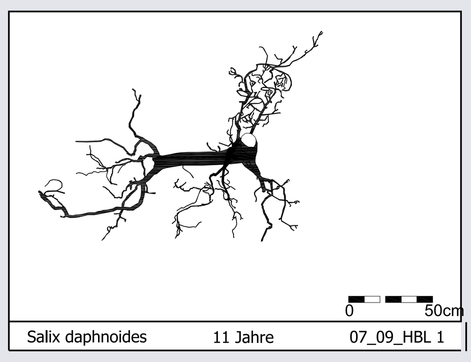

Figure 1: Root structure of *Salix daphnoides* Vill., 11 years old (cutting)

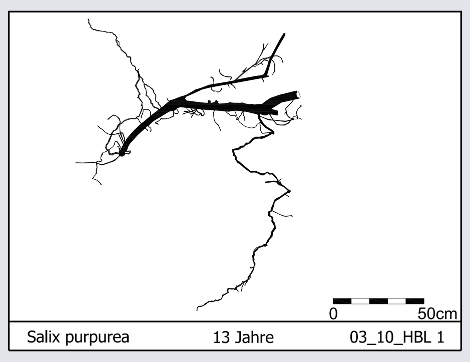

Figure 2: Root structure of *Salix purpurea* L., 13 years old (cutting)

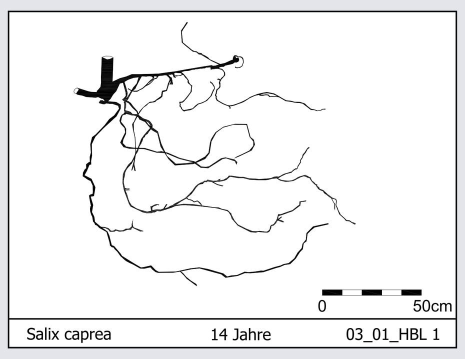

Figure 3: Root structure of *Salix caprea* L., 14 years old (cutting)

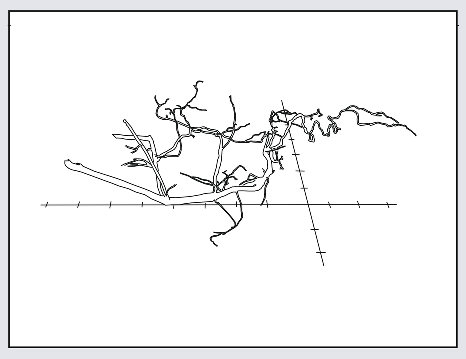

Figure 4: Root structure of *Prunus padus* L., 10 years old (rooted plant)

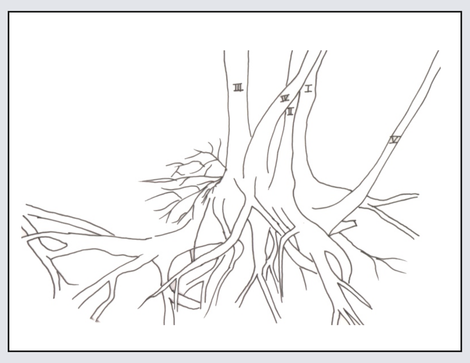

Figure 5: Root structure of *Alnus incana* L., 48 years old (rooted plant)

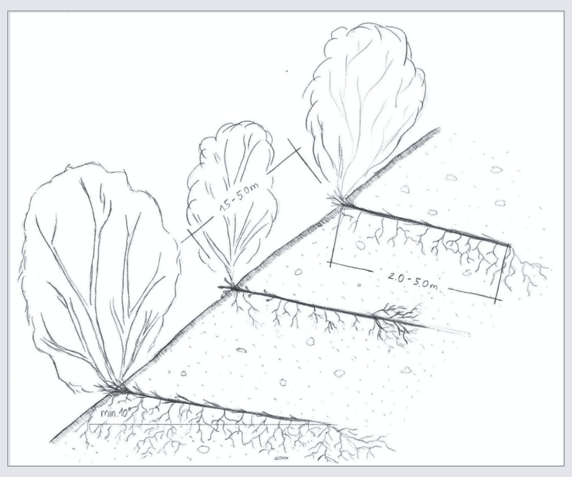

Figure 6: Hedge brush layer (according to H.-M. Schiechtl)

Spatial sector analyses of root biomass

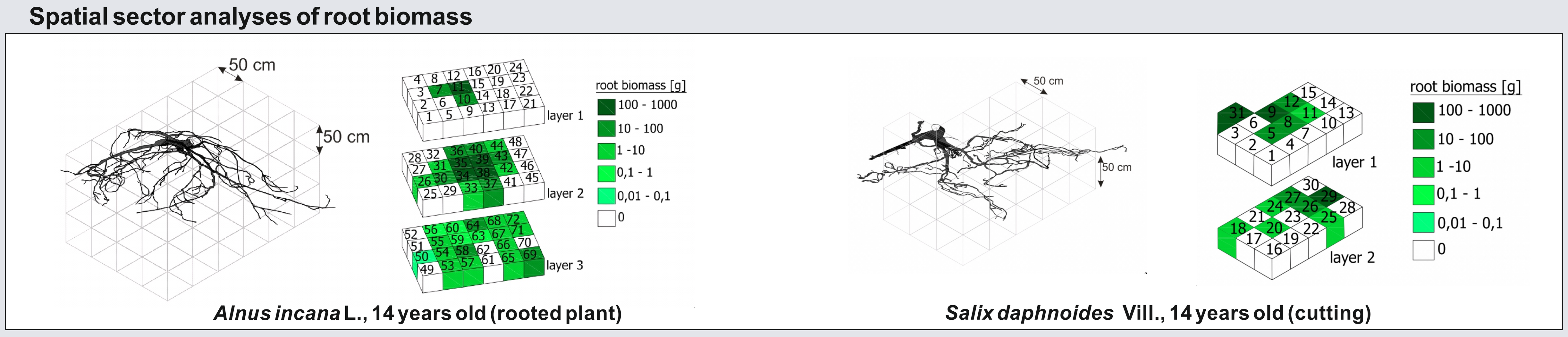

Figure 7: Spatial root biomass distribution excluding dry weight of plant inlay and stem

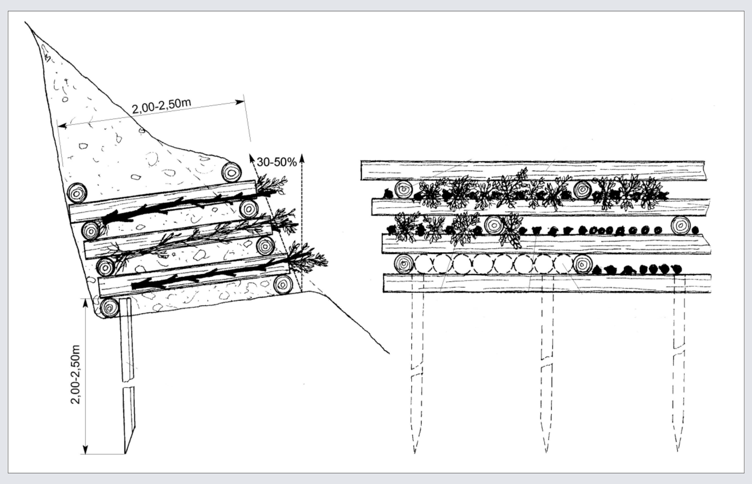

Figure 8: Vegetated crib wall

Cross-profile root analysis

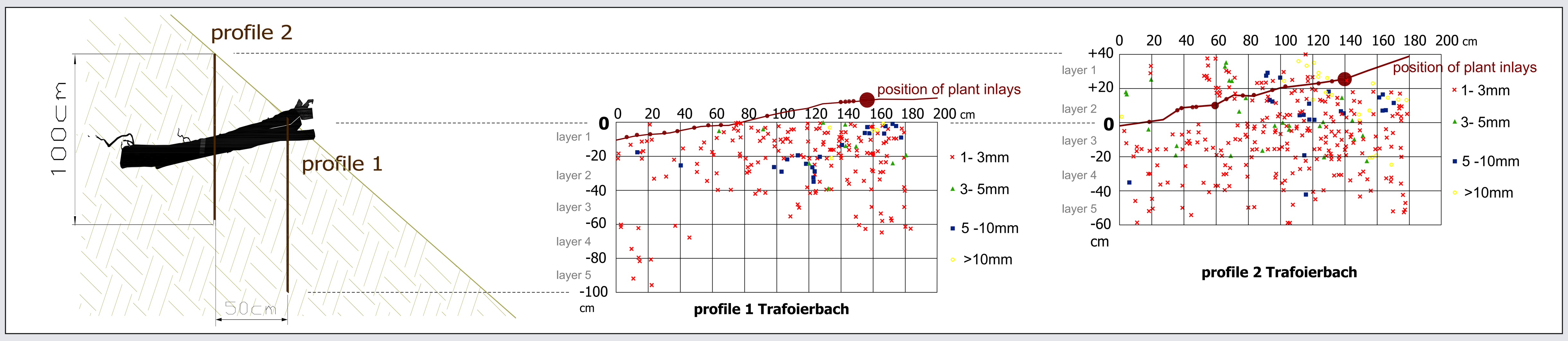

Figure 9: Cross-profile root distribution of a 13 year old hedge brush layer, including *Salix purpurea* L. (13 cuttings) and *Alnus incana* L. (1 rooted plant)

25 years after installation the buried stems could be clearly identified.

All individuals developed adventitious roots, thus showing species specific root characteristics.

The buried stems act as "main roots", providing horizontal anchorage.

The root biomass concentrates around the shoot centre and is dominated by the former plant inlay.

Due to root intergrowth, dense and stable root collectives developed large root biomass and are very effective in

Figure 10: Isolated root collective (*Alnus incana* L., rooted plants) from a live crib wall, 12 years old (rooting depth: 70 cm, total diameter: 230 cm)

Figure 11: Isolated root collective *(Fraxinus excelsior* L., rooted plants) from a slope grid, 25 years old (rooting depth: 130 cm, horizontal root extension: >200 cm)

Figure 12: Isolated root collective (*Alnus incana* L., rooted plants, and *Salix daphnoides* Vill., cuttings) from a hedge brush layer, 20 years old (rooting depth: 130 cm, total diameter: 800 cm)

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