Are hardwood species suited for reconstructing landslides?

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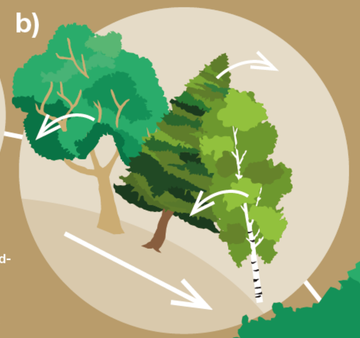
Introduction

The kinetic energy of landslides highly influences the growth structure of tree stems and thus causes the development of reaction wood in the xylem. Most studies focus on assessing the reaction wood development in conifers (softwood) (Heinrich and Gärtner 2008). However, the response of hardwood species on mechanical stress caused by landslides were rarely adressed so far. In this study, we intend to assess the reaction wood development in three species, coniferous and broad-leaved (Fig. 5) growing on locations where different mechanical stressing factors as landslides and snow pressure cause deformation of the stems.



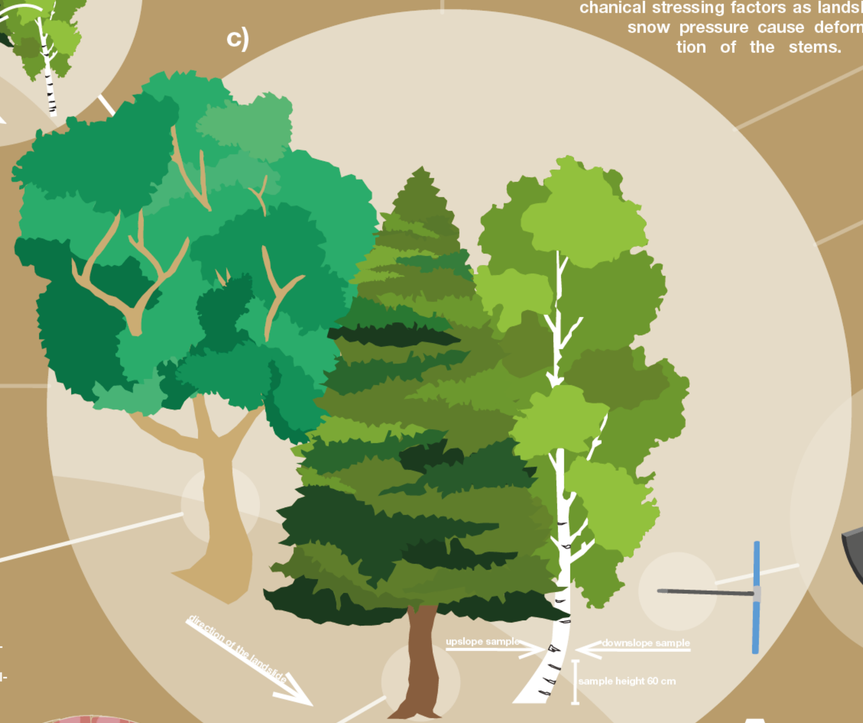


Fig. 1: Development of trees on a landslide with
a) trees growing on a stable slope without mechanical stress
b) moving ground that causes a shift of the gravitational centre and can lead to uprooting or stem damage
c) Trees are developing reaction wood due to mechanical stress. The gravitational centre shifts and stabilizes the tree

Study area

Samples were collected in a landslide prone area in Vorarlberg, Austria near the community of Düns (Fig. 4). The area is sparsely populated and agriculturally used. Three sites from which two were located on a shallow landslide and the third experiences snow pressure were chosen for sampling.

Fig. 4: Location of the study area in Vorarlberg, Austria.

Data and methods

103 trees, consisting of beeches, birches and Norway spruces (Fig. 5) were sampled with an increment corer on two positions (upslope and downslope). Crossdating is currently performed with 50 reference trees using the software CDendro. To identify reaction wood, thin sectioning and staining of the samples were conducted with the broad-leaved species. The reaction wood found in the samples will be recorded and compared to the reference chronology of all sampled tree species, to date anatomical changes occurring in the rings.

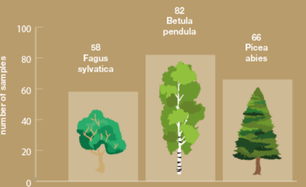


Fig. 5: Number of samples from Fagus sylvatica L, Betula pendula and Picea abies L. Karst

Compression and Tension wood - the differences

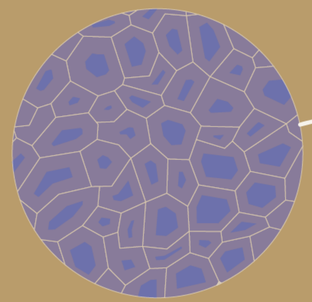


Fig. 2: Tension wood of a hardwood tree with gelatinous layer, low lignin, and high cellulose content

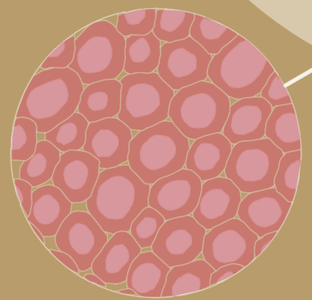
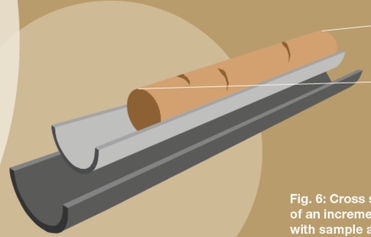


Fig. 3: Compression wood of a coniferous tree with rounded tracheids and intercelluar spaces

Reaction wood is formed due to mechanical stress to counteract the shift of the center of gravity. It can be detected macroscopically or microscopically depending on the tree species. Coniferous trees do form compression wood on the lower side of the inclination that can be indentified by its darker colour macroscopically (Fig. 3). Further, it shows rounded tracheids and therefore, intercellular spaces. Tension wood (Fig. 2) in hardwood species is hardly visible macroscopically but shows gelatinous layers with a silvery sheen (Bräuning et al. 2016).



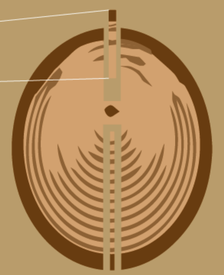


Fig. 6: Cross section of an increment corer with sample and the position of a sample in an eccentric stem

Items to discuss

The work of this study is still in progress. The aim is to evaluate whether hardwood species are suited to reconstruct landslides with macroscopic and microscopic methods. Reaction wood in broad-leaved species can be hardly detected macroscopically and the data will have a qualitative character. In order to examine reaction wood quantitavely an Index of eccentricity can be calculated (Gussenstätter et al. 2004). To realize a precise dating of events, there is a need to evaluate which method is best suited for this purpose and data availability.

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Gussenstätter, F. and Bräuning, A. (2004): Changes in growth rates and wood anatomy of broad-leaved and coniferous tree species after a landslide event in the Remstal Valley (Southern Germany). - In: Tree Rings in Archeology, Climatology and Ecology 2, 31-35.
Heinrich, I. and Gärtner, H. (2008): Variations in tension wood of two broad-leaved tree species in response to different mechanical treatments: Implications for dendrochronology and mass movement studies. - In: International Journal of Plant Sciences 169 (7), 928-936.

Further Literature:
Heinrich, I., Gärtner, H. and Monbaron, M. (2007): Tension wood formed in Fagus sylvatica and Alnus glutinosa after simulated mass movement events. - IAWA Journal 28 (1), 29-48.
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