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Modeling and analysis of the vertical roots distribution in levees - a case study of the third Rhone correction

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In recent years the effects of roots on river banks and levees have been the subject of major discussions. The main issue about the presence of woody vegetation on levees is related to the possibility that roots increase internal erosion processes and the superimposed load of large trees compromise the integrity of these structures. However, ecologists and landscape managers argue that eliminating the natural vegetation from the riverbanks also means eliminating biotopes, strengthening anthropisation of the landscape, as well as limiting recreations areas. In the context of the third correction of the Rhone in Switzerland, the discussion on new levee geometries and the implementation of woody vegetation on them, lead to a detailed analysis of this issue for this specific case. The objective of this study was to describe quantitatively the processes and factors that influence the root distribution on levees and test modeling approaches for the simulation of vertical root distribution with laboratory and field data.

An extension of an eco-hydrological analytic model that considers climatic and pedological condition for the quantification of vertical root distribution was validated with data provided by the University of Vienna (BOKU) of willows' roots (Salix purpurea) grown under controlled conditions. Furthermore, root distribution data of four transversal sections of a levee near Visp (canton Wallis, Switzerland) was used to validate the model. The positions of the levee's sections were chosen based on the species and dimensions of the woody vegetation. The dominant species present in the sections were birch (Betula pendula) and poplar (Populus nigra). For each section a grid of 50x50 cm was created to count and measure the roots.

The results show that vertical distribution of root density under controlled growing conditions has an exponential form, decreasing with increasing soil depth, and can be well described by the eco-hydrological model. Vice versa, field data of vertical roots distribution show a non-exponential function and cannot fully be described by the model. A compacted layer of stones at about 2 m depth is considered as limiting factor for the rooting depth on the analyzed levee.

The collected data and the knowledge gained from quantitative analysis represent the starting point for a discussion on new levee geometries and the development of new strategies for the implementation of woody vegetation on levees. A long term monitoring project for the analysis of the effectiveness of new implementation strategies of vegetation on levees, is considered an important prospective for future studies on this topic.