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Geophysical investigation of biomechanical effects of trees on soils and hillslope topography in the Sudety and Western Carpathian Mountains

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Recent studies showed that trees are efficient biogeomorphic and pedogenic agent on hillslopes, along river channels and coastlines. Through their root systems trees can have a long-term impact on soil and regolith properties mainly due to biomechanical and biochemical weathering processes and the action of associated microorganisms living in the root zone. In consequence, soil production can be intensified under the impact of trees and hillslope topography can be changed as a consequence of, for instance, tree uprooting process. Both aspects, which are narrowly linked to the living functions of trees and disturbance events, can be investigated through the traditional field methods used in geomorphology and pedology. However, geophysical techniques offer a fast and effective way of indirect evaluation of various effects of trees on soil properties and hillslope topography.

In the present research project we used electrical resistivity tomography (ERT) to study the impact of trees within five study sites of two mountain regions in southern Poland. We used different spatial resolution in the ERT survey: i) long profiles through the entire hillslope segment with the Wenner-Schlumberger method employed (3 m electrode spacing); ii) short profiles of three kinds: under living trees, decayed tree stumps and through treethrow pit-mound forms, with the dipol-dipol method applied (0.5 m electrode spacing).

Additionally, we compared geophysical imaging of shallow subsurface obtained by ERT with electromagnetic (EM) measurements on selected test site in the Karkonosze Mountains where slope microtopography was strongly disturbed by the tree uprooting process. We carried out the EM measurements for effective depth ranges 1.1, 2.1, 3.3 and 2.2, 4.2, 6.7 meters below the surface with steps of 0.5 m for each profile. The data were processed in Res2Dinv software.

Through the application of ERT and EM in different geological (mudstones, sandstones and granite) and pedogenic settings we were able to evaluate various effects of trees. Simultaneously, we were able to test the applicability of ERT and EM method to such a specific scientific problem as biomechanical influence of trees on soil properties and hillslope topography.
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