The role of tree uprooting processes on the dynamics of Fe (Mn, Al and Si) forms in different forest soils

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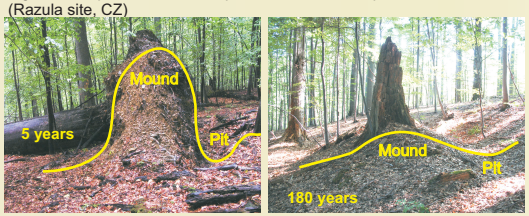
Introduction

Tree uprooting dynamics plays an important role in the development of forest ecosystems. This process causes bioturbation of soils and creates new microenvironments which consist of pits and mounds (Fig. 1.). These microtopographical forms could persist for some thousands of years. Pits and mounds undergo different pedogenesis in comparison to adjacent undisturbed soils.

Fig. 1. Examples of microsites pits and mounds of uprooted trees (Razula site, CZ)



Materials and Methods

Localities

- (spruce)-fir-beech natural forest in the Razula region, CZ
  Haplic Cambisols - flysch parent materials
- (spruce)-fir-beech natural forest in Zofin, CZ
  Entic Podzols - granite parent materials
- northern hardwood forest in Upper Peninsula, Michigan, USA
  Albic Podzols - outwash parent materials

Soil Samples

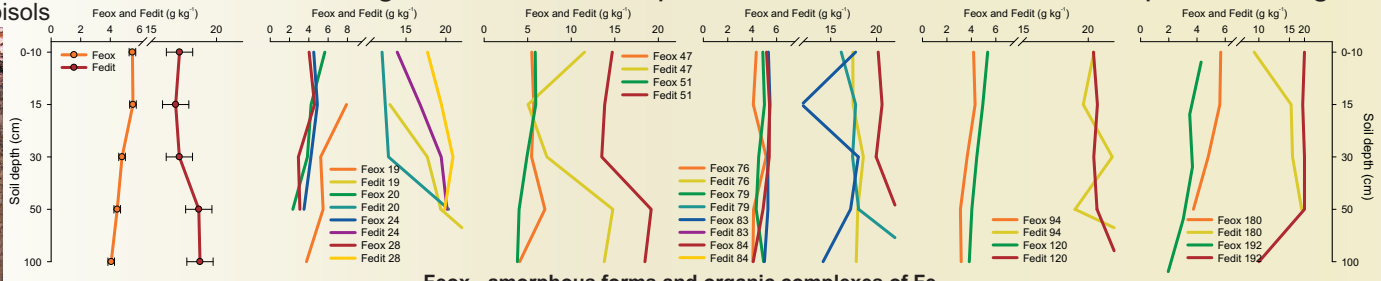
Collected at 6 depths - 0-10 (0-5), 15, 30, 50 and 100 cm from pits, mounds and on undisturbed control sites

Soil Analysis

Single extraction (Šamonil et al. 2010):
(a) The amount of crystalline forms of Fe (Fedit) - based on extraction with a dithionite–citrate solution at a ratio of 0.5:25 (w/v)
(b) The amount of amorphous forms and organic complexes of Fe (Feox) - based on extraction in the dark with ammonium oxalate at pH 3 (at a ratio of 0.25:10, w/v).

Pedogenesis of pits microsites of uprooting

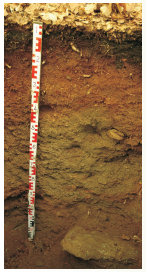
Razula
Haplic Cambisols

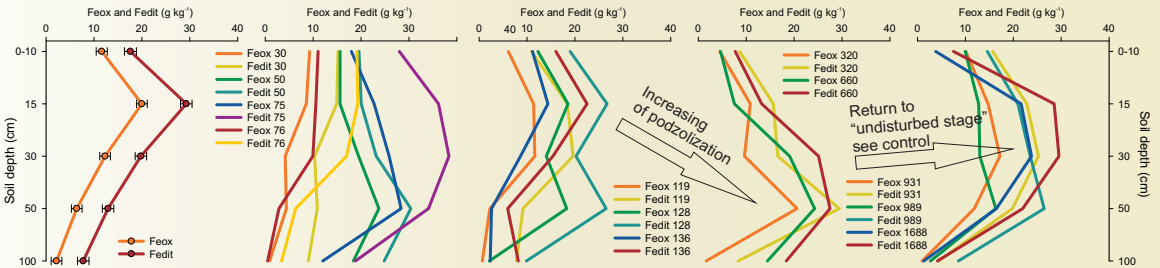


Feox - amorphous forms and organic complexes of Fe
Fedit - crystalline forms of Fe

Undisturbed control | 19-28 | 47-51 | 76-79 | 94-120 | 180-192 years

Zofin
Entic Podzols

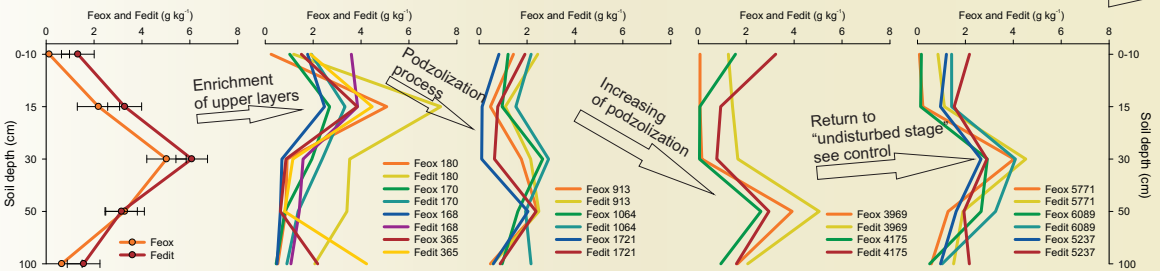




Undisturbed control | 30 - 76 | 119-136 | 320-660 | 931-1688 | years

Zofin natural forest (CZ)

Michigan
Albic Podzols



Undisturbed control | 180 - 365 | 913-1064 | 1721-4175 | 5237-6089 | years

Mound-pit pair after 5229 years of pedogenesis (Michigan site, USA)

Conclusion

Razula site

- small differences between sampled layers
- short time scale
- hard to assess determining process of pedogenesis in Cambisols - main processes are brunification (the release of iron from primary minerals, followed by the dispersion of particles of iron oxide in increasing amounts (Schaetzl and Anderson 2005))
- use of other methods of analysis of Fe forms and species such as Voltametry of microparticles, X-ray powder diffraction or Diffuse reflectance spectroscopy (Tejnecky et al. prepared for publication)

Zofin site

- weathering of granite bedrock - the highest amount of Fe forms
- main process is podzolization (resulting in the genesis of Podzols and Podzolic soils; translocation of Al (Fe, Mn) and humus (Schaetzl and Anderson 2005)).
- mounds microsites tend to return to undisturb stage in about 1000 years after uprooting

Michigan site

- the highest differentiation of soil layer - podzolization processes
- mounds microsites are returning to undisturb stage in about 5200 years after uprooting

Acknowledgements

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Tejnecký, V., P. Šamonil, T. Matys Grygar, L. Borůvka, P. Drahota, O. Šebek, K. Němeček & O. Drábek (prepared for publication) Disturbances as a soil forming factor: How tree – uprooting affects transformation of iron in Cambisols?