-Forest soils under global and local changes: from research to practice -

Characteristics and effects of ecosystem disturbance and consequences for site restoration:

Mining areas and other landuses with major disturbances

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Disturbance:

"A disturbance is a relatively discrete event in time and space that alters the structure of populations, communities and ecosystems. It can do so by changing the density, the biomass or the spatial distribution of biota, by affecting the availability and distribution of natural resources including substrate, or by otherwise altering the physical environment. It often results in the creation of patches and/or patterns and the modification of spatial heterogeneity. Considering socioeconomic aspects, these alterations of the environmental structure and of site factors also change the living

conditions, the economic opportunities and the utility of the people living in and around disturbed landscapes.

Disturbance is a relative term that requires explicit delineation of the system of concern, including the spatial and temporal scale of the components of interest."

(Walker & Willig 1999; Hüttl et al. 2003)





































































Lignite producing nations worldwide







Lignite Mining Districts in Germany





Lignite production in Germany: Areas affected by mining





The Lusatian Lignite Mining District







The Lusatian Lignite Mining District

- Intensive opencast mining started in the 1920ies
- 22 opencast mines, 5 active mines
- affected area: ca. 80.000 ha
 recultivation: ca. 45.000 ha
 future mining area: ca. 20.000 ha
- proportion overburden : coal
- total mining area: ca. 1.000 km² (production of 1 Mio. t lignite ≅ Disturbance of 10 ha land)



5:1













Aims of recultivation of lignite mining areas in Lusatia

- Establishment of forest ecosystems
- Establishment of agricultural ecosystems
- Establishment of sites for innovative landuse options (e.g. agroforestry, fast growing tree plantations)
- Establishment of limnic eco-systems
- Controlled succession







Lusatian lignite mining district

Central German lignite mining district

Scale: 1:500,000





Distribution of land use sectors before and after mining in Lusatia



(from Pflug 1998, modified)



Natural forest vegetation in Lusatia







Main tree species in Lusatia (Germany)







Main tree species in mining landscapes of Lusatia (Germany)

















































Chronosequence studies



compared to non-mined sites (pyrite-/lignite-free substrates)



Heterogeneity of mine soils

Initial phase of soil development on "terra nova" (mine spoil at site Bärenbrück)

- Amelioration of spoil substrate (deep ploughing + ash)
- Afforestation with pine and fertilisation
- Root growth concentrated in the ameliorated top soil
- Development of soil organic matter
- Lignite particles as powder or as fragments; heterogenous distribution
- Inclined layers due to the dumping process







S-fractions in the soil of chronosequence sites







S- and Ca-fluxes: chronosequence of pine stands



S-flow under pine on pyritic substrate (kg S ha⁻¹a⁻¹)

Pine stands on mine sites and compared to a pine stand on a sandy non-mined site (Taura)



Ca-flow under pine on pyritic substrate (kg S ha-1a-1)



Heterogeneity of mine soils



Results of a jodid-tracer study (rainfall simulation): distribution (%) of the tracer in a mine soil (Bärenbrück)



Organic Carbon in Mine Soils - Sources









- in forest floor lignite contribution due to atmogenic deposition
- contribution of recent carbon (e.g. plant litter) in Ai horizon increases with time
- in Cv horizon most of the carbon is derived from lignite



Root development and mycorrhizal fungi









Penetration of mycorrhiza-free lignite by inoculated mycorrhizal fungi after 3 months

[magnification: a) 1:1000, b) 1:2500, c) 1:25000, d) 1:60000]





Vitality of mycorrhizae of pine stands



(from: diploma thesis B. Schmincke, A. Ullrich)





Succession of Mine Spoils - Carabidae





BTU comaus

Succesion of mesofauna abundances







3D sampling of a forest soil monolithe: sampling areas









3D soil sampling: soil chemical properties

Carbon content [%]







Application of forest soil material for reclamation of mine spoils – effects on soil bulk density







Establishment of a experimental catchment area







Conceptual model of a defined water catchment









Chronosequence starting from "point zero"







Further study areas for valuation of results



different types of streams and lakes





Conclusions

- Mining substrates mark extreme site conditions
- Establishment of forest ecosystems is possible after sitespecific amelioration measures
- However, significant differences exist between the development of forest ecosystems on mine sites as compared to non-mined sites of the general region
- Disturbed landscapes offer the chance to establish new ecosystems and even entire new landscapes on terra nova starting at point zero

