PHYTOTECHNOLOGY FOR FORESTRY

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Content

Summary

Polluted sites exist around the world, and the number and size of polluted areas is tending to increase. When such sites become exposed, they can be influenced by forces such as weathering and erosion, thereby posing a threat to the environment. Polluted sites containing waste products can be restored by covering the surface with a dense sealing layer to prevent the atmosphere from influencing the material, causing it to release toxicants.

Woody species can be used in restoring polluted sites, and various species are found in the naturally volunteering vegetation colonizing such nutrient poor areas. Woody plants are difficult to plant as seedlings or cuttings, since they have a low survival rate on polluted sites, but more easily become established when grown in situ from seeds and trees of inherent genotypes. Most woody species need a cover layer containing nutrients and organic materials.

Biosolids, sewage sludge, ash, and sewage water, can be used as plant nutrients.

Polluted industrial sites are often nutrient poor with sandy soil, which keeps the water-retention capacity low, so both nutrients and water must be added – at least in the establishment phase of colonization. Mycorrhiza and microorganisms can help woody species colonize contaminated sites.

Uptake and distribution of toxic elements and substances in plants occurs during reforestation and is species dependent. Toxic elements can influence the establishment and growth of woody plants, though other factors, such as nutrient deficiency, salinity, and water deficiency, are generally what prevent establishment. The pollutant tolerance of woody species varies in various species and ecotypes.

High nutrient levels in polluted soils often reduce the toxic effects on the plants growing in them. Various amendments have been tested for ability to stabilize toxicants in the planting material and reduce toxicant availability. Plants are themselves also able to stabilize toxicants in polluted material.

Good reasons for reforesting polluted sites are 1) promoting high evapotranspiration reducing the amount of leachate, 2) reducing erosion and 3) production of biomass for bioenergy on sites unsuited to food production. Reasons for not growing woody species on polluted sites are that roots may penetrate the sealing layers covering mine tailings, landfills, or dumps and toxic elements may be taken up and distributed to the shoots, making them more available to the ecosystem.

1. Introduction

Polluted sites exist around the world, and the number and size of polluted areas is tending to increase. Sites that are lightly polluted by toxic elements or substances are unsuitable for growing food crops, while extremely polluted industrial sites can pose a *direct* danger via leaching to groundwater and the high availability of toxicants to plants, animals, and humans. Sites containing industrial waste products, especially those left after mining and landfilling, can be found in otherwise natural environments. When such sites become exposed, they can be influenced by forces such as weathering and erosion, thereby posing a threat to the environment.

Polluted sites containing waste products can be restored by covering the surface with a dense sealing layer to prevent the atmosphere from influencing the material, causing it to release toxicants. On top of that sealing layer, a high-nutrient cover layer can be added in which plants grow to prevent erosion. In less-polluted sites or where there is no risk of pollutants escaping, no such layers, or at least no sealing layer, are necessary; plants are still needed to minimize the movement of the waste product material or polluted soil by erosion.

The availability of pollutants in the soil or waste product materials varies, and the more available a substance is, the more is released from a site if it is not restored. Plants and/or microorganisms degrade some organic substances while other such substances or toxic elements may be accumulated by plant roots. Plants also stabilize pollutants in the substrate, for example, by increasing the pH in the rhizosphere. High accumulation of such toxicants in plants requires that the plants be tolerant of the pollutants, otherwise the plants cannot grow.

Reforestation is a suitable way to restore polluted sites and bring back a natural site appearance. In most cases, plants will colonize the site naturally; it is important, however, to prevent the negative effects arising from the presence of unsuitable plant types.

2. Woody Plants on Polluted Sites

2.1. Species

Species	Pollution	Means of establishment
Sambucus nigra, *Salix alba*, *S. viminalis*, *S. caprea*, *S. cinerea*	Dredge sediment landfills	Volunteer vegetation
Acer pseudoplantanus, *Alnus glutinosa*, *Fraxinus excelsior*, *Populus alba*, *Robinia pseudoacacia*	Dredged brackish sediment	Planted vegetation
Pinus sylvestris	Vast U-mining dump	Planted
Myrtus communis, *Arbutus unedo, Retama sphaerocarpa*	Semiarid degraded soils	Planted
Albizia lebbeck, *Albizia procera*, *Tectona grandis*, *Dendrocalamus strictus*	Mine spoil	Planted
Acacia auriculiformis, *Lawsonia inermis*, *Eucalyptus citriodora*	Lead–zinc tailings	Planted
Populus davidiana	Tailings	Volunteer
Salix viminalis, *Betula pendula*, *Alnus incana*, *Fraxinus excelsior*, *Sorbus mougeotii*	Landfill covered with metal-contaminated sewage sludge	Planted
Pistacia terebinthus, *Cistus creticus*, *Pinus brutia*, *Bosea cypria*	Cu-rich mine tailings	Planted
Salix phylicifolia, *S. borealis*	Mine tailings	Volunteer

Table 1. Examples of woody species growing at polluted sites.

Woody species can be used in restoring polluted sites, and various species are found in the naturally volunteering vegetation colonizing such areas. Table 1 profiles some woody species that grow on polluted sites, either planted or naturally colonizing.

Woody plants are difficult to plant as seedlings or cuttings, since they have a low survival rate on polluted sites, but more easily become established when grown in situ from seeds. In addition, trees of inherent genotypes seem to be those most easily established on such sites.

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Biographical Sketch

Maria Greger was borne in Stockholm, Sweden, in 1956. She was educated at Stockholm University where she received her B.Sc. in biology and chemistry 1981. She received a Ph.D. in botany at the same university in 1989, and became Associate Professor of plant physiology there in 1994. Her major field of study is the intersection of plant physiology, plant ecophysiology, plant ecotoxicology, and soil science.

She has been teaching basic levels of plant physiology and ecotoxicology since 1994 at Stockholm

University and other universities, university colleges, and technical high schools in Sweden. She has worked at the Department of Botany, Stockholm University, as a scientist, research officer, and lecturer since 1989. She was guest researcher for a total of one year (1994–1996) at the Swedish Agriculture University in Alnarp, Sweden. She has published 59 peer-reviewed articles, 15 contributions to proceedings, seven book chapters, 148 congress abstracts, and 36 reports. Her current and previous research focuses on the mechanisms underlying differences in metal tolerance and uptake between various species of terrestrial and aquatic higher plants as well as on phytoremediation.

Dr. Greger is a member of the American Society of Agronomy (ASA), the Crop Science Society of America (CSSA), and the Association of the Environmental Health of Soils (AEHS).