Streamline test as a method for optimizing land characterization for phytoremediation of heavy metals

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Abstract
Site characterization and treatability studies currently are conducted sequentially, prior to the initiation of the soil phytoextraction process. The purpose of these activities is to describe the nature and extent of contamination at the target site (site characterization), and to determine if, and under what conditions, proposed plant species will extract the target contaminants (treatability study). This approach is time consuming, expensive and may not lead to success at field scale phytoextraction. A new approach, streamline test, integrates site characterization and treatability studies into a continuous concise effort. The concept of the streamline test is based on a geostatistical assumption, that an adequately distributed number of soil samples may describe the distribution of metals across an investigated site. Furthermore, it is supposed that planting with the same pattern would provide information on whether the soil would support plant growth, and an estimate of phytoextraction efficiency for the site. The general expectations are: 1 - streamline test as an extension of the traditional treatability study will reduce the total cost of this initial step of the phytoextraction process; 2 - streamline test can exclude phytoextraction as a remediation technology in the early stages of the process, if it is not applicable to an area. Our experiments showed that streamline test can be used as a method for optimizing land characterization.

Introduction
Phytoextraction is emerging as a potential solution for the remediation of heavy metal contaminated soils. Phytoremediation offers large-scale, cost-effective, on-site treatment of contaminated land areas. A phytoextraction project typically includes site characterization, treatability study, site layout and design, supply and application of amendments and seeds, field engineering, and metal analysis (Ensley, 2000). Site characterization and treatability studies currently are conducted sequentially, prior to the initiation of full scale planting. The purpose of these activities is to describe the nature and extent of contamination at the target site, and to determine if, and under what conditions, proposed plant species will extract the target contaminants. The present approach is time consuming, expensive and may not lead to success at field scale phytoextraction. The traditional treatability study is conducted in greenhouse conditions with controlled air temperature, light, water regime and homogenized soil. These carefully controlled conditions often do not mimic the real world situation. A Streamline test (ST), as described below, is an attempt to combine the treatability study and site characterization into an integrated single effort.

Results and Discussion

The concept of the ST was based on a geostatistical assumption that an adequately distributed number of soil samples may describe the distribution of metals across an investigated site. The variability of lead and cadmium contents in soil has been estimated in previous field scale phytoextraction experiments (Kucharski et. al. 1998; Korcz et. al. 1998). Based on these findings, it was assumed that two crossed strips covering approximately 20% of the total site surface would be sufficient to represent the entire area for site characterization purposes (Fig. 1).

To prove this hypothesis, topsoil samples were taken in a regular grid. A total of 66 samples were collected from a 100 m x 50 m site. This set of samples was divided into two groups. One group consisted of individual samples taken outside the strips (12 soil samples), whereas the other group was composed of soil samples, which were taken inside the strips (54 soil samples). Soil samples were extracted with 10 % HNO_3 and Pb, Cd and Zn concentrations were measured by AAS.

Comparison of average concentrations of lead, cadmium and zinc in the soil inside and outside the strips showed no significant differences. Minimum and maximum values of lead, cadmium and zinc concentrations as well as medians are presented in Figure 2. Presented data show no important differences between the strips and the other area of the field. The phytotoxic effect of heavy metal contaminated soil inside and outside the strips also was analyzed. It was observed that the pattern of plant growth at the site was reflected by the strips. In conclusion ST:

1. Can be used instead of site characterization
2. Since during ST diversity of heavy metals concentrations at the field is taken into account, the phytotoxicity and biomass production can be more precisely assessed in contrast to traditional treatability study where homogenized soil is used.

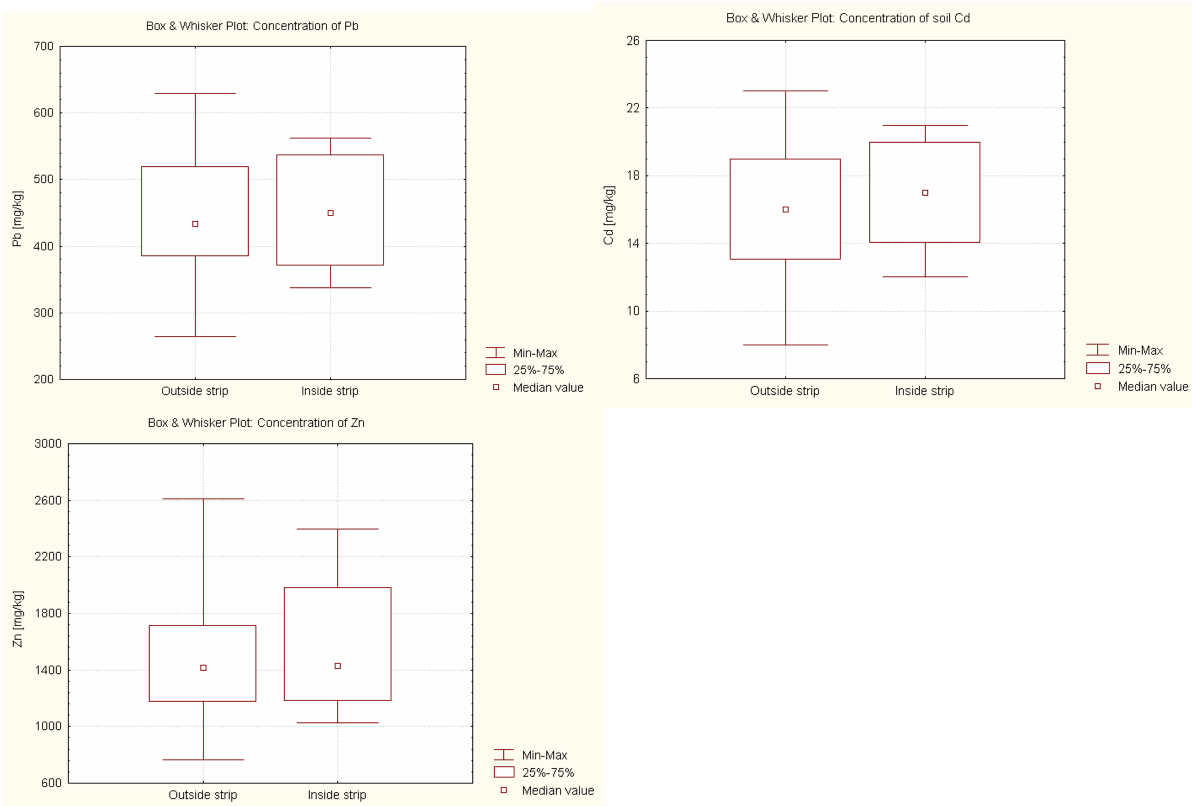

Figure 2. Minimum, maximum and median values of lead, cadmium and zinc concentration inside and outside of the strips

3. Eventually, phytoextraction effectiveness may be evaluated, and the method can be excluded in the early stages of the process, if it is not applicable to an area.

References

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