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Detection of buried tree root samples by electrical measurements

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ASTRACT

Trees growing on earth dikes generate safety problems and reduce dikes durability. Root systems generate internal and external erosion risks which can be important on wooded dikes. The aim of this study was to differentiate various root samples of trees rooted in dikes by geo-electrical measurements.
Before proceeding to roots detection in situ, it is necessary to make tests in laboratory. The objective of this experiment is to characterize exactly the electrical signal of buried roots according to root samples orientation and depth and to materials type.
Root samples were buried in plastic boxes in different type of dyke materials. Electrical conductivity measurements were carried out on buried root samples with their complete structure.
Keywords: earth dikes, root samples, detection, electrical measurements.

INTRODUCTIONS

Detection of tree roots in situ would be very interesting to prevent risks due to some roots orientation or dimension. But this could be complicated in regards to the lack of bibliographical data on this topic, many variables uncontrolled and results interpretation, so it is necessary to make tests in laboratory. The aim of this study is to characterize root samples of trees rooted in dike by electrical measurements. A laboratory experiment allows describing electrical signal of buried tree root samples according to root samples orientation and depth and to material types.

METHODS

Thirty six samples of 30-40 cm length, with complete structure (heart wood and bark), were selected on stumps (30 – 50 years old) extracted from Loire dikes near Cosne-Cours-sur-Loire (France) in October 2008. Studied species were poplar (Populus), black locust (Robinia pseudoacacia), oak (Quercus), ash (Fraxinus), maple (Acer) and willow (Salix). Samples were chosen in 2 diameter classes [3-4] and [6-7] cm.

Six big plastic boxes (1.1 x 0.9 x 0.6 m) were filled up with different types of dyke materials (silt, sand and gravel). For each box, granulometry and sedimentology analyses and water content assessment were realised on material samples.

The geo-electrical measurements were performed at the soil surface of containers in an inverse Wenner configuration using an electrode spacing of 0.1 m (Figure 1). In a first step, the electrical properties of the soil material in containers were characterized without buried samples. In further steps, the big root samples were buried with the upper margin at a depth of 0.1 m in different orientation: (a) parallel to the electrode array (longitudinal) and (b) perpendicular to the electrode array (transversal). The measurements without buried roots were repeated after finishing all measurements with the roots. Then samples were characterized out of materials with two nails spacing of 0.1 m knocked on bark samples, and two otheron each samples side, in the heartwood (Figure 2). The complex conductivity spectra were observed in the frequency range 22.9 mHz - 750 Hz. The measured resistivity amplitude and phase values are transformed into both the real and imaginary part of conductivity.

RESULTS

Conductivity depends on tree root samples species and on material types. In most cases, the buried wood caused a conductivity increase. This trend could mainly be observed in the gravel and sandy soils. The conductivity of buried root samples increased the integral conductivity of the ground. The parallel orientation resulted in the most significant increase of the real part of conductivity. A channelling of the current flow in the root seems to be a reliable explanation.

A conductivity ratio has been determined considering the measurements with and without buried root samples at a frequency of 1.46 Hz (Table 1). Regarding the longitudinal samples in the container filled with gravel, the largest increase of the real part of conductivity with a factor of 1.76 is observed for the poplar followed by oak (1.503), ash tree (1.406) and locust tree (1.352). In the sand container, the order becomes slightly different, but the strongest effect is caused again by the poplar root sample.

DISCUSSIONS

This experiment in laboratory opens perspectives for in-situ measurement. The aim of this study is to develop a non destructive method for detecting roots in dikes. But the numerous variables which can influence the results (material, moisture heterogeneities, and dense root network) could complicate results interpretation.

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FIGURES

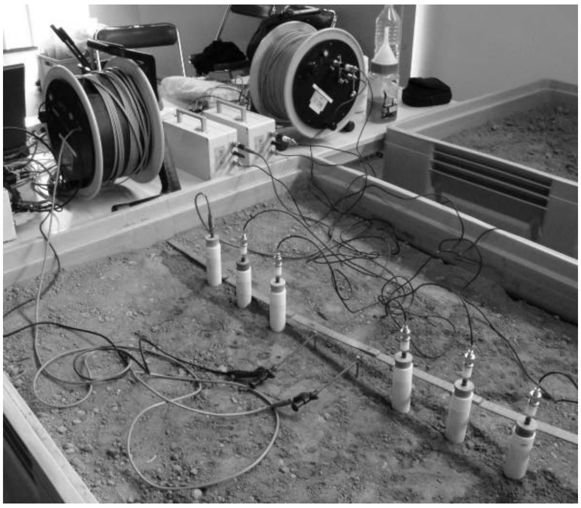

Figure 1. Mesurements with NPE and buried root sample

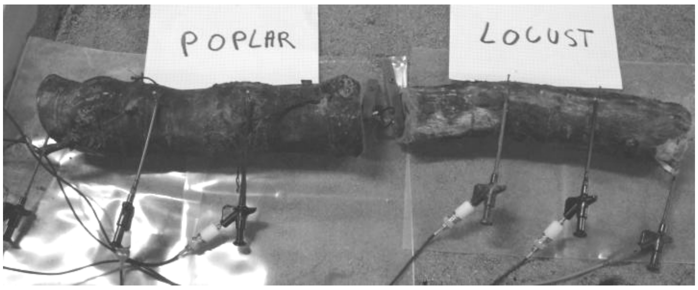

Figure 2. Direct measurements on samples out of materials

TABLE

Species	Samples orientation	Gravel		Sand		Silt	
		real	imaginary	real	imaginary	real	imaginary
Ash	transversal	0.935	1.494	0.934	1.337	0.904	1.322
	longitudinal	1.406	2.125	1.144	1.718	0.785	1.111
Locust	transversal	1.079	1.422	1.343	1.697	1.183	1.355
	longitudinal	1.352	1.729	1.505	2.099	1.005	1.211
Oak	transversal	1.022	2.000	1.068	1.370	1.046	1.577
	longitudinal	1.503	3.701	1.224	1.683	1.064	1.106
Poplar	transversal	1.353	7.448	1.164	3.151	1.318	3.367
	longitudinal	1.795	9.807	1.699	4.861	1.337	5.307

Table 1. Conductivity ratio between measurements with and without buried root samples for both real part and imaginary part of conductivity at 1.46 Hz.