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Using a Ground Penetrating Radar to predict upper soil moisture levels.

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Abstract

In this study, controlled experiments with a GPR (Ground Penetrating Radar) were conducted in a parcel cultivated with the red wine grape variety "Vinhão" in the Campos Lima Farm. This farm is located in the mountainous region of North-Western Portugal, in Arcos de Valdevez. The objective was to verify the ability of this technique to detect variations in moisture level of the upper soil in the vineyard.

This farm sits on a very extensive granite bedrock that extends over great part of Portugal's 5-B Geological Map (Ponte da Barca geological zone). In this area several petrographic types of granite can be found, with the calc-alkaline porphyroid granite types being the most prevalent.

This study aimed to assess the possibility of using the propagation of electromagnetic waves on the surface of the soil to predict the level of moisture present in the uppermost layer of the soil. The methodology involved the collation of soil wave data (radargrams) followed by a correlation study between the amplitude of the direct wave signals and the levels of moisture in the soil.

The GPR equipment used in this study was assisted by an 800 MHZ antenna. The challenge was to place the antenna at the right elevation, a height which would allow for the differentiation between the direct signal of the wave and the reflected wave signal from the ground.

Two GPR wave profiles (radargrams) were created during two different weather periods. Simultaneously, the level of moisture in the soil was directly measured using a TethaProbe ML2x soil moisture sensor. The purpose was to compare the wave amplitude values as measured by the GPR with the "true" moisture levels recorded by the TethaProbe sensor.

Radargrams that corresponded to the "wave strength and pattern" in the soil surface were produced. These radargrams represented the contrast (thus difference) between the different dielectric characteristics of the materials present, namely air, soil and level of moisture.

In this study, the distance between the antenna and the ground allowed for the clear differentiation between the direct wave signal and the reflected wave signal. The measurements obtained with the 800 MHz antenna, were coherent with the measurements of the moisture sensor. During the time period with higher soil moisture levels the wave amplitude values were also higher, contrasting with the

lower wave amplitudes measured during the time period with lower moisture levels. The strong correlation between these two types of measurements suggests that the prediction of moisture level in the soil upper layer using GPR is possible and accurate.

However, the interpretation of the GPR results requires some caution as a difference in the amplitude of the surface reflected signal between dry soil and wet soil was noted. The reflected signal noise was more pronounced at lower moisture levels, which suggests that predictions will get more difficult to make as the moisture level of the soil falls.