SOIL MOISTURE IMPACT ON LAB MEASURED REFLECTANCE OF BARE SOILS IN THE OPTICAL DOMAIN [0.35 - 15 µm]

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1. INTRODUCTION

The purpose of this paper is to analyse the impact of surface soil moisture on the spectral reflectance in the optical domain [0.35 - 15 µm]. This work is based on lab spectral reflectance measurements of bare soils at different moisture contents.

Knowledge of surface soil moisture is significant for many applications like trafficability after flood, ground – atmosphere exchanges and plant good health. Remote sensing data have several advantages over other in situ methods for monitoring surface soil moisture, like better temporal and spatial coverage [1]. Moreover, hyperspectral data composed by numerous and contiguous spectral bands provide the most detailed information. Thus, the opportunity of using such technique to retrieve the soil moisture is investigated.

2. PROBLEM STATEMENT

Soil optical properties are usually studied in the solar [0,35 – 2,5 µm] and infrared thermal [3 – 15 µm] domain, and soil moisture characterisation from spectral reflectance is more studied in the solar domain.

Indeed, in the solar domain, first works [2] have been performed in 1925 with lab measurements of reflectance of bare soils at different water content. This study showed a decreasing of reflectance level with an increasing of soil moisture. Later, other lab measurements [3] [4] have confirmed this result, and some approaches have been also developed to estimate soil moisture [5] [6] but not validated with remote sensing data.

In the infrared thermal domain, few works have been realised [7], [8] and soil moisture impact have been studied only in the long wavelength infrared (LWIR) [8 - 14 µm] domain [9].

Consequently, relationship between ground reflectance and surface soil moisture is currently poorly known in the entire optical domain [0.35 - 15 µm], and this is the reason for having purchased lab measurements.

3. METHODOLOGY

To perform these measurements, about thirty natural soil samples have been collected over eight locations in France (From South-West to South-East). Soil samples, covering different ranges of composition and coloration, are measured at different moisture contents, obtained by in lab oven dry. Sample soil moisture is estimated with the gravimetric method, by weighting each sample under wet and dry conditions [6].

Concerning reflectance measurements, bi-conical spectral reflectance data over [0.35 - 2.5 µm] wavelength region were acquired using ASD (Analytical Spectral Device) spectroradiometer, and directional-hemispherical spectral reflectance were acquired with Bruker spectroradiometer (Labsphere) in the infrared domain [3 - 15 µm].

Therefore, three hundred and eighty spectral reflectances have been measured and analysed.

4. RESULTS

Impact of soil moisture on reflectance is analysed in the different atmospheric window from the visible (VIS) [0.35 - 0.8 µm], near and shortwave infrared (NSWIR) [0.8 - 2.5 µm], medium wavelength infrared (MWIR) [3 - 5 µm], and to the long wavelength infrared (LWIR) [8 - 14 µm] domain.

From the VIS to the LWIR, measurements exhibit an increasing of moisture content with a decreasing of the reflectance level. This behaviour gives information on absorption peaks related to soil mineral components like hydroxyl, carbonate, and quartz. More accurately, the hydroxyl (OH^-) causes an increase of absorption peaks at 1.4 and 1.9 µm and a decrease at 2.2 µm (NIR-SWIR domain).

Furthermore, in MWIR and LWIR, reflectances present generally a decrease of carbonate and quartz absorption peaks respectively at 4 µm and 4.6 µm, and of Reststrahlen bands of quartz and carbonate respectively at 8.5 µm and 11.5 µm.

5. CONCLUSIONS

Thus, the analysis of our lab measurements indicates that soil moisture's impact on spectral reflectance depends on considered domain. These results will be used to develop an empirical model of soil at different water content.

These measurements may complete existing data bases, and will be used in a processing chain to estimate the surface soil moisture (cases of bare soil and/or sparse vegetation) in the optical domain [0.35 - 15 µm] using hyperspectral imaging.

6. REFERENCES

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