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Effect of mineralogical, geochemical and biological properties on soils reflectance to assess temporal and spatial dynamics of BSCs in Sahelian ecosystems

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Land degradation and desertification are among the major environmental problems, resulting in reduced productivity and development of bare surfaces in arid and semi-arid areas of the world. One important factor that acts to increase soil stability and nutrient content, and thus to prevent water and wind erosion and enhance soil productivity of arid environment, is the presence of biological soil crusts (BSCs). They are the dominant ground cover and a key component of arid environments built up mainly by cyanobacteria. They enhance degraded soil quality by providing a stable and water-retaining substratum and increasing fertility by N and C fixations.

The BioCrust project, funded by ANR (VMCS 2008), focuses on BSCs in the Sahelian zone of West Africa (Niger), a highly vulnerable zone facing soil degradation due to the harsh climatic conditions, with variable rainfall, and high anthropic pressure on land use. Unlike arid areas of developed countries (USA, Australia and Israel) or China where BSCs have been extensively studied, studies from Sahelian zone (Africa) are limited (neither the inventory of their different form nor the estimation of their spatial extension has been carried out).

The form, structure and composition of BSCs vary depending on characteristics related to soils and biological composition. This study focuses on the soils characterisation using ground-based spectroradiometry. An extensive database was built included spectral measurements on BSCs, bare soils and vegetation that occur in the same area, visual criteria, in situ and laboratory measurements on the physical, chemical and biological characteristics of BSCs and their substratum.

The work is carried out on geo-statistical processing of data acquired in sites along a north-south climatic gradient and three types of representative land uses. The investigated areas are highly vulnerable zone facing soil degradation due to the harsh climatic conditions, with variable rainfall, and high anthropic pressure on land use Soil surface disturbances due to the intensification of human activities. Spectral field and laboratory data were acquired in 2009, 2010 and 2011 with the FieldSpec Pro®.

The spectra of soils with respect to different parameters are studied in details and their separability from BSCs, vegetation and vegetation residue as well are be analysed. First, the effect of the mineralogy and the geochemical variables on the soil reflectance properties is studied and then the feasibility to resolve some of these effects with satellite imagery (e. g., ASTER) will be tested in order to define the potential capability for identifying the locations of sensitive areas affected by soil degradation and appearance of BSCs.