Integración de Colorimetría y Sistemas de Información Geográfica

Desarrollo de un procedimiento para la medición del color del suelo y su inclusión en una base de datos espacial

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ABSTRACT

This thesis describes a procedure for measuring soil colour and loading colour information into a spatial database. The procedure takes into account all the major issues of the process of assigning colour to soil samples and is specifically adapted to typical laboratory workflows. This thesis is divided in five chapters and two appendices as described below.

Chapter one includes an introduction to the general subject of colour. First, the importance of colour in several disciplines is explained, with emphasis on technical and scientific fields. Next, the human visual system is described. We particularly highlight the influence that our visual system has on physical models and mechanisms invented to understand, as well as to numerically process colour. Colour order systems are introduced in this context. Finally, the subject of soil colour is presented in detail. We first give an introduction to the concept of soil from the agricultural standpoint and describe the significance that colour has in soil studies. Colour spaces and colour order systems used in soil science are conveniently outlined . The chapter ends with a review of the classical methodology commonly used to measure and communicate soil colour.

Chapter two is concerned with Colorimetry, the science of Colour measurement. There are three different parts in the chapter. The first part contains a summary of physical units and magnitudes used in Colorimetry. The second part concentrates on CIE (Commission Internationale de l'Éclairage) colour spaces, which are essential elements to numerically process colour data. The third part deals with instrumentation, specifically with the trichromatic colorimeter, which was the one used in this thesis. This chapter was written with laboratory users in mind. It is, therefore, both an introduction to the newcomer and a reference to experienced users interested in precise soil colour measurements.

Chapter three, "Spatial databases", defines a suitable framework for storing and processing spatial information. There is a major section on geographical information systems (GIS), which is the specific tool used to manage all the relevant information related to soil colour. Next, we cover the different spatial datasets that can be required to build a spatial

database suitable for agricultural applications. The chapter concludes with two sections on data formats and metadata, which nowadays are becoming more important in the field of spatial information technologies.

This thesis suggests a working procedure that is described in Chapter four. The reader can find major contributions here. The proposed procedure is accounted for in the context of classical soil colour measurement techniques, determining their weaknesses with the purpose of reducing their impact on colour measurements. We describe in detail the laboratory equipment and setup needed. In addition, we propose a colour transformation method based on automatic learning techniques, together with a computer program. The development of these two items was based on laboratory experience. The last section contains a summary of the whole procedure within a step-by-step description.

Chapter five contains conclusions of the research and a discussion of the proposed procedure. It also contains future lines of research derived from the procedure proposed in the thesis. These include the use of new sensors and advanced colour models.

Appendix A provides programming and implementation details on several programs that were written as part of this thesis. The two most important programs are described. The objective of the first program is twofold. Firstly, it controls the measurement operations of the colorimeter over a serial line. Secondly, it stores and organises colour data on disk files. The second program performs the conversion between colour spaces with a novel approach based on a classification method used in machine learning and data mining applications. This appendix contains several code snippets which show the use of specialised libraries to create data files in different spatial data formats.

Appendix B concludes this thesis and presents a practical application that were carried out using data collected with our procedure. In this study, we found a number of statistical relationships between soil colour and several forming factors and soil characteristics that contribute to soil management and conservation.

KEYWORDS: geographical information systems, spatial databases, soil science, colorimetry