iSOIL and Standardisation

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Abstract
The project iSOIL "Interactions between soil related sciences – Linking geophysics, soil science and digital soil mapping". iSOIL focuses on improving and developing fast and reliable mapping approaches of soil properties, soil functions, and soil degradation threats. This requires the improvement and integration of advanced soil sampling approaches, geophysical and spectroscopic measurement techniques, as well as pedometric and pedophysical approaches. A prerequisite for the application of geophysical measurements for proximal soil sensing are reproducible and reliable data. The procedure of the CEN Workshop of the European Committee for Standardization (CEN) seems to be an adequate framework to introduce standardised procedures into geophysical measurements. Because electromagnetic induction measurements (EMI) are widely used for soil mapping the existence of several problems with the comparability of EMI results, we want to establish a widely accepted voluntary standard for a best practice of EMI with help of the CEN Workshop.

Key Words
Geophysics, Digital Soil Mapping, Pedophysics, CEN, Standardisation, electromagnetic induction method.

Introduction
All terrestrial environmental processes involve the pedon, including hydrological, geological, meteorological, ecological and anthropological. These processes occur in particular at the upper soil which is the dynamic area from the land surface to the ground of the upper aquifer. Consequently investigations of soil properties become an increasing importance for the majority of land and water resource management. Fast and cost-effective techniques as well as recommendations for high resolution, economically feasible, and target oriented soil mapping under conditions realistic for end-users are needed. The development and evaluation of such techniques and recommendation is the aim of the iSOIL project. A general overview about the project iSOIL will be given in the following. The reproducibility of data of a single geophysical measurement method is the prerequisite for common interpretation of different methods. In our project we focus on one geophysical method – the electromagnetic induction measurements for the proximal soil sensing. We will give more details on one activity of the iSOIL project: the CEN Workshop" Best Practice Approach for electromagnetic induction measurements of the near surface" to establish widely accepted voluntary standard for a best practice of EMI measurement. Please see also our other presentation "Acquisition and reliability of geophysical data in soil science" about results concerning reproducibility of EM38DD data to show the importance and the need for such best practice approaches.

Project iSOIL
iSOIL - "Interactions between soil related sciences – Linking geophysics, soil science and digital soil mapping" is a project financed by the European Commission within the 7th Framework Program. The iSOIL consortium consists of 19 partners from nine countries. In the project are involved universities, research organizations as well as small and medium sized enterprises (see www.isoil.info).

The focus of the project iSOIL is to develop new and to improve existing strategies and innovative methods for generating accurate, high-resolution soil property maps. At the same time the developments will reduce costs compared to traditional soil mapping. The project tackles this challenge by integrating the following three major components:

- **(i)** high resolution, non-destructive geophysical (e.g. electromagnetic induction -EMI; ground penetrating radar, magnetics, seismics), spectroscopic methods and other suitable methods,
- **(ii)** spatial inter- and extrapolations (e.g. geostatistics, machine learning) concepts (McBratney *et al*. 2003), and
- **(iii)** soil sampling and validation schemes to provide representative and transferable results (Brus *et al*. 2006; de Gruiter *et al*. 2009; Behrens *et al*. 2009).

Within iSOIL we will develop, validate, and evaluate concepts and strategies for transferring measured physical parameter distributions into soil property, soil function and soil threat maps of different scales, which are relevant to and demanded by the "Thematic Strategy for Soil Protection" (European Commission 2006). The final aim of the iSOIL project is to provide techniques and recommendations for high resolution, economically feasible, and target- oriented soil mapping under conditions which are realistic for end-user. The resulting soil property maps can be used for precision agriculture applications and soil degradation threats studies, e.g. erosion, compaction and soil organic matter decline.

The iSOIL project is structured in seven work packages (WP), see Figure 1. Two WPs apply the concept of mobile measuring platforms by integrating existing geophysical techniques (WP1) and exploring emerging technologies (WP 2). WP3 will develop physically based transfer functions or so called constitutive models to establish site-specific relations between geophysical and soil parameters. WP4 will use the pedophysical relations found in WP3 together with geostatistical methods for Digital Soil Mapping (DSM) to derive digital soil property maps. Furthermore WP4 will optimize soil sampling schemes for calibration of sensor data in WP1, 2 and 3. WP5 is responsible for validation of the derived techniques and exploring its uses in studying soil threats. WP6 will formulate guidelines and standardize technologies. WP7 is responsible for dissemination of the outcome to relevant end-users (WP7)

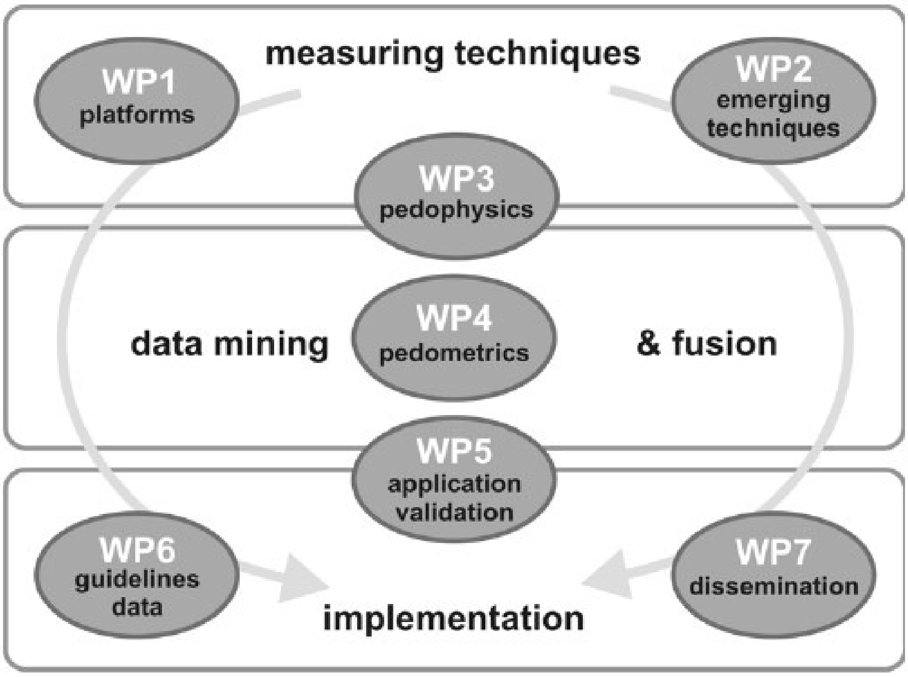

Figure 1. Relation of the work packages to the overall tasks of the iSOIL project.

CEN Workshop

The reproducibility of data of a single geophysical measurement method is a important prerequisite for common interpretation of different methods. There is a need to introduce standardised procedures into geophysical measurements. We focus on one geophysical method for standardization– the electromagnetic induction method. Electromagnetic induction (EMI) measures the apparent electrical conductivity of the subsurface, which corresponds with different soil properties such as clay content, water content, and salinity. EMI methods are already widely use for proximal soil sensing. Measured EMI data could be compared qualitatively for a single survey, but it is difficult to compare data from different surveys. This can be explained by an analysis of the relevant factors. The factors influencing the measured data could be divided into two main groups:

1) Factors related to the subject of study and environmental conditions

Variations of soil conditions

Variations of weather conditions especially temperature, humidity and cloudiness

2) Factors related to instruments and their application

Different calibration procedures

Instrumental drifts especially battery voltage, temperature drift and alteration of electronic parts over time.

Furthermore, there are significant differences between the various EMI instruments e.g. in the calibration, operating frequency and effective depth. Another problem lies in the quantitative difference of data measured with different instruments under uniform circumstances.

Due to the importance of the reproducibility of electromagnetic induction measurements for the proximal soil sensing, the iSOIL project undertakes the effort of establishing widely accepted voluntary standard for a best practice of EMI measurement. A very suitable approach for this purpose is the organisation of a CEN workshop. CEN is the European Committee for Standardization. The result of a CEN Workshop is an agreement which offers a new mechanism and approach to standardization. There are non-bureaucratic rules to set up a workshop and the structure decided is set up by members in the workshop to reach maximum efficiency. A CEN Workshop is open to anyone willing to join and accepting the Business Plan with no geographical restrictions. The CEN workshop comprised a public process. The draft business plan is on web for comments for a defined period prior to the Workshop's launch. In comparison to other standardization procedures the CEN Workshop is a fast process, because of reduced rules, the privileging of electronic working and results based on consensus during a meeting or by electronic means. The record is 5 months and normally it takes 12-15 months. The result of the foreseen CEN Workshop is a consolidated document which is called a CEN Workshop Agreement. Any interested party is welcome to register for membership in accordance with the CEN Rules for CEN Workshops.

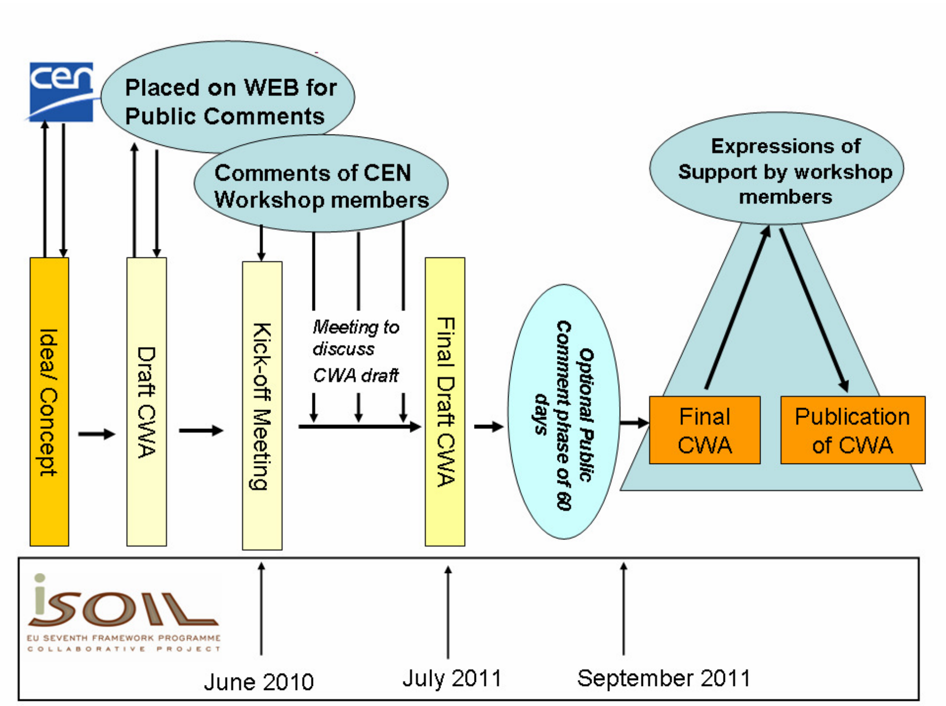

Figure 2. Procedure and anticipated schedule of the iSOIL-CEN Workshop "Best Practice Approach for electromagnetic induction measurements of the near surface".

The iSOIL project organizes a CEN Workshop on "Best Practice Approach for electromagnetic induction measurements of the near surface". We will consider the most common instruments for electromagnetic induction measurement of the near surface such as instruments from Geonics (e.g. EM31, EM38, EM38-DD), GSSI (e.g. Profiler) Dualem (DUALEM-2) and GF-Instruments. The workshop aims at a voluntary standardization of electromagnetic induction measurement to ensure that results can be evaluated and processed under uniform circumstances and can be comparable. The workshop will consider points listed in Table 1. The procedure and anticipated schedule is shown in Figure 2. The final agreement of the iSOIL-CEN workshop should provided guidelines for the best practice approach of EMI measurement. It should help to minimize such potential problems of e.g. reproducibility of measurements and will help to improve the comparability of data. This could give the opportunity of a better comparison and joint interpretation of measurements done at different times and with different instruments as well as of establishing a European database for electromagnetic data.

Table 1: Proposed objectives of the CEN Workshop

1. Definition of terms to be used consistently	Terms are used in a different content e.g. calibration. It is necessary to define terms that have to be used consistently.
2. Best practice field calibration method	To avoid problems by e.g. different operators and different instruments there should be some guidelines for instrument calibration and to choose a single location for the field site to carry out calibration and the calibration interval for the considered instruments.
3. Definition of reference standards for instrument evaluation	Apart from the series of EM38 instrument from Geonics, all other instruments are factory calibrated. To estimate the effects caused by different calibration standards, a reference standard for instrument evaluation and their implementation should be discussed.
4. Best practice measurement at field site	The best practice measurement should improve the repeatability and reproducibility of data and minimize the effect of uncertainty to some agreed value. It will consider e.g. definition of measuring procedures; selection of the best location to carry out calibration, time steps for recalibration and performance of reference measurements.
5. Quality assurance	Quality assurance is an integral part of every field measurement. The purpose is to establish standardized field protocols to meet quality goals for all field activities and to ensure that all site specific data are documented.
6. Possibilities of data processing and evaluation	Results of electromagnetic induction methods are processed by various techniques. A summary about possible data processing and evaluation methods will be compiled and advantages and restrictions will be listed.
7. Areas of application	Electromagnetic induction methods are applied in several areas. An overview will show examples of application in which best comparable results are obtained and gives recommendations for monitoring the near surface.

The current status of the iSOIL-CEN Workshop ”Best Practice Approach for electromagnetic induction measurements of the near surface” will be presented at the 19th World Congress of Soil Science.

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