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SOIL-RELATED MAP SERVERS IN HUNGARY AND THEIR ROLE IN THE DEVELOPMENT OF KNOWLEDGE-INTENSIVE SERVICES

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ABSTRACT

In line with the European development, three complete, centrally edited soil maps were compiled in Hungary between 1953 and 1984. They have also been published in map servers which are up-to-date distribution tools to share spatial information with experts and the general public. Digital soil mapping is an up-coming research area in soil science with the aim to produce reliable soil maps for those areas where soil information is sparse or missing. Its general idea is that once soil forming factors can be represented with high spatial detail (maps, ortophotos), their combination will be well related to soil types and properties. In general form, this has been the axiom of soil science since the late 19th centaury but the idea of its mathematical formulation was conceived in the mid 20th centaury and it has been put into practice since the advent of the modern GIS software. The power of the approach has been proven but it is far from perfection. Much better prediction accuracy can be achieved if field observations on soils are incorporated. We give a short overview of the map servers which provide information on soils and soil forming factors, evaluate their functionality and suggest how mesh-up services of the recent GIS software should be used to combine information and enable users to formulate mental models of soil formation. Citizen science approach should be implemented to make users involved in soil related issues. The program should have two-fold objectives: 1.) to collect soft but highly detailed information on soils for research and 2.) to develop services for soil users.

Keywords: INSPIRE directive, soil related map servers, soil formation, digital soil mapping, citizen science

INTRODUCTION

Since the work of Dokuchaev, the axiom of the soil science is that soil forming factors (climate, geology, hydrology, biota, elevation, time and humans) and their specific interaction determine soil formation and soil properties. JENNY (1941) suggested that these complex relationships should be described with mathematical formulas thus, qualitative and quantitative soil properties will be predictable. MCBRATNEY ET AL. (2003) gave an overview on digital soil mapping (DSM) which is Jenny's idea put into practice with help of GIS software and geostatistical analysis. A very large number of publications have appeared for the last two decades on DSM which have clearly proven the power of the approach but it is still far from perfection. Seven soil forming factor (variables) with, let's say 10 levels within each variable give ten million combinations and the interactions between different factors are non-linear. It is no wonder that DSM approaches which utilize soil information from existing soil maps and field observations perform much better than pure theoretical constructions (MENDONCA-SANTOS ET AL., 2008). Soil maps are physical representations of the mental models of the mappers on how soil forming factors interact (BUI, 2004). They provide us a path through the almost infinite number of theoretically possible combinations to the most probable outcome.

Soil information systems are most developed in the USA. The State Soil Geographic database (STATSGO) and Soil Survey Geographic database (SSURGO) created by the Natural Resources Conservation Service are the most commonly used conventional soil databases. The SSURGO maps, compiled at scales between 1:12000 and 1:63360, are the most detailed products of conventional soil mapping. Such conventional soil maps are widely available and used extensively for many applications (YANG ET AL., 2011). The INSPIRE directive of the European Union (EC, 2007) aims to create a spatial data infrastructure which will enable the sharing of environmental spatial information among public sector organisations and better facilitate public access to spatial information across Europe. Its full implementation required by 2019. Initially, soil information was not a top priority but soil is a crucial part of our environment and soil information is essential part of the envisaged system. The Institute of Environment and Sustainability, one of the Joint Research Centres of the EU is maintains the European Soil Data Centre MapViewer (http://eusoils.jrc.ec.europa.eu/wrb). The spatial resolution of the data is coarse but it provides harmonized soil data for whole Europe in the WRB system (IUSS WORKING GROUP, 2007). However, the EU level database cannot be a substitute for national data infrastructure.

The Georgikon Map Server played a pioneering role in Hungary in 2003 to provide soil information via the Internet (BUSZNYÁK AND SISÁK, 2012). Several map servers have appeared on the web since then and many of them contain direct soil information or soil related information. We are going to review selected map server services which provide information for the area of Hungary and we evaluate them from the point of view how they can be related to soils. Our hypothesis is that the combination of already existing data into a complex system may be a direct and immediate help for soil users and this could serve as a basis for further scientific and service development. This would also be in line with the requirements of the INSPIRE directive.

MATERIAL AND METHOD

We briefly reviewed the following sources:
- Georgikon Map server (http://map.georgikon.hu)
- the agrotopographic data base of the Research Institute of Soil Science and Agrochemistry of the Hungarian Academy of Sciences (www.mta-taki.hu/osztalyok/gis-labor/agrotopo),
- the soil map among the open access maps in the Agro-environmental Information System (http://terkep.air.gov.hu/terkep/nyilvanos/nyilvanos.htm),
- the 1:100 000 scale geological map (http://mafi-loczy.mafi.hu/Fdt100/),
- the CORINE CLC100 data base (http://www.fomi.hu/corine/clc100_index.html) and
- the Information System on Nature Conservation Areas (http://geo.kvvm.hu/tir/viewer.htm).

We also discuss the use of the
- Google Earth program and the
- Shuttle Radar Topographic Mission (http://www2.jpl.nasa.gov/srtm/cbanddataproducts.html) data base.

RESULTS

There are three centrally edited soil maps in Hungary with nationwide coverage. The first one was published in 1953 at a scale of 1:200,000 (MATTYASOVSZKY ET AL., 1953) by using more detailed previous maps (KREYBIG, 1937). It has been digitally published on the Georgikon Map Server (SISÁK AND BENŐ, 2012). The second one (popularly called AGROTOPO) was published between 1983 and 1988 on 1:100,000 sheets (MÉM, 1983-1988) and also relied on the Kreybig soil maps. This was released in digital form in the early 1990’s and has been recently published on the web by the Research Institute for Soil

Science and Agrochemistry of the Hungarian Academy of Sciences (MTA ATK TAKI, 2013). The third one (genetic soil map) was compiled by the experts of the agricultural extension agency of the agricultural ministry in 1984 at scale of 1:200,000 (MÉM-NAK, 1984). It was compiled independently from the Kreybig soil maps and it was also digitally published (AIR, 2013).

Each of the three soil maps has advantages but also serious drawbacks. The first map has not been digitized until recently (SISÁK AND BENŐ, 2012) and it does not contain soil units of the recent Hungarian soil classification since it is older than the existing classification system. It contains several soil categories (texture, chemical reaction, fertility constraints) but also other categories (land-cover: forests, temporarily flooded areas). However, this is the most detailed (21306 polygons) regarding its spatial resolution despite the nominal scale of 1:200,000. The AGROTOPO has only a rough spatial resolution since it covers the area of the country (93000 km^2) with 3311 polygons. Regarding soil classification, it is also rough because it contains only 30 % of the categories in the Hungarian system. However, it has a complete coverage of the landscape and it has several data layers (parent material, texture, soil reaction, clay mineral assembly, organic matter content etc.). The genetic soil map provides a complete display of the Hungarian soil classification, better resolution (5972 polygons) than AGROTOPO and it contains data on parent material, texture and chemical reaction but does not show soil data for forests. The topology of the AGROTOPO is satisfactory but it is not so for the other two maps. The AGROTOPO has a topographic layer to guide the users but the other two have not.

One of the most important maps exhibiting soil forming factors is the geological map at 1:100,000 scale published by the Geological Institute of Hungary (PELIKÁN AND PEREGI, 2005). It has very good resolution (50163 polygons) and excellent additional layers to help the users (roads, railroads, populated areas, water courses, lakes). The geological classification is much more detailed thematically than it is necessary for DSM but still lacks important texture information. CORINE CLC100 database is available at the website of the Hungarian Institute of Geodesy, Cartography and Remote Sensing (FÖMI, 2013A) but it is more an illustration than a functional map server. Zooming is limited and restricted to the central part of the country in spite of the fact that the database is freely available from the webpage (http://www.eea.europa.eu//themes/landuse/dc) of the European Environment Agency data centre. The spatial resolution is very good (39849 polygons). The Information System on Nature Conservation Areas is very rich in topographic information and exhibits points of protected nature conservation objects and polygons of protected areas with some additional information. Google Earth has free and commercial versions and exhibits ortho-rectified space images. Even the free version has very good functionality and its file formats are supported by the major GIS softwares. The Shuttle Radar Topographic Mission (SRTM) produced digital elevation model with 90x90 and 30x30 m pixel sizes and various vertical accuracies. It is a freely available product.

DISCUSSION AND CONCLUSIONS

Neither of the three soil maps is complete or sufficiently detailed spatially with regard to the recent need for soil information. However, weaknesses of one map could be easily corrected with the strengths of the other map once they are collated as different layers of a GIS system. This could be the up-to-date and publicly available version of the concept map-stage in traditional soil mapping where all the background information was gathered and a mental model was formulated by the mapper on how soil forming factors interact and how they determine soil class and soil properties at a given place. Then, concept maps were validated by field work. Advanced GIS software (e.g. ArcGIS 10.x) are able to use various layers from the web geo-services and combine them with own sources. However, this is still a remote possibility for ordinary users and soil experts in most parts of the public and commercial sector.

To overcome knowledge gap and software constraints, already freely accessible data should be assembled into a combined data service which would provide enormous synergies for the economy. The most promising platform could be the Google Earth because its spatial detail far exceeds any of the other data sources, thus the users could interpret the general information of the relatively large polygons accordingly. Citizen science approach (SILVERTOWN, 2009) could be used to make the users involved in collection of soil related problems, thus soil scientists could be made directly aware of the interest of the soil users and scientific focus would be better directed towards economic needs. The signals from the users would be valuable source of information, too.

The new inputs could steer scientific research and policy making. For the research part, even the harmonization of a few polygon maps is more than trivial (SISÁK AND BENŐ, 2014) if we use scientific scrutiny. However, the formulation of a mental models and the intuitive local solution of the interaction problem could be done by large number of users once the digital source maps are assembled. For the policy part, user demand may initiate new mapping efforts which have been overdue for a long time.

Even brief investigation of the discussed maps gives us a hint on the direction of further research. At a local scale, geology, DEM and hydrology are the most influential soil forming factors. More detailed geological maps than the freely accessible 1:100,000 scale map exist, and DEM with 5x5 m pixel size was produced from contour lines of the 1:10,000 topographic maps by the Hungarian Institute of Geodesy, Cartography and Remote Sensing (FÖMI, 2013B). The thematic details of the geological maps are usually too high for DSM purposes, the categories must be simplified (LAWLEY AND SMITH, 2008). However, geological maps usually lack sufficient texture information. Detailed soil maps overcome this problem (SISÁK AND BENŐ, 2014). High resolution DEM can be used to calculate several terrain attributes but in many cases only a few of them explain most of the total variance (CARRÉ ET AL., 2008). SRTM is suitable for countrywide studies, its vertical resolution can be improved and it also can be used to estimate vegetation height (KELLNDORFER ET AL., 2004).

Our expectation is that the synergies from the assembly of all the soil and soil related maps in one map server would drive much better utilization of the data due to interpretation of the users on their own, due to rapidly developing knowledge intensive services for the users and due to more intensive user oriented research.

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