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National Digital Soil Mapping Initiatives in Europe: A Review and Some Examples

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Abstract : Soils are at the crossing of many issues such as food and water security, sustainable energy, climate change mitigation and adaptation, biodiversity protection, human health and well-being. They deliver many ecosystem services that are essential to life on Earth. Therefore, there is a growing demand for soil information on a national and global scale. Unfortunately, many countries do not have detailed soil maps, and, when existing, these maps are generally based on more or less complex and often non-harmonized soil classifications. An estimate of their uncertainty is also often missing. Thus, there are not easy to understand and often not properly used by end-users. Therefore, there is an urgent need to provide end-users with spatially exhaustive grids of essential soil properties, together with an estimate of their uncertainty. One way to achieve this is digital soil mapping (DSM). The concept of DSM relies on the hypothesis that soils and their properties are not randomly distributed, but that they depend on the main soil-forming factors that are climate, organisms, relief, parent material, time (age), and position in space. All these forming factors can be approximated using several exhaustive spatial products such as climatic grids, remote sensing products or vegetation maps, digital elevation models, geological or lithological maps, spatial coordinates of soil information, etc. Thus, DSM generally relies on models calibrated with existing observed soil data (point observations or maps) and so-called “ancillary co-variates” that come from other available spatial products. Then the model is generalized on grids where soil parameters are unknown in order to predict them, and the prediction performances are validated using various methods. With the growing demand for soil information at a national and global scale and the increase of available spatial co-variates national and continental DSM initiatives are continuously increasing. This short review illustrates the main national and continental advances in Europe, the diversity of the approaches and the databases that are used, the validation techniques and the main scientific and other issues. Examples from several countries illustrate the variety of products that were delivered during the last ten years. The scientific production on this topic is continuously increasing and new models and approaches are developed at an incredible speed. Most of the digital soil mapping (DSM) products rely mainly on machine learning (ML) prediction models and/or the use or pedotransfer functions (PTF) in which calibration data come from soil analyses performed in labs or for existing conventional maps. However, some scientific issues remain to be solved and also political and legal ones related, for instance, to data sharing and to different laws in different countries. Other issues related to communication to end-users and education, especially on the use of uncertainty. Overall, the progress is very important and the willingness of institutes and countries to join their efforts is increasing. Harmonization issues are still remaining, mainly due to differences in classifications or in laboratory standards between countries. However numerous initiatives are ongoing at the EU level and also at the global level. All these progress are scientifically stimulating and also promissing to provide tools to improve and monitor soil quality in countries, EU and at the global level.

Keywords : digital soil mapping, global soil mapping, national and European initiatives, global soil mapping products, mini-review

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