How well is the WDC-Soils serving its user groups?

Authors: Niels H. Batjes, Rik van den Bosch

Summary

Soil is an important provider of ecosystem services, yet it remains one of the least developed data layers in global land models and uncertainties are large. In this context, there is a pressing need for improved, quality-assessed soil information at multiple scale levels. ISRIC - World Soil Information (WDC-Soils) has a mission to serve the international community as custodian of global soil data and information, and to increase awareness and understanding of soils in major global issues. To achieve this goal, we operate according to four work streams: 'standards and reference', 'soil information brokering', 'building an effective user community' and generation of 'derived products'. Through the 'soil information brokering' work stream, in collaboration with our partners and data suppliers, we are generating an increasing range of quality-assessed soil data (point, polygon, and grid). These products are made available freely using a range of web services based on open-source software and FAIR principles. Key questions for us in this context are 'How well are we communicating with the international community' and 'what challenges do we need to address in terms of data sharing and interoperability standards?' As described in this case study, this requires regular monitoring and evaluation of the use of our products as well as an insight into the (evolving) needs of our diverse user community. This type of inventory then serves to identify emerging strategic developments in the field of soil sciences and related spatial data infrastructure, and serves to consolidate our communication strategy.

Introduction

Within the ICSU World Data System (WDS), ISRIC provides the focal point for soil-related collections and information services, as custodian and creator of global soil information. In this capacity, we are known as the World Data Centre for Soils (WDC-Soils) since 1989.

In 2016, ISRIC refined its medium-term strategy and restructured its activities in four work streams (WS):

- WS1: Standards and reference WS. Here we strive to be part of international standard-setting processes for soil mapping and soil classification, soil measurements and standards for data exchange and interoperability of soil data.

- WS2: Soil information brokering. Here we follow a hybrid approach to assist partners in national and regional soil data information systems through capacity building and information supply. At the same
time, we build global soil information products, by collating available soil information and environmental covariates, used primarily for global studies and assessments. The two-pronged approach enables us to serve different users and create synergies that lead to enhancement in the quality and range of information products generated.

- **WS3**: Building an effective user community. The focus here is to work on dedicated capacity building programmes as well as to engage with potential users from the soil science and other communities to boost the use of our products and receive feedback for further improvement.

- **WS4**: Derived products. Through this stream we actively engage with potential users of soil information to develop derived information products geared towards their specific needs.

We provide free access to many parts of our holdings, including the soil library (reports and maps), world soil museum (soil monoliths and associated materials) and soil databases (point, polygon, grid) through a range of web services. This paper may be seen as a case study for an evolving soil repository. It aims to assess how well we are serving the international community and how this may be improved. Subsequently, it outlines some of the 'key' challenges that we will need to address, with our partners, in terms of soil data harmonisation, data sharing, data interoperability and data use in the coming three years.

**Data life cycle and need for standards**

Our activities consider the whole data life cycle from field sampling to serving quality-assessed soil data to the world community [1]. Consistent procedures and de facto standards are used to screen (QA/QC) and standardise respectively harmonise the wide range of soil-related data that have been shared with us for consideration in our world-covering databases and web services. This paper may be seen as a case study for an evolving soil repository. It aims to assess how well we are serving the international community and how this may be improved. Subsequently, it outlines some of the 'key' challenges that we will need to address, with our partners, in terms of soil data harmonisation, data sharing, data interoperability and data use in the coming three years.

Harmonisation, in the soils domain, involves 'providing mechanisms for the collation, analysis and exchange of consistent and comparable global soil data and information' [2]. Areas of harmonisation include those related to: soil sampling, description, classification; soil laboratory analyses; exchange of digital soil data; and interpretations. In partnership, we are working towards the maintenance and development of new, internationally, recognised standards for many of the above. Important working groups include those of the International Union of Soil Sciences (e.g. Soil Information Systems and Proximal Soil Sensing), the pillars on 'information and data' and 'harmonisation' of the Global Soil Partnership (GSP), the 'soil working group' of GODAN (Global Open Data for Agriculture and Nutrition), and the working group on 'soil data interoperability' of the Open Geospatial Consortium (OGC). Recently, we were selected to develop and host the Soil Data Facility (SDF), an important component of GSP's emerging Global Soil Information System (GLOSIS).

**Reaching the user community**

As indicated, we aim to serve a wide range of user groups and it has been a challenge to assess to what extent our various resources are being consulted or used. For example, the ISRIC World Soil Museum, with its display of reference monoliths from all over the world, provides the foundation for our activities and programmes on education, research, collection and documentation. Since the opening of the new museum in Wageningen (April 2014), we have had some 2450 visitors each year, up from around 750 a decade ago. The accessibility to our soil reference collection has been increased with the launch of the virtual museum in 2017.

We also maintain a repository for 'endangered' documents on soil resources. In December 2017, the collection consisted of some 9,100 soil-related maps, of which 87% have been digitised, and some 16,200 reports of which some 37% are available online in full-text format. The library holdings provide a valuable source of soil profile and map data for consideration in the World Soil Information Service [WoSIS, 3] and other projects. Further, there is a steady demand from all parts of the world for the scanned materials held in the online library.
Some 10,000 unique visitors consult our website monthly and this is monitored using Google and Wiki statistics. These show us which type of data and information are most consulted. Actual proof-of-use is reflected, for example, in the number of citations to specific data holdings. In March 2018, we prepared an overview of 'main uses' of our gridded soil property maps (SoilGrids [4]), since 2014, to identify main user groups and potential clients. The citing articles were analysed according to three in-built Web-of-Science® groupings, broadly defined as: research areas, Web of Science Categories, and citing organizations. Separate visualisations were provided for each of these searches (Batjes, unpublished). The top 15 categories for 'research areas' are listed in Table 1.

### Table 1. Grouping of SoilGrids citations according to Web of Science 'research categories'

<table>
<thead>
<tr>
<th>Research areas</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Sciences Ecology</td>
<td>84</td>
</tr>
<tr>
<td>Agriculture</td>
<td>82</td>
</tr>
<tr>
<td>Geology</td>
<td>46</td>
</tr>
<tr>
<td>Water Resources</td>
<td>30</td>
</tr>
<tr>
<td>Science Technology Other Topics</td>
<td>29</td>
</tr>
<tr>
<td>Meteorology Atmospheric Sciences</td>
<td>21</td>
</tr>
<tr>
<td>Physical Geography</td>
<td>16</td>
</tr>
<tr>
<td>Plant Sciences</td>
<td>11</td>
</tr>
<tr>
<td>Remote Sensing</td>
<td>9</td>
</tr>
<tr>
<td>Biodiversity Conservation</td>
<td>8</td>
</tr>
<tr>
<td>Evolutionary Biology</td>
<td>8</td>
</tr>
<tr>
<td>Forestry</td>
<td>8</td>
</tr>
<tr>
<td>Geography</td>
<td>7</td>
</tr>
<tr>
<td>Computer Science</td>
<td>6</td>
</tr>
<tr>
<td>Marine Freshwater Biology</td>
<td>5</td>
</tr>
</tbody>
</table>

*For legibility, only the top 15 cases are listed here. The same citing article may relate to one or more Web of Science categories.*

Another proof-of-use is that SoilGrids-derived products have been used by the UNCCD (United Nations Convention to Combat Desertification) to provide member countries with information on baseline soil organic carbon (SOC) stocks in support of their Land Degradation Neutrality reporting [5]. Similarly, a SoilGrids-derived SOC map is included in ResourceWatch [6], an on-line resource built by the World Resources Institute (WRI) and over 30 partners to make data more readily available to policymakers, business leaders, and analysts so that they can make informed decisions about the environment and human well-being.

### Present and emerging challenges

Despite the above improvements and changes over the last three years, numerous scientific, technical and institutional 'challenges' remain. Many of these issues are 'too big' for a small institute like ISRIC to tackle on its own and so typically require international collaboration as well as adequate resources. For example, pressing issues we are currently addressing with our partners include (not listed in any particular order):

- Implementation of a widely accepted system for soil data exchange and inter-operability with the IUSS Working Group on Soil Information Standards, this in relation to related activities of GODAN, ISO, OGC and GSP Pillar 5.
- Standardisation of soil analytical method descriptions in the GSP Pillar 5 framework, in collaboration with the recently formed Global Soil Laboratory Network (GLOSOLAN) and other laboratory networks.
- Development of a spatial data infrastructure for GLOSIS within the GSP framework, and improvement of workflows and tools for handling soil point data sets shared by national GSP members and other data providers within an interoperable, federated system.
- Incorporation of proximally-sensed soil data, and the supporting calibration sets, into a global
soil repository, and ultimately in GLOSIS. • Develop novel approaches to digital soil mapping, at various scale levels, with special attention to quantification of the uncertainty in the predictions (i.e., which level of uncertainty is considered acceptable by a given user seen their specific needs). • Testing options for including soil biological data in WoSIS, as a possible complement to international activities such as the Global Biodiversity information Facility (GBIF). • Refine international soil classification in the framework of the IUSS Working Group on World Reference Base for soil resources. • And, overall, fulfil recommendations for improvement made by the WDS Scientific Committee, during the recent CoreTrustSeal certification and WDS re-accreditation process.

Concluding remarks

The ISRIC WDC-Soils holdings provide a unique resource for addressing pressing agricultural, environmental and societal issues of our times, at various scale levels. As indicated, we continuously expand and develop our physical collections, products (point, polygon, grids) and web services. Decisions of policy makers and planners of the future must be based on the best possible data. To secure the continuity of the WDC-Soils it is essential that its significance is recognized by the whole scientific community and, importantly, by those who fund the work. This requires foresight, patience and an awareness of the great potential value of the information that can emerge from archived materials and quality-assessed, standardised soil data holdings through judicious analyses. It also requires willingness and ability of data owners to share (part of) their soil data for the benefit of the international community.

Acknowledgements

We gratefully acknowledge the contributions and shared knowledge of a steadily growing number of data providers and experts. ISRIC receives core funding from the Netherlands Government.

Competing interests

The authors declare that they have no competing interests.

References


Available via: https://doi.org/10.17027/6f38-hn42