ISRIC World Soil Reference Collection management policy

Reference soils serving research, education and advocacy

ISRIC Report 2021/01

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Preface

Collections in natural sciences provide a valuable resource for understanding the world around us. They are a source and reference for research and provide a basis for education through museums. Yet, in many natural history museums soil is not on display and museums dedicated to soils are very scarce. Systematic collection of objects for research is more common in biological sciences than in soil sciences.

In the World Soil Museum of ISRIC people are informed about and inspired by the great diversity of soils and their functions. It is a venue for study, education, and edutainment. It reflects the efforts of ISRIC since 1966 to establish a reference collection and collect, document, study the soils of the world, contribute to standards for analysis, description and classification and provide a global overview of soils and their properties. A clear example for which the ISRIC collection provided a reference is the pre- and post-Chernobyl comparison of radionuclides in soil samples.

The physical collections of ISRIC are recognized by the international soil science community as a unique resource which is valued for classification, research, verification of hypotheses, and methodology development for soil measurement methods. It contributes to the fulfilment of core tasks of the overall function of ISRIC as a soil reference and information centre.

Management of the physical collections includes, among others, maintenance, organisation, documentation, digitization and data verification. ISRIC will continue to enhance quality of its collections and increase accessibility. This investment goes in parallel with, and is guided by, the implementation of Spectrum international standards for collection management. This report documents the status and management of ISRIC's World Soil Reference Collection and how we will work towards compliance with Spectrum procedures.

Rik van den Bosch

Director, ISRIC - World Soil Information

Summary

The soil reference collection of ISRIC - World Soil Information is a unique resource. It is used for research and display in the World Soil Museum of ISRIC. This report describes the current collection management practice and our strategy to implement the Spectrum international standard for collection management.

The mandate of the World Soil Museum is to increase, throughout the Netherlands and internationally, interest in, knowledge of and appreciation and respect for the soils of the world. It does so by establishing, maintaining and developing a global soil collection that provides a reference for identification (classification), comparison, research and education. This report discusses the soil reference collection of ISRIC, its curation and use, in relation to the functions of the World Soil Museum and ISRIC - World Soil Information.

The soil reference collection requires continued attention and quality investment. This means scrutinizing reference data, assessment and documentation of the collection and acquisition and disposal of collection objects. To ensure the quality of the collection and provide accountability, ISRIC has been working towards compliance with Spectrum procedures of museum collection management. There are 21 procedures in Spectrum. These are discussed in relation to the management of the ISRIC soil reference collections, which is specific due to the unique nature and scientific aspect of the purpose of the collections. Not all Spectrum procedures are therefore relevant for the management of the ISRIC physical collections. Yet, many aspects of the philosophy of the Spectrum standard are relevant. Spectrum procedures will, among others: 1) help to better formulate the strategy of the collections; 2) provide a framework to enhance the quality of the collections; 3) enhance accountability for collection management; and 4) result in documentation of all parts of the collection management.

Spectrum procedures for the curation of the soil reference collection will be implemented over the coming years in prioritized phases.

Acronyms and abbreviations

FAO - Food and Agriculture Organization of the United Nations

ICARDA – International Center for Agricultural Research in the Dry Areas

ICRAF - International Centre for Research in Agroforestry

ICSU - International Council for Science

IIASA - International Institute for Applied Systems Analysis

ISIS – ISRIC Soil Information System

ISO - International Organization for Standardization

ISSCAS - Institute of Soil Science, Chinese Academy of Sciences

IUSS - The International Union of Soil Sciences

ISRIC – International Soil Reference and Information Centre

JRC - Joint Research Centre

KNAG - Royal Dutch Geographical Society

LABEX - Laboratory methods and data exchange

NGO - Non-governmental organization

NIOZ - Netherlands Institute for Research of the Sea

PDA - personal digital assistant

RDF - Radio-frequency identification

UNESCO - United Nations Educational, Scientific and Cultural Organization

WDS – International Science Council (ISC) World Data System

1. Introduction

This report discusses the nature, management and uses of the ISRIC - World Soil Museum. The current collection management practice is described and compared with the Spectrum international standard for collection management (Spectrum 5.0, 2017). Various sources for museum and collection management have been consulted for this report (amongst other Boylan et al., 2004, Smithsonian Institution Office of Policy and Analysis, 2005 and Unesco, 1967).

1.1 Mandate, mission and vision

The mandate of the ISRIC World Soil Museum is to increase, throughout the Netherlands and internationally, interest in, knowledge of and appreciation and respect for the soils of the world. It does so by establishing, maintaining and developing a global soil collection that provides a reference for identification (classification), comparison, research and education. The museum informs visitors, both onsite and online, of soils from around the world, their properties and their management, the knowledge derived from them and the understanding of what they represent.

The mission of the World Soil Museum is to research, inform and educate about the nature and the diversity of soils in the world and what that means for society. We aim to achieve this by providing science-based information, evidence-based insights, inspiring visitor experiences, and real engagement with soil in context of their formation, their management and major global themes.

Our vision is an international recognition and understanding of the diversity and functions of soils and their relevance for societal and global themes, such as food security, biodiversity, water quality and availability, and climate change adaptation and mitigation.

1.2 Positioning

In the World Soil Museum visitors are informed about and inspired by the great diversity of soils and their functions. It is a venue for study, education, and edutainment. It reflects the efforts of ISRIC since 1966 to collect, document and study the soils of the world, contribute to standards for analysis, description and classification and provide a global overview of soils and their properties.

The World Soil Museum provides a stage for experts of ISRIC and Wageningen University and Research to interact with various stakeholders, such as students, teachers, researchers, donors, policy makers and NGO’s. The visitor, in direct contact with experts, is exposed to research done on Wageningen Campus and to the fascination and passion of scientists.

The museum aims to increase impact with an expanding group of stakeholders and highlight and enhance the understanding of the relevance of knowledge and information on soils for society. A move towards a larger public, more experience-driven, museum is currently not aimed for. A soil museum for the general public will focus on highlighting soil as a natural system and its functions in the context of landscapes and society. The soil monolith collection of ISRIC, that is representative for the major soils from around the world has only partial relevance for this.

1.3 Structure of report

This report discusses the soil reference collection of ISRIC and its curation in relation to the functions of the World Soil Museum and ISRIC - World Soil Information itself. The role and functions of the World Soil Museum are presented in Chapter 1. Chapter 2 discusses the nature, composition and history of the world soil reference collection and highlights the use of the soil reference collections. In Chapter 3, the current collection management practices are described and compared with the Spectrum international standard for collection management (Spectrum 5.0, 2017). Where the current practices are not compliant with Spectrum, it is indicated what, how and when we aim to achieve more compliance. Concluding remarks, concerning developments over the next 5 years, are made in Chapter 4.

2. World Soil Reference Collection

2.1 History and nature of the collection

The International Soil Museum (ISM) was established in 1966; in 1984, it was renamed International Soil Reference and Information Centre (ISRIC), and in 2003 is was registered as ISRIC - World Soil Information. The main task of the then ISM was to collect soil profiles, soil samples and associated information representative of the legend units of the FAO-Unesco Soil Map of the World (FAO, 1974, 1988, 1995, 2003; Mantel, 2017).

The principal selection criterion was representativeness of a major soil type within any particular country from the legend of the Soil Map of the World. Furthermore, specific soil and land use features were taken into account, such as sites with original vegetation versus cleared land (Kauffman et al., 1995). Such reference soils are described using a comprehensive set of soil and environmental data that are assessed and measured using uniform and standard methodologies (van Reeuwijk, 2002; FAO, 1990, 2006). The quality-assessed data of the ISRIC soil reference profiles are stored in the ISRIC Soil Information System (ISIS). Such homogeneous and consistent data are an important source for verification of national datasets (Kauffman, 1996) and for development of new measurement methods on the reference samples. Data of the reference profiles are also valuable for verification and calibration of models, such as for soil hydraulic functions and for soil erosion prediction, and for the development of pedotransfer functions (ptfs), e.g. Van den Berg et al. (1997), Arthur et al. (2019).

The definition of a reference soil in relation to ISRIC's soil monolith and samples collection is:

'A set of soil profiles, soil samples and associated information representative of the legend units of the FAO-Unesco Soil Map of the World (FAO, 1974, 1988, 1995, 2003), Harmonized World Soil Database (FAO et al., 2012) and the World Reference Base for Soil Resources (IUSS Working Group WRB, 2015) of which the properties are assessed according to uniform and standard methods (FAO, 2006; Van Reeuwijk, 2002)'.

2.2 Collection description and overview

The work on the world soil reference collection started in 1966 with the establishment of the institute. The primary purpose was to show and characterise representative examples of soils from around the world. Since then, it has grown to become an unmatched resource for the purpose of research and education. As

indicated, the collection consists of soil monoliths (Box 1) and associated samples of representative soil groups/types shown on the FAO Soil Map of the World (FAO, 1974, 1988, 1995, 2003) or HWSD (FAO et al., 2012). The soil monoliths are the core of the ISRIC world soil museum exhibition.

Box 1 Soil monolith: a look into the soil

A monolith (appr. 150 cm length, 25 cm width, and 10 cm thickness) shows the natural, undisturbed structure of a soil and the sequence of soil horizons. Monoliths are prepared with a glue so that they are preserved for a long time. They are the best alternative to viewing a soil in a soil pit in the field and are therefore an important educational resource. Monoliths in the ISRIC reference collection are accompanied by: (i) a complete description of the soil, including its location; (ii) chemical, physical and mineralogical analyses of the different horizons; (iii) thin sections* of the horizons to be studied by microscope; (iv) bulk soil samples of each of the soil horizons, to be used for possible analyses in future; and (v) photographic documentation and supporting soil maps and reports.

* A thin section is a slice of soil that is prepared from a hardened sample impregnated with a resin. It can be examined under a transmitted-light polarizing microscope.

The soil reference collection is the focal part of the ISRIC physical soil collection. The broader collection itself also includes a number of 'non-reference' objects such as hand pieces, rock samples, and soil monolith and lacquer profiles that lack soil samples or are otherwise incomplete (e.g. for soil description).

The various classes of physical soil collections, as of March 2020, are specified in Table 1.

Table 1: Description of the ISRIC – World Soil Information physical collection

Collection/sub-collection	Items	Owner
Soil monoliths	1166 conserved soil profiles	ISRIC[1]
Thin sections:		
ISRIC	4000 thin sections	ISRIC
Jongerius-Stiboka	6000 thin sections	ISRIC
Schmidt-Lorentz	10.000 thin sections	ISRIC
Soil samples:		
ISRIC	7000 samples	ISRIC
Kubiena	100 samples	ISRIC
Mohr	1000 samples	ISRIC
Hand pieces	250 pieces	ISRIC
Images/slides	20000	ISRIC
Reports/maps	15000	ISRIC

Requirements for soil profiles to be included in the ISRIC World Soil Reference Collection are:

- Complete site and morphological description, including accurate location;
- A 'good' soil monolith with adequate accompanying sample material to permit additional research — in some instances, where monoliths for similar soil units are already on display in the World Soil Museum, these may be replaced by high resolution, digital imagery as a cost-effective solution;
- Analytical data (*from a certified, reference laboratory*) enabling correct characterisation and evaluation;
- Characteristic for one of the soil units of the FAO-Unesco *Soil Map of the World*, or its successor the digital *Harmonized World Soil Database*[2], and important for the country/region), with added scientific and/or educational value (with reference to the existing collection). Conversely, they may be illustrative of specific themes such as catenas or chronosequences, cultural-historical (e.g. *Terra Preta do Indio* from Brazil; set from Italy illustrating

[1] In 1997, the soil monoliths of ISRIC and associated materials have been formally recognized as 'state collection' of the Dutch Government (see the report *'Rijk en divers*' of the 'Ministerie OCW, Inspectie Cultuurbezit').
[2] http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/

the effects of deforestation in the Mediterranean since Roman times), biological activity (e.g. termitaria), land use and land management aspects (e.g. effects of manual and mechanical forest clearing), or soil formation on specific parent materials.

Soil samples are collected to characterise the various genetic layers, or horizons, in a soil. Consistent guidelines for soil description[3] (FAO, 2006) and sampling underlie the reference collection; soil analytical analyses are carried out according to defined reference methods (Van Reeuwijk, 2002 and Soil Survey Staff, 2014) and in accordance with Good Laboratory Practice (Van Reeuwijk, 1998; Gowing and De Hayr, 2020; GLOSOLAN, 2020). On average, each soil profile collected is characterised by six samples (two to thirteen samples per profile), depending on the number of soil horizons identified and soil depth.

The overall method for taking soil profiles and making soil monoliths was first described by Van Baren and Bomer (1979). Since that time, adaptations have been made to the procedure. After decades of using nitrocellulose lacquer, the environmental friendly (safer to handle for the operator) and cheaper wood glue (PVA) was shown to be effective as a conservation fluid (Mantel and Van Kleef, 2021). Figure 1 shows a detail of the monolith store.

[3] ftp://ftp.fao.org/agl/agll/docs/guidel_soil_descr.pdf

Figure 1: Store for the soil monoliths.

2.2.1 Reference soil samples

The (dried, grinded and sieved) materials that remain after soil analysis of the reference soil samples are stored in glass containers that have labels with unique numbers and a barcode. Their position in the cabinet is recorded in a database. The reference soil samples themselves are stored in the ISRIC workshop on the Wageningen Campus. Some material (soil peds), that was removed from the profile in the process of preparation of the soil monolith, is also stored in labelled and barcoded glass pots; these materials may be used to repair damaged profiles (Figure 2). The 'repair samples' themselves are stored in a storage facility off the Wageningen Campus in the neighbouring city of Ede. This is a commercial storage facility (Shurgard) that provides storage at a cheaper rate than on-campus storage. Since the 'repair samples' are rarely required, this is an economic option. Yet, the option is not completely safe for the collection. It once happened that a box was broken into and about 10 pots were damaged. Other collection items that are stored at the Ede facility, are bulk sampling material for the reference profiles in bags, special samples (e.g. from the Laboratory methods and data exchange – LABEX project), thin section blocks, and larger sized field equipment and measuring devices such as augers and groundwater level measurement tubes.

Figure 2: Storage of samples for repair of damaged monoliths.

2.2.2 Digitization of collections

ISRIC has established procedures for making reproductions of the collections. These are scans of maps, reports and thin sections (Figures 3 and 11) and digital high-resolution images of soil monoliths (Figures 3 and 8).

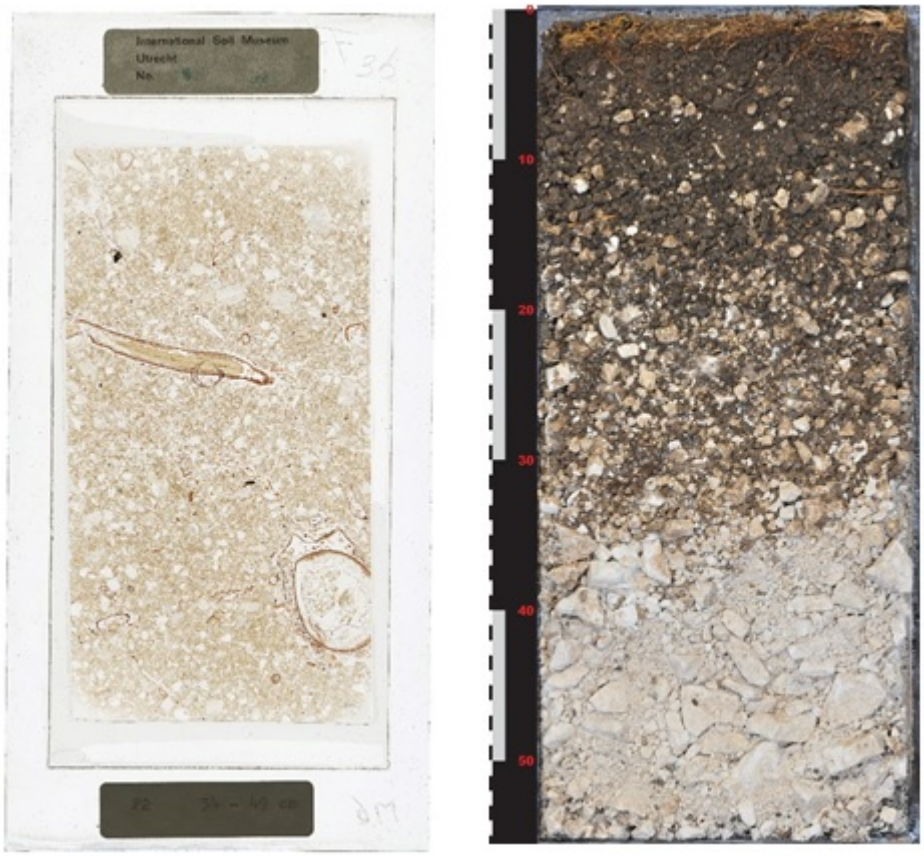

Figure 3: Scan of thin section from a section of a soil from France (l) and a HR image of a soil monolith (r) from the United Kingdom.

2.3 Use of the collection for research

The reference collection provides an international standard for the study of soils and their properties. It is recognized by the international soil science community for its value for: 1) classification and research, e.g. soil formation; 2) definition and verification of criteria, such as in soil classification; and 3) methodology development, for example correlation material for new methods through use of the reference samples.

On a regular basis, ISRIC receives requests from researchers and institutes around the world for soil reference sampling material. This material is valuable for research or used to develop new methods for analysis because: 1) the samples have a wide geographical spread; 2) they are well documented according to

standard international protocols; and 3) they have been fully analysed in (mostly) one laboratory using consistent laboratory methods.

Examples of the use of samples from the reference collection (see Figure 4 for an example of storage of the samples) are: 1) calibration of spectral analytical equipment for rapid, non-destructive and low-cost analysis of various soil attributes such as particle-size distribution, organic carbon and nutrients (ICRAF, Kenya[4]); 2) soil carbon related studies by researchers at Wageningen University for; 3) development of detergents by Unilever (UK); 4) improvement of estimation of clay content from water content for soils rich in smectite and kaolinite (Arthur et al., 2019); 5) assessment of marine influences on shore soils by the Netherlands Institute for Research of the Sea (NIOZ); 6) pre- and post-Chernobyl soil conditions in the Middle East by ICARDA (Syria).

Figure 4: Barcoded pots with sieved and grinded reference soil samples.

[4] A Globally Distributed Soil Spectral Library Mid Infrared Diffuse Reflectance Spectra: https://worldagroforestry.org/sites/default/files/Description_ICRAF-ISRIC%20Soil%20VNIR%20Spectral%20Library.pdf

2.4 Collection and education in the World Soil Museum

The unique world soil reference collection is at the core of the museum's exciting exhibition displays and educational activities. We seek to increase the appreciation and understanding of soils as a natural resource by higher education students and at the same time inform and inspire the general public. For many visitors, the World Soil Museum is a first introduction to soils a natural body and resource, to ISRIC and its activities, and to Wageningen Campus. The museum has five main functions: (i) education; (ii) provision of courses; (iii) info- and edutainment; (iv) social function; and (v) real museum function (objects of art). The World Soil

Figure 5: Visitors exploring the displays and soils in the World Soil Museum.

Museum is well known in soil science circles, both at the national and international level. Although the principal visitor groups of the museum are from higher education centres and universities from Germany, Belgium and the Netherlands, there has been a sharp increase in number of visitors from the 'general public', 'spontaneous' visitors of the museum, visiting scientists and related (international organizations and policy makers) as well as student groups. The annual number of visitors in 2018 and 2019 were three to four times higher than the long-term average of annual visitors between 2000 and 2013 (Figure 7). The latter category is traditionally composed of higher education student groups (mostly first to second year), but has broadened to secondary and primary school classes and tailored programs are provided.

The core of the visitor groups is academic: mainly students and researchers from higher education centers and universities. Links have been established with other programs of Wageningen University, such as the Science Lab for kids (children's University[5]) and with geography teachers through the Royal Dutch Geographical Society (KNAG). The increase in number of visitors and broadening of user groups has generated more exposure for ISRIC and for Wageningen University and Research (Mantel, 2017).

Figure 6: Guided group in the World Soil Museum.

Figure 7: Visitor numbers to the World Soil Museum (2000-2018).

For documentation purposes and to provide online access, the digitization of the collections was started in 2010. The digital collection is the basis for the virtual soil museum. It consists s of a virtual tour in the museum, an audio guided tour, and online collections search facility. In 2021, the whole of soil monolith collection has been photographed in high resolution according to a fixed procedure. Soil monoliths are put in a vertical position under additional lighting. The monolith is

[5] https://www.wur.nl/nl/Onderwijs-Opleidingen/Wetenschapsknooppunt/Ons-aanbod/Wetenschapper-in-de-klas/Diep-de-bodem-in.htm

then photographed section by section. These images are digitally ‘glued’ together into one high resolution image.

Figure 8: HR image of a Technosol with example of zoomed in detail of profile.

Figure 8 shows and example of a high-resolution image of a soil with human influence from the Netherlands and a detail of the profile after zooming in.

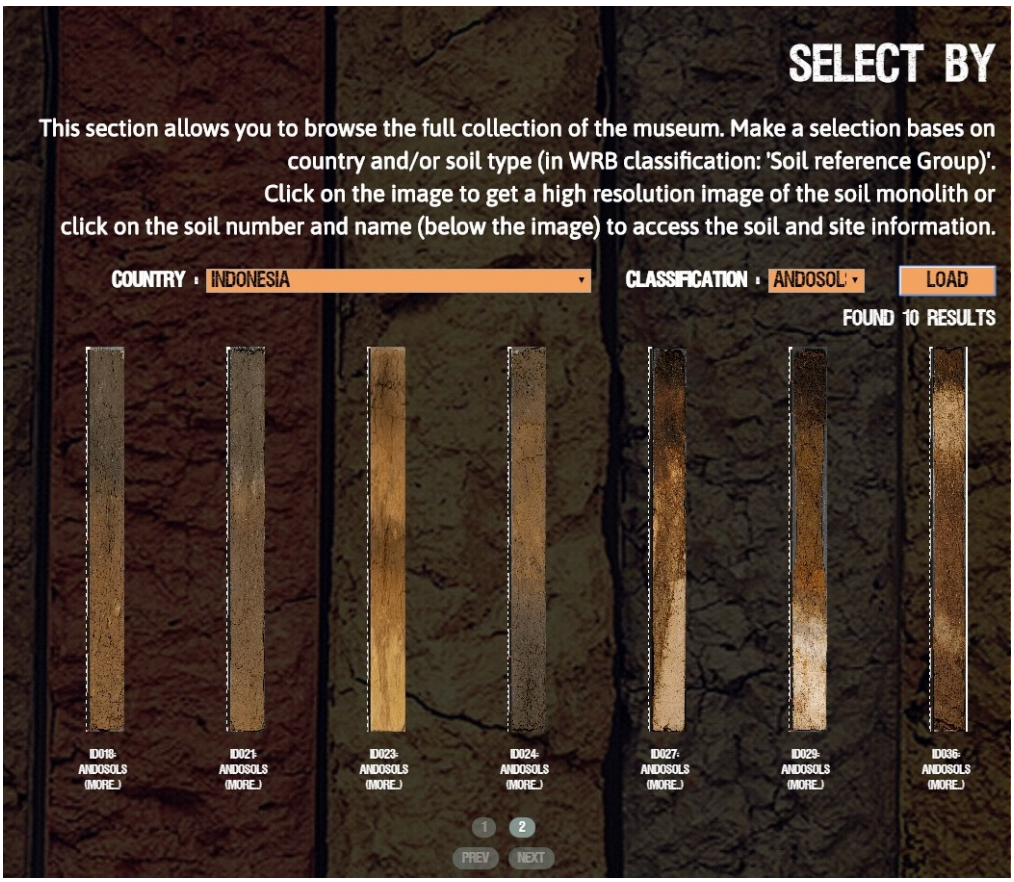

Figure 9: Virtual soil museum (1): online access to soil monolith collection.

The thin sections of the ISRIC soil reference collection are in the process of being scanned under a flat back scanner. These images will be made available online for web-access (Figures 9 and 10) once linked to the corresponding profiles in the ISIS database. Figure 9 shows the collection searcher[6] that allows users to retrieve online images and associated data files of monoliths of their selection, by the taxonomic class or originating country. Another tool in the virtual soil museum shows the profiles in the museum on a world map[7] (see Figure 10) on the location where the soils actually have been sampled. The online visitor can switch with a satellite image and zoom into field level.

[6] https://wsm.isric.org/#gallery
[7] https://wsm.isric.org/#mapsMono

Figure 10: Virtual soil museum (2): online access to soil monolith collection.

3. Collection management: towards compliance with Spectrum

Introduction

This chapter discusses the management of the collections of ISRIC with reference to the UK Trust collection management standard (Spectrum 5.0, 2017). The Spectrum standard for collection management is accepted widely as an 'international' standard. It provides guidelines on how to manage museum or museum-like collections, which in principle is relevant for museums of any size and type of collection. Some of these guidelines apply to daily activities, such as moving collection objects and updating location records. Others apply to more occasional activities such as updating insurance cover. Spectrum calls all these activities procedures and there are 21 of them (Spectrum 5.0, 2020). The sub-chapters of this chapter each discuss a Spectrum procedure and indicate to what degree the ISRIC collection management meets the standard and if, how and when compliance may be achieved (see also Table 2, Chapter 4), and what is required to achieve (partial) compliance.

The management of ISRIC's soil physical collections is specific due to the unique nature and scientific aspect of the purpose of the collections. Not all Spectrum procedures are therefore relevant for the collection. Yet, many aspects of the philosophy procedure of the Spectrum standard are relevant to consider here. Spectrum procedures will, among others: 1) help to better formulate the strategy of the collections; 2) provide a framework to enhance the quality of the collections; 3) enhance accountability for collection management; and 4) result in documentation of all parts of the collection management.

Compliance, partially or in full, with Spectrum procedures implies a change in ways of working. The advantages are that all collection management steps are based on clearly defined policies. Spectrum requires documentation and filing of steps to be taken, also in daily management of the collection. This implies that all involved staff has to be informed and trained on the procedures that are developed. Staff time will be dedicated to document policies, actions and decisions much more so than is done in current work procedures. The development of the procedures themselves also requires an investment, in definition, IT support, testing, training and implementation. In the long run, it will save time and contribute to enhancing the quality of and accountability for the collection. Inventories and evaluations need not to be repeated since they are documented. Future strategy formulations can benefit from earlier documented strategies and day-to-day decisions may become less ad-hoc and more based on an agreed and defined framework. The overall purpose of implementation of this is an increased trackability, accountability and a continued investment in the quality of the collections.

3.1 Spectrum procedure 1: Object entry and registry

Current procedure: All monoliths are labelled with a unique code that consists of a two digit ISO country code and a follow-number for the object from the given country. A RDF (Radio-frequency identification) chip is inserted in each monolith board for identification with a PDA (personal digital assistant) device. The monoliths are stored in a large cabinet and the location of each monolith is recorded in a database with respect to the number of the cabinet and its position. Other objects associated with the reference soil profiles, such as thin sections (see Figure 11), have unique sample numbers that refer to the corresponding reference profiles.

Figure 11: Storage of thin sections of soil.

Gaps with Spectrum procedure: The larger part of the ISRIC soil physical collection consists of objects that have been acquired by or on request of ISRIC staff with the objective of building a reference collection for soils of the world. That means that issues such as ownership, liability and other terms are already taken into account. Yet, these procedures may be better documented. Especially for orphan collections, such as the Kubiena and Mohr soil samples as well, as the Jongerius-Stiboka and Schmidt-Lorentz thin section collections (see Table 1), the object entry is to be improved.

Actions required: This means, among others, a need to document why the object was accepted, who is the previous owner, and the status and condition of the object upon acceptance. This procedure is currently not Spectrum compliant. The aim is to make an inventory of all objects that are not part of the soil reference collection itself, e.g. hand pieces, educational objects, such as lacquer profiles, historical items related to soil science (e.g. medals, knifes) and write procedures documenting why, how and under what terms orphaned objects should be included in, or excluded from, the ISRIC soil physical collections. The aim is to work towards a procedure that considers the relevant elements of the corresponding Spectrum procedure.

We aim at Spectrum compliance for this procedure to be achieved by December 2026.

3.2 Spectrum procedure 2: Acquisition and accessioning

Acquisition of objects is defined here as the process of sampling soil with the purpose to be added to the physical soil collection. In case of orphan collections or objects, this means taking legal ownership of objects that are donated to ISRIC. These objects may, but need not, become part of the long-term physical soil collection through the process of accessioning.

Accessioning is the formal commitment to include an object in the collection and care for it over the long term. In case of accepting an orphaned object a 'transfer of title' from the previous owner is required. This may be formalised in a procedure that provides a proof of ownership. All objects should be assigned a unique number that provides a link to all information known of the object. These include collection management data, but also scientific information about the object proper.

The implication of accessioning objects is that the museum preserves the object over time. To sample or accept an object for the soil physical collection, a careful consideration must be made in light of an established collection policy.

Current procedure: Most of the objects acquired over time have been sampled and collected by ISRIC in collaboration with national partners. The purpose has been and still is to build on the reference soil collection. However, some objects are offered by individuals or institutes that can no longer care for them. Often these objects are relevant for the museum, but not necessarily for the reference collection. They may be useful for specific purposes, such as education or display (e.g. for pop-up expositions). For these cases, a different, partial, procedure may apply.

Gaps with Spectrum procedure: ISRIC has an acquisition policy to build on the unique reference collection of soils from around the world. All these objects have unique numbers and are fully documented in our institutional database. Yet for orphan collections the procedure is less clear and acceptance still is on an ad-hoc basis, without numbering of the incoming objects, systematic documentation of the previous owner, reason for acceptance, copyrights issues, etc.

Actions required: Develop a policy on acquiring objects and document a procedure that explains the steps to follow when acquiring objects. Spectrum defines minimum requirements for the procedure.

In the coming years ISRIC will work towards a Spectrum compliant procedure for acquisition and accessioning. We aim at Spectrum compliance for this procedure to be achieved by December 2023.

Future acquisition of objects

In 2010, the reference collection was reviewed providing an inventory of locations of the soil pits and taxonomic classes represented (ISRIC, 2010). Several criteria discussed in the review may be used for selection of new soils and sampling sites.

Main focus here is to increase the scientific and educational value of the collection, for example concerning gaps in terms of taxonomic classes and regional representation. The relevance for this focus is discussed in the following sections.

Criteria for acquisition of new samples for the soil reference collection

Classification is a way of organizing knowledge. It creates order in a seemingly chaotic world. The legend of the first edition of the Soil Map of the World (FAO-Unesco, 1974) considered 26 major soil groupings and 106 soil units. Presently, as a result of accrued knowledge, 32 Reference Soil Groups (RSGs) are considered in the World Reference Base for Soil Resources (IUSS Working Group WRB, 2015), the international soil classification system that evolved from the Legend of the Soil Map of the World.

Originally, representation of the taxonomic units of the legend of the units of the FAO-Unesco Soil Map was a key criterion in management of the world soil reference collection, as the objective for ISRIC reference collection is: 'to collect soil profiles, soil samples and associated information representative of the legend units of the FAO-Unesco Soil Map of the World (FAO 1974)', *with added scientific and/or educational value (with reference to the existing collection)*. Nowadays, however, the HWSD (FAO et al., 2012) is used as the geographic reference basis, and WRB (IUSS Working Group, 2015) as the preferred international classification system for charactering soil profiles in the ISRIC soil reference collection.

The first criterion for adding new soils to the collection will be 'gaps in taxonomic classes' in the reference collection. Other criteria are soils from specific biomes and soils that have changed by human action. Soils underrepresented in the reference collection are, broadly speaking, soils from desert areas, soils from mountains, soils from polar regions and organic soils. Man-made soils and soils that have been changed significantly by human activities are especially relevant for future collection.

Figure 12: Newly arrived soil profiles in boxes.

In addition to the soils and criteria discussed in the above paragraphs, special interest may be paid to the following: soil catenas (genetically related soils down a slope), soil management sequences, and a combination thereof. Figure 12 shows how soil profiles arrive at ISRIC in sample boxes.

3.3 Spectrum procedure 3: Location and movement control

Current procedure: Objects that are not on display or loan, are stored in the basement of the building (GAIA) that houses the World Soil Museum on Wageningen Campus (Figure 1). Further, a workshop for preparation of the soil monoliths and handling of the reference soil samples is located in an adjacent building on the Wageningen Campus (Bedrijfsgebouw), behind the GAIA building. There are about 70 unprepared soil profiles in column (wooden) boxes, some of which are duplicates.

Records are kept of the (storage) locations of all objects in the collections of the World Soil Museum, and these are registered in a database that can be linked to ISIS using the unique identifiers of the objects. There are seven different stores in four buildings for the collections of ISRIC, including the exhibition toom. The records include information on the building, storage room, box number (if applicable), drawer and shelve position. These records are checked and updated over time or when objects are moved. This complies partly with the Spectrum procedure for location movement and control.

Gaps with Spectrum procedure: The date of movement or re-allocation of objects are currently not recorded. Also, the person that has moved the object should have authorisation and the name should be recorded. Adding the name of the person and the date of movement to the register will ensure that at any time the location and history of movement can be traced back and that individuals are accountable for moving collection objects.

Actions required: Develop a policy on moving objects within institute and on recording the location of our objects whether in the museum or elsewhere. The policy will consider questions like, how will the object location records be kept to date at all times? And: Who can request and approve the movement of objects around your museum? The procedure will, among others, record every movement of an object, including the date moved, and change the location record in line with your policy.

We aim to achieve full Spectrum compliance of this procedure by December 2022.

3.4 Spectrum procedure 4: Inventory

A proper registry is a requirement for collection management. For all objects in the collection a basic amount of information is required to be accountable. The core inventory information (Spectrum) that is required for each object (or group of objects) is:

- Object number: a unique object number (from which it should be clear whether the object is from accessioned collections, on loan, or has some other status such as a handling item)
- Object name: an object name
- Number of objects: the number of objects (if a group)
- Brief description: a brief description (or image)
- Current location: the current location
- Current owner: if not part of ISRIC collection, a record of who owns the object and a record of where it came from
- Recorder and recording date: a note of who recorded this information and when.

Current procedure: Most of these procedures are already implemented in our collection management policy, yet there is room for improvement.

Gaps with Spectrum procedure: The location, information on current location, of the collection objects is incomplete. The collection is stored in four different buildings and some objects are on loan. The location list of objects has some gaps, among others related to the lack of recording of deaccessioned objects. This information gap is currently assessed and filled. The other weakness concerning this topic is the poor inventory and documentation of hand pieces, such as rock specimens and soil survey historical items.

Actions required: The first step in the effort to overcome this gap is to make an inventory of objects that are not documented as yet in the storage rooms. The objects need to be labelled with a unique number. The number is then registered with basic information about the object. A procedure will be developed for the movement of objects. In practice this involves mainly registry of the recorder and recording date using a standard format. Each object that is found and that has never been accessioned needs to be evaluated against acquisition criteria and a decision is to be made on disposal or accession.

Full Spectrum compliance of this procedure is foreseen for December 2023.

3.5 Spectrum procedure 5: Cataloguing

Cataloguing according to the Spectrum definition is 'Managing the information that gives your collections meaning, not as an end-in-itself but to record and retrieve

what is known about your objects'. This topic is covered as concerned the reference collection.

Current procedure: All data on the soil monoliths, samples and sites from where the soil was sampled are stored and managed in a relational database (ISIS, International Soil Information System); since 2016, ISIS is part (a schema) of ISRIC's institutional, relational (PostgreSQL) database (WOSIS). ISIS contains both descriptive and measured data that are publicly accessible online[8]. Data on the location and movement of the samples and monoliths are (and will be) stored in separate database tables that are linked to the main database through a unique object identifier.

Gaps with Spectrum procedure: Absence of a catalogue of partial collections and hand pieces. Lack of documentation of additional information on soil and sites of the sample objects, including collaboration partners and institutes and the occasion or reason for acquiring the object.

Actions required: The cataloguing work that remains to be done is related to the hand pieces and other partial collections. Also the link to research papers and reports relating to the soil and/or site of the object is currently not facilitated in the database. Information on the history of the sampling is also not documented systematically. This concerns for instance information on the occasion of sampling a soil at a particular sites (e.g. a project, a request), who ISRIC collaborated with to sample the soil, and the historical context of the sampling site (land use history). Adding a comment field for this information in the database will allow documentation of this information.

Full Spectrum compliance is foreseen for 2025.

3.6 Spectrum procedure 6: Object exit

Objects may be moved from the storage for different reasons. They may have been selected for display in the World Soil Museum, they may be retrieved from the store for repair, or they may be lent to an external organisation.

Current procedure: The procedure of the ISRIC - World Soil Museum for exit of objects for loan is documented through separate loan contracts in which both the receiver and the object owner (ISRIC) sign a contract that states the purpose and period of loan, way of transport, insurance, way of storage at loaning institute and the conditions for exhibit of the object (see Section 3.7 on loans).

Gaps with Spectrum procedure: Lacking procedures for authorisation and documentation about the object exit process.

[8] https://isis.isric.org/

Actions required: Compliance with Spectrum on object exit requires a procedure for documentation about authorisation of the exit of the object, data on the destination (contact and address), statement about the reason for moving the object, signature for the confirmation of the handover, update of the collection database. Object exit forms need to be developed and implemented. These will then be used when objects from the collection leave the museum, for loans or for disposal.

To comply with Spectrum standards, we aim to develop a procedure and implement an object exit form by Dec 2022.

3.7 Spectrum procedure 7: Loans in of collection objects

Objects may be borrowed from individuals or organisations for display in the museum, for example for temporary expositions.

Current procedure: Lending of objects by the World Soil Museum is rare. There have been temporary expositions, such as on 'soils and art' with work from artist Herman de Vries in 2014. Currently, the museum has two objects (soil profiles) on long-term loan (in). This concerns a (Dutch) profile that is polluted with cyanide and a profile (Podzol) from the a heathland area in the Netherlands.

Gaps with Spectrum procedure: Lack of use of formal documents such as the loan policy (why objects are borrowed, for what period, who will authorize, etc) and a written procedure that documents agreement with lender, reason for loan, period, etc.

Actions required: The step towards compliance with this procedure is to develop and test the form (digital format) and operationalize by discussion and training of the procedure with the staff involved. A form is to be made that includes the following, Spectrum compliant, information:

1) A reference number for loan in - Loan in reference number

2) Name and contact details of the lender:

Lender (use a standard form of name)

Lender's contact (use a standard form of name)

Address

3) The person responsible for managing the loan on your behalf - Loan in contact (use a standard form of name)

4) The reason for the loan - Loan in reason (use a standard term source)

5) The proposed dates and status of the loan:

- Loan in begin date (use a standard format)
- Loan in end date (use a standard format)
- The status of the loan - Loan in status (use a standard term source)
- The date of the status - Loan in status date (use a standard format)

6) Object identification information

- The lender's object numbers for the items being borrowed:
- Other number
- Other number type (recorded as 'lender')

If the incoming objects of loan are not numbered, a temporary number is to be assigned to each item. This could be in two parts separated by a dash: first the loan-in reference number, then a sub-number for each individual object borrowed from the same lender.

The loan-in contract should contain information that is comparable to the contract for lending-out objects of the collection. This should include items that apply to the object (and lender):

- The lender's object number (if applicable)
- Object description
- Name and address of owner
- Object valuation
- Condition of the object
- Display requirements
- Environmental requirements
- Handling requirements
- Indication of any potential risks
- Object dimensions
- Photographs of object upon arrival, for reference of its condition
- Details of any relevant intellectual property rights and associated licensing requirements
- Any additional descriptive and historical information as required
- Exhibition number (if applicable)

The (digital) form is yet to be developed and the procedure to be implemented. This is foreseen to be ready and implemented by Dec 2022.

3.8 Spectrum procedure 8: Loans out of collection objects

Current procedure: The policy for the reference collection, given its unique character, is to expose as many people possible to it. This is primarily achieved through the exposition in the World Soil Museum. With the Virtual Soil Museum many more people around the globe have access to the full extent of the collection

for exploration, education and research. Through loan of soil monoliths to trusted parties, such as natural history museums, the World Soil Museum provides more people the possibility to view the unique objects of the World Soil Reference Collection. Loan is provided on a temporary basis. Soil monoliths have been out for loan in expositions of the Naturalis Museum of Natural History in the Netherlands, the Natuurmuseum Brabant in the Netherlands, the London Museum of Natural History and the Naturmuseum Südtirol. Two museums have soil monoliths on long-term loan (10 years with the possibility of extension); the Africa Museum in Tervuren, Belgium, and the National Museum of Natural Sciences in Madrid.

Thin sections are borrowed by external parties. This is almost exclusively related to archaeological research. The thin sections (from Dutch sites) provide information on history and human influence in soils. In addition the ISRIC World Soil Museum makes available soil sample material from the reference collection for relevant research that adds to the current state of knowledge.

Presently, 95 monoliths are on display in the World Soil Museum, while 14 are on long-term loan to other museums including the Africa Museum in Tervuren, Belgium, and the Museum of Natural Sciences in Madrid.

Gaps with Spectrum procedure: Lack of a documented policy, that considers issues such as why objects are loaned-out to external parties, to whom, who authorises loan, period of loan, and a written procedure that explains the steps to follow when objects are borrowed from ISRIC.

Actions required: Apart from the loan contract (see Section 3.6 Object exit), a policy for borrowing objects from ISRIC, a form and an associated procedure is yet to be developed and implemented.

This is foreseen to be ready and implemented by Dec 2022.

3.9 Spectrum procedure 9: Documentation planning

Documentation of the collection is a broad, complex and time-consuming issue. It requires the inventory and update of various aspects of objects of the (partial) collections. Documentation planning is a way to manage this process and monitor progress. Improving the documentation system and enhancing the information it contains is an ongoing process of continual improvement.

Current procedure: ISRIC is currently reviewing the number of soil reference samples and the amount of material available for each of these. In the future, we will know for all horizons of the soils and sites within the collection if a sample is present, how much grams of soil material is are available. A procedure will be developed to update the weight of the sample in the jar after material (form and database) has been extracted for research.

Gaps with Spectrum procedure: Incomplete documentation of partial collections and absence of unique codes of partial collection objects. Lack of integration of various documentation files of sub-collections that exist.

Actions required: To embed this process in the workflow and consolidate it, a documentation plan or collection information policy will be written that identifies what improvements need to be made and what activities need to be prioritised. This will indicate what activity will lead to effective results with minimal effort. The plan will describe the objectives, actions, resources required, measurable results to be achieved, and milestones to be reached.

The procedure will be written before mid-2022. The implementation of it will be distributed over several years.

3.10 Spectrum procedure 10: Condition checking and technical assessment

Current procedure: ISRIC has implemented a full check of the status of its core collection; the soil monoliths. A description and classification of the quality of the monoliths has been documented. This provides a basis for planning further work on the collection, such as minor and major repairs. This is to a great deal in line with the Spectrum standard for condition checking and technical assessment.

Gaps with Spectrum procedure: Current practice lacks documentation of policy on condition checking and technical assessment and there is no written procedure.

Actions required: In order to comply with Spectrum procedures on this topic, a policy needs to be defined and documented. The written procedure will describe the steps to follow when managing and carrying out condition checks and technical assessments of objects. It will consider among others who is responsible for checking the condition of the collection, when checks are to be carried out, when and what kind of action is required for identified problems with collections objects.

A policy document and a procedure will be written according to Spectrum standards. Documentation of this policy and procedure should be ready by the end of 2021.

3.11 Spectrum procedure 11: Collections care and conservation

Current procedure: Collection management at ISRIC aims at long-term conservation of the collection in general and of the monoliths in particular. Conservation work on the collection is relatively straightforward for two reasons. First, the core collection is rather homogeneous in nature. Quality assessment and conservation approaches are easily standardized and do not require involvement

of staff with different specialisms. Secondly, ISRIC maintains spare material for repair of soil monoliths. It consists of soil material that was set aside during monolith preparation and is stored in jars. Monoliths that require repair, because of damage or decay, are repaired in the soil monolith workshop.

Gaps with Spectrum procedure: Current practice lacks documentation of policy on collection care and conservation and there is no written procedure.

Actions required: The Spectrum standard on this topic requires a policy on the care of collections and the conservation of collection objects. In the case of ISRIC, this can be addressed together with the formulation and documentation of the policy on condition checking and technical assessment (procedure nr 10). Required additions to the current procedure are the documentation of the responsibility (conservator), authorisation and work procedure for conservation work. Documentation of this policy should be ready in 2022 (see previous section, reference to overview table).

3.12 Spectrum procedure 12: Valuation

Current procedure: Most museums have a procedure in place to document the financial value of objects, whether owned or borrowed. Since over about 95% of our collection was collected by us or on our request (in collaboration with partners) there is no registered purchase value of the collection objects. Neither is there a market value as there are no soil monoliths available for sale. We can estimate the costs involved with acquiring other comparable objects, including travel, staff time, transport and other expenses. Such an indicative value is often required for the purpose of insurance, for instance for transport and loan of a monolith to another museum. The value of repair of a monolith can also be assessed by the number of staff hours required to conserve or rehabilitate a damaged object, as well as material costs.

Gaps with Spectrum procedure: No registered purchase value of the collection objects.

Actions required: None. We consider current procedures on valuation to be adequate for stated purpose. Further elaboration of these procedures, e.g. towards a Spectrum compliance, therefore is not envisaged.

3.13 Spectrum procedure 13: Insurance and indemnity

Current procedure: The World Soil Museum does not borrow high value objects for exhibitions or other purposes from other museums. The soil monolith collection and the soil samples, do not have a real market value themselves, yet have an

important scientific and educational value. The value will be assessed at the cost for replacement upon loss.

Gaps with Spectrum procedure: The collection is not insured for theft, loss or damage.

When objects of the collection are handed over for loan to other parties, these parties are obliged to insure the object from the moment it is picked up from the storage at ISRIC until it is brought back to the storage. This includes transport, handling and safekeeping during the period of the exposition.

The storage facility for the monoliths, the samples, thin sections and for the library holdings (maps and reports) are all in a building at the Campus of Wageningen University and Research that has an insurance for damage to the property for amounts above 50,000 euro. That means in case of calamities, the larger part of the costs of damage are covered.

Actions required: The current procedure is considered adequate. Further elaboration of the procedures, e.g. towards Spectrum compliant procedure, will therefore not be done.

3.14 Spectrum procedure 14: Emergency planning for collections

Planning for emergencies related to the collections concerns managing information about potential risks to all the objects in the collection. It specifies what protective actions need to be taken in case of emergency situations.

Current procedure: The storage rooms of the reference soil collections are mainly located in the basement of the GAIA building at the Wageningen Campus, whereas the core collection is presented aboveground in the World Soil Museum in a separate building (located between GAIA and Lumen). The unlikely but most conceivable risks for the collections are flooding and fire. Other operational risks include damage due to inappropriate environmental conditions in the storage that may create mould, for instance due to high humidity.

Gaps with Spectrum procedure: No documentation available on policy or procedures for emergency planning.

Actions required: To better plan for emergencies, an assessment needs to be done first of the emergency situations that may endanger the collections. Based on that assessment, a plan can be made to minimize the risks of such emergencies. Recommendations from that assessment must be translated into actions for change. Knowing what to do in case of an emergency should be specified in an emergency plan. The role assigned to each person related to the collection is specified indicating who will do what and who is to be contacted. Also the responsibilities and contacts of other people in the building (reception, head of

Emergency Response) and professional organisations potentially to be contacted, such as plumbers, movers, fire brigade, etc.

Alternative locations must be identified for moving the collection in case when it is under threat. The plan should describe what route should be taken to the alternative location and how the evacuation should be organized, including the conditions (e.g. equipment required). Such a situation happened in 1995 in Wageningen when part of the city was under threat of flooding. After a long period of high water level in the river Rhine, the dikes became unstable. Valuable goods were evacuated that were at risk, including the ISRIC soil reference collection.

Working toward a risk assessment, risk minimization recommendations and an emergency action plan requires time and this will be done in phases. The risk assessment is foreseen to be ready by Dec 2022. The other parts of the emergency planning and procedures are planned to be ready by 2023, with the aim to be Spectrum compliant.

3.15 Spectrum procedure 15: Damage and loss

This section is about how the curator and associated staff should respond to damage to, or loss of, objects from the collection. A procedure must be in place that when damage or loss of collection objects occur, the incident is documented so that decisions can be made and actions recorded. If damaged, from minor to very significant, the condition of the object and the need for conservation/repair are to be assessed (procedure of condition checking and technical assessment).

Current procedure: If the damage is discovered upon return of a monolith from loan, then the borrower is to be informed first. Subsequently, a report is made to the insurance company.

Gaps with Spectrum procedure: There is no documentation on policy and procedure for damage and loss of objects. A procedure must be in place that ensures proper checking of the status of the monolith for loan upon sending and after return and the follow-up if damage is discovered. The responsibilities, tasks do be done and by who, and who to inform, must be specified. The date of discovery of the damage and the conditions under which the damage occurred should be recorded.

In case of loss the procedure should be similar as for reporting damage. The date of discovery of the loss and the conditions under which the loss occurred should be recorded. A report is sent to the company that provided insurance for the loan. The location record of the object is to be adjusted in the files (procedure for location and movement control). In a review of the collection management (audit) such information can be taken into account for recommending improvements to the procedures.

Actions required: A section will be written in the collection management policy that specifies the procedures to be followed in case of damage or loss. That will partly be a confirmation of current practice and partly an elaboration of the procedure as described in Spectrum, especially on the documentation.

This section will be ready in 2022.

3.16 Spectrum procedure 16: Deaccessioning and disposal

Deaccessioning is the formal decision to take objects out of the accessioned collection and managing the disposal of those objects through an agreed method. Some objects may be damaged or degraded to the extent that they are considered beyond repair. Such objects are then to be disposed of. Other objects may not fall within the criteria defined for the collection.

Current procedure: The quality and relevance of the collections is based on established collection and quality criteria. On the basis of these criteria, deselection, or withdrawal of objects from the collection, is an essential part of collection management (Smithsonian Institution Office of Policy and Analysis, 2005). Objects that are outside the scope of the objectives and quality criteria of the collection management policy will be considered for withdrawal. These may be: damaged objects, collection pieces that lack information, objects that are not relevant enough for scientific or educational value for a global collection. In case of withdrawal of collection parts, the acquisition status will be checked. If it is acquired through an orphaned collection, an attempt will be made to contact the original owner and offer the return of the object. In case of rejection or in case the owner cannot be found, then a new owner of the object will be sought. This is also the case for original (self-acquired) objects. A severely damaged object that is beyond repair will be destructed and disposed of.

In the unlikely circumstance that the whole institute will cease to exist or will be strongly reduced, e.g. due to financial problems, the unique collection must be kept together. A new owner has to be found for the collection as a whole. The collection was founded on initiative of international organisations, i.e. it was instigated by Unesco, the Food and Agriculture Organisation of the United Nations (FAO) and the International Union of Soil Sciences (IUSS, formerly ISSS). The soil monoliths of ISRIC and associated materials have been formally recognized as 'state collection' of the Dutch Government (see the report 'Rijk en divers' of the 'Ministerie OCW, Inspectie Cultuurbezit', 1997). The collection will therefore likely be transferred to another institution in the Netherlands, unless decided otherwise by the Dutch Government. This aligns with our agreement with the International Council for Science (ICS, formerly ICSU) World Data System (WDS), of which ISRIC has been a regular member since 1989 (WDC Soils), that if 'for any reason, ISRIC WDC-Soils is unable to continue its long-term commitment, then it should

endeavour to find a mechanism to secure its data activities by transferring them to another WDS facility or other suitable host organization.'

A sub-collection that is currently (2021) identified for reallocation is the Dutch collection of thin sections (both blocks and thin sections). This is a collection that was orphaned by the Soil Geography and Landscape (SGL-WUR) department of the Wageningen University (formerly the Soil Science and Geology department). The thin sections are almost exclusively from Dutch sites and the (limited) users that request loan are archaeology researchers from Dutch companies or from the Netherlands Cultural Heritage Agency (RCA). After communication with the original owner an effort will be made to transfer these thin sections to either RCA the Netherlands Cultural Heritage Agency (NCHA) or provincial archaeological depots.

There are 71 soil profiles (status March 2020) in the store of the workshop that have not been prepared yet. Those that have descriptions and samples will be prepared to monoliths. Some profiles have arrived damaged or have no samples nor proper description, including sixteen profiles from India. One more effort will be done to recover the description and location of these profiles. If unsuccessful the profiles will be disposed of in 2021.

Gaps with Spectrum procedure: There is no documentation on policy and procedure for Deaccessioning and disposal.

Actions required: A procedure is to be written that is compliant with Spectrum standards on the topic of deaccessioning and disposal. It should, among others, specify the responsibilities of staff in the deciding on deaccession and disposal, the procedure towards taking a decision and how that decision is reviewed.

Documentation of this policy and procedure should be ready in 2024.

3.17 Spectrum procedure 17: Rights management

Most material in the ISRIC physical collections was collected by or at the request of ISRIC itself. That means that rights of images of objects from collection and the information associated with the sites and soil profiles (monoliths) are with ISRIC.

Current procedure: Data of the profiles and derived educational or scientific information, such as images, texts and video's, can be used by others under the Share-Alike license (Creative Commons Attribution) that allows re-distribution and re-use of a licensed work on the conditions that the creator is appropriately credited and that any derivative work is made available under 'the same (Creative Commons), similar or a compatible license'. More information about this can be

found in the ISRIC 'Data and Software Policy'[9]; management of personal information is according to GDPR regulations[10].

Gaps with Spectrum procedure: None.

Actions required: None. The current policy is considered adequate hence no further action is deemed necessary at the moment.

3.18 Spectrum procedure 18: Reproduction

Current procedure: Through digitization, the World Soil Museum provides a broader accessibility to the collection. It will safeguard the collection for the future, support research and education, adds value, encourages collaboration and facilitates the presentation of the collection on digital platforms such as the Virtual World Soil Museum (Figures 9 and 10). The digital images are recorded with unique identifiers/file names. The current procedures are considered nearly optimal.

Gaps with Spectrum procedure: Documentation of procedure for reproduction are not all up to date or publicly available not.

Actions required: Manuals for the process of reproduction are in development. These documents must be made available on ISRIC website. A short description shall be made of the different procedures that are in place of the photography and digitization and where the files are stored.

This should be ready by December 2022.

3.19 Spectrum procedure 19: Use of collections

Current procedure: Monoliths are made available for loan to museums that meet requirements for safe transport and exhibition of the monoliths, after agreement through a signed contract. Sample material is made available at handling costs under the condition that the research is relevant and adds to the current state of knowledge.

Gaps with Spectrum procedure: No specific collection access policy is documented.

Actions required: The current practice on use of the collections must still be recorded in what is called a collection access policy. In that policy, we will describe how we use the collections and how we will make them available for others to use, in line with the mission of the World Soil Museum. This includes the loan of collection objects (monoliths) and the request of sample material for analyses.

[9] https://www.isric.org/about/data-policy
[10] https://www.isric.org/cookies

Apart from this policy, a document will be prepared that specifies steps to be followed in managing the use of the collection (e.g. authorisation, actual use, users, and educational materials developed for display of the collection). This will yield valuable information for audits and reviews of the collections and the museum.

The aim is to comply with the minimum requirements for a collection access policy by 2023.

3.20 Spectrum procedure 20: Collection review

The Spectrum definition of collection review is 'managing and documenting any formal assessment of your collections that follows a stated methodology'. Collection review provides a basis for collection planning and management, acquisition and deaccessioning and disposal.

Current procedure: The World Soil Reference Collection is in a state of constant review, see for example ISRIC (2010). These specific-purpose assessments, however, do not meet Spectrum requirements.

Gaps with Spectrum procedure: There is no documentation of the review status and progress, neither is there a written policy that details among others the methodology to be followed. For the purpose of the ISRIC collections, the relevant aspects of the Spectrum procedures are that the reviews are well documented and archived, so that any assessment in the future can take account of earlier reviews and recommendations. Documentation must include objectives of the review, the methodology to be followed, name of the reviewer/curator, date of review, addition of review to catalogue and a documentation of the recommendation that follows from the review.

Actions required: For improvement of the current practice it is recommended to: 1) archive and describe reviews of the past in a separate folder; 2) update the information and assessment on the ISRIC's collections in a separate document and add the minimum required information from the Spectrum policy on collection review.

This will be a new baseline for strategic collection management to be completed by Dec 2022.

3.21 Spectrum procedure 21: Audit

An audit of a collection is a way to systematically check the accuracy and completeness of the information of the museums' collections.

Current procedure: On an ad-hoc basis inventories are made of the status of the collection and the location of the collection objects.

Gaps with Spectrum procedure: ISRIC does not have a formalised audit system in place. Theft is not a large threat to the collection, but in the context of the collections of ISRIC, auditing can be a way to assess the status and quality of the procedures that are in place (or in development). It is a way to verify that objects are where they should be (linking with the procedures for 'location movement and control', 'cataloguing' and 'inventory') and have the correct identifier.

Actions required: Develop a formalised audit system. An audit is not necessarily done for all objects in the collection, but rather through a sample check, e.g. by selection of random object numbers for audit. An audit in the context of ISRIC must be based on a policy (to be written and agreed upon) which is recorded in a 'policy brief'. The audit should be done on the basis of a written procedure and must be filed in an identified location. The audit can, or preferably must be done, by someone not directly involved in the collection management. A colleague from ISRIC, that is not in the collection management team, will be asked to do the audit. Such procedure makes the audit more objective. The procedure must specify what is to be audited (coding, object location, score of the condition of the object, etc.) and how this is then documented. Post-audit actions are defined from the audit (summary) report.

The audit policy brief or procedure are not yet defined and will be included in the definition of work plans for the coming years.

4. Concluding remarks

The World Soil Reference Collection of ISRIC is a unique collection; there is no other comparable collection in the world. It is considered as national and world cultural heritage, recognized by the international soil science community for its value for classification, research and education. The policy for the reference collection is to engage, educate, inspire and entertain as many people possible with it. This is primarily achieved through the exposition in the World Soil Museum, through loan of soil monoliths to trusted parties, such as natural history museums, and through presentation of the collection on digital platforms such as the virtual soil museum. Reference sample material is shared with researchers and institutes around the world for research when it adds to the current state of knowledge and understanding.

By its nature, the collection requires continued attention and quality investment. This means scrutinizing reference data, assessment and documentation of the collection and acquisition and disposal of collection objects. Working towards increased compliance with Spectrum procedures for different components of collection management will contribute to enhancing the quality of the collection, (re)formulating the strategy for the collection and increasing accountability for the management of the collection. This effort should be planned over the coming 5 years for implementation in prioritized phases. Updated versions of the Collection Management Policy will be published on a 5-year basis to reflect progress. Table 2 summarizes the information from chapter 3 on Spectrum procedures, the degree of compliance, required actions and planned date to achieve compliance.

Table 2: Spectrum 5.0, 21 collections management procedures and compliance levels.

Nr	Procedure	Compliance	Aim to comply	Required action	Expected compliance
1	Object entry	Partly	Yes	Documentation, Develop P&P[1]	Dec 2026
2	Acquisition and accessioning	Partly	Yes	Develop P&P[1]	Dec 2023
3	Location and movement control	Partly	Yes	Develop P&P[1]	Dec 2022
4	Inventory	Partly	Yes	Inventory and develop procedure	Dec 2023
5	Cataloguing	To a large extent	Yes	Documentation	Dec 2023
6	Object exit	Partly	Yes	Develop procedure	Dec 2022
7	Loans in (borrow objects)	No	Yes	Develop P&P[1]	Dec 2022
8	Loans out (lending objects)	Partly	Yes	Develop P&P[1]	Dec 2022
9	Documentation planning	Partly	Yes	Develop P&P[1]	Mid 2022 and further
10	Condition checking and technical assessment	To a large extent	Yes	Develop P&P[1]	Dec 2021
11	Collections care and conservation	To a large extent	Yes	Develop P&P[1]	Dec 2022
12	Valuation	No	No	None	NR
13	Insurance and indemnity	No	No	None	NR
14	Emergency planning for collections	No	Yes	Develop P&P[1]	Dec 2023
15	Damage and loss	Partly	Yes	Develop P&P[1]	Dec 2022
16	Deaccessioning and disposal	No	Yes	Develop P&P[1]	Dec 2024
17	Rights management	No	No	None	NR
18	Reproduction	To a large extent	Yes	Develop procedure	Dec 2022
19	Use of collections	No	Partial	Develop policy	Dec 2023
20	Collections review	No	Partial	Develop P&P[1]	Dec 2022
21	Audit	No	Partial	Develop P&P[1]	Undefined

[1]P&P = Policy and procedure

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