
ISRIC
World Soil Information
ANNUAL REPORT
2024

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Director's message

We are in contact with soil every day without even realising it. It supports the growth of the food we eat, filters the water we drink, and purifies the air we breathe. It is a thriving ecosystem, quietly working behind the scenes for human and nature's well-being. It is not just "*dirt*"; it is a living, life-giving system that needs action to protect it and ensure a healthier planet, resilient ecosystems, and a sustainable future for younger generations.

So, how do we protect soil and ensure its long-term health, so that humans, animals, and nature can continue to thrive? A key approach is to ensure accessibility to reliable soil data, information and knowledge to enable better decision-making for sustainable land management around the world.

At ISRIC – World Soil Information, we are driven by the vision where reliable and relevant soil data, information and knowledge are freely available and properly used to address global environmental and societal challenges. We ensured this vision by providing data, tools, products, and insight needed to understand, monitor, and manage soil health effectively at local, national, regional, and continental scales, in collaboration with our partners.

Throughout the year, we worked globally to addressed societal challenges such as food security, climate change adaptation and mitigation, and biodiversity conservation.

We continued developing global soil data products to strengthen national and continental soil information systems. Global soil databases like WoSIS and SoilGrids are advancing, and offer high-resolution, open-access soil information. These products support researchers, policymakers, and land users with trustworthy data and knowledge for sustainable soil management.

In Africa, ISRIC supports the development of soil information systems at national, regional and continental level. Initiatives like the Community of Practice for Soil Information Providers brings together soil practitioners in Africa to network and share knowledge and expertise. In 2024, the Soils4Africa project developed a continental level soil information system including tools and guidelines for future soil monitoring in Africa. Because decision-making is not done based on soil information alone, information hubs, such as those developed in the Land, Soil, and Crop Information Services project in Ethiopia, Kenya, and Rwanda, give access to soil information and other types of information to support land users.

The Soil Information System Framework, developed and tested in Ghana and Zambia, helps countries to develop and fund a national soil information system or improve their existing SIS. By offering a structured approach, the framework helps stakeholders to identify gaps in the enabling environment for SIS development. It also guides strategic improvements, prioritises needs, aligns data practices with national goals, and fosters collaboration across sectors. Considering its successful application, the approach will be extended and scaled to other African countries that have an interest in developing their own soil information system.

In Ethiopia, we worked together with the Ministry of Agriculture to align the National Soil Information System with international standards and ensure the data is FAIR.

By connecting soil data with real-world decision-making, ISRIC guides farmers, land managers and policymakers in selecting the appropriate practices for their localities. We are developing a decision support tool that will provide recommendations for soil fertility management on both regional and local scale.

By participating in European Union-funded soil research projects such as SoilWise and HoliSoils, we cooperate with the European soil research community in the development of new methods and standards for data standardisation, harmonisation, management and serving, and innovative methods for continental monitoring of soil organic carbon and soil health. Although these methods are primarily developed for application in Europe, ISRIC plays a crucial role in the application of these methods and tools in the African context, thereby contributing to the African Union – European Union Partnership.

Last but not least, ISRIC fosters global soil awareness through the World Soil Museum, the World Soil Reference Collection and the Library. These resources engage the public and scientific communities alike in valuing soil and understanding its importance for the world to thrive. Further, as World Data Centre for Soils, ISRIC provides a focal point for soil-related collections and information services, and ensures their long-term preservation and archiving.

As our planet's challenges grow more complex, the need for reliable, accessible, and actionable soil information has never been more critical. ISRIC stands at the forefront of this mission—bridging science, data, and real-world impact. Through collaboration, innovation, and a deep commitment to sustainability, we continue to support communities and decision-makers worldwide and inspire global action for soil health. Together, these initiatives drive informed decisions for healthy soils and a sustainable future.

Rik van den Bosch

Director of ISRIC – World Soil Information

This is ISRIC

Founded in 1966, ISRIC - World Soil Information has grown into a leading global authority on soil information and serves as the World Data Centre for Soils since 1989. For over five decades, this independent science-based organisation has been collecting, documenting, sharing, and developing innovative methods to support soil data and knowledge — to address worldwide challenges related to food security, environmental sustainability, and climate change.

ISRIC maintains a reference collection on soils and provides quality-assessed, science-based soil data products for users around the world. The organisation combines data, research, and collaboration to protect Earth's essential natural resource — soil. Through education and advocacy, ISRIC fosters awareness about the critical value and role of soil in future sustainability. Together, these initiatives support policymakers and leaders to make data-driven and informed decisions at various levels, to ensure sustainable land use, stronger ecosystems, and a more food-secure and climate-resilient world.

ISRIC's efforts are driven by a strategy which aims to:

- Provide user-oriented global soil information.
- Provide a reference and standards for collecting and sharing soil information.
- Cultivate a Community of Practice for Soil Information Providers.
- Support people to make sustainable land management decisions.
- Educate about soils and their diversity.
- Preserve and maintain the unique world soil reference collection and soil resources.

ISRIC's vision

A world where reliable and relevant soil data, information and knowledge is freely available and properly used to address global environmental and societal challenges.

2024 Highlights

- The **World Soil Information Service (WoSIS)** is an extensive open-source database that now represents over 230,000 georeferenced profiles from 174 countries, corresponding to more than 900,000 soil layers (or horizons), and over 6 million soil records.
- **SoilGrids** is a system for global digital soil mapping that uses soil profiles from WoSIS, and a series of environmental covariates. ISRIC tested new approaches to expand SoilGrids with global maps of complex soil features such as soil thickness, soil organic carbon stocks, and water availability.
- **CUP4SOIL** developed high-resolution soil health indicators for Europe using Sentinel 1 and Sentinel 2 satellite data to support EU-level land monitoring of soil health and quality.
- The **ESA WorldSoils** project has developed a soil monitoring system for soil organic carbon (SOC) in the topsoil, which is crucial for soil fertility and addressing climate change. The WorldSoils Graphical User Interface platform was launched, which shows three-year estimations of SOC content from earth observation data and large soil data archives.
- **Europe's Holisoils** project ingested new forest soil data into WoSIS, high-resolution (100m) soil property maps were created for forest soils in Europe, and published online.
- The **Soilwise Repository** was launched, which houses and safeguards over 20,000 European soil datasets and is linked to over 50 European projects.
- The **Community of Practice (CoP) for Soil Information Providers** in Africa grew from 26 to 38 member countries, with a total of and 670 members. The network continues to convene, build and share knowledge among members.
- The **Soils4Africa** project developed a unified African Soil Information System. The platform focuses on the sustainable intensification of agriculture and boosting food security, by improving the quality and availability of African soil data.

Our contribution to research excellence

As an independent science-based organisation, ISRIC wrote and contributed to 50+ publications, which include, amongst others:

- 34 articles in peer-reviewed international scientific journals.
- 7 technical reports.
- 1 article in a professional journal.
- 15 conferences and events.

- The **Soil Information System Framework** was initially tested and applied in Ghana and Zambia, and provides structured guidelines for designing and developing a sustainable national soil information system, taking into account financial, institutional, human capacity and technological considerations.

- The **Land, Soil, and Crop Information Services (LSC-IS)** project is setting up data hubs in Ethiopia, Kenya, and Rwanda to improve access to land, soil, and crop information for a wide group of stakeholders, including farmers and decision-makers. Hubs have already been created in Ethiopia and Kenya.

- The **Enhancement of the National Soil Information System (NSIS) of Ethiopia** project focused on aligning national soil data to international standards, creating soil workflows for processing and serving topsoil and legacy data, and digital soil mapping.

- The **Space2Place project** supports farmers in Africa to use fertilisers more effectively by combining satellite data with local field information. Following the development of a prototype decision-support tool in 2023, efforts in 2024 focused on refining and enhancing the tool's functionality.

- The **Soil Values program** was launched to address soil fertility and promote sustainable soil management in the Sahel (Nigeria, Niger, Burkina Faso, and Mali), and targets 1.5 million farmers, with a strong focus on women.

- The **World Soil Museum** continues to be ISRIC's pride and joy, with numerous exhibitions attracting over almost 3,000 visitors.

- The **World Soil Reference Collection** continues to provide baseline information for innovative research, such as the development of the first global soil DNA microbial reference database which has extracted DNA from 1536 samples, so far.

We cannot do it alone

At ISRIC we are passionate about our work in soil and in creating and sharing soil information for the benefit of our planet. We wouldn't be able to do our work without the support of the Ministry of Agriculture, Fisheries, Food Security and Nature in the Netherlands, along with other partners.

Why soil?

Soil is the foundation of life on Earth. It supports crops, filters water, stores carbon, and sustains biodiversity, making it one of the planet's most vital and precious resources. From agriculture and water regulation to environmental protection, urban development, and nature conservation, soil plays a central role in nearly every aspect of human and ecological well-being. Yet despite its critical importance, soil is often undervalued and faces growing threats from unsustainable land use, climate change, pollution, and biodiversity loss.

According to the FAO's *Status of the World Soil Resources Report* (Smith et al, 2024), 33% of all soils are moderately to highly degraded due to erosion, loss of organic matter, poor nutrient balance, salinisation and alkalinisation, contamination, acidification, loss of biodiversity, sealing, compaction, and poor water status. Preserving, restoring, and protecting soil health is essential for achieving the Sustainable Development Goals, safeguarding ecosystems, and building resilience to climate change.

This is at the heart of ISRIC's mission. Through global collaboration, open data, and science-based solutions, ISRIC helps ensure soils are recognised, managed wisely, and sustained for future generations — laying the groundwork for a more food-secure and climate-resilient world.

This report highlights ISRIC's contributions across four key focus areas that reflect the organisation's mission and impact. Each focus area represents a core aspect of ISRIC's work — from generating and sharing quality-assessed soil data, to supporting countries in building robust soil information systems, providing references and standards, promoting sustainable land use, and raising awareness of soil's essential role in our lives. These interconnected areas showcase how ISRIC bridges science, policy, and practice to support better decisions for people and the planet. Together, they illustrate ISRIC's commitment to ensure that soils are understood, valued, and managed wisely for a more sustainable future.

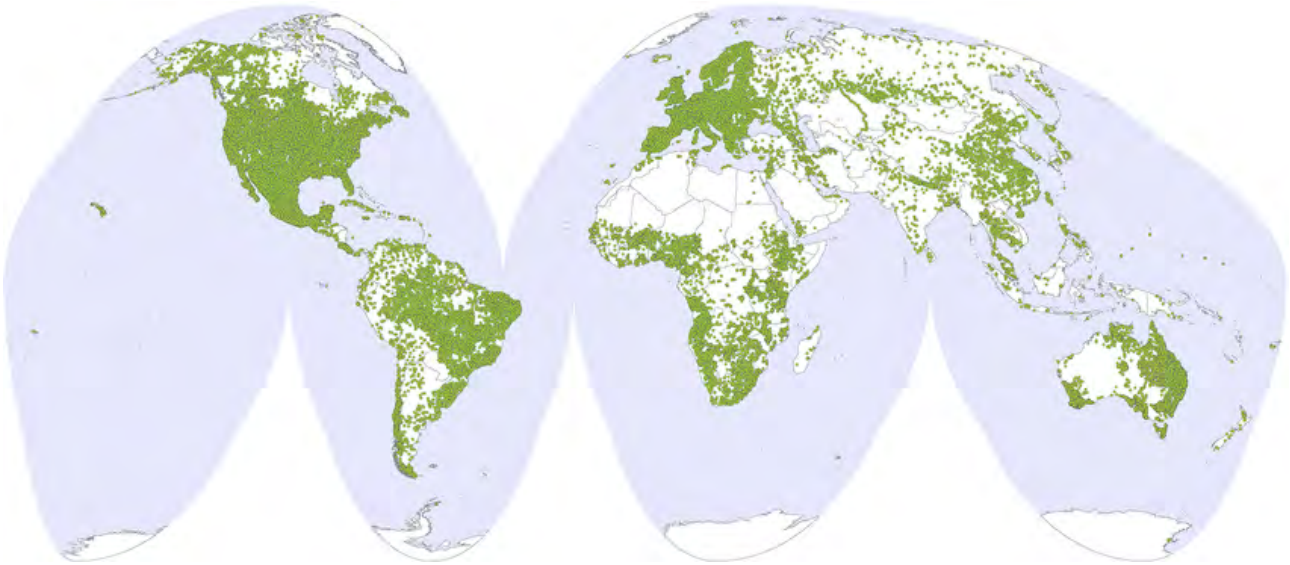
Soil data and information products

ISRIC provides quality-assessed soil data and information to the global and national community. We ensure that soil information is up-to-date, accessible, and comparable to suit a range of disciplines, applications, and sectors. Through our flagship soil information products (WoSIS and SoilGrids), we collate, quality-assess, standardise, and provide credible data to our community using ISRIC's reliable approaches, technical capacity and expertise. The datasets include basic soil chemical and physical properties for geo-located soil profiles that can be used to support digital soil mapping and environmental applications at global and regional levels.

Global soil data in one harmonised database

The World Soil Information Service (WoSIS) is an online open-source database management system. It draws on soil data shared by numerous data providers and applies consistent, systematic workflows to clean and standardise the source data before their ingestion into WoSIS. The resulting shared datasets are freely available to the international community through ISRIC's website and other web services.

WoSIS-served data are used for predictive soil property mapping, space and time modelling of soil organic carbon stock change, and various regional to global environmental assessments that support food security, biodiversity conservation, climate change mitigation, water management, and land degradation control and rehabilitation. The products derived from WoSIS are crucial for creating awareness, informing and supporting policymakers, business leaders, and conventions (e.g., the United Nations Convention to Combat Desertification and the United Nations Framework Convention on Climate Change) in making well-informed decisions about the environment, biodiversity, climate change, and human well-being.



The location of soil profiles provided by WoSIS (Homolosine projection, see also the WoSIS dashboard)

ISRIC's impact in 2024:

International data standards are constantly evolving to keep up with technological advancements, emerging global challenges, and the complexity of data exchange. As new discoveries emerge, WoSIS must adapt to ensure accuracy, interoperability, and relevance. In 2024, WoSIS implemented a new data model based on the ISO 28258 standards, and improved procedures for extracting, cleaning, standardising, loading, and serving data. All these technical developments are based on open-source software, ensuring the wide accessibility of publicly available data that complies with the FAIR (Findable, Accessible, Interoperable, and Reusable) principles.

WoSIS standardised data represent over 230,000 georeferenced profiles from 174 countries, corresponding to more than 900,000 soil layers (or horizons), and with over 6 million soil records. All these data contributed to the latest snapshot (see Batjes et al, 2024). Snapshots derived from WoSIS are static datasets that provide quality-assessed and standardised soil profile data that support digital soil mapping and environmental applications.

Viewing the WoSIS data

To learn more about WoSIS, visit the following website.

The public version of WoSIS can be explored through its dashboard. Alternatively, the GraphQL API can be used to query the data.

For an overview of soil properties included in WoSIS, please go to the ISRIC Soil Data Hub.

Global soil property maps

SoilGrids is a system for global digital soil mapping that uses state-of-the-art machine learning methods to map the spatial distribution of soil properties across the globe. SoilGrids prediction models use soil profile observations from the WoSIS database (see above) and a series of environmental covariates. Covariates were selected from 400 environmental layers and other environmental information such as climate, land cover and terrain morphology.

SoilGrids's outputs are global maps of fourteen soil properties at a spatial resolution of 250 meters, provided for six standard depth intervals, that follow the specifications established by the Global Soil Map Working Group of the International Union of Soil Sciences, and include an assessment of prediction uncertainty. The SoilGrids maps are publicly available on the SoilGrids website.

SoilGrids maps provide information about many soil properties such as:

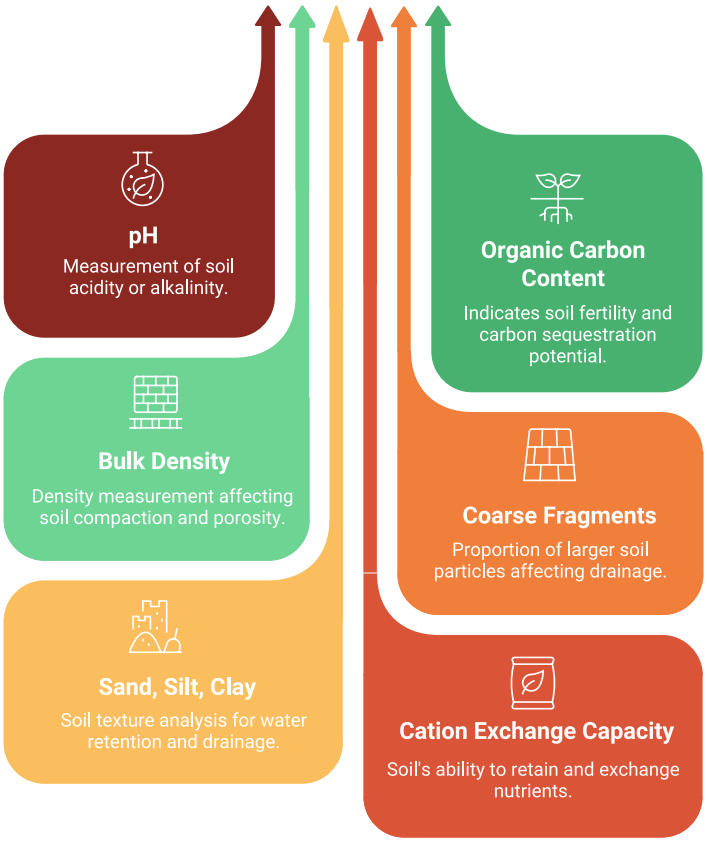


Figure 1: Examples of soil property maps that can be generated using SoilGrids.

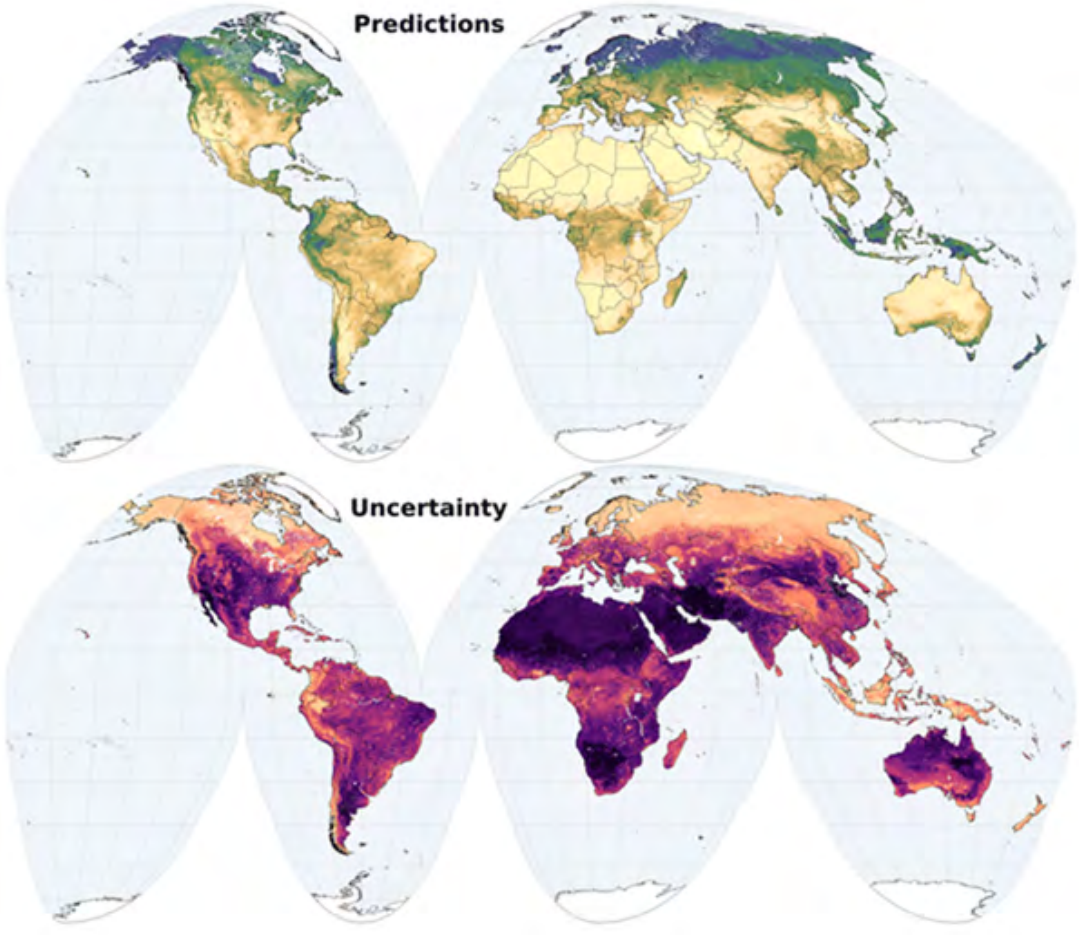
SoilGrids maps are used in various applications, such as environmental modelling, carbon sequestration, nutrient cycling, water flow, agricultural planning, optimising fertiliser use, managing soil health, land management, conservation, and restoration.

ISRIC's impact in 2024:

In 2024, ISRIC explored new approaches to produce global maps of complex soil properties such as soil thickness, carbon stocks, and water availability. The project worked on updating the environmental layers used in the mapping, and connecting them to WoSIS. SoilGrids, as any digital soil mapping product, relies on the statistical prediction of soil properties at locations that lack measurements of these properties.

These predictions come with a quantified measure of uncertainty, which refers to how much the predicted soil property might differ from the real values, since it's not possible to directly measure soil everywhere, by samples. ISRIC investigated better ways to measure and explain this uncertainty so that users know how reliable and accurate the SoilGrids predictions are.

SoilGrids updated technology for data dissemination and the latest standards in soil information and data. In 2024, SoilGrids focused on improving the back-end for better user experience, and preparing for future developments and releases of SoilGrids data layers.



SoilGrids250m version 2.0 predictions (Soil Carbon stocks) and uncertainty (adapted from Poggio et al, 2020).

Soil information development in Europe

Europe has a vision that at least 75% of soil health is significantly improved by 2030, as this will improve food security, biodiversity, and climate resilience. To support this mission, ISRIC is working on several European initiatives that aim to advance regional soil health, data, knowledge and information systems.

Projects like CUP4SOIL, ESA WorldSoils, HoliSoils, and SoilWise are improving soil data and monitoring, modelling, and managing soil health across Europe. Several of these initiatives use advanced technologies, drawing on satellite imagery data and machine learning methods to produce high-resolution soil maps. Collaboration across agencies and projects ensures harmonised standards and accessible, actionable data. Together, these efforts strengthen Europe's soil information infrastructure for long-term environmental resilience, and support sustainable land use, biodiversity protection, and climate goals through better soil insights.

Developing, applying, and promoting standardised soil data practices in Europe

ISRIC's has a pivotal role in developing standards to contribute to a cohesive soil data infrastructure for Europe by the following:

- In **CUP4SOIL**, ISRIC **standardises and maps European-wide soil** properties using satellites and harmonised methodologies.
- In **ESA WorldSoils**, ISRIC contributes to the **modelling of organic carbon concentrations in soil** with associated uncertainty.
- In **HoliSoils**, ISRIC contributes to improving the **spatial consistency of forest soil property maps**.
- In **SoilWise**, ISRIC contributes to **an open-access knowledge and data repository** to safeguard soils in Europe.

Across all projects, ISRIC ensures its activities align with international standards (e.g., ISO data model, FAIR principles).

Using satellite data and imagery to improve EU soil quality

CUP4SOIL (Copernicus User Uptake for Soil Information Products) is a collaborative project to develop high-resolution soil property services to assist national and European agencies in reporting on soil health and quality. CUP4SOIL's objectives included generating European-wide data products and indicators characterising soil health, preparing a community to test and validate these products, and ensuring close cooperation with related initiatives such as the ESA WorldSoils project. The project will develop high-resolution soil health indicators for Europe using Sentinel 1 and Sentinel 2 satellite data to support national and EU-level land monitoring of soil health and quality.

ISRIC's impact in 2024:

CUP4SOIL reviewed a wide range of literature and project resources about essential soil health indicators, to produce a User Requirement Document (URD), which includes the results of an online user survey, which was based on the framework of the FPCUP (Framework Partnership Agreement on Copernicus User Uptake) requirements. The URD summarises the needs and expectations of a broad group of stakeholders across Europe regarding satellite-based soil property maps, and has the potential to be incorporated into soil health indicators.

CUP4SOIL generates European-wide soil information products based on Copernicus datasets, including Sentinel-2. One of these products is the **SoilSuite**. SoilSuite was developed in 2024, and provides information about the spectral and statistical properties of European soils and other bare surfaces such as rocks. ISRIC used SoilSuite, together with other earth observation data, to develop a set of soil property maps for Europe in 2024.

Measuring organic carbon in soil to address climate change impacts

The **ESA WorldSoils project** is part of the European Space Agency's (ESA) Earth Observation Strategy 2040, and the ESA's Earth Observation Envelope Programme. The ESA WorldSoils project aims to build a global soil monitoring system, with a focus on soil organic carbon (SOC) using earth observation data.

From 2020 to 2025, the project will track how much organic carbon is stored in European top soils, which is important for maintaining soil fertility and mitigating climate change. The project also brings together stakeholders to develop soil indicators for monitoring the health of global top soils.

ISRIC's impact in 2024:

In 2024, the project focused on modelling and mapping SOC by integrating two different modelling approaches: one for bare soils such as agricultural land, and the other for permanently vegetated soils such as those found under forests or grasslands. This integration improves the accuracy of the resulting maps. A key component of the final product is the integrated uncertainty from both models.

Lastly, the project worked on prototyping IT solutions to distribute the soil predictions at continental and global scale in cloud-agnostic environments. All of these efforts contributed to building a robust global monitoring system for organic carbon in top soil.

The WorldSoils Graphical User Interface is a platform launched in March 2024 to share soil data. The platform shows three-year estimations of SOC content using satellite data, and leverages large soil data archives and modelling techniques to improve the spatial resolution and accuracy of SOC maps. Users can download the SOC data directly from the platform.

A scientific paper on the European soil organic carbon monitoring system (van Wesemael et al., 2024) was published, presenting the project's main results.

Protecting and monitoring European forest soils

Forest soils play a crucial role in supporting biodiversity, nutrient cycling, carbon sequestration, water regulation, and erosion control. Their conservation is crucial for sustaining ecosystems and human well-being; however, degradation threatens these functions, exacerbating climate change and biodiversity loss. To address these complex issues, the **HoliSoils** project (EU Horizon 2020) holistically addresses the management, modelling and monitoring of European forest soils. In the project, ISRIC's focuses on improving the spatial information on European forest soils.

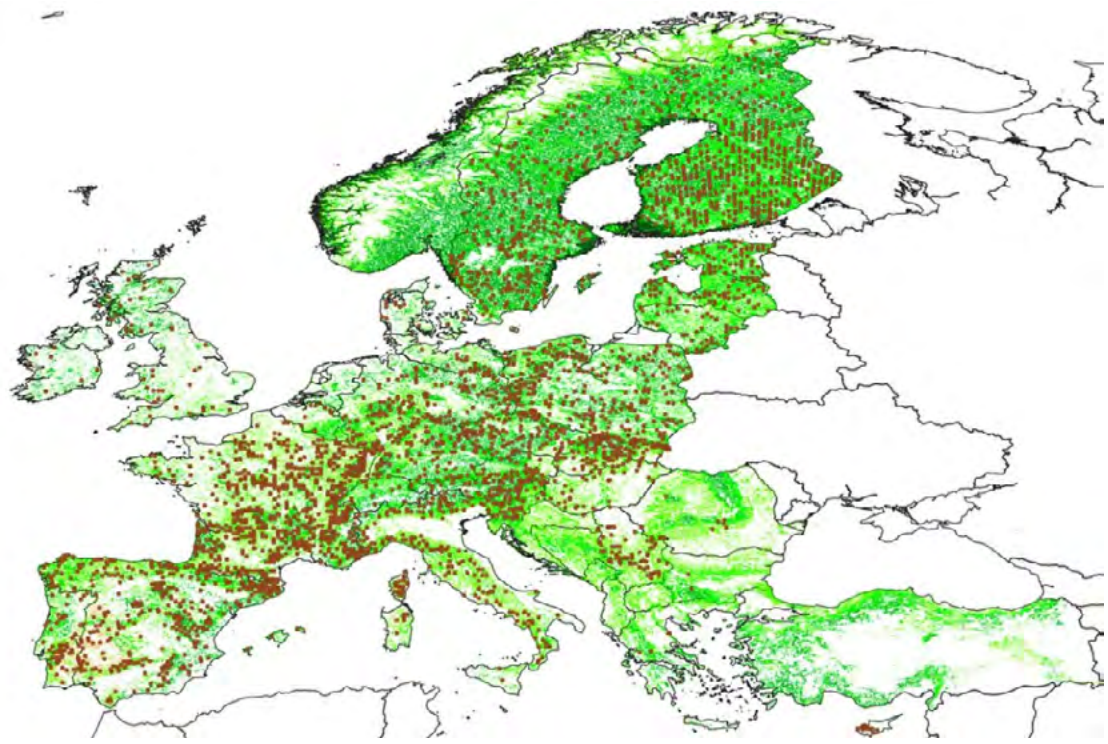


Figure 2: The EU H2020 Holisoils project identifies 3,500 points using the EU Corine Land Cover dataset (2018).

ISRIC's impact in 2024:

After collecting, standardising, and integrating new forest soil data into WoSIS, a digital soil mapping approach, featuring model tuning, environmental covariate selection and a regression random forest model, was used to generate soil property maps for forest soils in Europe, with associated measures for the uncertainty of the predictions.

In 2024, ISRIC created a prototype web service for delivering the soil property maps. In 2025, all maps generated by the HoliSoils partners will be hosted by the Thünen Institute.

A preliminary comparison with soil organic carbon (SOC) maps generated in the framework of HoliSoils and several other European-scale projects, such as CUP4SOIL, EJP SOIL and ESA World Soils, using different soil data, covariates and models, showed that there are still quite some differences in the estimated SOC content in Europe, as well as in their spatial distribution. This work highlighted the importance of having sufficient quality-assessed, harmonised profile data when mapping and modelling across countries at a continental scale to support decision-making towards climate and sustainability goals, and the need to clearly indicate the suitability of each map product for different applications. Data fusion of the different SOC maps could lead to more accurate and reliable estimates in the future.

Open-access soil repository for Europe

The **SoilWise** project (EU Horizon 2020) aims to improve soil health across Europe by providing better access to knowledge and data about soils. The project will create an open-access repository that consolidates a wide range of soil data and knowledge, making it easily findable, accessible and reusable. By collating and standardising information from various sources, and by enhancing its description (metadata), SoilWise supports informed decision-making for sustainable land management for researchers, land managers, policymakers, public authorities, and businesses.

ISRIC's impact in 2024:

The Soilwise Repository was launched in 2024 and houses knowledge and data to help safeguard European soils. Since its release, the open-source repository collected about 20,000 datasets and knowledge resources from European research projects, open data repositories and metadata collections. Either directly, or through the Mission Soil Cluster on Knowledge and Data Management, the project is linked to over 50 EU projects. This collaboration across the continent contributes to open-source tooling, standardised terminology development, metadata standardisation, and FAIR data and knowledge management procedures for the soil community.

The repository builds an open-source European soil data and knowledge infrastructure that is expected to be taken up by the EU Soil Observatory, ensuring its sustainability after the project closes. Other repositories with similar or different aims in similar or different geographies can adopt its open-source components, procedures, guidance, and content. To improve soil resources with good quality metadata and soil data standardisation, the project continued to work on the soil vocabularies. Work on the soil vocabularies concerns the digitalisation of common soil terms, descriptions or definitions, and adding machine-readable unique identifiers to the terminologies. By agreeing on terms across soil science domains, and by making them digitally available and machine-readable, soil information producers can use the same terminology in their data models and metadata descriptions of their resources. This increases an understanding of the resources, their interoperability, findability, and re-usability because soil information users can use the same terms to find existing soil information resources better. This work was started with partners of the Global Soil Partnership Pillar 4 and 5 work, and European Joint Programme on Soils. Continued collaborations with other projects with specific domain expertise are expected to further strengthen this effort in the years to come.

The Annual 2024 meeting of the SoilWise consortium. Credits © SoilWise

The SoilWise repository and Mission Soil Cluster on Knowledge and Data Community serve as a shared platform for EU countries, the European Commission, researchers and other stakeholders to support soil policy development and decision-making aligned with the 2030 goals of the Green Deal, the EU Soil Strategy and other soil related legislation, aiming for healthy soils in Europe by 2050.

Strengthening soil information systems at national, regional and continental levels in Africa

Soil Information Systems (SIS) are vital for informed decision-making in agriculture, land management, and environmental sustainability. Across Africa, efforts to enhance SIS are present at national, regional, and continental levels. ISRIC strategically supports the continent by empowering national SIS, building a collaborative and capable soil data community, and strengthening soil data infrastructures for sustainable development.

At the continental level, initiatives like the **Community of Practice (CoP)** for soil information providers in Africa, **Soils4Africa project**, and the **SIS Framework workshops** are supporting the development of soil information products and systems, and building knowledge-sharing networks. National initiatives such as the **National Soil Information System (NSIS) of Ethiopia** focuses on soil data quality and decision-making in land and agricultural management. All of these efforts are boosting capacity, fostering innovation and knowledge, and integrating global standards to build resilient, data-driven African soil systems.

Continental-level initiatives

The Community of Practice for Soil Information Providers in Africa

Well-organised and accessible soil information is essential for increasing agricultural productivity, promoting sustainable land management, protecting the environment, fostering research and innovation, and ensuring food security and informed decision-making. To support African partners in their efforts to develop soil information and establish and strengthen national, regional, and continental soil information systems, ISRIC is facilitating a Community of Practice (CoP) for Soil Information Providers.

Established in 2022, the CoP serves as a collaborative platform for networking, knowledge sharing, and capacity building among members involved in soil data collection, production, analysis, and dissemination. The CoP also strengthens community engagement through showcases, joint publications, and reports that help sustain online interactions amongst members. Notably, the community established dedicated sub-communities to further enhance collaboration and communication among members on specific domains of the soil information workflow that represents the life cycle of soil information (see Figure 3).

Altogether, these efforts have resulted in a vibrant, knowledgeable, and active CoP in soil information.

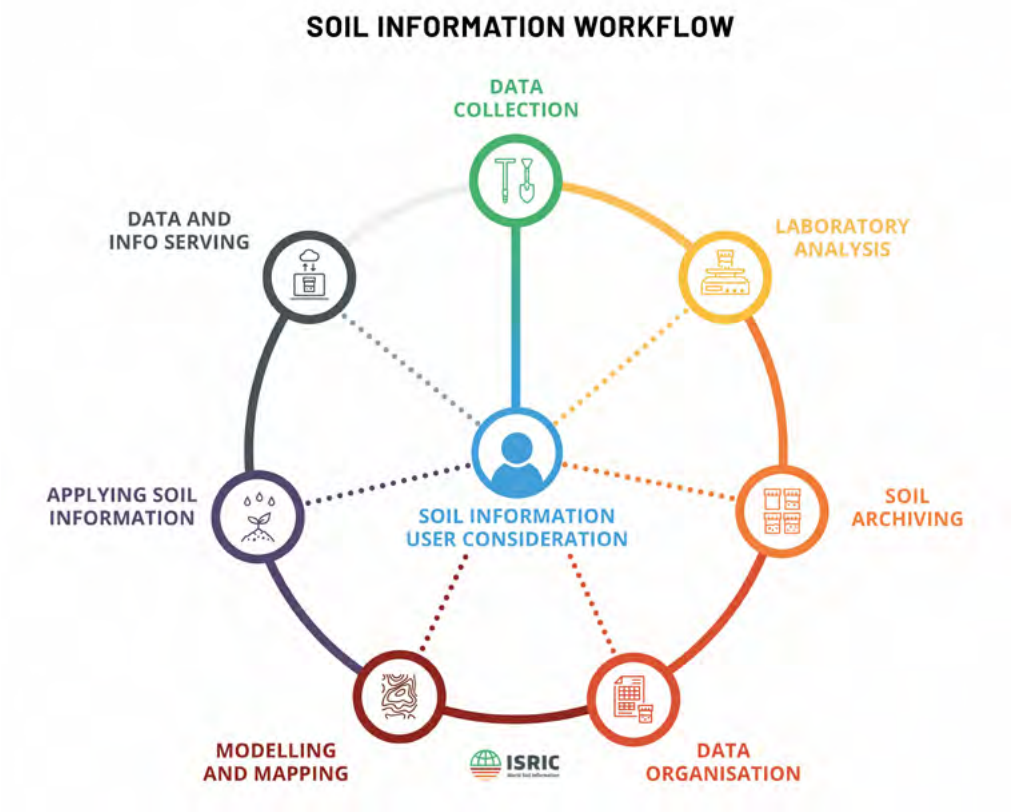


Figure 3: The Soil Information Workflow

ISRIC's impact in 2024:

In 2024, the number of countries represented in the CoP network in Africa increased from 26, to 38.

Figure 4: The COP's 38 member states

In 2024, the CoP continued to build trust and a sustainable network among soil experts, to further foster knowledge sharing, standardisation, capacity strengthening, collaboration, expertise and innovation, which has notably increased the impact and visibility of the community.

The CoP has successfully integrated members into other soil projects such as Soil Values. Bringing together national and regional partners, the CoP enhances collaboration, harmonises soil data, and aligns projects for greater impact. It also promotes knowledge exchange and supports evidence-based decision-making for sustainable land management.

With over 15 years of experience, Dr. Ashenafi Abduljelil is a land management and soil information expert. He has dedicated his career to advancing how soil data is used, shared, and understood. In 2024, he worked with ISRIC and the Ministry of Agriculture in Ethiopia on the Enhancement of the National Soil Information System (NSIS) of Ethiopia.

Today, he is a vital part of the Africa Soil Information Community of Practice (CoP). Already part of the Coalition of the Willing (CoW), which works for better soil and agronomy data sharing, Ashenafi believes that the CoP has facilitated capacity building, peer learning, and technical exchange among soil scientists in Africa. “Thanks to the CoP,” Ashenafi shares, “We have built strong networks with global and regional soil experts and upskilled our national teams across all levels of soil information workflows.”

For him personally, he mentioned how his knowledge in bridging soil information and innovation has expanded. He explained, “The development of skills in soil data harmonisation and standardisation, aligned with the ISRIC’s ISO model, and hands-on training in using various soil data collection applications, is a key skill (of mine) that has improved through CoP activities.”

He further noted that “The CoP is more than a platform, it is a driver of quality and consistency in soil data practices.” He added, “Through the CoP’s knowledge sharing, and the subsequent implementation of the ISO soil data model, that was introduced by ISRIC in 2024, significant legacy soil data in Ethiopia has been standardised and is being made accessible to national soil data users.” This will ultimately improve sustainable land management and agriculture in the future.

Looking ahead, Ashenafi envisions the CoP growing into a dynamic platform that empowers soil experts. He also emphasised the need for more recognition amongst members, to sustain momentum, motivation and commitment in the network.

> *The CoP is more than a platform, it is a driver of quality and consistency in soil data practices.*
>
> *Ashenafi Abduljelil*

Dr. Blessing Iveren Agada, is an academic, soil scientist, farmer and a champion for soil information systems across Africa. Dr. Agada's impressive career spans over 16 years in academia and in development projects. Her professional journey is rooted in Nigeria, where she serves at Joseph Sarwuan Tarka University Makurdi as a professor guiding and educating science students, while also advancing research through a Postdoctoral Fellowship at the Universidade Federal Roraima in Brazil. Her work straddles continents, blending local relevance with global insight.

As a member of Africa's Community of Practise (CoP), Dr. Agada actively contributes to discussions in specialised groups such as *Applying Soil Information and Data Collection* and is currently co-authoring the *CoP Manuscript on Soil Information Systems in Africa* (third edition).

The CoP has also supported Dr. Agada in expanding her knowledge of soil data management. She noted, "For me personally, the CoP has been beneficial in fostering unity, collaboration, networking, and capacity strenghtening. One such training was on *R Programming*, which has improved my statistical computing, data analysis and data visualisation skills."

Reflecting on her journey in the CoP, Dr. Agada describes the community as a "great unifying initiative — a bank of intellectuals harnessing shared knowledge to tackle Africa's most pressing soil challenges." It is not just a network, but a community of action and impact.

For the future, Dr. Agada envisions the CoP as a "*one-stop hub*" of soil-related knowledge, and a community that has expanded representation across African nations (especially marginalised ones). "I hope that the CoP will continue to serve as a launchpad for transformative research, policy, and practice. The CoP's collaborative spirit and collective expertise, makes it an indispensable resource for countries like Nigeria, where soil health is central to food security and climate resilience."

> *The CoP has been beneficial in fostering unity, collaboration, networking, and capacity strenghtening.*
>
> *Blessing Iveren Agada*

Africa's soil information system

The **Soils4Africa** project (EU Horizon 2020) aims to tackle the challenge of limited availability and accessibility of up-to-date, consistent soil data at continental level. The project is developing an open-access, continental-scale soil information system (SIS) in Africa, which is scheduled to launch in 2025. This SIS will enhance soil monitoring and soil data sharing across Africa, and provide valuable support to agricultural extension services, agri-businesses, scientists, and policymakers for sustainable agriculture and food security.

The SIS will be populated with new soil data from over 15,000 agricultural locations across Africa. In 2024, soil sample collection and analysis progressed significantly, following a consistent and standardised methodology. The evolving SIS is currently hosted by ISRIC, however the system will be transferred to and hosted by FARA — the implementation secretariat for the Africa Fertiliser and Soil Health Action Plan.

ISRIC's impact in 2024:

In 2024, various components of the SIS advanced significantly. The SIS data catalogue was expanded to include nearly 90 geospatial data layers at continental scale, which are relevant for supporting agricultural intensification. Most of these layers were integrated into a map viewer that enables users to discover and interact with the data easily. A dedicated dashboard offers various overviews and summaries of the soil data in the SIS, along with the functionality to download the data. Additionally, a new section was added to the SIS offering access to all guidelines, manuals, protocols and video instructions developed by the project for continental soil sampling and sample analyses. The SIS was created in 2024, and is currently accessible online.

In parallel, the analysis of the collected soil samples progressed at the laboratory of the Agricultural Research Council in South Africa. ISRIC set up automated data pipelines to seamlessly ingest both analytical and spectral data from the laboratory into the SIS. By the end of 2024, thousands of results were loaded into the system.

To raise the profile of the Soils4Africa project in the international policy circles, ISRIC actively participated in key events throughout 2024. In May, ISRIC attended the Africa Fertiliser and Soil Health Summit and contributed to a parallel session on the need for a robust soil information system in Africa. In September, Soils4Africa joined four EU H2020 projects to host a cluster event on sustainable intensification in Africa, at the Tropentag 2024 Conference. In November, ISRIC co-organised a side event in Zimbabwe, with the theme *Soil Information Systems for Attainment of Soil Health in Africa: Pathway for Progress*, during the Comprehensive Africa Agricultural Development Program-Partnership Platform (CAADP-PP) meeting. These events highlighted Soils4Africa's key results and innovations while fostering dialogue on technology adoption, data use, and sustainable land management.

A key outcome of the Soils4Africa project's sustainability strategy, developed by ISRIC and FARA, is that the SIS, and its methodology will serve as the foundation for the development of a more comprehensive Africa Soil Observatory. The development of this new observatory will start in 2025 under a new EU Horizon Europe-funded project, and will monitor and enhance soil health across the continent. The observatory will play a central role in supporting the Soil Initiative for Africa and the Africa Fertiliser and Soil Health Action Plan.

Conducting soil sampling in South Africa for the Soils4Africa project.

> *The SIS framework is well structured, insightful, and provides clarity and guidance in the development of Zambia's SIS. The SIS framework workshop generated good participatory feedback and connected partners.*
>
> *Rodger Kabiti, Principal Research Scientist, Zambia Agriculture Research Institute (ZARI), Zambia.*

National-level initiatives

Scaling a new soil information system framework across Africa

African countries often experience constraints that prevent SISs from being sustainable and adaptable to their context. To address this issue, the **Soil Information Systems Review** project that took place in 2022 and 2023, explored ways to make a SIS more responsive and applicable to a local context. As part of the project, a global assessment of national SISs was conducted to gain deeper insights into SIS design, functionality, and success factors. The analysis included a survey conducted in collaboration with CABI, the International Network of Soil Information Institutions of the Global Soil Partnership, as well as extensive interviews with representatives from nine countries worldwide: Ethiopia, Tanzania, Ghana, Lesotho, Rwanda, Uganda, Australia, New Zealand, and the United States of America.

Insights from the assessment led to the development of the **Framework for Sustainable National Soil Information Systems** ("SIS Framework") in 2024. The framework is designed to guide the development of new soil information systems, or improve existing ones. It provides practical guidance, tools, and resources for funders, soil data practitioners, and system developers.

The SIS Framework is also a key resource for the Coalition for Soil Information Systems in Africa (CSISA) implemented by FARA, ISRIC and CABI, with support from FAO. The Framework provides Africa-wide technical support (expertise, tools, methods, and approaches) for the SIS to address the Africa Fertiliser and Soil Health Action Plan.

Accessing the SIS Framework:

The SIS framework is integrated with ISRIC's Resource Library and ISRIC's Community of Practice, and can be found here.

The SIS framework has been added to The African Development Bank initiative called the Technologies for African Agricultural Transformation (TAAT) e-catalogue — an initiative to boost agricultural productivity by rolling out proven technologies to millions of farmers. TAAT links public and private sector decision-makers with providers of the best vetted and validated agri-tech solutions for the African continent.

> *Due to the workshop, we have been able to bring together all relevant stakeholders (farmers representatives, policymakers, development partners, etc.). That is the starting point. When the stakeholders are aligned on the vision, planning, and implementation, then the operations will be successful.*
>
> *Dr. Edward Yeboah, Chief Research Scientist and Former Director SRI, Ghana*

Participants of the SIS Framework workshop in Ghana. Credits: CABI Ghana.

ISRIC's impact in 2024:

The development of a national SIS requires a collaborative, multi-stakeholders approach to ensure strategies align with national needs and priorities. In 2024, ISRIC and CABI facilitated the National SIS Roadmap Workshops to guide participating countries in designing and implementing effective SIS strategies.

The SIS Framework was validated, adapted and used in workshops in Zambia and Ghana. These workshops integrated the best practices from nine diverse countries and their SIS, and fostered the exchange of feedback and insights among stakeholders to ensure that each country's SIS development aligns with national priorities, and incorporates the latest innovations in data management and policy support. Applying the SIS Framework helps ensure that national SISs are compliant with the FAIR principles, are financially and operationally sustainable, meet user needs, and address key soil health challenges.

The workshops brought together diverse stakeholders from government, research institutions, universities, non-governmental organisations, funders, private, and the public sector. This diverse participation enhanced collaboration across existing soil-related initiatives, built relationships, identified bottlenecks and solutions, and supported the development of a country's SIS.

Notably, the workshops produced a roadmap with a detailed strategic pathway for the design and implementation of a national SIS. This roadmap typically centres around five critical components of the development of the SIS, which include: defining the SIS mission and goals, assessing the enabling environment, identifying stakeholder needs, brainstorming the ideal system design, establishing partnerships, and developing a sustainable funding plan. The approach incorporates lessons learned from other countries, while tailoring solutions to the specific country's unique needs and priorities.

The positive outcome of this work is the growing interest across Africa in applying the SIS Framework.

> *"The workshop has opened my eyes to what other soil information exists elsewhere, what has been done, and what key takeaways the Ghanian context can use from the framework.*
>
> *Dr. Kofi Atiah, Department of Soil Science, University of Cape Coast, Ghana.*

Ethiopia's National Soil Information System

The Enhancement of National Soil Information System (NSIS) in Ethiopia project, is improving the national SIS, by aligning it with international standards and ensuring that soil data is shared in a FAIR manner. NSIS-Ethiopia focuses on soil data quality, digital mapping, and supports decision-making in land and agricultural management for various Ethiopian partners while building the capacity of the Ministry of Agriculture (MoA) to sustainably manage the system's ongoing improvements. The project also positions NSIS-Ethiopia as a benchmark for other African National Soil Information Systems.

ISRIC's impact in 2024:

In its first year, the project achieved substantial progress. The team conducted a thorough assessment of the existing NSIS components, encompassing data assets, web services, and data infrastructure. Furthermore, legacy soil datasets were analysed, and technical working sessions with the MoA team were held to chart a pathway for the development of the SIS. The project developed a data model for integrating the NSIS data into the interoperable ISO 28258 standard, and created a sophisticated workflow to process existing soil data into one single curated, harmonised and standardised (ISO 28258) database. Finally, a digital mapping workflow was established, and the World Reference Base system of soil classification was customised to the Ethiopian context.

Meeting between ISRIC and the Ethiopian Ministry of Agriculture at the ISRIC World Soil Museum in June 2024.

Sustainable land management

Sustainable land management is at the heart of improving food security and resilience. ISRIC provides information services (e.g., models, apps, platforms, and websites) and capacity strengthening for applying soil information to sustainable land management. Sustainable land management comprises measures and practices to protect, conserve, use, and restore degraded land, and ensure the management of fertility in soil.

In 2024, ISRIC contributed to this goal through three key initiatives: the development of a fertiliser-focused decision support tool (DST) in the **Space2Place project** to improve soil health and farmers' yields; the **Soil Values program** aiming to improve soil fertility and soil management in the Sahel; and the **Land, Soil, and Crop Information Services (LSC-IS) project** supporting climate smart agriculture. All projects use data-driven approaches to support informed land management decisions, promote climate-smart agriculture, and ensure long-term soil health and productivity for smallholder farmers.

Enhancing fertiliser use efficiency in Sub-Saharan Africa

In 2024, ISRIC worked on the **Space2Place project** to develop a decision support tool (DST) that enhances fertiliser use and efficiency for farmers in Sub-Saharan Africa. The DST will provide science-based information to support agriculture decision-making at scale and is applicable in a variety of localised farming systems and geographies. The DST helps farmers in Africa to use fertilisers more effectively by combining satellite data with local field information. It provides tailored fertiliser recommendations based on soil conditions and crop needs, which improves yields, increases incomes, and supports sustainable farming practices. For this project, ISRIC supported the collection and management of data, the development of the DST tool, and built the necessary digital infrastructure to support these efforts.

ISRIC's impact in 2024:

In 2024, the project focused on making the DST tool smarter and more accurate. The previously developed prototype of the DST for countries including Madagascar, Ethiopia, Zambia, Tanzania, Malawi, and Uganda was improved using existing maps and data, including the Global Yield Gap Atlas, to estimate potential crop yield, the effects of farming practices, and the minimum fertiliser needs (N, P, K) based on available water.

In addition to the Quantitative Evaluation of the Fertility of Tropical Soils (QUEFTS) model, which guides fertiliser recommendations, new models (WOFOST and INITIATOR) were aggregated to the tool to account for variations in crops growth across different regions, and to better estimate the water, nutrients, and fertiliser required to support crop growth. The project continued to tailor the tool to local farming conditions, helping farmers to receive advice and recommendations suited to their land.

Soil Values: Mainstreaming sustainable soil management in the Sahel

The Soil Values program is a 10-year initiative (2024-2034) aimed at addressing soil fertility and promoting sustainable soil management in the Sahel region in Nigeria, Niger, Burkina Faso, and Mali. The program supports over one million smallholder farmers, over half of them women, to reduce yield gaps and build resilience to climate shocks. Soil Values promotes the sustainable management of over two million hectares across forty river basins and landscapes. Soil fertility is placed at the centre of agricultural policies and development efforts in participating countries.

For the project, ISRIC is committed to developing the required spatial soil information products with local soil institutions for soil mapping, monitoring and assessment of soil fertility, providing standardised tools and methods for soil surveys, soil data delivery, capacity-strengthening, and peer learning opportunities through the Community of Practice for Soil Information Providers in Africa.

ISRIC's impact in 2024:

Launched in 2024, the Soil Values program aimed to ensure its long-term success in enhancing soil fertility in the Sahel. ISRIC helped shape the program's strategy, setup an efficient soil mapping and monitoring plan, reviewed existing integrated soil fertility management (ISFM) technologies, and established the PhD program.

The inception phase revealed that the project countries have limited soil data for decision support at the watershed scale, along with limited access to training, unavailability of extension services for farmers, inaccessibility and unaffordable inputs (e.g., seeds, fertilisers, and organic matter), and these factors all hinder the adoption and implementation of ISFM technologies. Long-term strategies to address these shortcomings were therefore developed for execution in the implementation phase of the program.

Figure 5: Countries in the Soil Values project.

Land, soil and crop hubs in East Africa to support climate-smart agriculture

To enhance the effectiveness of national Agricultural Knowledge and Innovation Systems and to support climate-smart agriculture in East Africa, **the Land, Soil, and Crop Information Services (LSC-IS) project** is establishing sustainable information hubs within national agricultural research organisations in Kenya, Ethiopia, and Rwanda. These hubs aim to integrate and link existing land, soil, and crop data sources and portals, facilitating easier access to information while ensuring national data ownership.

The project focuses not only on designing the hubs with both technical and institutional considerations but also on enhancing the capacity of hub staff, such as effectively operating and maintaining the hubs, delivering support services to stakeholders, and promoting the use of the hubs' knowledge sharing and decision-making.

Our impact in 2024:

In 2023, the LSC-IS project focused on assessing needs, developing and testing the hubs, embedding and scaling their use, and monitoring and learning from the implementation process. In 2024, the LSC hubs were established and integrated into national systems in Kenya and Ethiopia, with Rwanda following in 2025.

LSC-IS visit to Taita Taveta County in Kenya.

Participants in the LSC-IS DSM training in Ethiopia.

Additionally, ISRIC delivered Digital Soil Mapping (DSM) trainings in Rwanda, Kenya, and Ethiopia, which were facilitated by national agricultural research institutes.

The trainings were attended by soil scientists, GIS specialists, irrigation engineers, crop and agricultural scientists, and IT professionals. A key component of these trainings included the *Seedling DSM Workflow* — a standardised process designed to streamline digital soil mapping projects, and to provide DSM capabilities to professionals with limited experience in data science. Developed by ISRIC's digital soil mapping experts, the seedling workflow organises data for modelling, performs modelling with Random Forest algorithms, and creates gridded soil property maps. This approach ensures consistency and efficiency in generating soil information.

National efforts in Asia - Digital soil mapping in Nepal

In 2024, ISRIC supported Nepal's National Soil Science Research Centre (NSSRC) in updating its Digital Soil Map (DSM). Soil maps are imperative because they provide nationwide information about soil fertility and support agronomic decision-making. The maps bring together soil-related information to be used by farmers, policymakers, researchers, agronomist, and other stakeholders.

For the project, ISRIC provided hands-on training for twelve scientists of the NSSRC. The training focused on running the automated DSM workflow to produce updated national soil maps from newly collected soil data and a large set of satellite imagery. In addition, a workshop was held to plan the long-term future of DSM in Nepal. Based on the outcomes of the training and workshop, ISRIC delivered a DSM Roadmap that will guide the creation of a dedicated DSM unit. These efforts have helped strengthen soil mapping and agricultural planning across Nepal.

Dr Giulio Genova (ISRIC) explains the elements of the digital soil mapping workflow to workshop participants in Kathmandu, Nepal in October 2024.

> *The DSM training was very relevant and fruitful for us. Updating the DSM is crucial for supporting farmers with up-to-date soil information and ensuring policymakers have access to accurate data for formulating agricultural development strategies and programs. The training enhanced the technical capacity of our staff in managing and updating the DSM. We have better understanding of the DSM framework, workflows, cleaning, modelling, running models, and all the applications. We are also delighted to get technical support to develop a roadmap for the sustainable management of DSM that considers our technical, institutional and infrastructural capacity as well. I am thankful to ISRIC and CIMMYT for facilitating the training.*
>
> *Dr Shree Prasad Vista, Senior Scientist at the National Soil Science Research Centre of the Nepal Agricultural Research Council.*

Soil education and advocacy

The World Soil Museum, Reference Collection, and Library promote global soil education and awareness. The Museum collects, documents, showcases and studies soils from around the world, contributing to their analysis and classification. The Reference Collection supports international soil classification, research on soil, and methodology development for soil measurement methods, while the Library preserves and safeguards historical and valuable soil survey data, maps, and reports – many of which are difficult to access, and at risk of being forgotten or lost over time.

The World Soil Museum

The World Soil Museum is the stage for the World Soil Reference Collection. It promotes the appreciation for and understanding of the nature and diversity of soils. It aims to engage as many people as possible on the topic of soils, their functions, and their importance for society and the environment, both at the museum and online.

The World Soil Museum showcases the diversity, functions, and importance of soils worldwide through interactive exhibits and real soil monoliths. It serves as an educational hub for researchers, students, and policymakers to learn about soils, their properties, functions, management, and sustainability. The museum contributes to global soil awareness by preserving and documenting soil samples from different regions. Through guided tours, the display of soils and educational resources, it highlights the vital role of soils in ecosystems, agriculture, and climate regulation.

Museum visitors

The museum works with motivated and skilled voluntary guides and ISRIC staff. In 2024, the World Soil Museum welcomed 2,798 visitors, including students, professionals, pupils and the public (see table).

Number and percentage of visitors at the World Soil Museum in 2024		
Visitors	Number	Percentage
Public	316	11%
Pupils	286	10%
Students	1315	47%
Researchers	165	6%
Professionals	507	18%
Policymakers	89	3%
Media	3	< 1%
Other	117	4%
Total	2,798	100%

Table 1: Visitors at the World Soil Museum in 2024.

A group of pupils from a secondary school in Wageningen being introduced to the world of soils at the Museum.

The World Soil Museum aims to engage a diversity of user groups (such as the youth) besides the core group of scientific students, by providing immersive and engaging online content through stories, data, information and experiences of the World Soil Museum.

ISRIC's reach and impact in 2024:

In 2024, **the museum focused on innovating and expanding its reach** through two key platforms: a new website for the World Soil Reference Collection and the museum, and a mobile app for self-guided exploration. Both platforms are designed to offer tailored content to different user groups depending on their interests and background, with special attention given to engaging youth and scientists. The website and app are scheduled to be launched in 2025 and 2026.

The museum collaborates with the CURIOSOIL project to leverage technologies to create immersive, interactive, and engaging experiences that bring soil science to life for young learners, especially children. This initiative aims to enhance soil literacy and foster connection and education in Europe.

The World Soil Museum is a vibrant cultural space that brings together artists and soil enthusiasts by hosting **exhibitions and educational events**. In April, the artist Kate Foster led a creative workshop in the museum called *Figuring Peatlands*, in which she explored how science and art help widen the views of wetland landscapes. In June, four artists (Sigrid Schmeisser, Miguel Teodoro, Kate Foster and pantea) organised an event called "Soil Horizons", which explored soils, landscapes, land use and sustainability.

In September, the World Soil Museum started a quarterly lecture series called "*The World of Soils*," where lecturers are invited to explore different topics related to soils and their role in the environment, art, agriculture, and daily lives. The series was kicked off by Dr Roy van Beek, who spoke about *the Dwelling mounds in the Dutch delta: Terps as soil archives of ancient landscapes and water management (500 BCE–1900 CE)*. The second lecture was organised in December by Dr Joop Okx, who spoke about *the Palette of the Earth: the use of earth pigments in visual arts*.

Soil tasting menu items were prepared by chef and designer Shuang Xu in collaboration with Miguel Teodoro as part of the Soil Horizons event. © Leidy Gomez Montoya

World Soil Reference Collection

ISRIC maintains the World Soil Reference Collection. The collection is unique in the world and was built to show representative examples of soil from around the world. These reference profiles – or soil monoliths – are a resource for education, correlation and research.

Soil monoliths are undisturbed, vertical soil samples, approximately 1.5 meters deep, that show the soil as it appears in a pit in the field, with the layering, colours, and structure. The Reference Collection contains 1,000 soil monoliths from around 82 countries, representing a wide range of geographic regions, environments, soil types, soil processes, and human impact on soils.

Each reference profile is fully documented with detailed description and field images, and analysed with additional sampling materials available for each soil horizon to support future research. The physical collections of ISRIC are recognised by the international soil science community as a unique resource to use for classification, research, verification of hypotheses, and methodology development for soil measurement methods. Data from the soil samples and profiles are part of the World Soil Information Service (WoSIS).

ISRIC's impact in 2024:

In 2024, ISRIC supported the **DNA Sequencing Initiative** which aims to create the first global reference database of soil microbes including bacteria, fungi, archaea, and various other microscopic organisms. The project will study microbial communities across major soil types, linking biodiversity to support soil functions and ecosystems. A notable component of this project is the use and assessment of soils from the reference collection. During 2024, the project focused on extracting DNA from 1,536 samples from about 63 countries that were sampled at various times between 1952 and 2014. The result of the DNA analyses will be studied in relation to site and soil conditions, including morphological, physical, and chemical data. The analysis will provide insights into the nature and distribution of soil microbial community distribution patterns and microbial functional characteristics at a global scale. It will serve as a reference for future study.

Ultimately, a total of 4,658 soil samples will be analysed for DNA. This new knowledge will advance understanding of soil health, support biodiversity preservation, optimise agricultural practices, and contribute to climate change mitigation.

Soil samples prepared for DNA extraction and sequencing.

The World Soil Reference Library

Legacy soil data is valuable as it provides geographic and time-specific records of soil and landscape conditions. However, such data is often at risk of becoming inaccessible or lost over time. To prevent this, the World Soil Reference Library safeguards, archives, and digitises these important documents.

The World Soil Reference Library houses over 27,000 records of legacy soil information, including 10,000 soil maps, and 17,000 books and reports. Its collection is open to the public, with most materials available online. Currently, 70% of maps are in high resolution, and over 35% of reports and books are in full-text PDFs. The scanning process is ongoing as the library continues to receive and digitise new additions.

Scientific research

ISRIC is a science-based organisation rooted in and contributing to the science behind soil information.

In 2024, ISRIC produced over 50 publications, including 34 articles in peer-reviewed international scientific journals, 7 technical reports, 1 article in a professional journal, and 1 editorial in a peer-reviewed journal. Additionally, ISRIC staff participated in 15 conferences and events. ISRIC's publications discuss findings of the wide range of activities undertaken by ISRIC and its partners, as illustrated below:

- Batjes, N. H., Calisto, L., & de Sousa, L. M. (2024). **Providing quality-assessed and standardised soil data to support global mapping and modelling (WoSIS snapshot 2023)**. *Earth System Science Data*, 16, 4735–4765. https://doi.org/10.5194/essd-16-4735-2024
- Batjes, N. H., Ceschia, E., Heuvelink, G. B. M., Demenois, J., le Maire, G., Cardinael, R., Arias Navarro, C., & van Egmond, F. (2024). **Towards a modular, multi-ecosystem monitoring, reporting and verification (MRV) framework for soil organic carbon stock change assessment**. *Carbon Management*, 15, 2410812. https://doi.org/10.1080/17583004.2024.2410812
- Hateffard, F., Steinbuch, L., & Heuvelink, G. B. M. (2024). **Evaluating the extrapolation potential of random forest digital soil mapping**. *Geoderma*, 441, 116740. https://doi.org/10.1016/j.geoderma.2023.116740
- Nenkam, A. M., Wadoux, A. M. J. C., Minasny, B., Silatsa, F. B. T., Yemefack, M., Ugbaje, S. U., Akpa, S., Zijl, G. V., Bouasria, A., Bouslihim, Y., Chabala, L. M., Ali, A., & McBratney, A. B. (2024). **Applications and challenges of digital soil mapping in Africa**. *Geoderma*, 449, 117007. https://doi.org/10.1016/j.geoderma.2024.117007
- van Leeuwen, C. C. E., Mulder, V. L., Batjes, N. H., & Heuvelink, G. B. M. (2024). **Effect of measurement error in wet chemistry soil data on the calibration and model performance of pedotransfer functions**. *Geoderma*, 442, 116762. https://doi.org/10.1016/j.geoderma.2023.116762
- van Wesemael, B., Abdelbaki, A., Ben-Dor, E., Chabrillat, S., d'Angelo, P., Demattê, J. A. M., Genova, G., Gholizadeh, A., Heiden, U., Karlshoefer, P., Milewski, R., Poggio, L., Sabetizade, M., Sanz, A., Schwind, P., Tsakiridis, N., Tziolas, N., Yagüe, J., & Žížala, D. (2024). **A European soil organic carbon monitoring system leveraging Sentinel-2 imagery and the LUCAS soil database**. *Geoderma*, 452, 117113. https://doi.org/10.1016/j.geoderma.2024.117113
- Wadoux, A. M. J. C., Courteille, L., Arrouays, D., De Carvalho Gomes, L., Cortet, J., Creamer, R. E., Eberhardt, E., Greve, M. H., Grüneberg, E., Harhoff, R., Heuvelink, G. B. M., Krahl, I., Lagacherie, P., Miko, L., Mulder, V. L., Pásztor, L., Pieper, S., Richer-de-Forges, A. C., Sánchez-Rodríguez, A. R., … Wetterlind, J. (2024). **On soil districts**. *Geoderma*, 452, 117065. https://doi.org/10.1016/j.geoderma.2024.117065

A detailed overview of our publications can be found here.

ISRIC team members, January 2024.

ISRIC's people

At ISRIC, our work with employees and on projects is transparent. ISRIC prides itself on providing a working environment and culture that fosters excellence, respect, and integrity. ISRIC works passionately to achieve the organisation's strategy through initiative and proactivity among colleagues.

ISRIC would not be able to achieve its goals or project success without the dedicated staff and volunteers, who are the driving force behind the organisation's culture and mission and who ensure that all projects and initiatives run smoothly and successfully.

In 2024, ISRIC had a total of 37 staff members from 15 countries, and 16 *affiliated* colleagues, which included PhD candidates, volunteers and guest researchers. They are all appreciated and acknowledged:

Senior soil science expert

Staff at ISRIC

Rik van den Bosch
Director

Andries Bosma
External relations manager

Bas Kempen
Operations manager and senior digital soil mapping expert

Judy Willems
Management support officer

Niels Batjes
Senior soil science expert
Coordinator WDC-Soils

Laura Poggio
Senior digital soil mapping and remote sensing expert

Chrow Khurshid
Community manager and project coordinator

André Kooiman
Senior sustainable land management expert

Stephan Mantel
Head of World Soil Museum
Sustainable land management expert

Silvana Summa
Communications manager

Gerard Heuvelink
Professor Pedometrics and digital soil mapping

Mary Steverink-Mosugu
Senior project coordinator

Ulan Turdukulov
Senior spatial data infrastructure expert

Zhanguo Bai
Senior soil and land degradation assessment expert

Luis Calisto
Database development expert

Fenny van Egmond
Soil sensing and soil information expert

Thaïsa van der Woude
Project coordinator

Ditte Trojaborg
Project coordinator

Johan Leenaars
Soil fertility expert

Maria Ruiperez Gonzalez
Digital soil mapping and GIS expert

Giulio Genova
Digital soil mapping expert

Francis Silatsa
Soil information expert

Luis Duque Moreira De Sousa
Geoinformatics expert

Lieven Claessens
Soil fertility expert

Paul van Genuchten
Spatial data infrastructures expert

Mara Grandia
Museum and education officer

Ingrid Haas
Webmaster

Jiarong Li
DevOps specialist

Laura Laroche
Sustainable land management expert
and visual communication developer

Betony Colman
Junior GIS expert

Diana Collazos Cortes
Junior GIS expert

Islambek Urazov
Junior spatial data infrastructure expert

Eric Asamoah
Soil science expert

Jelle Janssen
Research assistant

Cynthia van Leeuwen
PhD candidate

Erika Henskens
Project assistant

Brinda van den Berg
Secretary

Guest researchers

- Ad van Oostrum: supported ISRIC by advising on soil analytical methods, and by testing methods to quantify errors in laboratory measurements.
- David Rossiter: supported ISRIC as an in-house strategic consultant, and as an occasional research collaborator.

Volunteers

Ans Brom	Godert van Lynden	Kees van Diepen
Livija Petrovic	Piet Anker	Willem Dragt

ISRIC team members during team day in September 2024.

PhD candidates

ISRIC specifically collaborates with Wageningen University through the appointment of a special professor and membership of ISRIC staff in a Wageningen University graduate school. As part of this collaboration, multiple PhD researchers and their projects are being conducted. They include:

- Anselme Kouamé: A multi-model approach to identify the causes of variability in maize yield and response to fertiliser in Ghana. [status – ongoing].
- Bertin Takoutsing: Digital soil mapping using uncertain soil observations to support agricultural intensification in West and Central Africa. [status – completed in 2024].
- Cynthia van Leeuwen: Statistical modelling of analytical and spectral soil measurement errors. [status – completed in 2024].
- Eric Asamoah: Machine learning for fertiliser recommendation in Ghana. [status – ongoing]
- Musefa Redi Abegaz: Generating quality-assessed soil and crop information to derive climate-smart fertiliser recommendations in Ethiopia. [status – ongoing]
- Qiuhong Huang: Modelling the potato yield response to fertilisers and soil nutrients using semi-mechanistic models and machine learning. [status – ongoing]
- Stephan van der Westhuizen: Enhancement of the use of machine leaning in digital soil mapping. [status – completed in 2024]

Managing Board

ISRIC's Managing Board plays a crucial role in the success of ISRIC. As the organisation's governing body, it oversees ISRIC's strategy, operations, effectiveness, recruitment, finances and accountability.

ISRIC's Board members have diverse academic and technical expertise. Board members include:

- Prof. Dr. J. Wallinga, Professor, Soil Geography and Landscape Group, Wageningen University and Research (WUR), The Netherlands (Chair)
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