New Zealand: Country Case Study

A Process Toward Strengthening National Soil Information Services (SIS)

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INTRODUCTION

As part of the Process Toward Strengthening National Soil Information Services project, staff and associates from CABI and ISRIC—World Soil Information—compiled published reports, conducted interviews, and collected firsthand perspectives and information from SIS developers and stakeholders in each of nine countries. This information was synthesized to document the background, origins, current status, and challenges encountered in each country's unique SIS case.

HISTORY OF SOIL DATA AND INFORMATION IN NEW ZEALAND

Part 1: Pre-digital

Soil surveys in New Zealand, spanning from 1938 to 2001, yielded a collection of soil maps varying in quality and scale. By the end of 2001, the entire country was mapped at a scale of 1:253,440, with just over 50 percent of the nation benefiting from more detailed maps ranging from 1:126,720 to 1:10,000 scales (Lilburne et al., 2012). These surveys often included a soil bulletin providing qualitative descriptions of the mapped soil series, guided by publications such as The Soil Survey Method by Taylor and Pohlen (1970) and the Soil Description Handbook by Milne et al. (1995).

Despite these efforts, challenges persisted, with studies revealing significant variability in soil properties and types within map units, particularly on alluvial plains (Adams and Wilde, 1976; Di and Kemp, 1989; Karageorgis, 1980; Webb et al., 2000). However, this variability was not adequately captured in the resulting soil maps, which typically described map units based on a typical or modal profile, leaving users uninformed about soil variability (Lilburne et al., 2012).

The current national soil map resides within the New Zealand Land Resource Inventory (NZLRI), augmented by the addition of 15 soil properties known as the fundamental soil layers (FSL) (Wilde et al., 2000). Compiled at a scale of 1:63,360, the NZLRI incorporated data from various soil maps predating 1979. However, due to the need for simplification, the NZLRI does not always contain the most accurate line work, and in some regions, the General Soil Survey maps at a scale of 1:253,440 remain the primary source of information (Lilburne et al., 2012).

Part 2: transition into digital

The evolution of soil information systems in New Zealand has undergone significant strides over the years, driven by the need for accurate and comprehensive data to support various land management practices and decision-making processes.

Historically, soil mapping in New Zealand relied heavily on manual field surveys and classification schemes. Taylor and Pohlen (1970) outlined the soil survey method, providing a framework for the field study of soils in the country. These early efforts aimed to characterize soil variability within specific mapping units, such as soil types, to support agricultural practices and land-use planning (Adams and Wilde, 1976).

However, as the demand for more detailed and spatially explicit soil information increased, there arose a need for more efficient and accurate mapping approaches and estimation of key soil properties. This led to further development of:

- The New Zealand soil classification system to ensure nationwide correlation (Webb et al., 2011)
- Pedo-transfer functions to estimate values for soil properties and characteristics for all soils using data in the National Soils Database Repository (NSDR) (e.g., McNeill et al., 2024)
- Digital soil mapping (DSM) techniques, which leverage geospatial technology and statistical modeling to predict soil properties and distributions across landscapes (McBratney et al., 2003), (e.g., Roudier et al., 2020)

One of the initiatives in this evolution was the Soilscapes project, which laid the foundation for digital soil mapping (DSM) in New Zealand (Hewitt et al., 2008). Soilscapes utilized geospatial datasets and environmental covariates to model soil distributions at various scales, providing a more nuanced understanding of soil variability across the country.

A new soil survey database called S-map was started in 2004. This drew upon the integration of DSM techniques into soil information systems, marking a paradigm shift in how soil data were collected, processed, and disseminated. Landcare Research played a key role in developing the National Soils Database, which served as a centralized repository for soil information collected from various sources, including field surveys, remote sensing, and digital elevation models.

Furthermore, advancements in data management and visualization technologies facilitated the development of web applications, online services, and decision support tools for accessing and interpreting soil information. These tools, such as the S-map information system, allowed stakeholders to explore soil data interactively and generate customized reports tailored to their specific needs (Lilburne et al., 2012).

The evolution of soil information systems in New Zealand is also closely aligned with global initiatives such as the GlobalSoilMap project (GSM, 2010). Collaborative efforts between international organizations and research institutions have enabled the sharing of best practices and methodologies for soil mapping and modeling, fostering a more cohesive and standardized approach to soil data management and dissemination (Sanchez et al., 2009).

ORIGINS

The New Zealand government has been a key funder of the National Soils Database Repository (NSDR) and S-map, which is the digital soil mapping product. Various sectors of government have contributed: central, regional, and Landcare Research (LCR), which is one of the Crown Research Institutes. Legacy soil data dates back to 1959; in 1984, the first National Soils Database (NSD) was built; and in 2017, the NSD was relaunched as the National Soil Data Repository (NSDR). One of the practical motivations for the relaunch was to consolidate legacy data with newer datasets that were held by various organizations. The government experienced an increasing need for reporting, both nationally and internationally, about soil carbon, which was one reason for mobilizing the effort, along with S-map and the requirement to properly manage research data. Within New Zealand, many people understand that agriculture is one of the biggest economic sectors, and soils underpin much of the country’s ability to maintain and grow that sector.

Origins – success factors

- Soil information services are built by people knowledgeable about soils in general and about New Zealand’s soils specifically
- The SIS is sustained through a broad array of funding, including from the federal government,

data collection contracts from regional governments, and through a business model for user access to the data by the private sector, research institutes, and agribusinesses

Origins – challenges

- Historically, support and funding for soil data in New Zealand have endured ebbs and flows with changes in government
- A lack of funding for training experts has required importing expertise from elsewhere to fill gaps

CURRENT STATE

Current status of the SIS

S-map is fully functional. The NSDR is not openly accessible except to a smaller group of specialists. Not all of S-map is openly accessible either; there are licensing restrictions on some of the information produced by pedotransfer functions. Furthermore, the government is not allowed to collect and share data on Māori lands without the permission and involvement of Māori people, so data from these areas is more limited. All the S-map information is provided to regional councils and used widely. The NSDR contains point data, and S-map contains polygons developed from NSDR data. The SIS has advanced metadata and published policies in place for data governance.

Ownership and accountability

Manaaki Whenua – Landcare Research (LCR) is the Crown Research Institute that owns and maintains the SIS. Funding for the SIS comes from several sources: the NSDR database and S-map are supported primarily by the national government. Regional governments supply funding on a contract basis. This contract process works whereby regional councils submit requests for soil surveys as a service; in other words, the SIS team is hired to do surveys and data collection in their region at regular intervals, and then this data is inserted into the national SIS, which is used by the regional councils and other users. Additionally, an array of investors and partners contribute to S-map, including the private sector, federated farmers, and other research institutes. More sophisticated data products and levels of access are provided through a pay model, contributing to the financial sustainability of the S-map infrastructure. According to one of the sources interviewed for this case study, "If government funding were to be cut tomorrow, S-map would be able to continue with the current data, so the system would continue to run, but wouldn't be able to maintain the soil surveyors and pedologists."

Institutional Environment

Other institutions are involved in data collection in New Zealand, and LCR consolidates data from their projects under S-map and NSDR. However, these institutions do not seem to be involved in the management of the SIS. Soil carbon is a priority area for the SIS, so prior existing soil carbon datasets from ministries and regional councils are being consolidated and inserted into the NSDR. There are plans to build a national soil carbon layer that will meet the needs for analyses and reporting on soil carbon in national and international contexts.

Advocacy for soil data in New Zealand come from several directions and in various forms. People involved in the SIS development are themselves knowledgeable about soils in general and about New Zealand's soils specifically: According to sources interviewed for this case study, the SIS is "built by people who have seen the soils of the country." Another factor is that there is broad public support for soil data. Even as fluctuations in government lead to shifts in resources and commitment, the public still generally values soils and data. Sources shared that "People wouldn't let us on their land if they didn't have this understanding that the work we do is important." The SIS appears to meet the needs of the regional councils, its primary users. This is evidenced by regional councils requesting more soil sampling and soil surveys from the S-map team in recent years and requesting more consistent services. Previously, these contract requests were mainly made when councils had leftover funds from other budgets, but this has shifted to a higher priority in the past four years. A central government agency also provided a significant sum for five years (until 2025) to extend the coverage of S-map.

Legal and Policy Environment

The regional councils own some of the S-map data and intellectual property, but LCR has the license to serve their data. For MWLR-owned data, they have an open license. There are additional restrictions on collecting data on Māori lands.

IT and Human Resources

The technical capacity seems sufficient, and the team's approach involves soil surveyors and pedologists in the field submitting data directly via tablets. There is additional expertise in informatics and other roles. Maintaining the team sometimes requires international recruitment.

Users and Use Cases

Every few years, the SIS team conducts user surveys by requiring an email login to access the online data. Surveys are then sent to these email addresses. They also conduct a "survey of rural decision-makers" every couple of years, which includes questions specifically about S-map. Regional governments, which make land management decisions and set policies at local and regional levels, use the SIS. Agricultural advisory services and consultants, many of whom are private, access the data to consult with farmers and landowners on farm and soil management, as well as on developing sustainability plans and participation in programs that incentivize farmers for good practices.

Before 2006, New Zealand had an older system of soil taxonomy and classification, which was revised to align more closely with international standards. The older system was more descriptive of soils at a local level; some classifications were specific to a village and named after that village. In many cases, local farmers and extension advisors find these types of classifications more informative and useful than the newer system, so they sometimes back-translate S-map's classifications and information into the old system. Some farmers and landowners use the SIS, although the spatial scale of the data is too coarse for most farmers to get what they really need.

Historically, there have been issues with high-quality land and soil being used for buildings and residential zones, leading to soil sealing. Since New Zealand is a small country with an agricultural economy and a limited amount of good soil for agriculture, targeted land-use plans for soil suitability were important. A couple of key characteristics of S-map influence its ability to meet the stated use cases: first, its data are at a scale of 1:50,000, which makes it useful down to the landscape or catchment scale but less useful at the farm scale. Second, the data it contains include soil physical properties and carbon but are limited in soil chemical attributes. Because of these characteristics, use cases include land development decision-making, water resources management, and flood risk management. Farm-level soil management is only a tertiary use case because of the spatial scale of the data, and farmers still need to do their own testing for soil chemical attributes at a finer scale.

Current success factors

- Interest in soil data among the regional councils has been sustained over the past several years, which has allowed the SIS team to grow from five to 20 people and take on greater capacity
- The ability to hire expertise from outside the country to fill gaps in the team

Current challenges

- The spatial resolution is too coarse for most use cases at the farm level, limiting its ability to meet the needs of farmers
- Updated soil taxonomy and other standards for information in the SIS are not useful for some who prefer older taxonomic systems
- There is potential confusion for data users about which data are accessible for free; the data are not FAIR because of limited findability
- Accessing funding to continue developing the best techniques and tools for further soil surveys, as well as completing coverage of New Zealand

FUTURE PLANS

Growth of the SIS

The current SIS is still some way from achieving complete coverage of New Zealand. Further enhancements and evolution of the system may be added as the SIS grows.

SOIL DATA RESOURCES

Name	Description	Link
Land Resource Information System (LRIS)	The Land Resource Information System (LRIS) is a portal developed by Manaaki Whenua Landcare Research, New Zealand. It is a one-stop shop for data relating to the environments and land resources of New Zealand – The LRIS Portal hosts a variety of datasets, including the Land Cover Database version 5.0 (LCDB v5.0), which is a multi-temporal, thematic classification of New Zealand's land cover – The NZLRI is a national database of physical land resource information. It comprises two sets of data compiled using stereo aerial photography, published and unpublished reference material, and extensive field work.	Land Resource Information System (LRIS)
National Soils Archive (NSA)	The NSA holds the physical soil samples 'archived' once laboratory and other analysis has been completed, and data added to the National Soils Data Repository (NSDR). The NSA is a collection of some 35,000 dried and sieved soil samples. The earliest soil sample was collected by Harry Gibbs in 1939. Most samples were collected through soil survey work processed by the soil chemistry laboratory of the DSIR Soil Bureau until 1992. After 1992, soil samples were added to the collection after analysis by Manaaki Whenua's Environmental Chemistry Laboratory. The long-term vision is to form a true 'National Archive', including soil samples from other institutions across New Zealand1. Despite this incompleteness, the collection is an impressive archive of soil samples from throughout New Zealand.	National Soils Archive (NSA)

Name	Description	Link
National Soils Data Repository (NSDR)	The National Soils Data Repository (NSDR) is a versatile soil observation database that hosts a variety of soil datasets differing in content, format, and utility. It was developed by Manaaki Whenua - Landcare Research, New Zealand. – The NSDR is a versatile soil observation database – It hosts the original National Soils Database (NSD) – It has been specifically designed with the capability of housing a variety of soil datasets that differ in content, format, and utility – It comes with a dedicated authorisation and identification tool, allowing secure access for customers to see their 'own' datasets – It includes full provenance information (such as detailed descriptions of the methods used to collect and analyse the data) while audit trails track changes to the data over time – It contains records for soil observations from 1959 to the present day	National Soils Data Repository (NSDR)
S-map	S-map is the most comprehensive, quantitative soil survey information available for New Zealand. As of August 2022, S-map coverage stood at 37.8% of New Zealand soils with more than two thirds (68.5%) of multiple use land (horticulture, cropping and intensive pasture systems) covered S-map is being created by Manaaki Whenua with funding from central and local government. S-map Online is one of a number of delivery services for S-map data and has been developed and operated by Manaaki Whenua's Informatics team. Using S-map Online you can explore interactive soil maps of Aotearoa New Zealand, learn about the soil in your area, browse, view and download a variety of soil fact sheets including one for Māori, identify and compare soil siblings - the most detailed level of soil classification, and create custom soil maps for printing	S-map

SOURCES AND REFERENCES

Information sources that supported the development of this case study include:

- Interviews and conversations with personnel who were involved in the development of soil data in New Zealand
- Desk research conducted by CABI and ISRIC staff and associates

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Further information

For more information on the project visit: cabi.org/projects/soil-information-systems-review-a-process-toward-strengthening-national-soil-information-systems

To access similar resources and explore the framework visit: resources.isric.org/sis-framework

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