# Next generation information systems

*Sharing soils data regionally, nationally and globally*

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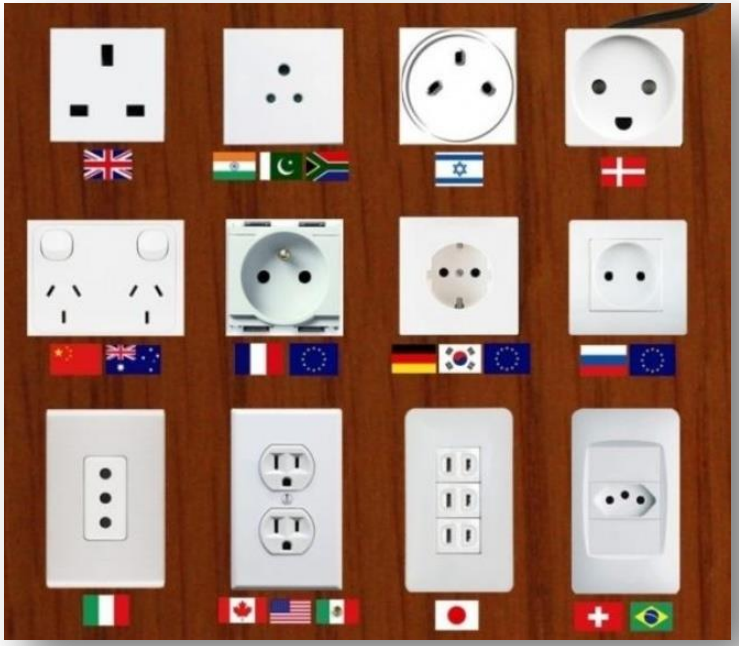
The problem space

A soil data interoperability experiment

- Background
- An information modelling view of soils
- Interoperability in action – demonstrations

The wider benefits

Lessons learnt and where next



# THE PROBLEM SPACE


# Broad Context

Urgent need for more information on soils at varying geographic scales

More and more data are being collected but diversity of data sources make integration and harmonisation difficult

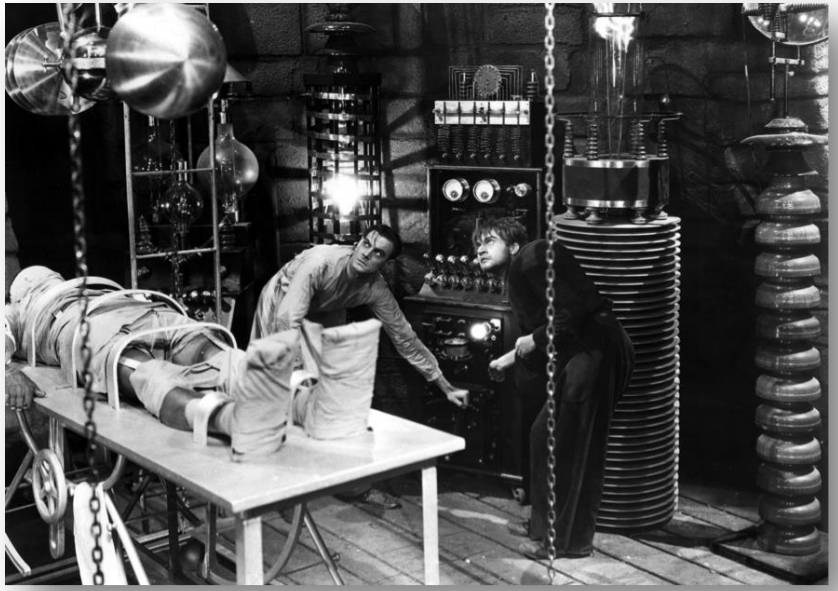
Soil data needs to be freely available and in formats that can be readily used for a wide range of purposes

There is a need for harmonization of methods

# We need an internationally recognized and adopted standard for the exchange and collation of consistent harmonized soils data and information worldwide

This would allow us to…

| | |
|---|---|
| at a technical level: | easily and efficiently transfer between databases, allowing easy access and analysis |
| at local levels: | easier comparison of similar soil landscapes and best-practices in similar areas |
| at national levels: | facilitate investigation of soil degradation or opportunities between regions for a better use of natural resources |
| globally: | to look at matters such as food security, biodiversity and desertification |



# A SOIL DATA INTEROPERABILITY EXPERIMENT

# The problem and first steps to a solution

- Global/national initiatives require interoperable solutions that use an agreed standard for exchanging soils data
  - *examples include FAO's GSP, GSM, LAWA+FDN (NZ), TERN (AUS), ISRIC Harmonized world database…*
- There are existing standards but diverse and don't cover all our data exchange needs
  - *we need to reconcile them in a single, comprehensive, global standard*
- An OGC Interoperability Experiment was seen as the first step in achieving this
  - *Initiated by the International Union of Soil Sciences Working Group on Soil Information Standards*
  - *led by Landcare Research, funded in part by the MBIE IDA Programme*

# Open Geospatial Consortium (OGC)

- An international industry consortium of 500+ companies, government agencies and universities participating in a consensus process to develop publicly available data exchange standards
- Different types of initiatives, e.g. Testbeds and Interoperability Experiments, used to develop standards
- Interoperability Experiments are brief, low-overhead, formally structured and approved initiatives led and executed by OGC members to achieve specific technical objectives
- An IE must focus on a single interoperability issue

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# Soil Data IE – Implementation

- Goal - the development and testing of a Soil Markup Language, a data encoding for soil features
- Participants: IE Initiators (CSIRO, Landcare Research, IRSIC) plus a number of other agencies e.g. USDA, USGS, Fed Uni (Aus), CRA-ABP (Italy) + Horizons Regional Council
- 6 months duration
- 4 main user stories (use cases)
- Develop a conceptual model and common exchange language (a GML-XML application schema)
- Deploy a set of demonstrators using web services (e.g. WFS, SOS) that used the schema

# Use Cases

Use Case 1: **soil data integration & publication**

Publication of heterogeneous soil data from different databases at different agencies

Use Case 2: **soil sensor data**

Publication of data from sensors monitoring dynamic soil properties

Use Case 3: **soil property modelling and predictions**

Provision of high resolution estimates of functional soil properties generated using digital soil mapping techniques – e.g. the world-wide soil property predictions made by the GlobalSoilMap project

Use Case 4: **pedo-transfer functions**

Delivery of observed and interpreted soil properties (by soil type and/or by spatial distribution) in a standard format that allows the use of pedotransfer functions - algorithms that calculate additional interpreted soil properties.

# Soil IE Candidate Standard

## No clear candidate from existing work

- Back to basics using as much existing work as possible

## Minimalist approach

- Don’t create standards when existing standards do the job
- Only extend standards when it is impossible to describe domain specific things … soil and soil horizons
- Model the thing, not the interface (soil characteristics, not portals)

## Obvious, huh?

- Apparently not. Egos and laziness often beat good design.

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# Soil IE Candidate Standard

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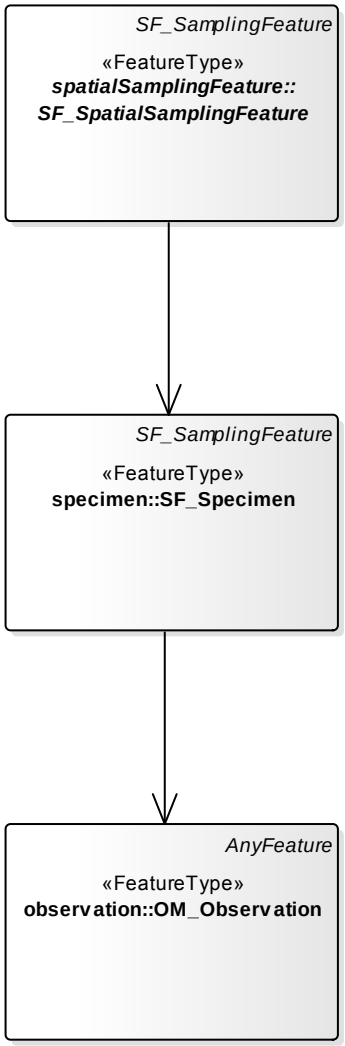
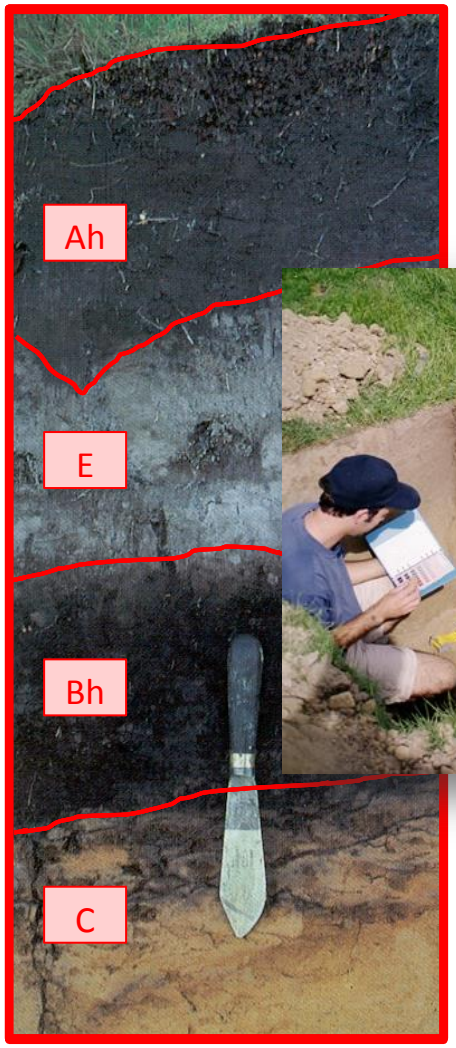
# Soil Observations





**ISO19156/OGC10-004r3 - Observations and Measurements**

# Soil Descriptions




*SF_SamplingFeature*
«FeatureType»
***spatialSamplingFeature::***
***SF_SpatialSamplingFeature***

*SF_SamplingFeature*
«FeatureType»
**specimen::SF_Specimen**

*AnyFeature*
«FeatureType»
**observation::OM_Observation**

*SO_SoilFeature*
«FeatureType»
**SO_Soil**

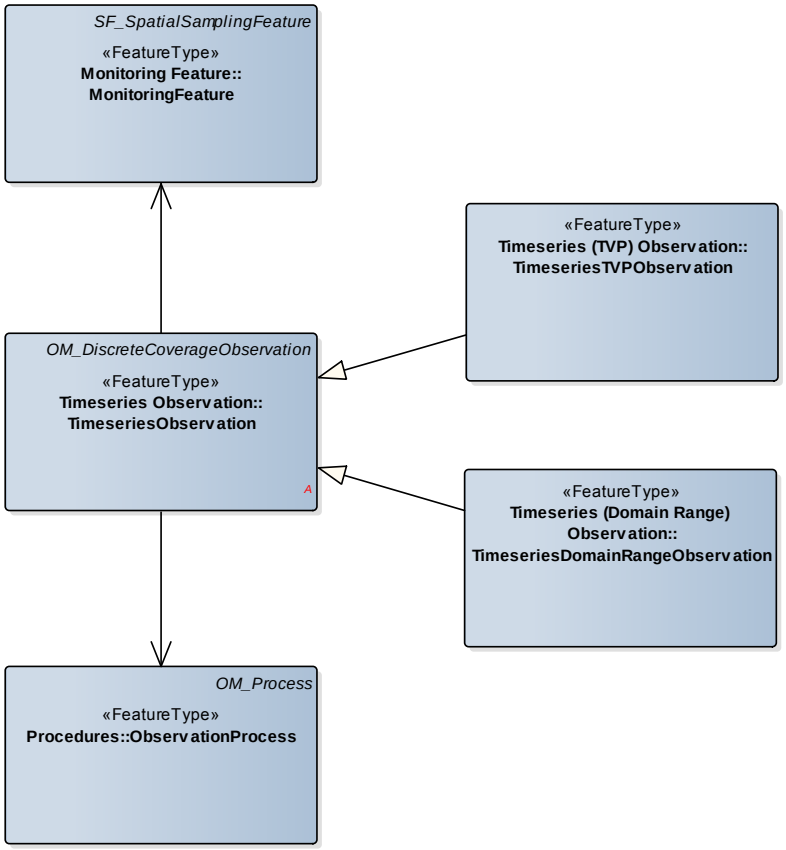
«DataType»
**SO_SoilTaxon**
Podzol Soil (Z)
[NZSC]

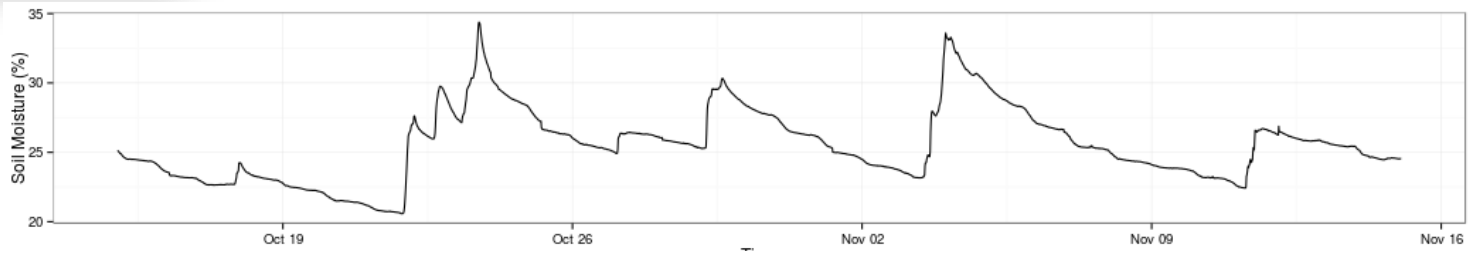
«DataType»
**SO_Component**
texture
bulk density
organic carbon
particle size distribution
…

*SO_SoilFeature*
«FeatureType»
**SO_SoilHorizon**

«DataType»
**SO_HorizonDesignation**

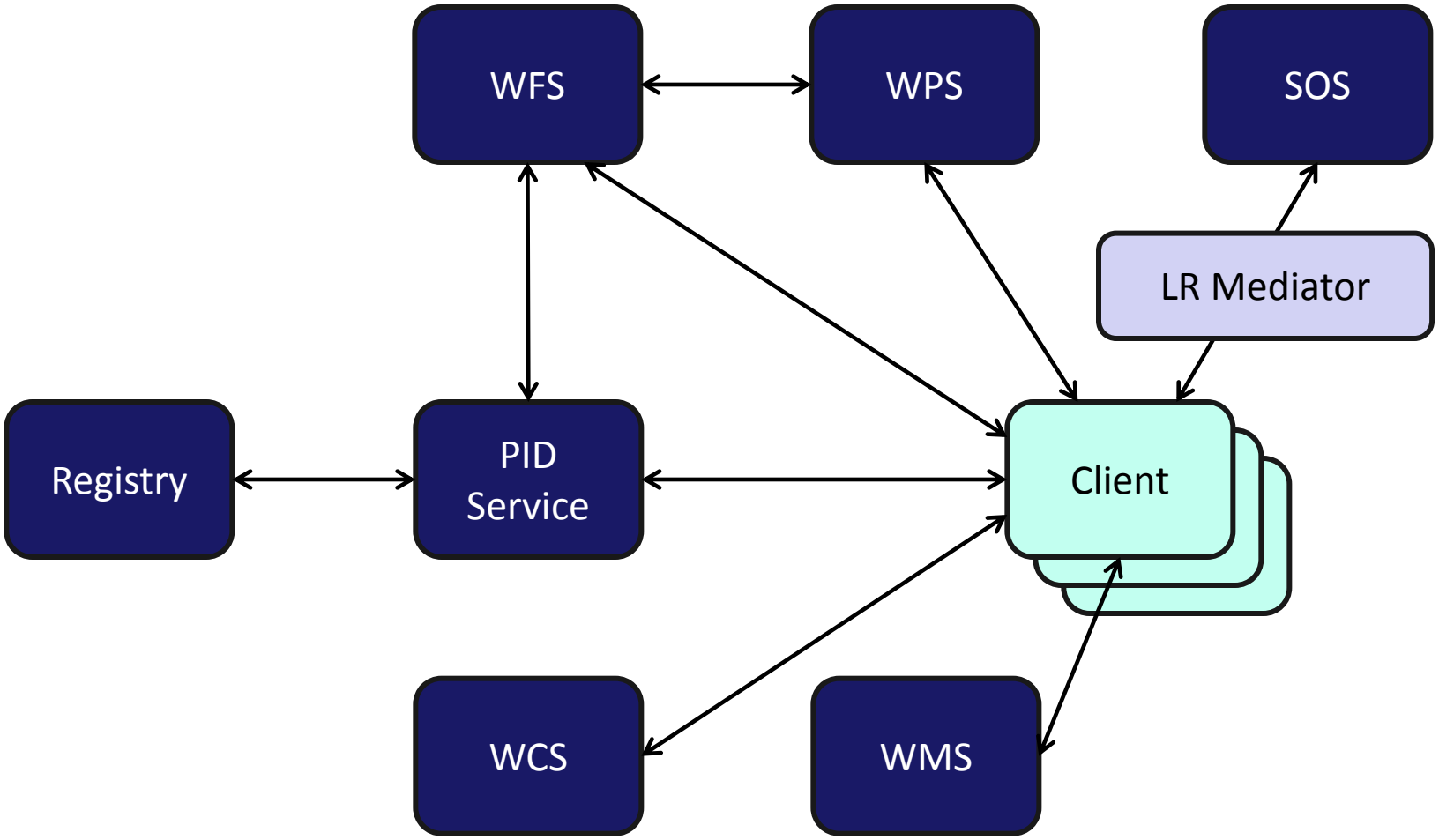
# Soil Sensors




**OGC15-043r3 – Timeseries Profile of Observations and Measurements**

# General architecture




‘Simple’ and ‘complicated’ services

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# Demonstration One

- Use Case Two
- Provision of soil sensor data as TimeSeriesML

  *Soil Moisture*

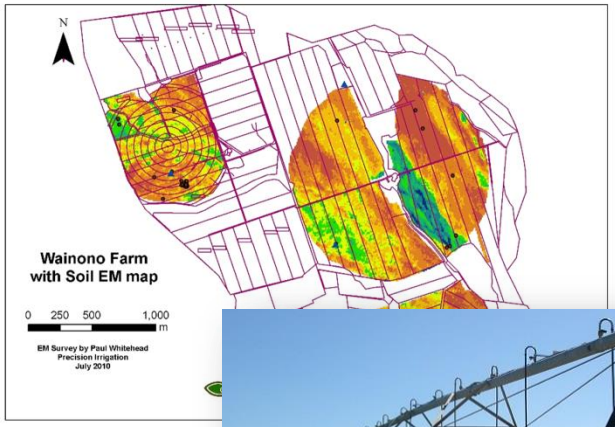
  *Soil Temperature*

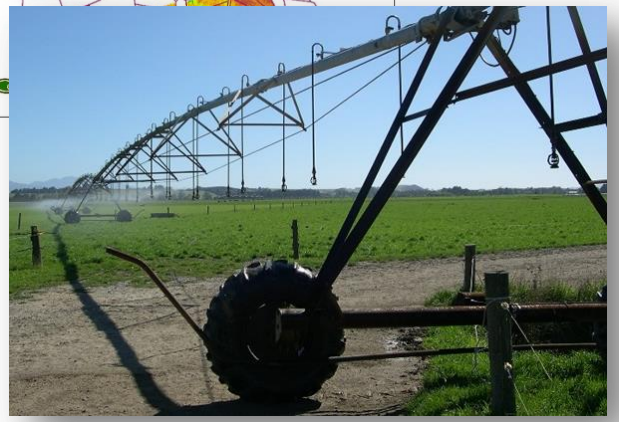
  *Rainfall*

- Example applications

  *Precision agriculture*

  *Flood hazard mapping*



# Demonstration One

- Contributors

  *Landcare Research (NZ)*

  *Horizons Regional Council (NZ)*

  *United States Geological Survey (US)*

- Video https://youtu.be/arMufkX6jJg

# Demonstration Two

- Use Case Three
- Model variation in soil properties in space
- Contributors

  *CSIRO Land and Water (AU)*

  *Federation University of Australia (AU)*

- Video: https://youtu.be/xuz8ZJ1RHSM

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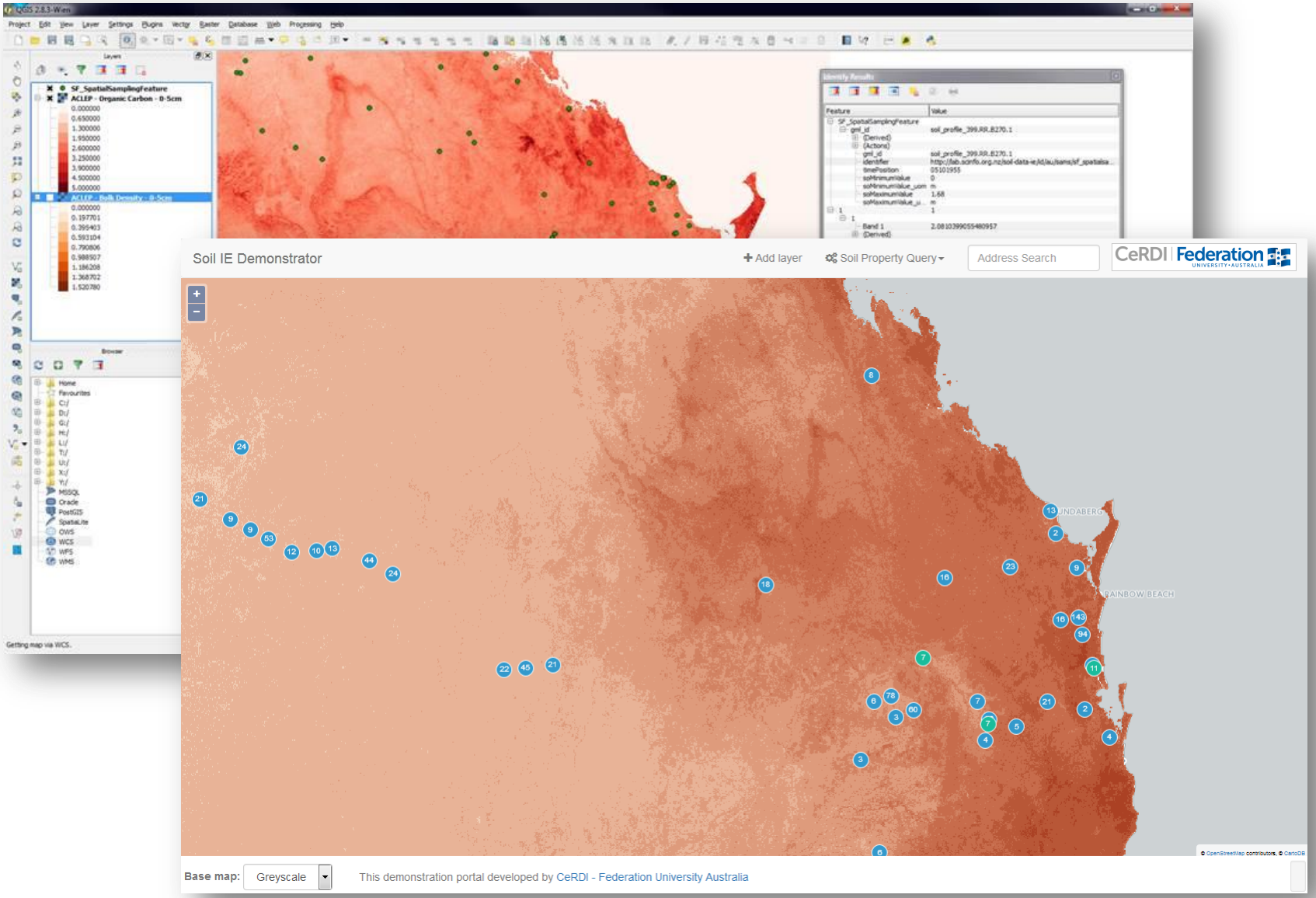
# Demonstration Two



# Demonstration Three

- Use Cases One and Four
- Soil sampling and observation data

  *Samples and archiving*

  *Laboratory analyses*

  *Field observations*

- Example application

  *Provision of a comprehensive description of the physical character of a soil at a specific location*

# Demonstration Three

- Contributors

  *Landcare Research (NZ)*

  *CSIRO Land and Water (AU)*

  *Federation University of Australia (AU)*

  *ISRIC World Soil Information (NL)*

- Video https://youtu.be/0_gdq4YludU

  *Landcare Research client with CSIRO Registry*

  *Federation University Australia client with ISRIC WPS*

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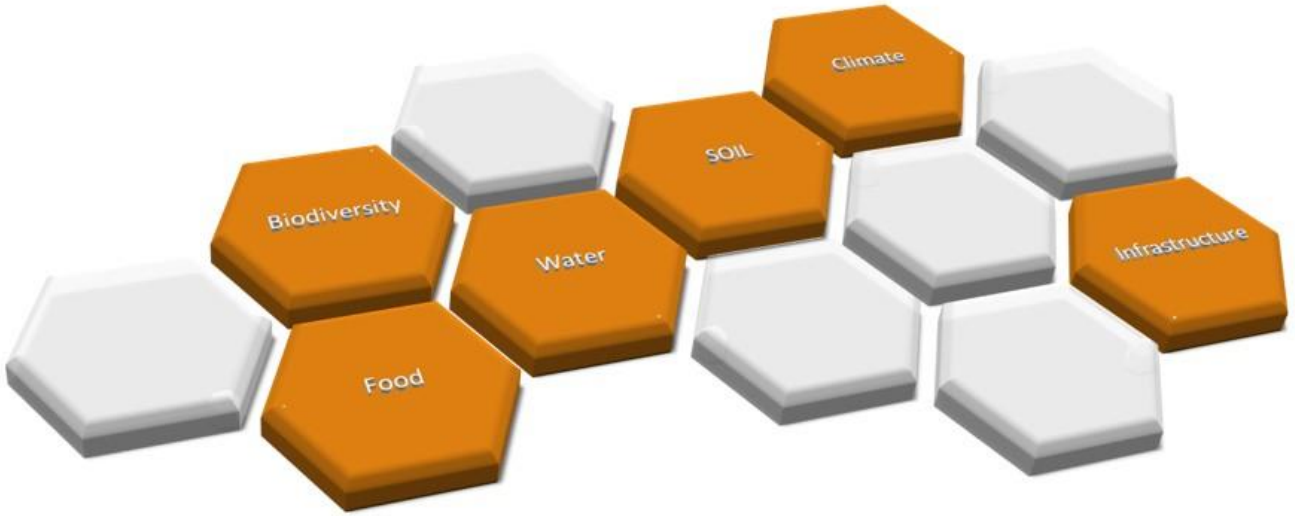
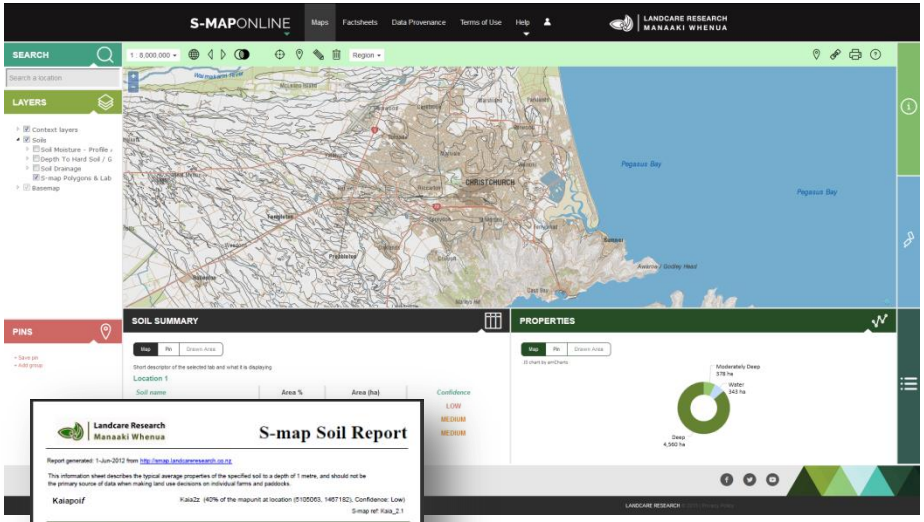
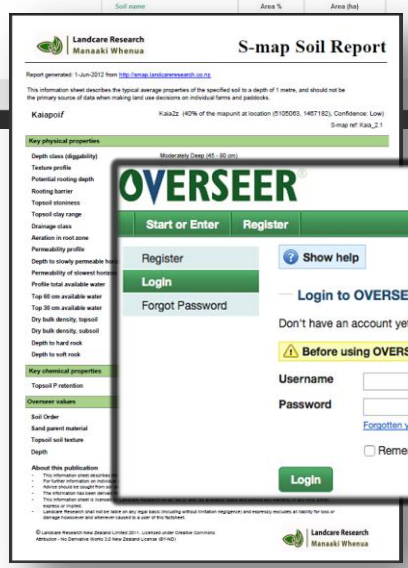
# THE WIDER BENEFITS

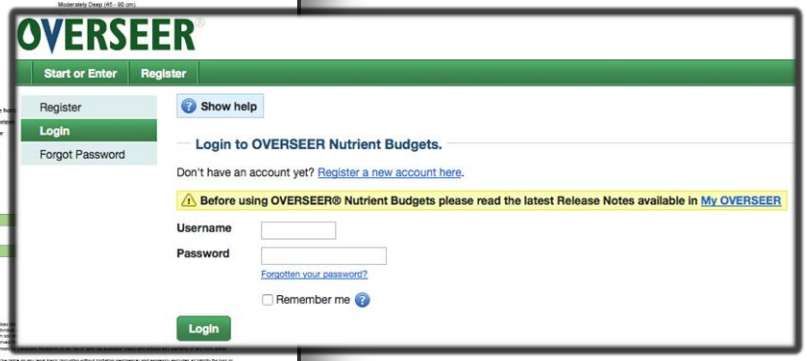


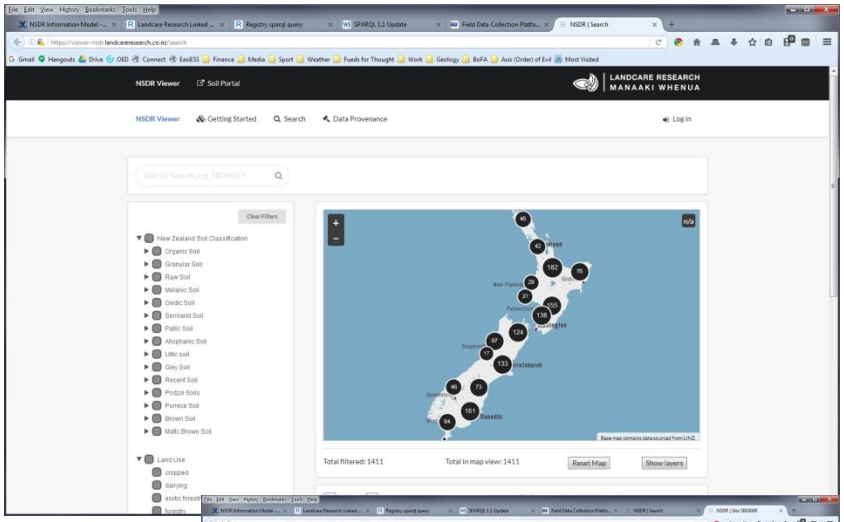
# Useful Tools

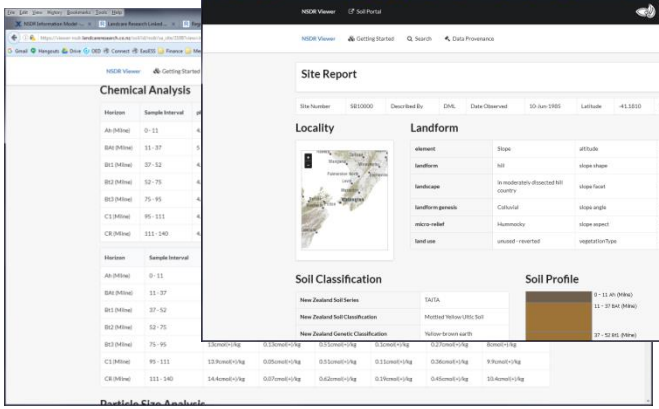
- O&M, TimeseriesML and *SoilML Services at LR



# Useful Tools

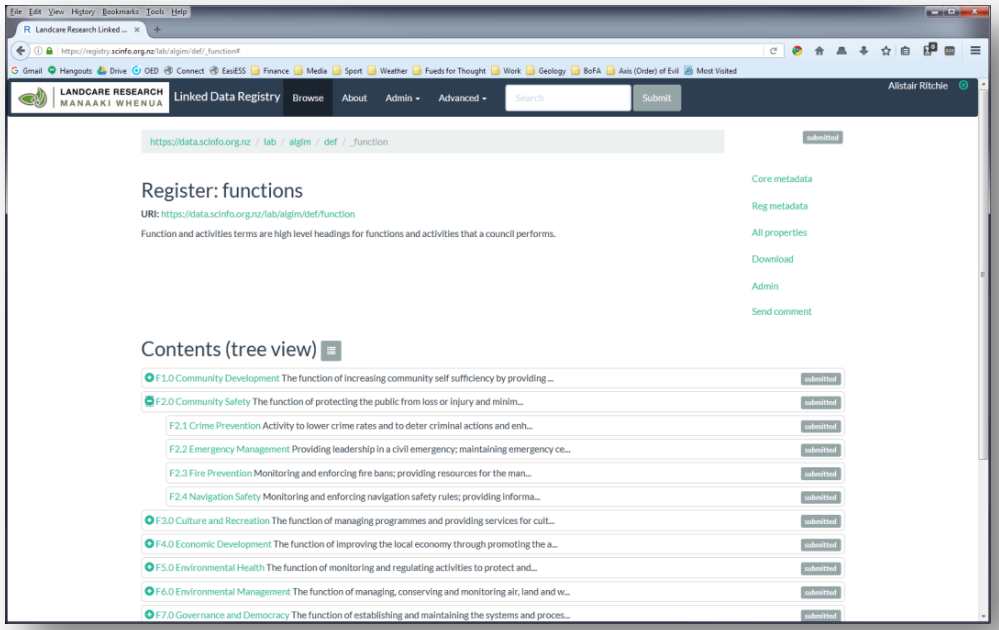
- Vocabulary and data dictionary services
- UKGovLD Linked Data Registry

  Shared vocabs and property definitions

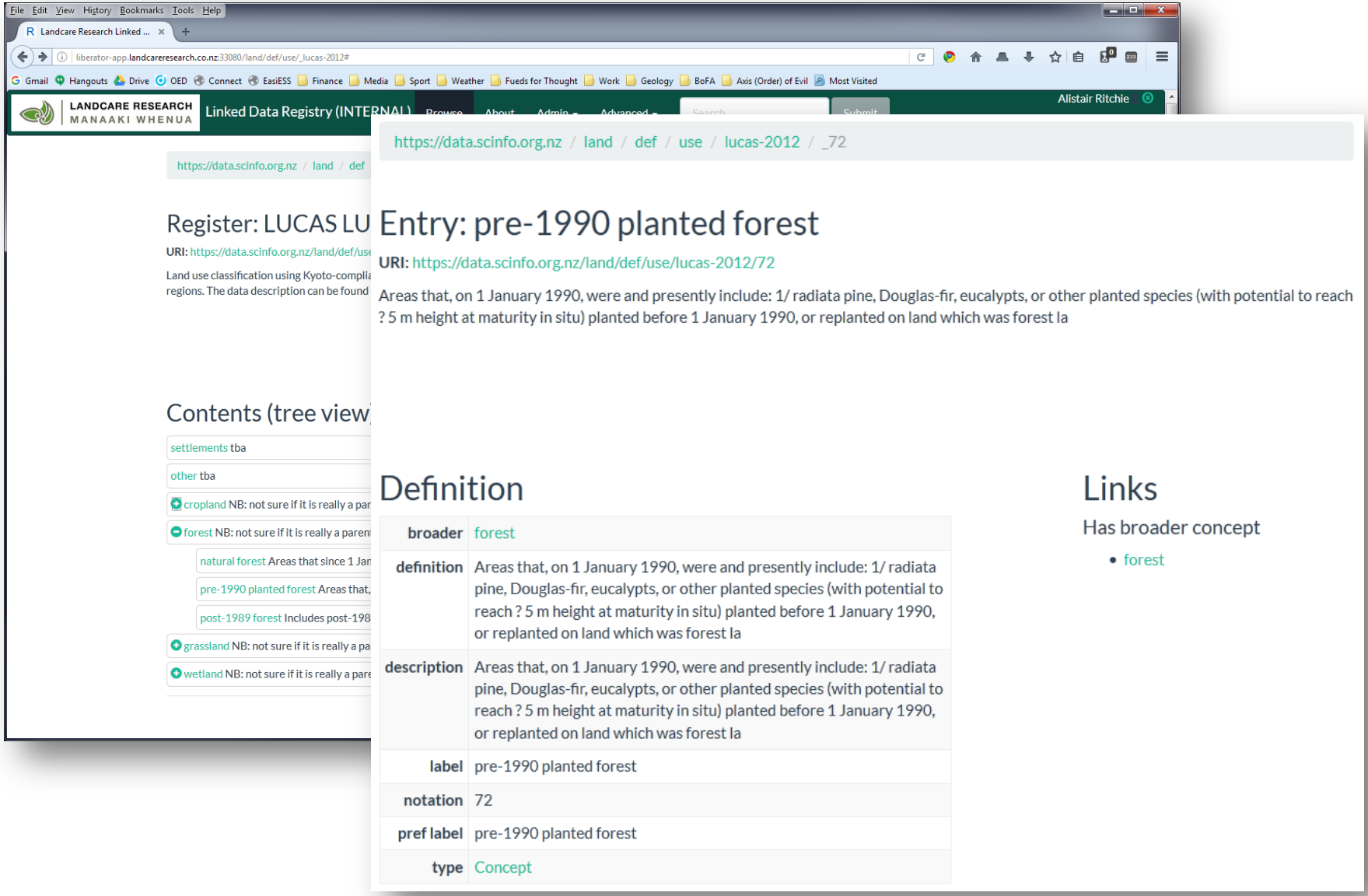
  Shared classification systems

  ALGIM: Laboratory

  LR: Landuse and Soil



# UKGovLD Linked Data Registry



# LESSONS LEARNT AND WHERE NEXT

# In the IE we used open standards to…

- create a simple *information model* of soils data
- *harmonise* the structure and some content of soils data between agencies
- bring data from different international soil agencies together in applications for users (*interoperability*)
- provide a way to describe and organise soil concepts, features, methods, etc (*semantics*)
- use *linked data* ideas to provide supporting information about the data inside the responses to queries
- to chain services for *processing* data

➢ And demonstrated cross agency *data sharing*

# Issues uncovered

- Developing standards is time consuming and expensive
- We need to engage further with the global soil community to reconcile existing models
- The modelling methodology is unfamiliar to scientists
- IE participants reported difficulties deploying services
- Standards technology is not keeping up with web technology
- Assumes open access to data and good governance
- Internationally, it's unclear who should be doing this

# Why did Landcare engage globally?

- To ease the use of soil data by our scientists and customers
- We learn from other people's experiences with implementations saving us significant research time and funding
- Ensures we/NZ conform with current best practices and stay aware and engaged with future developments regarding sharing soils data/standards
- Maximises opportunities to achieve research impact
  - *The lessons learnt will be valuable for other data infrastructure activities such as the New Zealand's Biological Heritage, OL&W*
- It’s got wider value than just soils
  - *It’s directly applicable to data integration and information sharing in infrastructures such as the EMaR/LAWA NFDS*
- Grows New Zealand’s expertise and our credibility internationally

# Conclusions

- Soil and land information is needed for a wide range of applications
- Data are difficult to access, data interoperability between agencies & their systems even harder
- Standards e.g. ISO 19100 & OGC provide us with the tools and guidelines to improve access, sharing and interoperability
- Linking data to semantic knowledge makes the ‘data smarter’
- What we learnt for soils can be applied more widely for the benefit of environmental data sharing in NZ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**Soil IE Engineering Report at http://www.opengeospatial.org/docs/er**