Status of global soil information

Adopting new technology and rebuilding institutions

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Key points

1. Most of our spatial information on soils is more than 20 years old, imprecise and often irrelevant to today's decisions on land use and management
2. Investment in soil knowledge declined sharply from the 1980s onwards and is only now starting to recover
3. Most of our knowledge was collected during the analogue era
4. Rebuilding our institutions, securing resources and investing in new scientific capability are our biggest challenges
5. We have exciting new technologies and opportunities to build enduring systems for monitoring and forecasting the condition of soil and land from local to global scales

Global soil information

Why we need to invest more into mapping and monitoring

Science and process knowledge

- Detailed process knowledge (field plot and laboratory) versus knowledge of the land

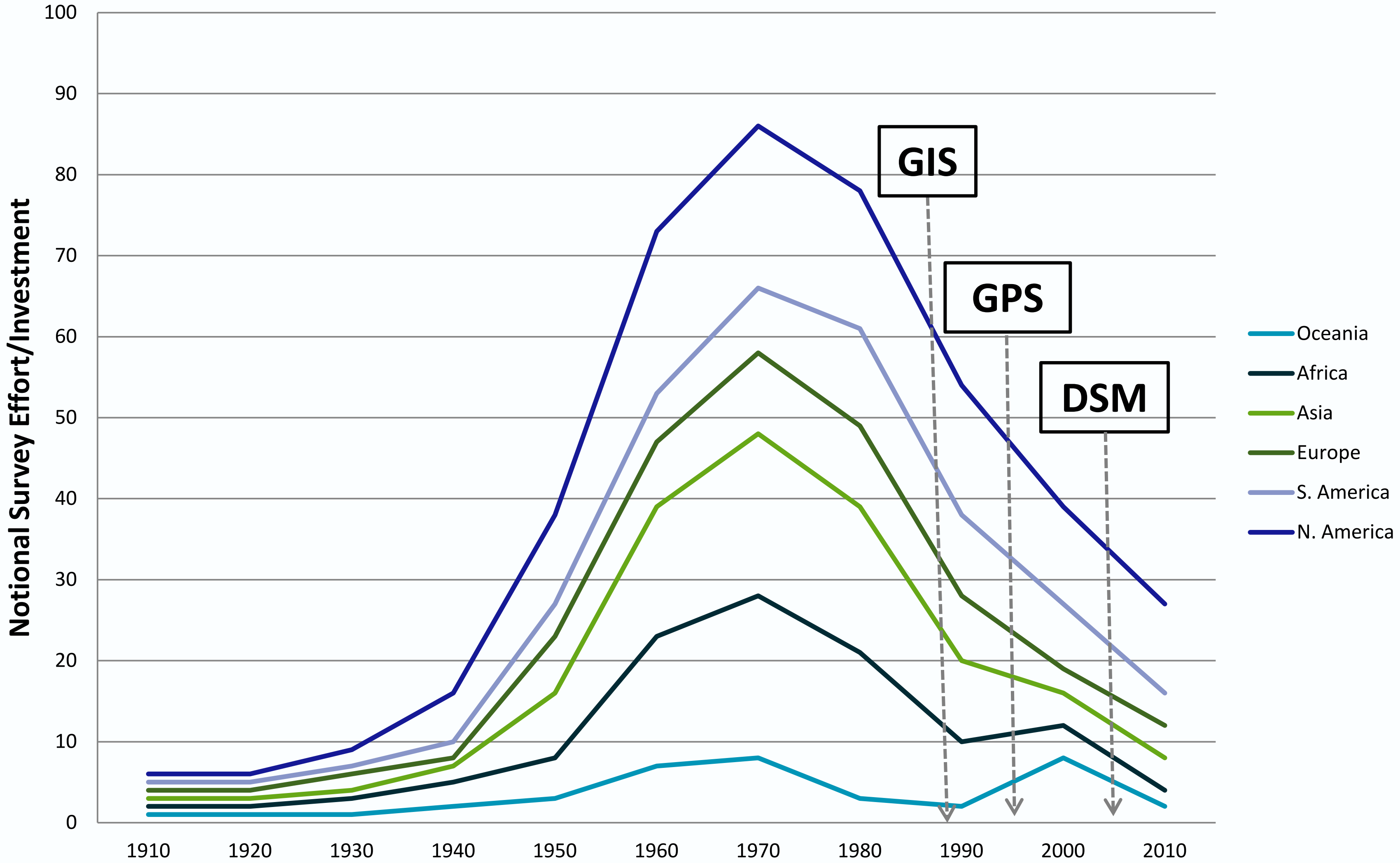
Simulation models

- Need for an integrated hierarchy of models across scales

Data and information

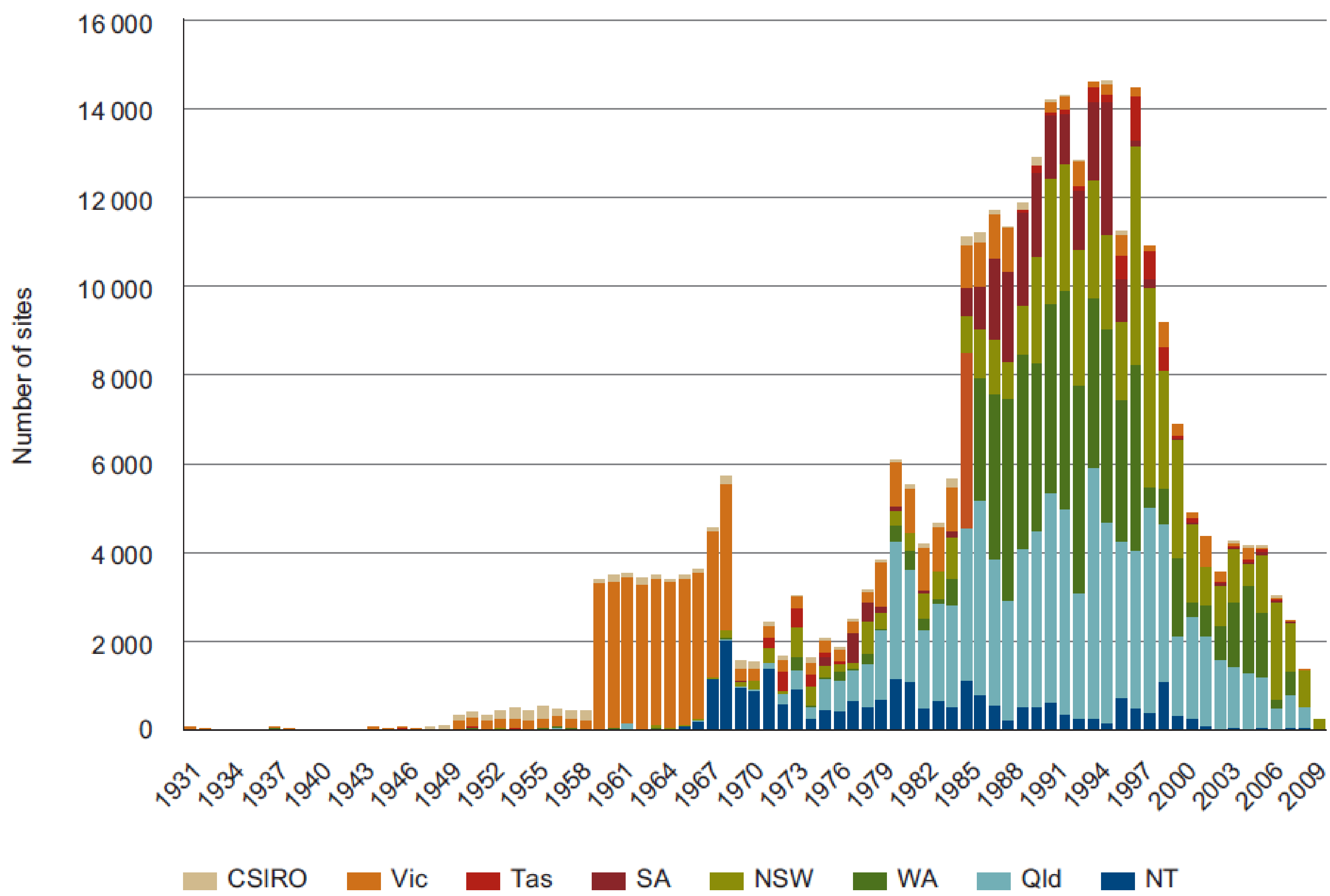
- Mapping and monitoring are essential to build the framework for decision making in land resource planning and management
- Primary barrier to soil knowledge being used more generally

Hypothesized global soil survey effort/investment



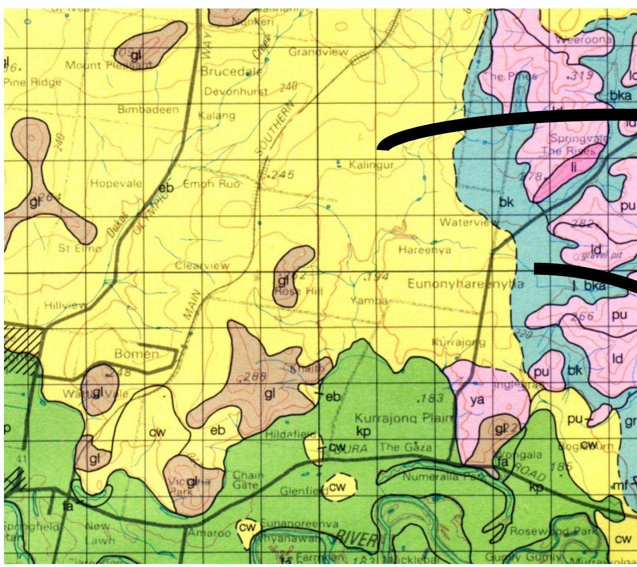
CSIRO

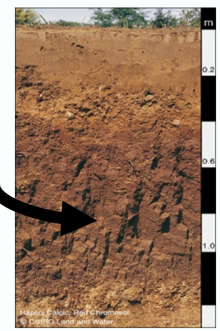
Number of sites by year in the Australian soil database

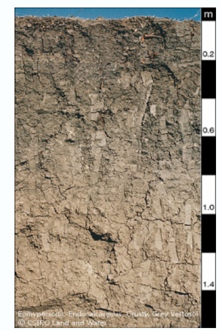


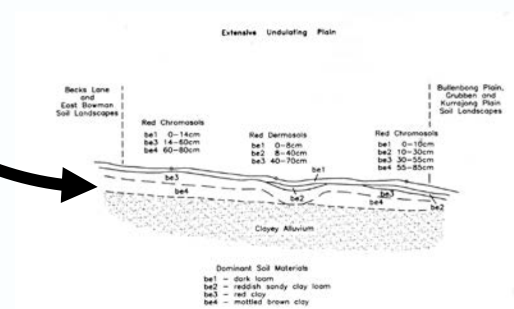
Conventional survey information

- Out of date in most regions
- Very generalised scale
- Reasonable compliance to standards
- Limited capacity to incorporate new information
- Soil classes are means for data analysis and communication
- Complex data model
- Current global data sets derived from conventional survey represent a small proportion of existing information









What do we have globally?

1. Key data sets
   - Harmonised World Soil Database
   - FAO-UNESCO soil map of the world
   - WISE database
2. Issues
   - Sometimes not linked to the best national data
   - Data model is restrictive even for HWSD
   - Coarse resolution
   - Interpretations are sometimes hard to understand
   - Estimation of uncertainty
3. Web delivery of soil information for specific regions and countries is increasing but only a few genuine web-services and associated apps

The changing nature of data acquisition and analysis

1. Very few countries have mandated soil and land resource mapping programs
2. Large point sampling efforts
   - Soil carbon (US, Europe, Australia)
   - Monitoring networks
3. Significant synthesis projects
   - ASRIS 1
   - AfSIS
4. Precision agriculture and proximal sensing
5. Environmental indicators, citizen science, crowd sourcing

There is no overall strategy and data are being used only once if at all

What do we really need to know?

1. State and trend of soil condition in most regions of the world is difficult to assess but the warning signs are serious
2. We need reliable estimates of
    - the availability of arable land
    - soil constraints on food and fibre production
    - rates of change affecting soil function
    - stores and fluxes of water, carbon, nutrients and solutes.
3. We need to prepare regular assessments and outlooks on the state of our soil and land resources that match the standards of the IPCC

Can we reduce uncertainty for decision makers?

1. There are many sources of uncertainty facing a decision maker (farmer, planner, policy maker) and soil information may not be the most important factor
2. **The utility of soil information depends fundamentally on whether it can increase certainty for a decision maker facing real choices**
3. We need to understand the decision making process and have objective measures of the certainty of our information

The transition to digital soil mapping

Definition

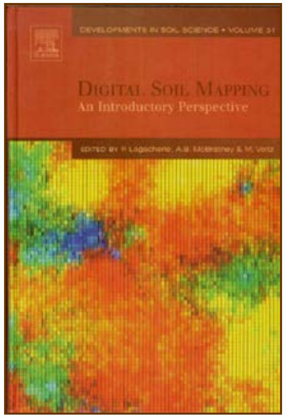
"the creation and population of spatial soil information systems by numerical models inferring the spatial and temporal variations of soil types and soil properties from soil observation and knowledge and from related environmental variables"

Lagacherie and McBratney 2007

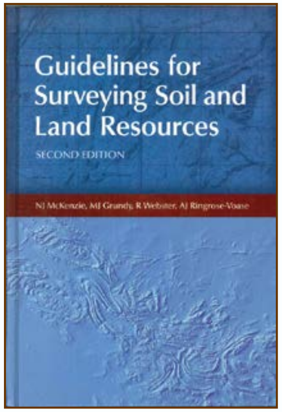
The aspiration

Methods are explicit, consistent and repeatable

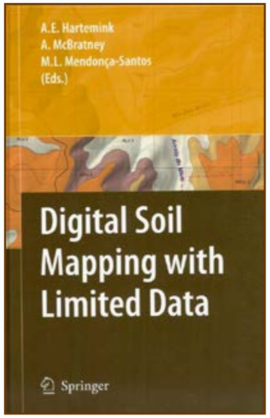
Spatial prediction of functional soil properties and their uncertainties



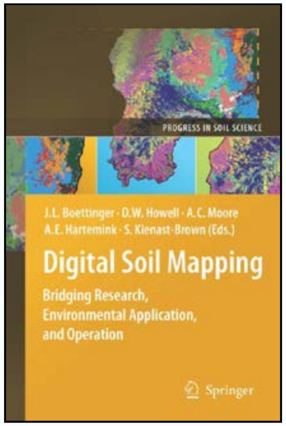
2006



2007



2008



2010

2010

2012

Required *operational* infrastructure

District

- networks involving soil scientists, land managers and planners
- field survey teams and capability for digital soil mapping
- proximal sensing units
- permanent monitoring sites

National

- networks involving soil scientists, policy makers and national leaders
- airborne remote sensing
- comprehensive laboratories and specimen archives
- national data analytical facilities
- soil information systems providing web-based services

International

- widely accepted and comprehensive standards and protocols
- fine-resolution remote-sensing (temporal, hyperspectral)
- high-resolution, hydrologically enforced digital elevation models
- spectroscopic calibration (e.g. carbon and nutrients)

One element: *GlobalSoilMap.net*

1. Aims to be a web-service layer of data generated by existing national systems with custodianship of primary data retained by the source agency or nominee
2. Grid is viewed as being complementary to polygon products
3. The data model aims to overcome limitations of existing models
4. Innovative use of depth functions
5. The grid is the framework for estimates of soil properties and does not imply that we have accurate and precise estimates for every grid cell

The goal

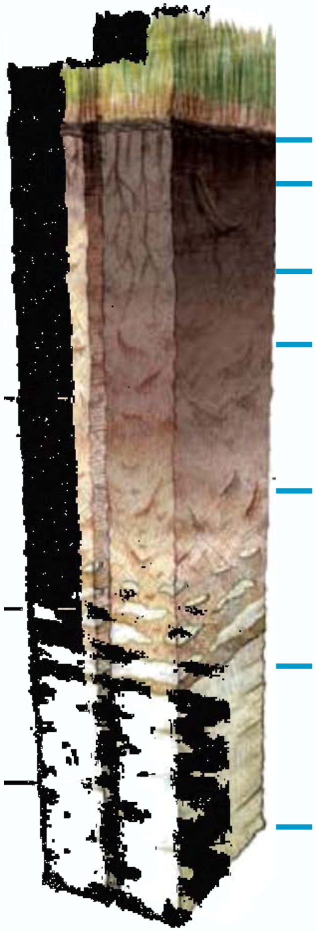


Image: courtesy of Alfred Hartemink

Fine-resolution grid (~100m) of the world

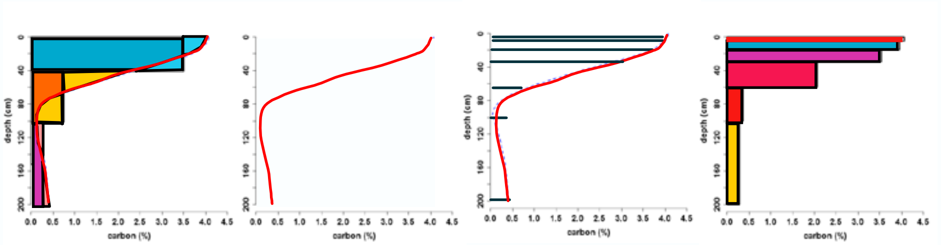
Estimation of functional soil properties

- Organic carbon (g/kg)
- Percentage sand, silt, clay and coarse fragments
- pH
- Depth to bedrock or restricting layer (m)
- Bulk density (kg/m3)
- Available water capacity (mm/m)
- Effective cation exchange capacity (incl. exch. acidity mol/kg)
- Electrical conductivity (dS/m)

Provision of uncertainties for all estimates

The products

- Fine-resolution gridded data supplied via the Internet
- Grid estimates are integrated over a depth and volume defined by the user
- Estimates for a grid cell include a point and block estimate of each soil property and its uncertainty
- Many derived variables will be possible



Soil carbon 0-50 mm

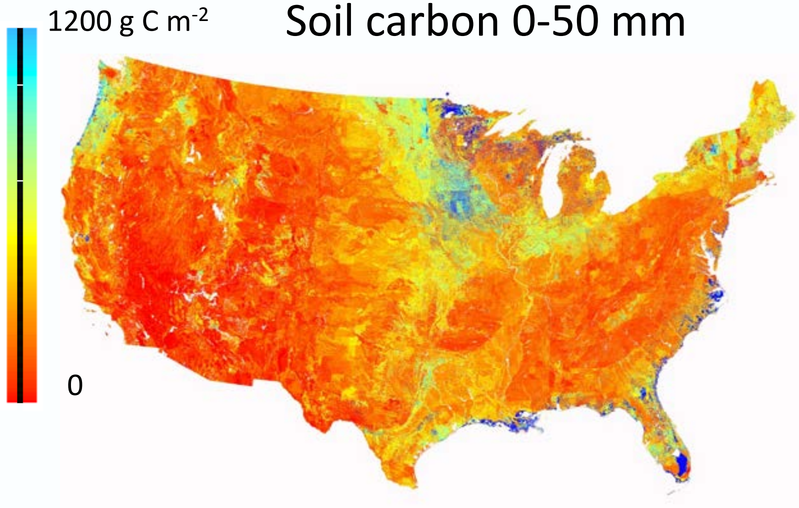


Image courtesy of Jon Hempel, Zamir Libohova, Nathan Odgers, NRCS, USDA

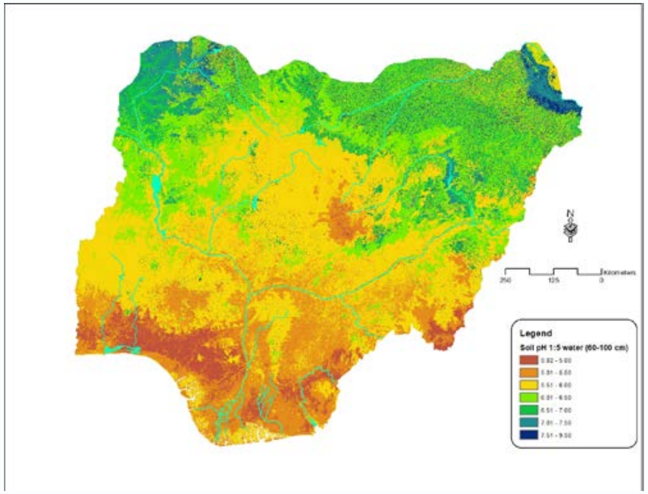
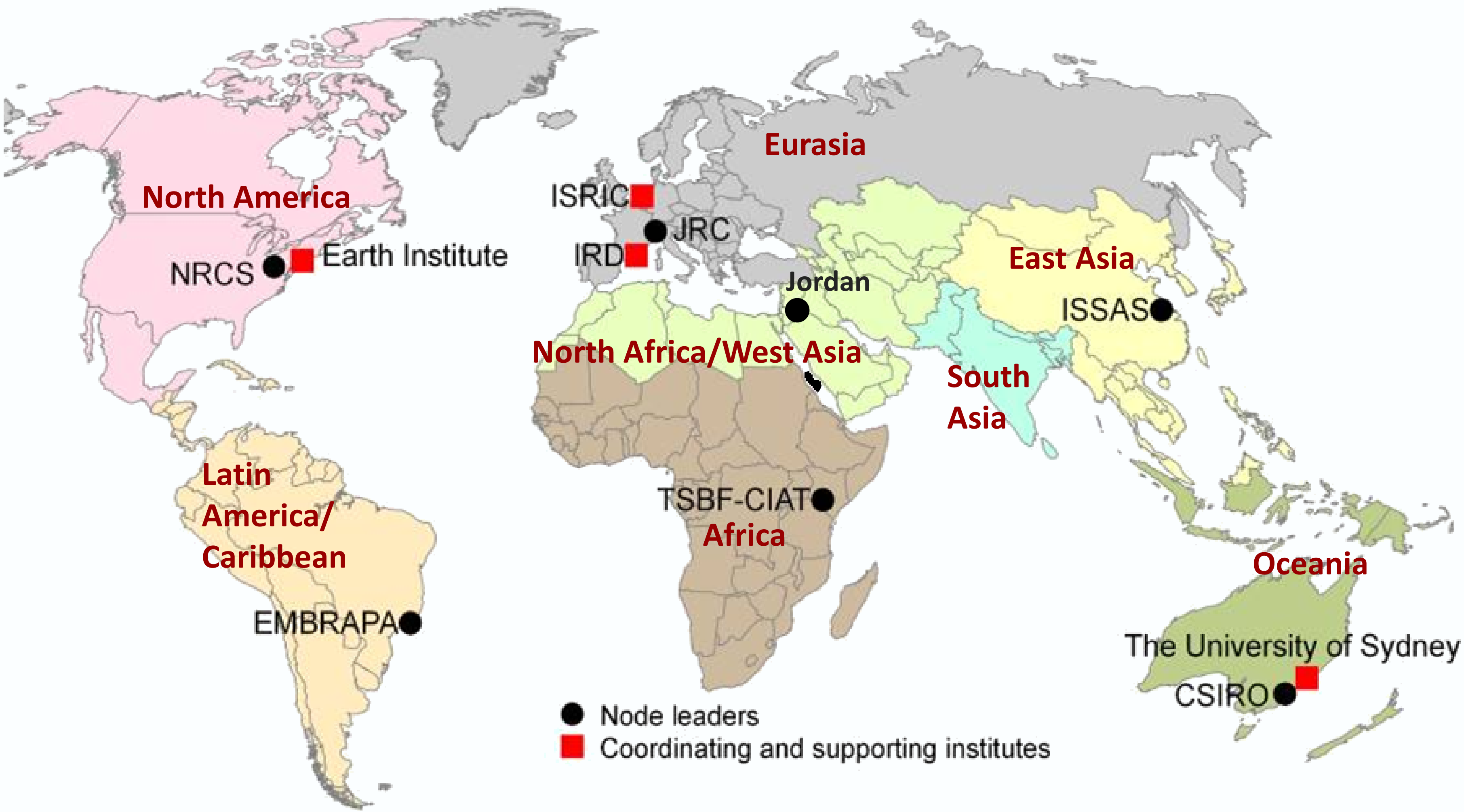


Image courtesy of Odeh, Hannes Reuter, University of Sydney and ISRIC

The global community of practice



GLOBAL SOIL PARTNERSHIP
JRC EUROPEAN COMMISSION
AfricaSoils.net
United States Department of Agriculture NRCS Natural Resources Conservation Service
ISRIC World Soil Information
The Earth Institute AT COLUMBIA UNIVERSITY
CIAT International Center for Tropi
Embrapa
The University of Sydney
ISSCAS
CSIRO

Global soil knowledge: are we just muddling along?

1. There are only a few ‘operational’ programs of digital soil mapping and most are undertaken by research institutions
2. Only a few agencies have a formal mandate to provide soil knowledge for their jurisdiction (e.g. a mandate to produce and maintain a national soil survey coverage)
3. At present, various agencies provide partial leadership internationally
   - European Commission
   - FAO
   - GEO
   - ISRIC – World Soil Information
   - International collaborative projects (e.g. *GlobalSoilMap.net,* B&M Gates Foundation in Africa, European Commission Atlases, USDA methods)
   - IUSS

Consequences of muddling along

- Unlikely to result in effective strategy
- Difficult to get agreement on much needed standards and protocols
- Hard to get economies of scale in investment
- Confusion over the role of research institutions and operational agencies
- Hard to get effective coordination with other disciplines who are well organised (e.g. climate and weather, geosciences, oceanography)

Institutional options

1. Maintain the status quo and really be part of the problem
2. GEO/GEOSS becomes the authoritative forum and network
3. Bilateral and multilateral agreements are developed between leading soil institutions
4. One agency emerges as the authoritative leader
5. The Global Soil Partnership becomes the primary vehicle for coordination and collaboration

Next steps

1. New technologies are our great opportunity for building a valuable global digital knowledge base and our greatest risk
2. We need to help build a better institutional system for soil knowledge at home and internationally (c.f. weather, climate and geosciences)
3. Good strategy is essential to design the soil knowledge base needed to meet the needs of 2020, 2030 and beyond
4. The institutional arrangements are our biggest challenge and the GSP with supporting investment is our best opportunity for a long time

GLOBAL SOIL PARTNERSHIP

Thank you

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