Global soil information: building an enduring and authoritative system to monitor the Earth's soil resources

Proposed strategy for Pillar Four of the Global Soil Partnership

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Recap on why we need a global soil information system

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. Area of land and water used to support a global citizen is scattered all over the planet
   - soil degradation and loss of production are not just local or national issues
   - global assessment and monitoring are essential

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Objective 1: Provide the spatial data infrastructure

The global soil information system is incomplete and out of date.

- supply relevant soil information online and in a form that allows integration of data with other disciplines.

- flexible methods are needed for data input from a variety of sensors and measurement systems.

- web services are needed that allow optimised soil information to be automatically exchanged via the internet.

Web services provide the mechanism for national soil agencies – or agencies acting on behalf of one or more countries – to deliver standard products into the global system.

Objective 2: Supply a complementary set of spatial soil-data products

We need orderly specification and delivery of global soil data products

Especially important for simulation modellers and engineering of models

Three data types form the core of the spatial data infrastructure:

- soil grids
- polygons
- profiles

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Global soil grids

Soil data in a grid format are compatible with many other forms of biophysical data (e.g. remote sensing, digital terrain data)

Significant advantages for the calculation of the stores and fluxes of water, carbon, nutrients and solutes.

Two key product lines at present:

1. Harmonised World Data Base

2. *GlobalSoilMap.net*

The global soil grid: Harmonised World Soil Database

Produced by FAO and IIASA and widely used by the climate change modelling community.

- Grid resolution of ~1km, two soil layers, 1m depth

- Comprehensive set of soil attributes.

Agreement yesterday on Freddy Nachtergaele's proposed update (will include new data from regions where current estimates rely on FAO-UNESCO Soil Map of the World)

Invaluable first step in providing gridded data globally but constrained by:

- two-layer soil model (e.g. simulation of water balance and plant growth)

- soil depth of 1 m is often limiting

- Grid resolution of 1 km is coarse

The global soil grid: *GlobalSoilMap.net*

Specifications developed between 2008 and 2012

- Functional properties of soils at fine resolution (approximately 100m) for the world.

- Flexible method for estimating and extracting soil data for any depth or depth integral.

- Relies on a variety of digital soil mapping methods to provide estimates of soil properties depending on local data availability.

- Estimate of certainty for each soil property.

Currently in the initial phase of product delivery.

Products can be aggregated and delivered in a wide range of formats

Forms the logical basis for the future delivery of gridded soil data.

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Strategy for globally gridded soil data

- By December 2013, update the HWSD using the current data model and incorporate data from countries missed in the first version.

- Between now and December 2015, have a major global campaign to complete the first approximation of the fine-resolution product according to the specifications of GlobalSoilMap.

- Provide the fine-resolution product as a web service

- In the longer term and if required, provide a web service from the fine-resolution product for users who still need data in the HWSD format.

- Add new variables to the minimum data set and progressively release these grids (e.g. more soil properties relating to nutrient availability and crop growth)

Soil polygons: SOTER

Many countries have national soil information systems based on conventional methods of soil survey and land evaluation

Typically have a hierarchy of soil and land mapping units with descriptions of soil properties, soil classes and interpretations relating to land use

The *de facto* global standard for soil polygons is provided by SOTER

The coverage provided by SOTER-compliant databases is incomplete.

Good reasons for completing SOTER

Polygon and gridded data are often complementary

Strategy for soil polygon data

Revise the specifications for SOTER particularly in relation to the taxonomic requirements (e.g. adoption of the Universal Soil Classification)

Revise terrain characterization via digital elevation models

Ensure compatibility with SoilML

Progressively deliver SOTER data from national systems via a web service

Negotiate a timeline for completion with the key parties.

Soil profile and point data

Good reasons for developing a global data base of soil profiles, however:

- Large soil profile databases are expensive to maintain and update

- Barriers to data exchange are often more complex and significant for these data (e.g. relating to intellectual property or privacy restrictions).

Our primary tasks should therefore be:

- Establish clear principles for custodianship and build capacity in lead national agencies (single point-of-truth)

- Develop a minimum data set for *representative* soil profiles and incorporate these specifications in SoilML

- Provide a web service for representative soil profiles with data on morphological, physical, chemical, spectral and biological properties.

- Encourage soil information agencies to provide data as a freely available web service.

Objective 3: Design and initiate the global monitoring and experimental network (2012–2015)

Evidence for soil change comes from:

- long-term monitoring sites (from simple plots through to complex field experiments)

- simulation modelling

- proxies (e.g. paired sites where space is substituted for time, or monitoring changes in land management rather than soil variables directly)

- narratives (e.g. historical accounts of soil condition)

At present, various lines of evidence are used to infer rates of soil change but there are only a few examples at a local or country scale where the system for data collection has a technically sound basis (e.g. Japan, South Korea, France, Switzerland).

Global monitoring network

Outputs

Guidelines for establishing and maintaining local and national soil monitoring networks are developed and agreed.

A plan for a global monitoring network of sites is developed.

Engagement with existing monitoring programs is achieved (e.g. the Long Term Ecological Research network)

Monitoring networks are established in priority regions where soil change is suspected to be occurring or likely to occur.

Outcomes

Baselines are established for important soil properties and regions.

Decision makers are aware of rates of soil change and key thresholds.

Objective 4: Rebuild the technical capability

Requires education and training, provision of physical infrastructure, development of standards and establishing professional networks.

Key task is to establish technical teams with sufficient critical mass and skills in:

- Field survey and monitoring
- Laboratory measurement (including spectral analysis) and archiving
- Digital soil mapping and web-based services
- Land evaluation (especially in relation to agronomy and forestry)
- Extension and communication

Number of such teams per country depends on its size and complexity

Better to have a smaller number of permanent teams rather than a major project-based effort with a large number of teams.

Primary GSP focus is education and training of technical teams.

Objective 5: Regularly report on status and trends in global soil health

Scope

Reporting on the status and trends in soil health has been *ad hoc* and inefficient.

Brings a rigour and focus to the survey and monitoring programs.

Five-yearly report on global soil health with first assessment in 2015

Aspire to scientific standards comparable to IPCC assessment reports.

Outcomes

Decision makers have a clear understanding of soil status and trends and the impacts of past and future decisions on the soil and the systems dependent on its health.

Regular attention on the state of the world's soils leads to more sustainable systems of land use.

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Example of a continental scale assessment of soil condition
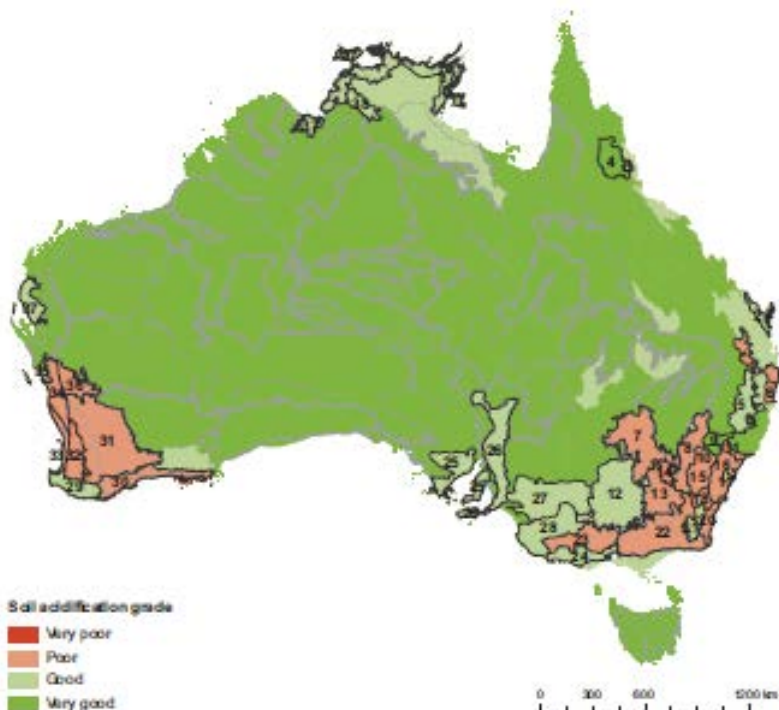
Physiographic region	Summary	Assessment grade				Confidence	
		very poor / poor / good / very good				grade	trend
31 Avon Plateau and Northam Slopes	Diverse soils. Widespread surface and subsurface soil acidity. Inadequate application of lime	▮ ↙ ▮ ▮				●	●
32 Darling Range	Mostly forested, but areas use for cropping and grazing are acidifying	▮ ↙ ▮ ▮				◖	◖
33 Swan Plain	Urban areas and intensive agriculture, with declines in pH in the latter	▮ ↙ ▮ ▮				◖	◖
34 Dandaragan Tablelands	Declines in pH restricted to areas used for cropping and grazing systems	▮ ↙ ▮ ▮				◖	◖
35 Greenough Hills	Significant acidification of both surface and subsurface horizons on noncalcareous soils used for cropping	▮ ▮ ↙ ▮				◖	◖
36 Woodramung Hills	Significant acidification and low pH in the western part of the region used for cropping	▮ ↙ ▮ ▮				◖	◖
37 Carnarvon and Top End Coastal Plains	Declining pH in agricultural areas used for intensive irrigation and horticulture	▮ ▮ ↙ ▮				◖	◖
38 Daly Basin	Declining pH in areas used for horticulture and more intensive pastoral development	▮ ▮ ↙ ▮				◖	◖

Recent trends	↗ Improving	— Stable	Confidence	● Adequate high-quality evidence and high level of consensus
	↙ Deteriorating	? Unclear		◖ Limited evidence or limited consensus
				○ Evidence and consensus too low to make an assessment

Grades		
	Very good	Current management adequate—low level of monitoring required
	Good	Needs management and monitoring, otherwise returns will be threatened
	Poor	Urgent amelioration. Yield and returns are compromised, returns currently threatened
	Very poor	Beyond recovery (economic). Yields no longer economic. Current system unviable with limited options

Soil acidification grade
- Very poor
- Poor
- Good
- Very good

0   300   600   900 km

Organisational roles and responsibilities

1. Will FAO host the global and regional technical teams needed to make Pillar Four viable
   - Central co-located team of ~5 to 10 FTEs
   - About 8 regional teams of ~5 to 10 FTEs either co-located or in lead national institutes
2. If FAO does not take on this role, how do we:
   - Agree on lead and regional institutions agencies to take the technical leadership role?
   - Ensure these agencies have a sufficiently strong mandate?
   - Establish a viable business model for these agencies?
3. A charter of responsibilities and service is needed for the lead agencies
   - Principles of data sharing and custodianship
   - Support for training and capacity building
   - Technical infrastructure and support

Proposed process to help establish Pillar 4 of the GSP

1. Prepare practical strategies and roadmaps for Pillars 4 and 5
   - Convene a small working group for each Pillar
   - Prepare a draft document (maximum of 50 pages) for discussion by November
   - Aim to achieve an agreed strategy and roadmap by April 2013
2. Gain consensus on organisational roles and responsibilities
   - Depends on guidance from FAO
   - Interim measure maybe to ask the Consortium of Leading Soil Institutions to clarify options
3. Develop a sustainable business model with adequate funding

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Thank you

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