Citizen Science to support Digital Soil Mapping

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Can citizen science assist digital soil mapping?

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Citizen Science

• “the participation of non-scientists in scientific research”

• the citizen acts as an observer or experimentalist, within structures established by a citizen science project run by professional scientists

• purposes:

  1. to enlist non-scientists to amplify scientific research

  2. to build citizen support for, and understanding of, science
Why the increasing interest in and success of citizen science?

- **Technology**: GPS-enabled mobile phones with data capture apps; web database backends

- **Mentality**: *empowerment* of citizens to participate as non-specialists in activities that once were restricted to specialists
  - encyclopedia entries (e.g., Wikipedia)
  - reviews of media (books, music), products, businesses (hotels, restaurants)
  - expressing opinions via blogs
  - “crowd sourcing”; “the wisdom of crowds”
Use of citizen science by professional scientists

- **Massive databases** (e.g., eBird) with much larger spatio-temporal coverage/density
  - improved models, e.g., habitat suitability
- **Monitoring** (time-series)
  - early-warning
Can citizen science be applied to soil science?

- **Popular knowledge** of the soil resource is much less than for other natural resources.
- Soil is not “fashionable”, there are no soil hobbyists (contrast with birders).
- Only the **surface soil** is easily visible to the non-specialist.
- **Training** is generally needed to make consistent observations.
- Difficult to have repeat or similar observations for **quality control** (but can compare with existing maps...).
Why involve citizens in (digital) soil mapping? — 1

• For the **professional soil mappers**:  
  • increasing the **density** and **geographic spread** of observations to **improve mapping accuracy**  
  • More (reliable) **observations** should result in better **predictive models**  
  • Correcting **mistakes** on published maps  
  • Disaggregating/**downscaling** published maps
Why involve citizens in (digital) soil mapping?

- For society:
  - building a wider **citizen appreciation** of soil geography
  - More people with field experience of soils, their diversity, their (im)proper use
  - improve “**connectivity**” between soil and citizen
Who could be citizen scientists for DSM?

1. consulting and research soil scientists
2. farmers / land managers
3. civil engineers and others involved in construction
4. gardeners
5. participants in outdoor activities
6. “greens”
7. “organizers”
What information can be provided to DSM by citizen scientists?

1. tacit ("expert") knowledge
2. opportunistic newly-acquired information
3. protocol-guided newly-acquired information
4. information accumulated in precision agriculture practice
5. physical samples submitted for analysis
Opportunistic newly-acquired information

• “See something, say something”

• Just need to motivate people to report what they see, wherever they are (with georeference)

  • maybe just a photo of the soil surface and landscape, we can see stones, colour, structure, erosion features, land use...

• No protocol, interpretation and quality control by organizers
Bog iron, Helmerhoek, Enschede (NL)
pZg23/III: ‘beekerdergronden’, loamy fine sand, groundwater <40 cm winter, 80-120 cm summer

CHc23/V: ‘laarpodzolgronden’, (fine lines of iron-rich sands in spodic horizon) loamy fine sand, groundwater <40 cm winter, > 120 cm summer

neither soil type is expected to have bog iron

Soil map 1:50k, 34 Oost (Enschede) (NL)
Idea for areas with published maps: “improve your soil survey”

• Citizens access the on-line map and display it for their location (determined by GPS) on smartphone or tablet.

• Citizens check soil description with whatever they can observe (often only surface, e.g., coarse fragments, texture) or easily measure.

• Citizens enter any discrepancies with published map, confirm others.

• Professional surveyors review the reports, collate, decide if and how to update the maps.
A published soil series map (on line)
Mapped soil series in a “natural” cemetery

SoilWeb as KML file displayed on Google Earth

http://casoilresource.lawr.ucdavis.edu/drupal/
Observation:
Depth to bedrock much shallower than mapped
Consistent through the area
Change soil series on map
Protocol-guided newly-acquired information

- Much more difficult than opportunistic observations
  - to organize, to establish protocols, to recruit observers
- But much of the quality control is now done by the observer; more consistent and higher-quality information
- Requires a protocol, simple enough for the non-specialist
  - safe (e.g., no harsh chemicals, no dangerous tools, no problems with access); reproducible
- May require training for consistency
- What is the motivation for the observers?
**Physical samples** submitted for analysis

- Must be *protocol-guided*

- Must have *consistent field methods*
  - site location, site preparation, sampling, sample handling...

- Farmers / consultants have experience with *soil fertility samples*
  - these are usually keyed to a field; just need to give the field *location* (GPS) and *sample support* size (composite samples)
Information accumulated in precision agriculture

- **On-the-go soil sensors**; yield monitors (both linked to GPS)
- Data collected digitally, downloaded for farm management
- Lots of research on how to clean, quality control
- But *proprietary* — trade secret!
Conclusions

1. The citizens form a crowd which can greatly **increase** the spatio-temporal density of observations to support DSM.

2. Soil is less glamorous than animals or plants or weather, but there is a community of people who appreciate its value.

3. The “environmental” and “sustainability” movements could increase this number.

4. **The citizen — scientist relation** is heavily dependent on **culture** (national, scientific, civil society, …)
Thank you for your attention!