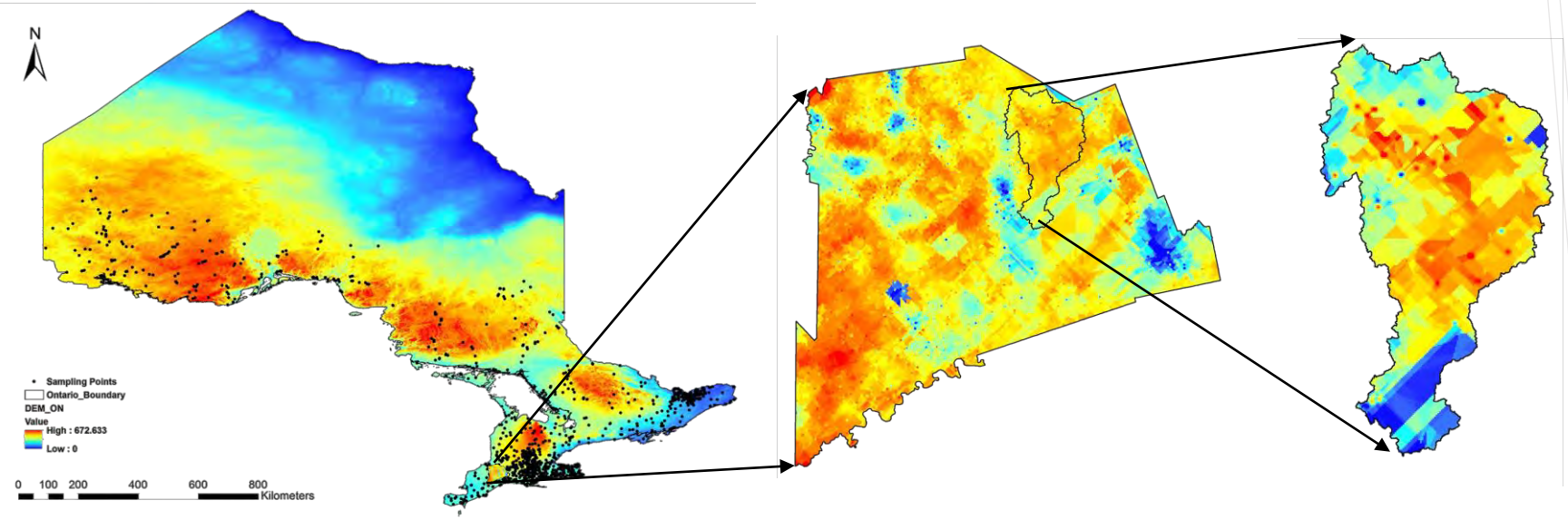

Research opportunities: Scaling up soil health information

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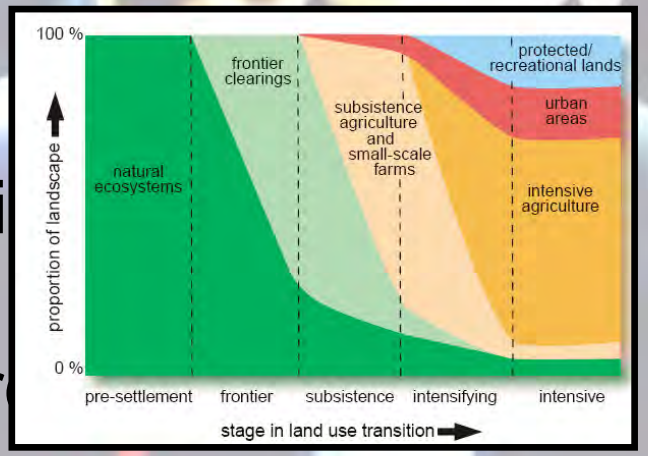
Challenges

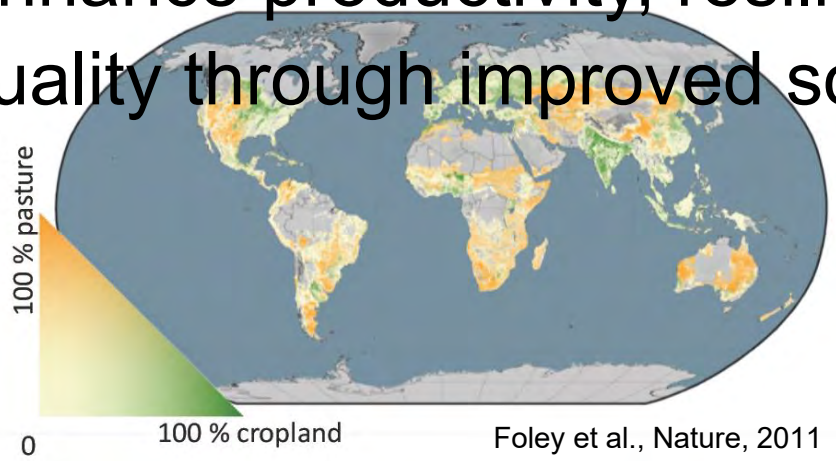
- **Change in -**
  - Population
  - Environment
  - Weather and Climate
  - Biodiversity
  - Land use and Land management



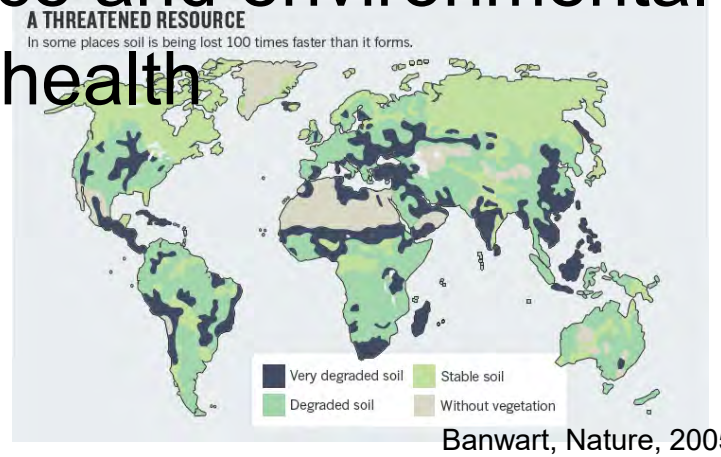
- Ecosystem and h

Opportunities

- We can not control things beyond our reach (weather events, changing climate).
- What ever lost is lost and will not get back.
- We should not let it go what we have.
- We can manage our soil resources better.
- Manage wisely and efficiently, more sustainably.
- Enhance productivity, resilience and environmental quality through improved soil health



Foley et al., Nature, 2011



Banwart, Nature, 2005

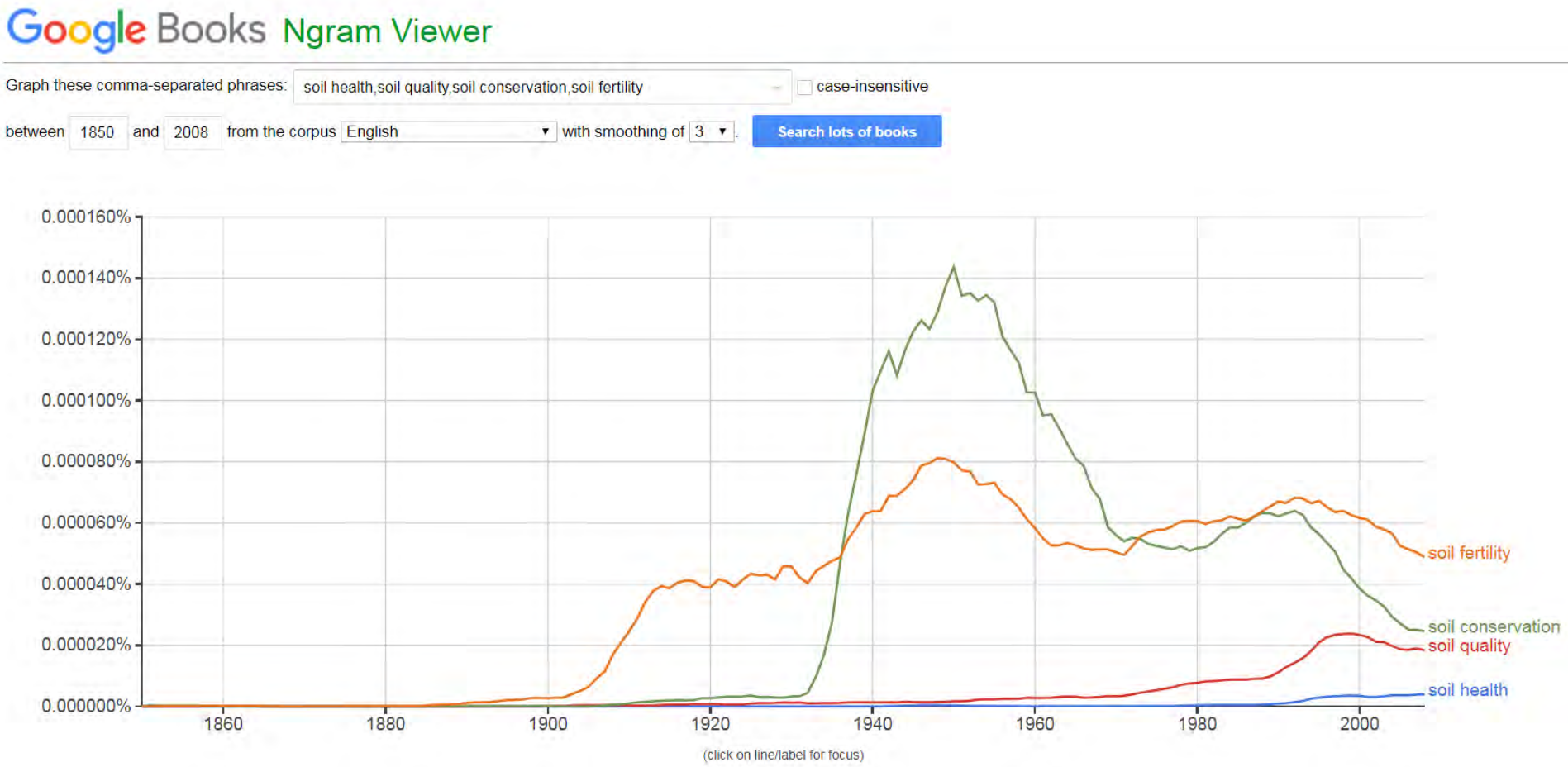
Soil health

- The continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals, and humans
  - Nutrient cycling
  - Water (infiltration & availability)
  - Filtering and Buffering
  - Physical Stability and Support
  - Habitat for Biodiversity

Soil health

- It is a state of a soil meeting its range of ecosystem functions as appropriate to its environment.
  USDA NRCS (2013)
- Soil Health and Soil Quality are often used interchangeably
  - Health refers to the internal state of an entity
  - Quality refers that entities "fitness for purpose"
- The term health implies a capacity to sustain function… not merely a particular function, but the full range of functions.

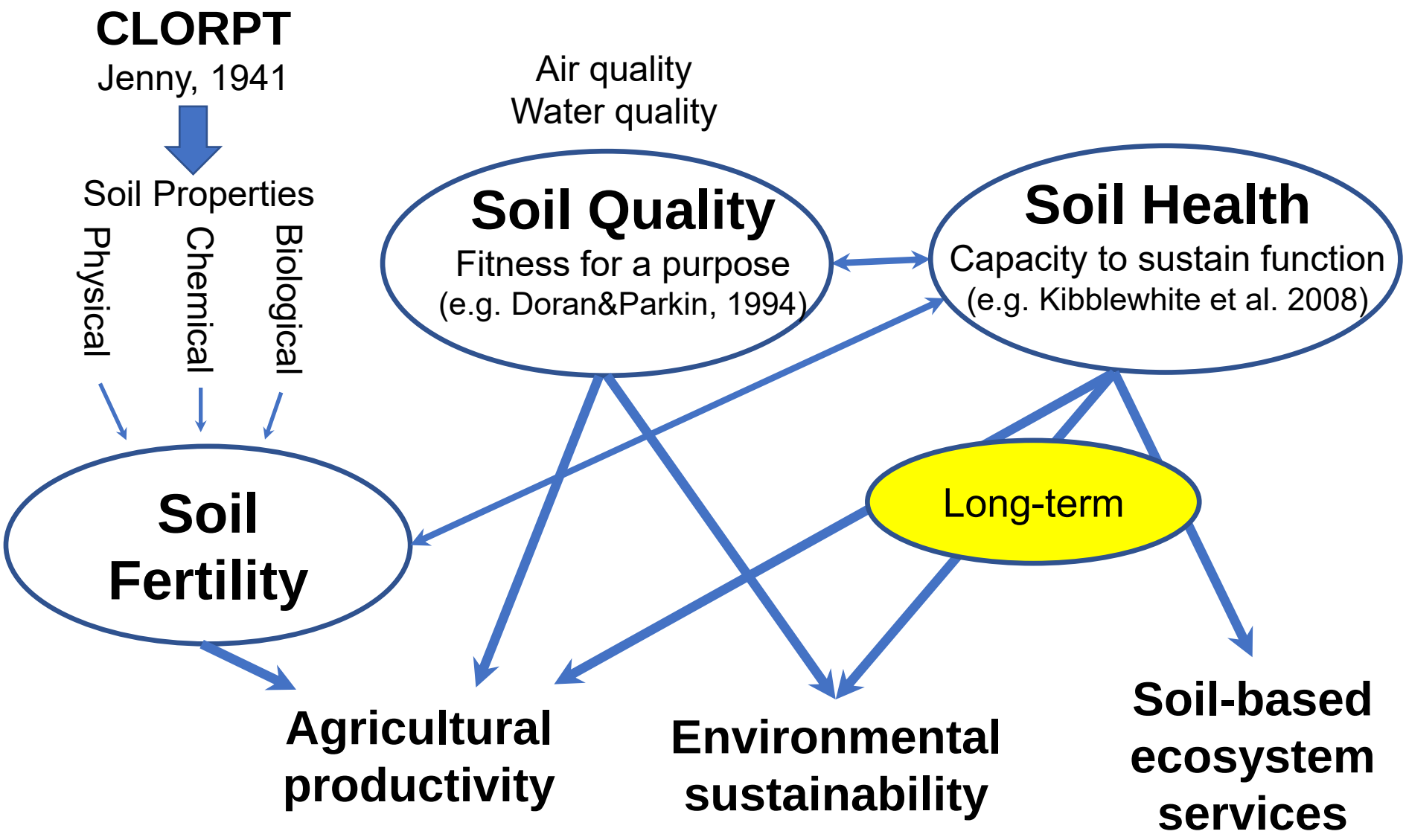
What in a word?



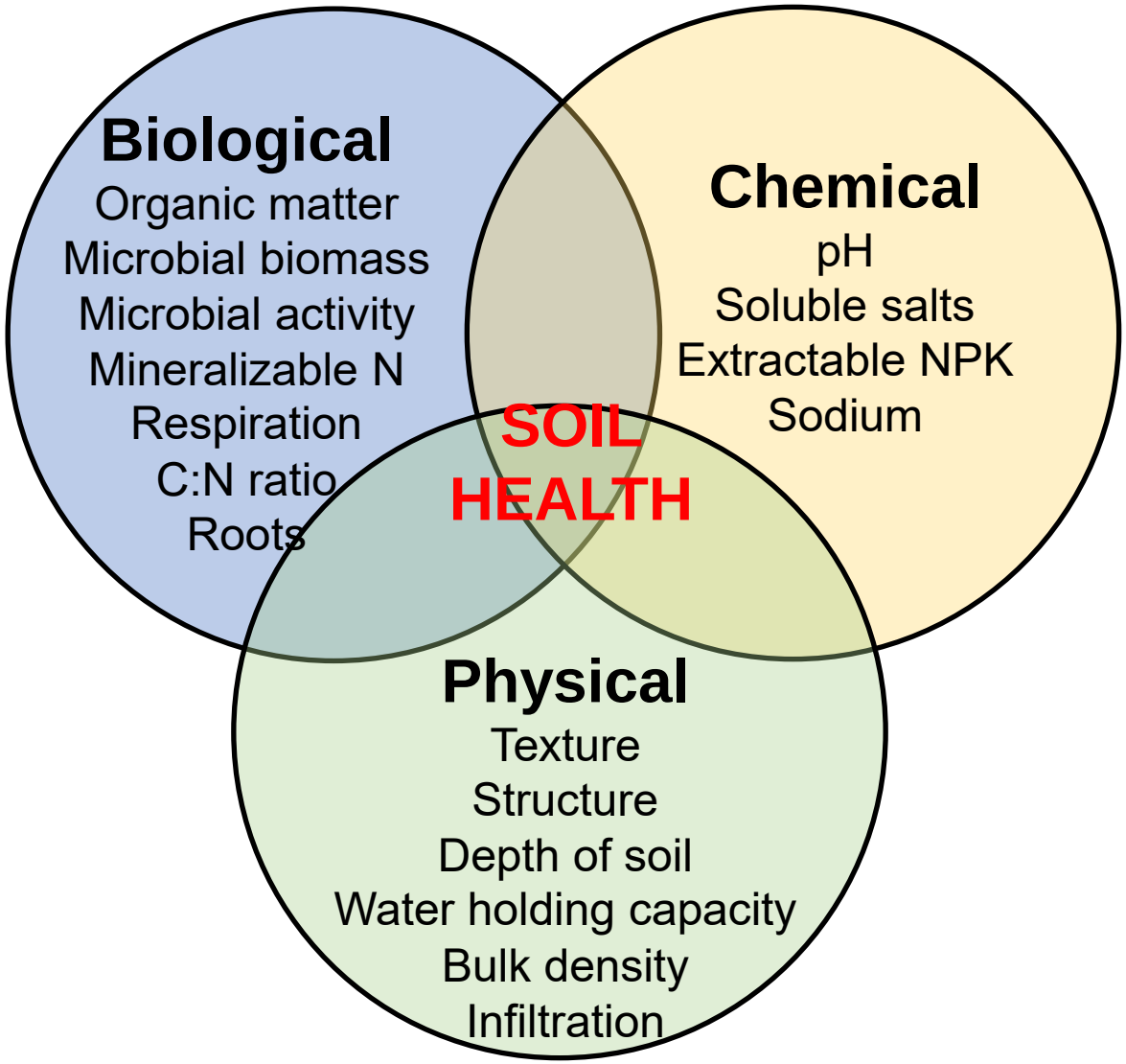
What in a word?

- We use the terms that resonate with issues of the day
  - **Fertility** addressed the desire to enhance crop productivity
  - **Conservation** spoke to our desire to halt soil erosion
  - **Quality** was about our desire to understand the total function of the soil for its intended purpose (most often crop production)
  - **Health** speaks to a broader concern about the physical, chemical and biological aspects of soil function
- Each of these concepts represents an increasingly complex and more complete understanding of soil function

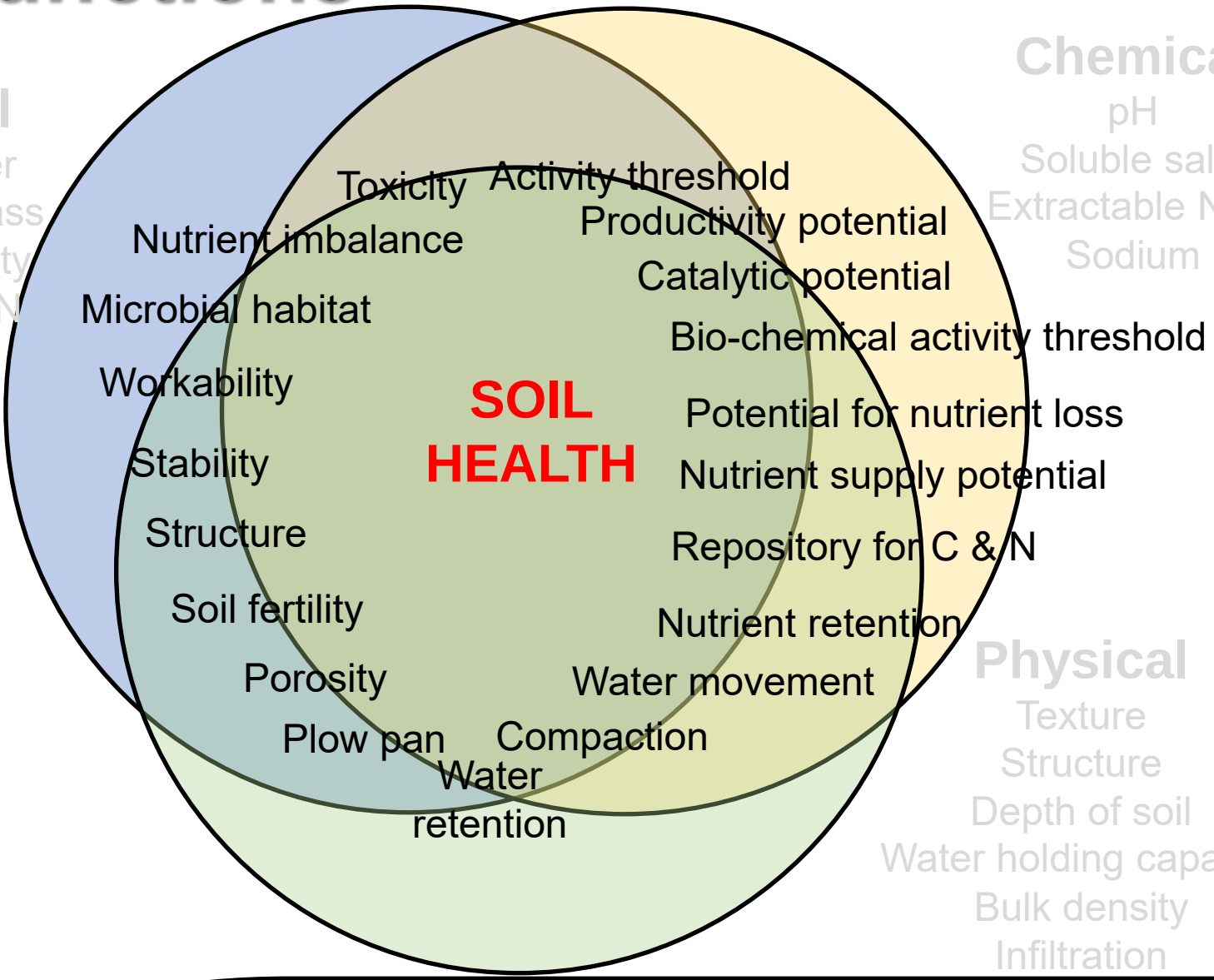
Soil Fertility-Quality-Health



Soil Quality Indicators



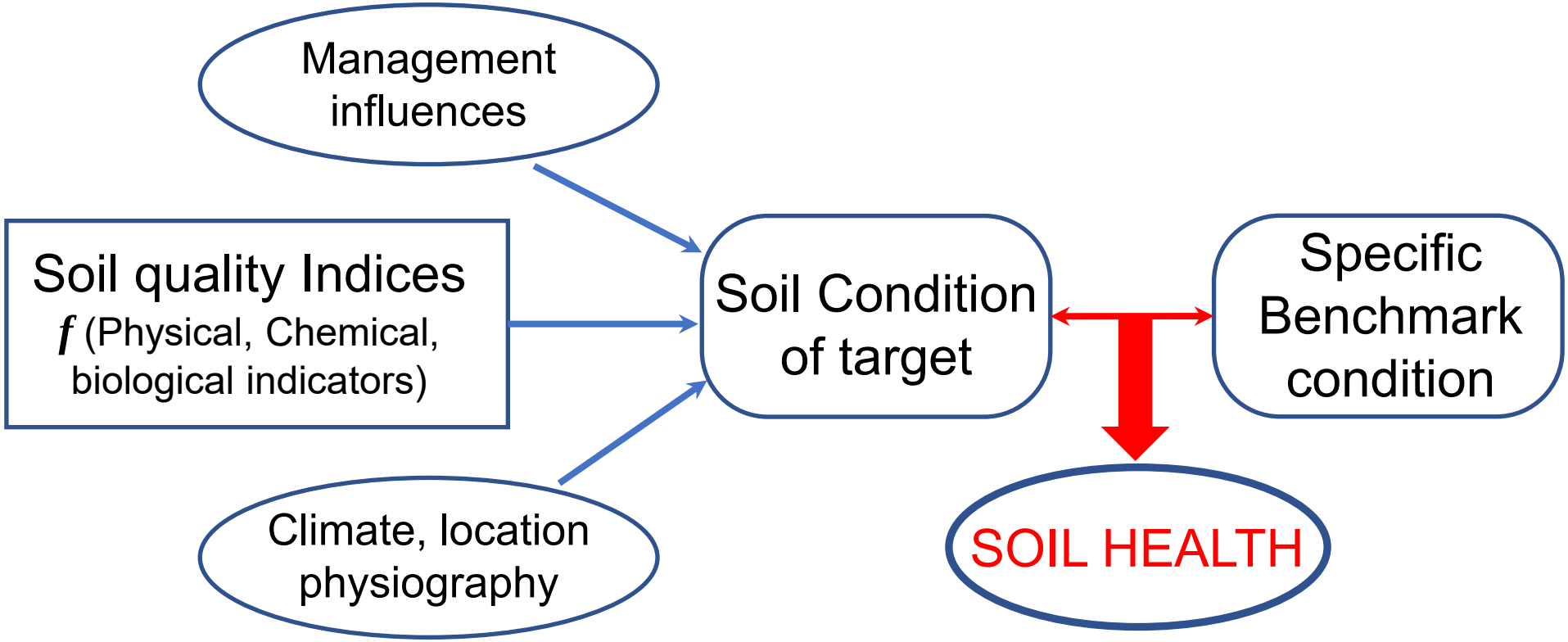
Soil functions



Soil Quality Indices

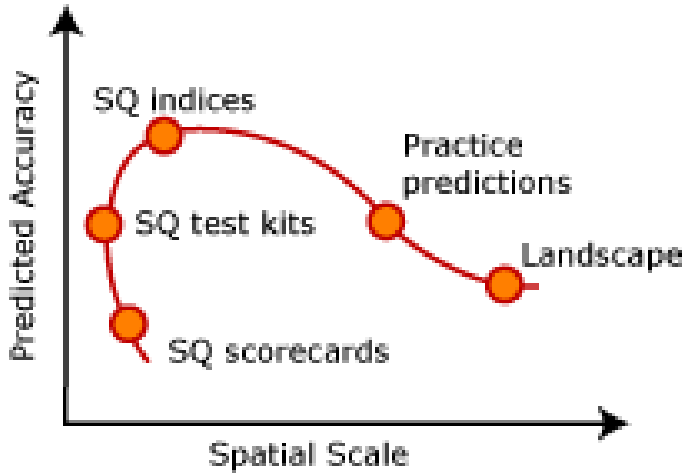
- Choosing the right set of indicators (management goals)
- Measuring soil health indicators (physical, chemical and biological)
- Providing scores to them
- Standardizing the scores
- Assigning relative weights (policy relevance, societal value, quantity or quality of data)
- Determining soil quality indices

Soil Health Assessment



Soil Health Assessment

- Soil quality assessment tools
  - Qualitative score cards
  - Field test kits
  - Laboratory based assessment
  - Practice predictions
  - Landscape level measurement

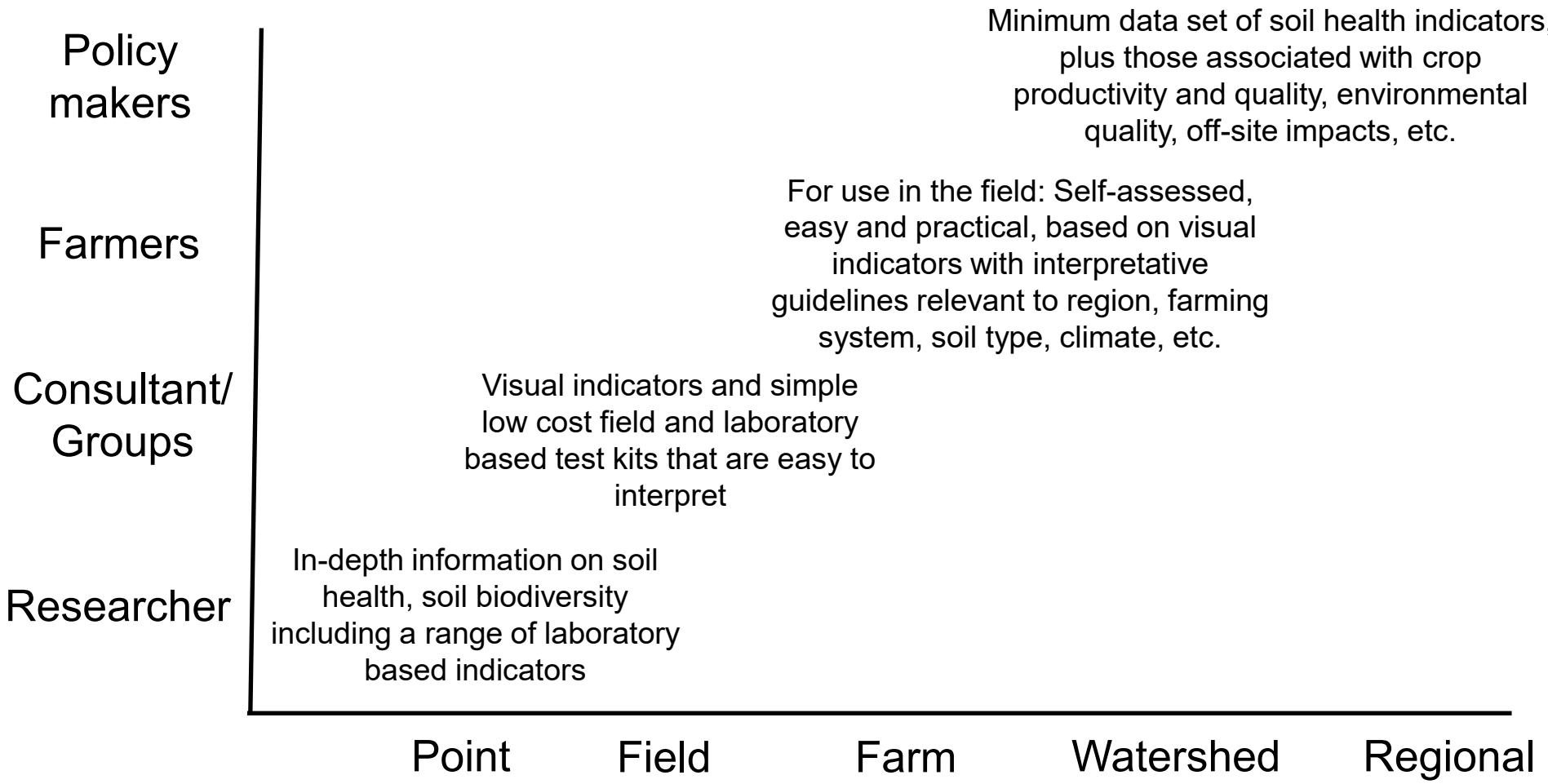


http://soilquality.org/tools.html

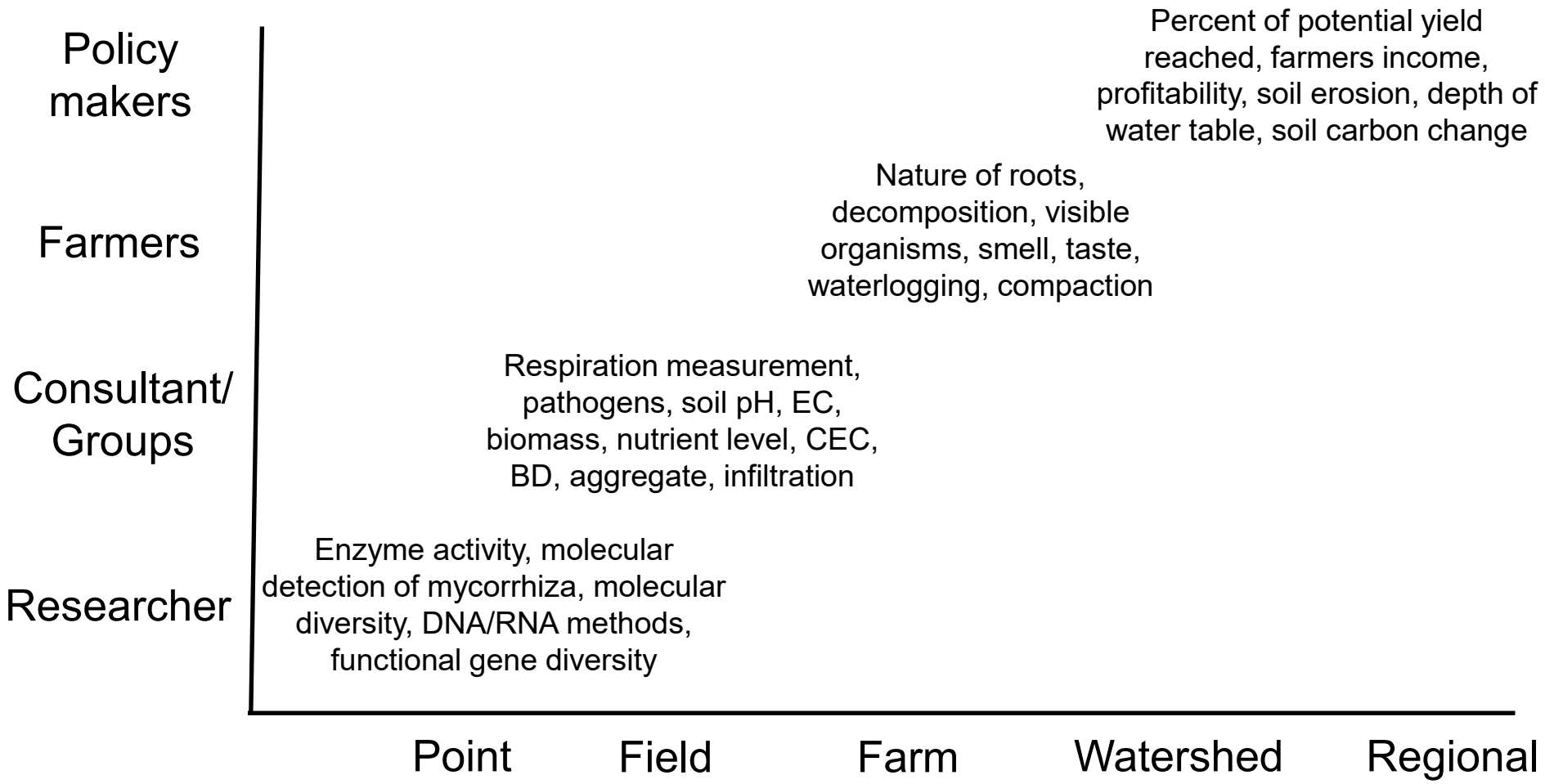
Uncertainty in Assessment

- Temporal scale of measurement (dynamic nature)
- Soil spatial variability
- Data quality, sample size, design
- Scoring and model (algorithm) limitation, assumptions

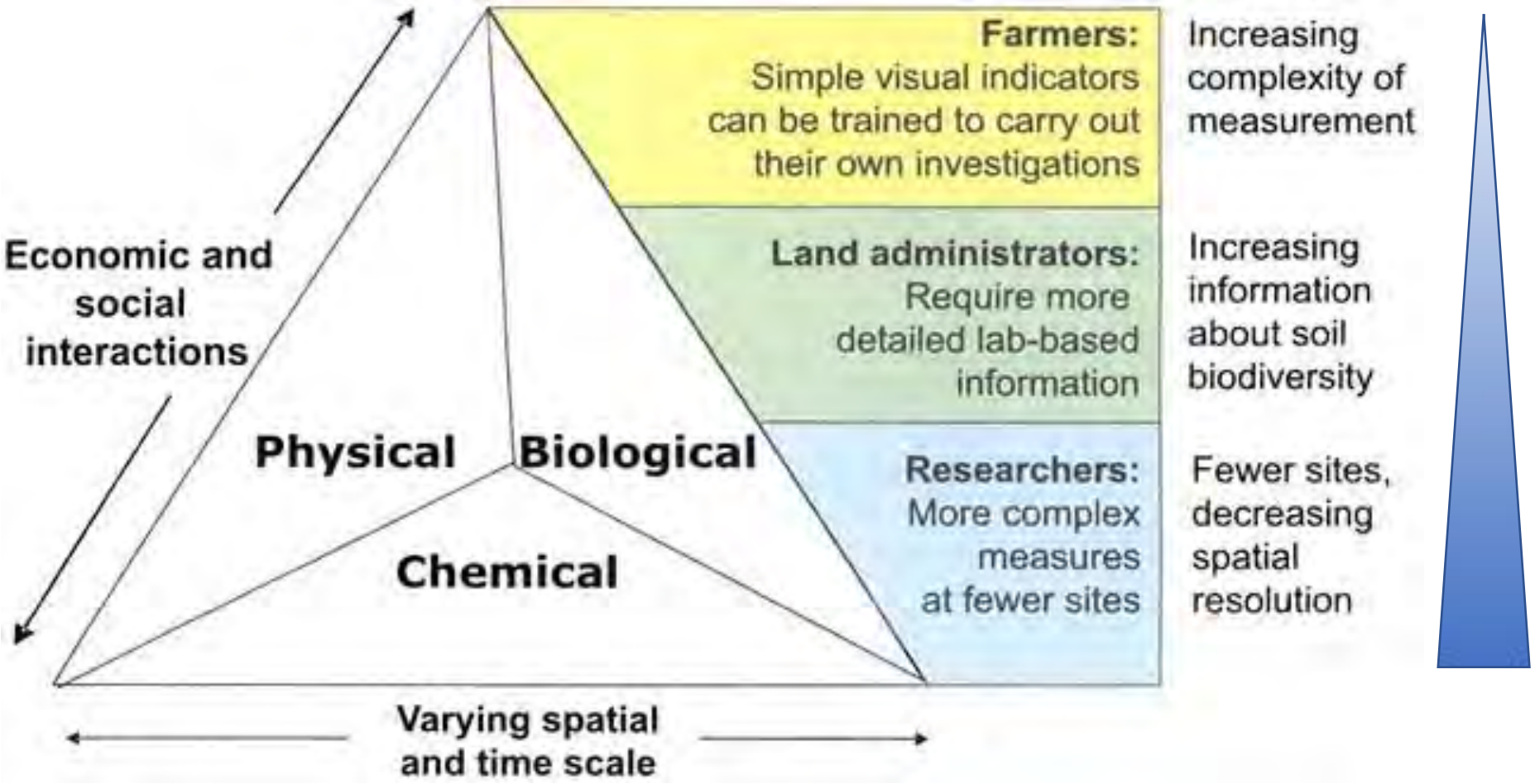
Scales in Assessment



Scales in Assessment

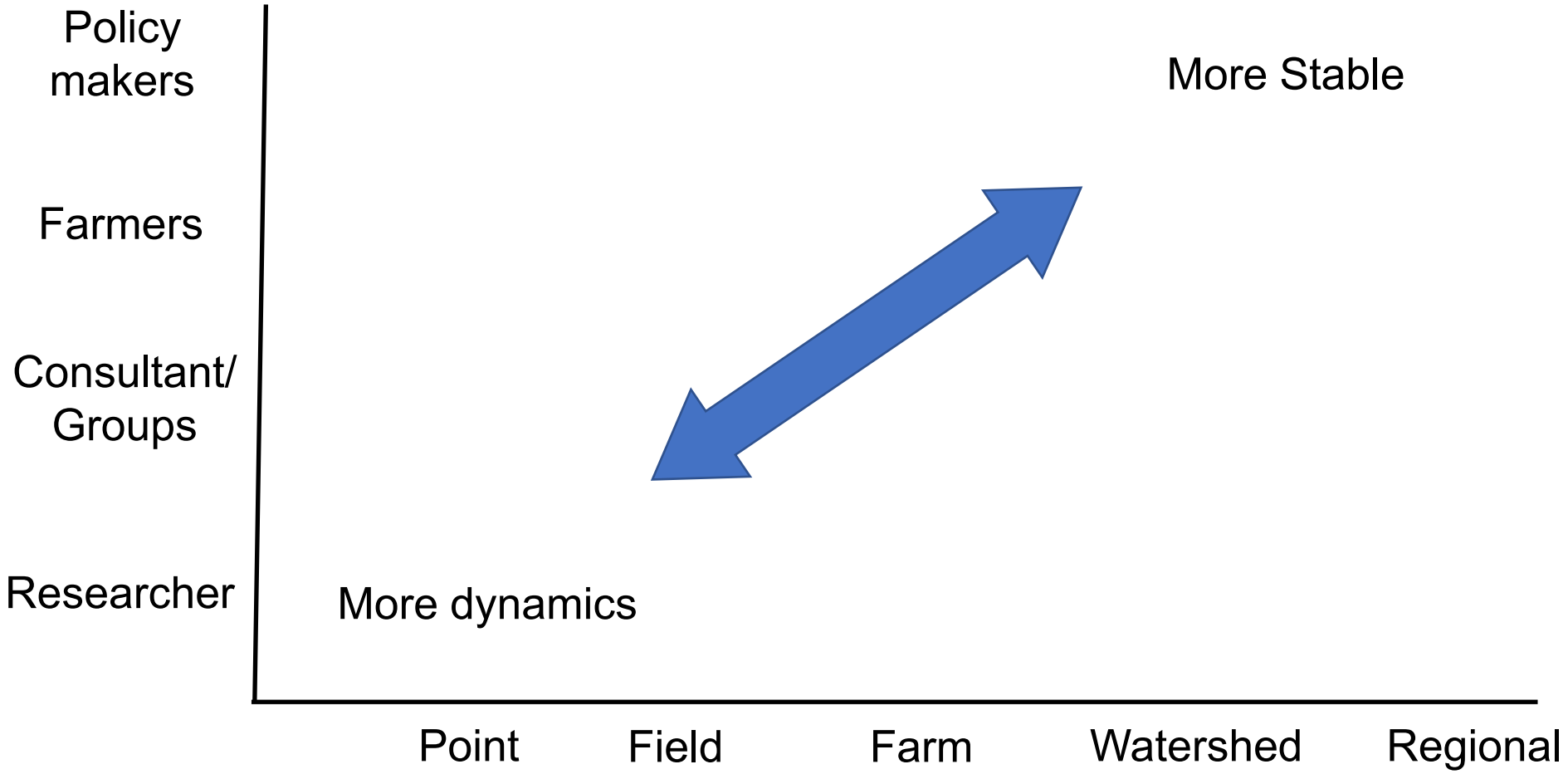


Scales in Assessment



http://www.fao.org

Scales in Assessment



Scaling up Opportunities

- Stable soil properties and processes important for assessing soil health at large scale
- Relationships validated at field scale with environmental and management data
- Commercial soil test data- not geolocated (also confidentiality and data sharing issue) but mostly attached to postal codes, county- temporal evolution
- Historical soil maps, survey reports
- High resolution environmental covariates/information including physiography, climate, satellite data
- Large-scale soil health indices
- Predicting future conditions

Field scale relationships

- On going studies on soil quality assessment mainly based on stable indicators
- Develop pedotransfer functions to predict difficult-to-measure properties from easy-to-measure properties
- Develop relationship with other management, physiography, climate (studies from different regions, possibility of working with Quebec)
- Assign scores, develop indices and compare with benchmark sites to assess the health status
- Alternative- assign scores based on literature or information from similar soil and climatic area and compare

Large scale data

- Commercial lab soil test data, spatialization
- Use pedotransfer functions to predict unavailable data from the available ones (e.g. soil texture, organic matter)
- High resolution satellite, climate and physiographic data
- Old soil maps and reports (SLC)- disaggregation of polygon based products
- Harmonization of information

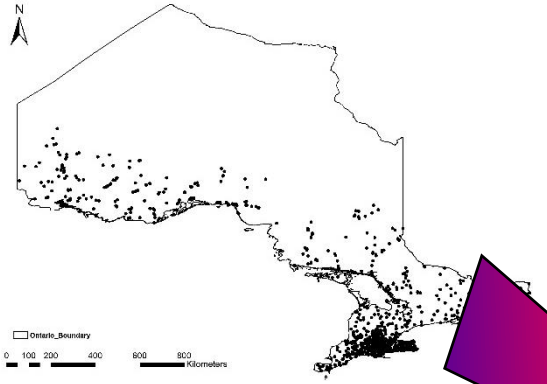
Spatial mapping of soil health

- Develop predictive (statistical) relationship between available (measured and predicted) soil data and environmental covariates for continuous mapping
- Develop predictive relationship between soil health (or quality indices) and environmental covariates
- Digital mapping soil properties, soil quality indices and soil health
- Quantify temporal evolution based on historical data
- Use the relationship to estimate future soil health (based on the climate and management scenario)

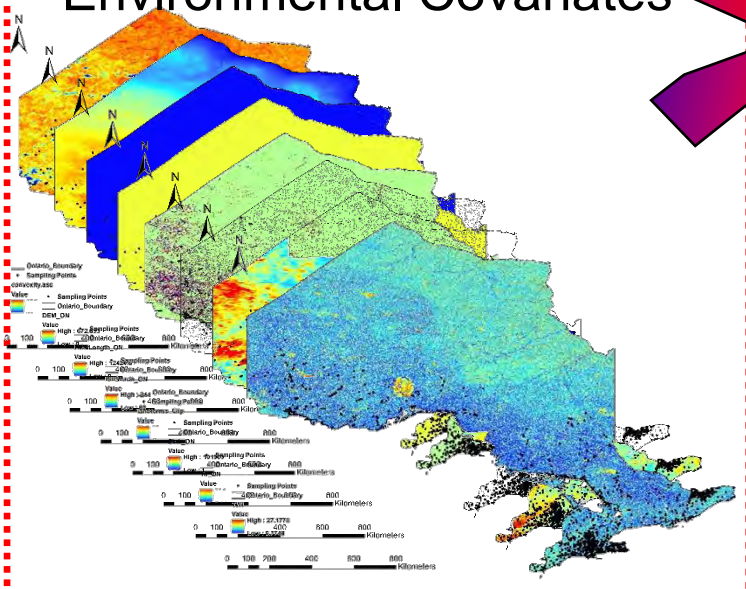
Spatial mapping of soil health

Input data

Soil observations

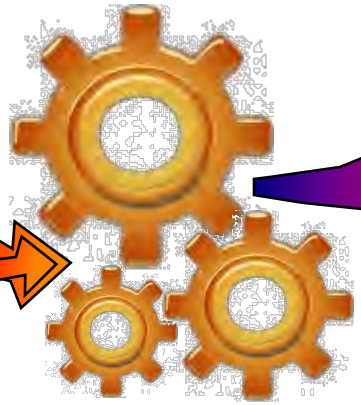


Environmental Covariates



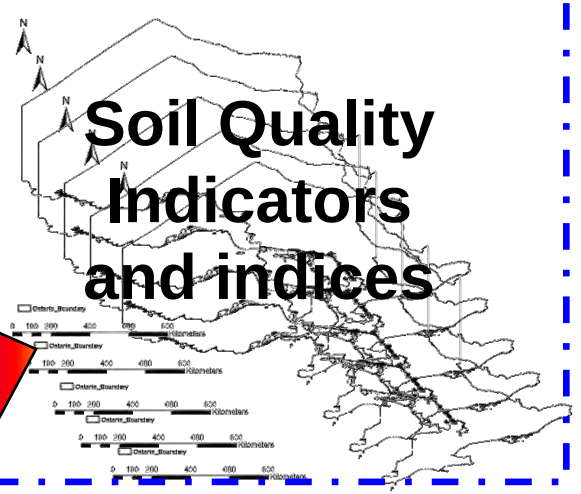
Modelling

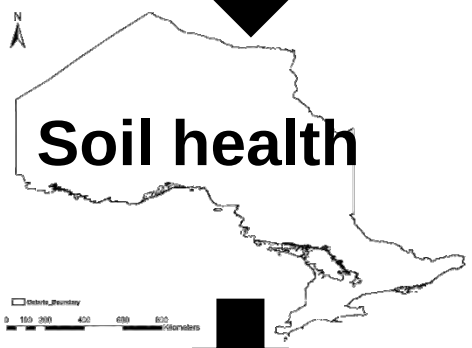
Predictive equations or classification rules



Mathematical or Statistical models

Output maps





Decisions, Risk assessment

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Thank You

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