Sparse sampling approach for soil mapping at regional scale using ASTER and VNIR spectroscopy

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Introduction

- *Sparse* sampling method for soil mapping on *regional* scale to reduce costs on soil mapping
- Latin Hypercube Sampling (LHS)
  - The use of ASTER data as a variability measure (spatial and spectral)
  - Do the sampled locations represent the actual spatial variability in soil properties?
- Substitute laboratory spectra by field spectra to further reduce data acquisition costs
  - Influence vegetation

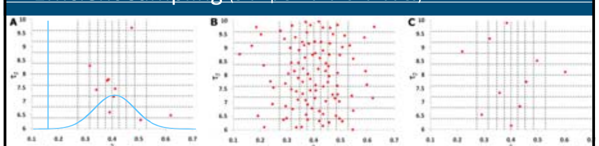
Minasny, B. and A. B. McBratney, 2006. A conditioned Latin hypercube method for sampling in the presence of ancillary information. Computers & geosciences **32**(9): 1378-1388.

Background

- Study area
  - Location: North Morocco
  - Area: 15000 km^2
  - Regional scale
- Fieldwork
  - Duration 3 weeks
  - Max. 100 sites due to limited time & budget
- Main goal: Sampling variability in soil properties to characterize the relationship with spectral variability

METHODS

Efficient sampling (example with two variables)



Random | full factorial | LHS

LHS for site selection Morocco

Hoare, A., Regan, D.G., Wilson, D.P., 2008. Sampling and sensitivity analyses tools (SaSAT) for computational modelling. Theoretical Biology and Medical Modelling 2008 **5**(4) doi:10.1186/1742-4682-5-4

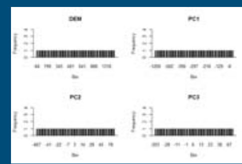
Methods

- Latin Hypercube Sampling (LHS)
  - Input LHS: PC1, PC2, PC3 from ASTER and DEM
  - Constrained by distance to road and steepness
  - 100 sites were optimised to optimally sample the Latin Hypercube
- Substitution of laboratory VNIR spectroscopy by VNIR field spectroscopy
  - Spectral Angle Mapper for calculation of spectral similarity
    - Feature based analysis
  - Influence of vegetation
    - Normalized Difference Vegetation Index (NDVI)

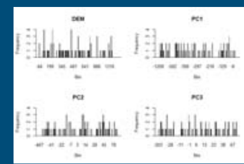

RESULTS

Realisation Latin Hypercube

Optimized Latin Hypercube



Realized Latin Hypercube



Coverage of soil and terrain properties

Soil and terrain property	Comparison data	Coverage
Soil type	Soil map 1: 50.000	Good
Soil texture	Soil texture triangle	Good
Mineralogy	Geological map 1: 1M	Good
Altitude	SRTM DEM	Moderate
OM	Soil legacy data	Good
pH	Soil legacy data	Good
CEC	Soil legacy data	Good
EC	Soil legacy data	Good

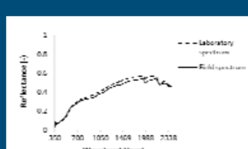
Relation between laboratory and field spectra

- Spectral similarity of spectra determined by calculation of the spectral angle
- A feature based analysis
  - Only the presence of absorption feature is taken into account
- Influence of vegetation on spectral similarity
  - NDVI

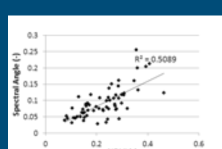


Substitution of lab spectra by field spectra

Spectral signature soil



Relation NDVI & spectral angle



Summarizing Statistics
Spectral Angle Mapper

	Average field spectra	Lowest NDVI spectra
Average angle	0.089	0.077
Minimum	0.012	0.020
Maximum	0.396	0.333
Standard deviation	0.063	0.053
Average NDVI	0.220	0.160
No. samples < 0.1^{rad}	21	13

Discussion points

- What does this mean for spatial prediction?
  - Pure nugget
  - Variogram ASTER data shows spatial correlation
  - Soil property prediction with regression kriging

Conclusion

- Constrained Latin Hypercube sampling can represent the spatial and spectral variability within ASTER and a DEM
- Large spectral similarity does exists between field and laboratory spectra and therefore field spectra from bare soils may substitute laboratory spectra
- Obviously, vegetation coverage degrades the relation between field and laboratory spectra

Thanks for your attention

Questions?

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