# Digital land resource mapping (DLRM) to address information and capacity shortages in developing countries

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# Land resource information required to underpin evidence-based land use planning

- Choice of alternative crops
- Necessity for alternative cropping systems e.g. agroforestry
- Choice of land management practices to overcoming limitations
- Identification of areas prone to degradation

## Chronic shortage of capability to survey land resources

- DLRM offers a new paradigm for providing information
  - More efficient use of experts

# Digital Land Resource Mapping (DLRM)

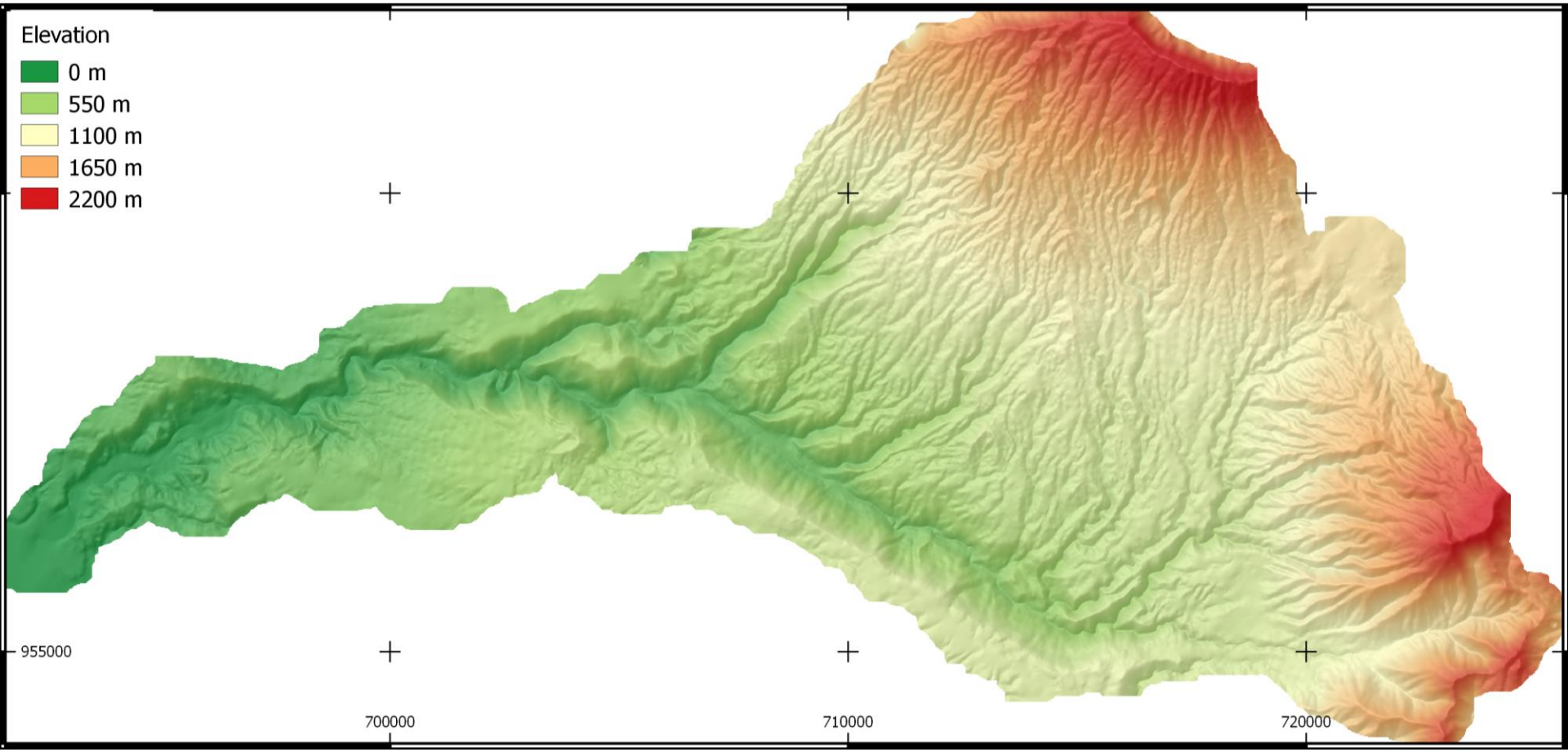
## including Digital Soil Mapping (DSM)

Based on 4 pillars:

1. Statistically-based sampling strategy

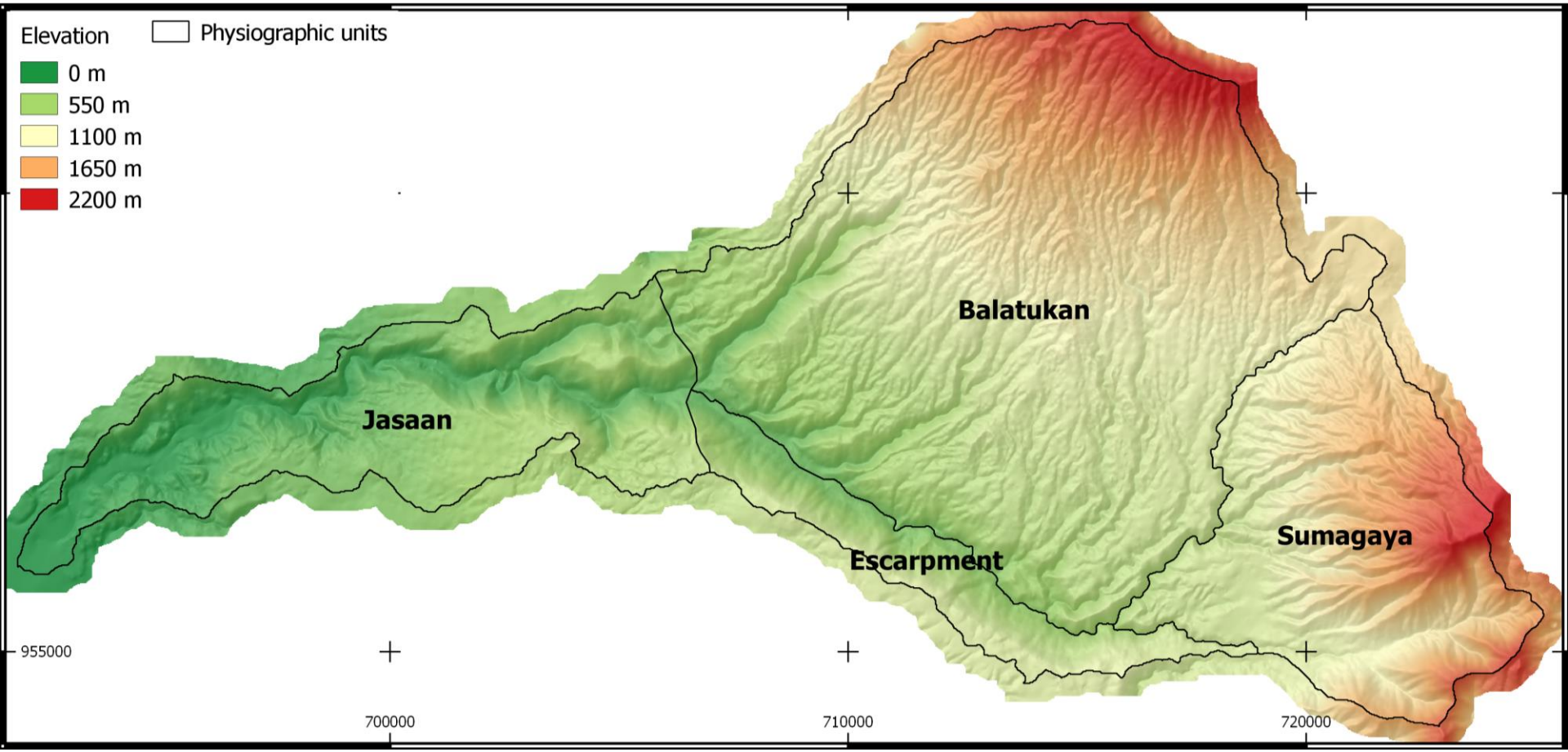
# Cabulig River Catchment, N Mindanao, Philippines

## 20 m digital elevation model – 220 km$^2$



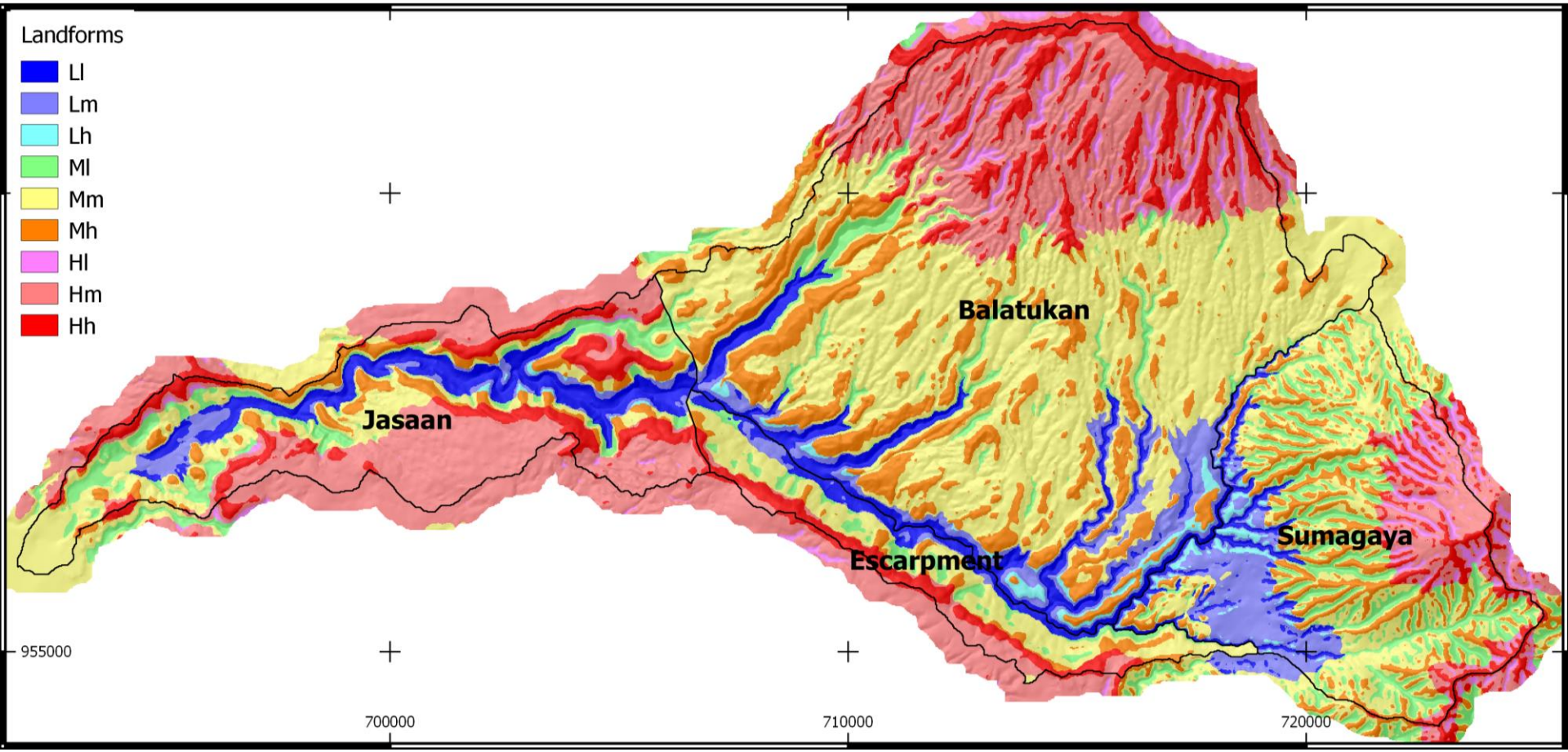
# Cabulig River Catchment, Northern Mindanao

## Stratification into physiographic regions



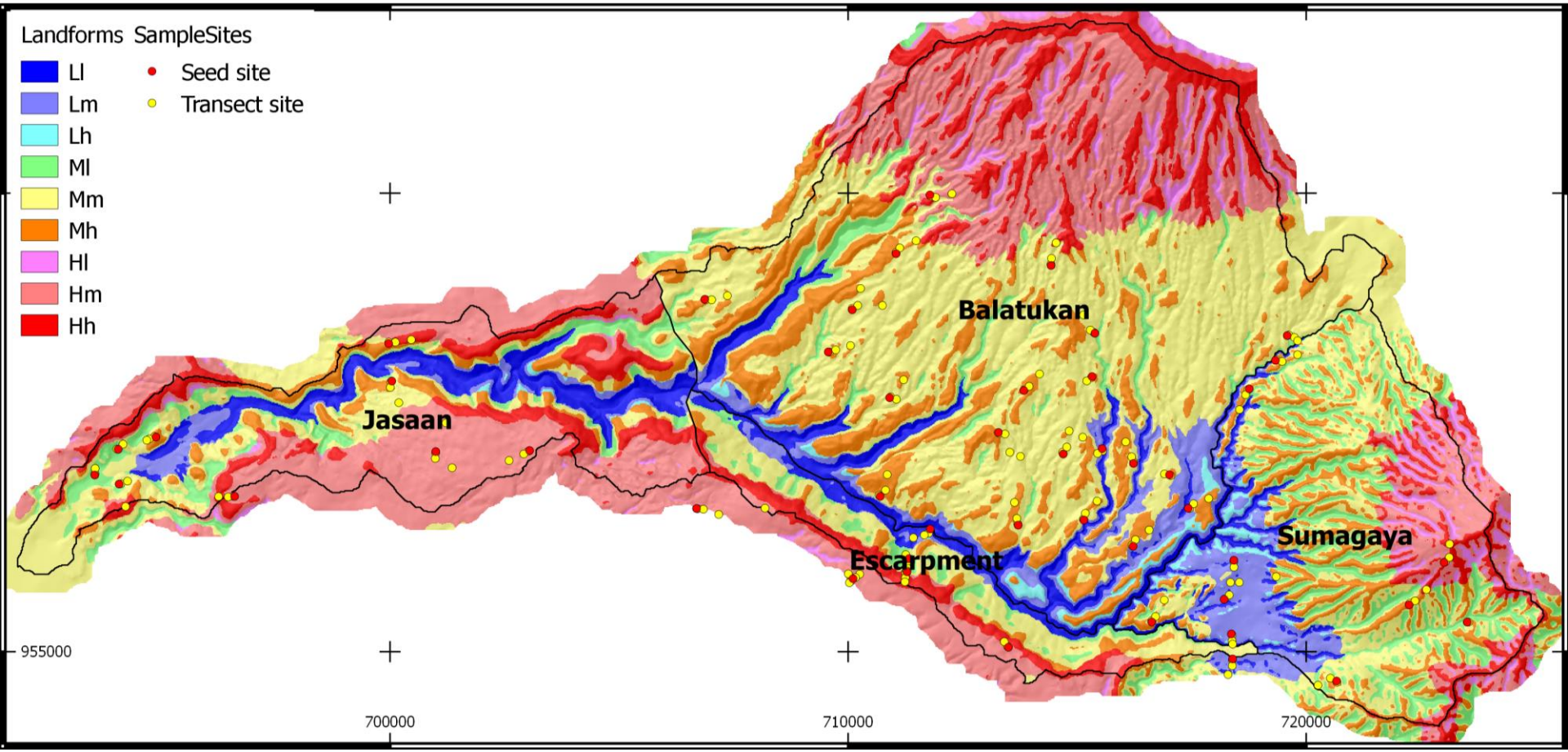
# Cabulig River Catchment, Northern Mindanao

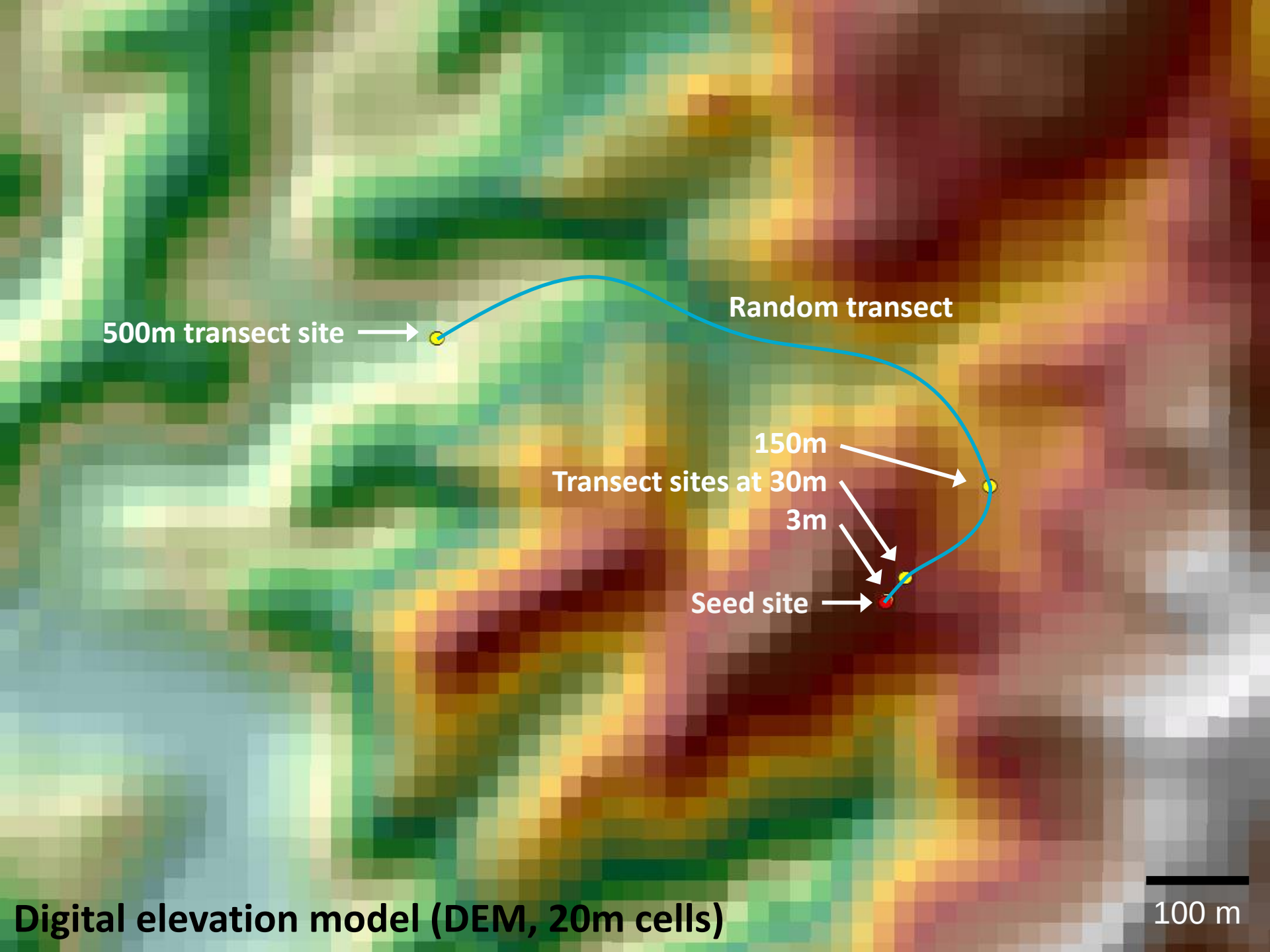
## Stratification into landform units using topographic position index



# Cabulig River Catchment, Northern Mindanao

## Stratified random selection of “seed” sites






Digital elevation model (DEM, 20m cells)

# 1. Statistically based sampling strategy

## Stratified random sampling

- Statistically valid
- Sites located by field teams using GPS
  - No need for pedologist to choose ‘representative’ sites in the field
- Landscape understanding improved by
  - Strata that are recognisable to pedologist
  - Transects along toposequences

# Digital Land Resource Mapping (DLRM)

## including Digital Soil Mapping (DSM)

Based on 4 pillars:

1. Statistically-based sampling strategy
2. Simplified site and soil profile methods

# 2. Site and soil profile methods

## DLRM – Simplified site and soil profile methods

- Emphasis on taking soil samples at every site
- Simplified description at each sample site
  - Can be done by non-expert
  - Chip trays and photographs allow checking by expert


# Digital Land Resource Mapping (DLRM)

## including Digital Soil Mapping (DSM)

Based on 4 pillars:

1. Statistically-based sampling strategy
2. Simplified site and soil profile methods
3. Rapid soil analysis

# 3. Soil analysis using MIR spectroscopy

## Some MIR calibration results from Cabulig catchment

| SOIL PROPERTY | $r^2$ | RPD* | |
|---|---|---|---|
| Organic carbon | 0.90 | 3.1 | Analytical |
| pH ($CaCl_2$) | 0.87 | 2.8 | Good |
| Clay content | 0.80 | 2.2 | Good |
| CEC | 0.78 | 2.1 | Good |
| Exchangeable K | 0.57 | 1.5 | Indicator |
| Olsen P | 0.38 | 1.3 | Poor |


* Residual Prediction Deviation

- Local calibration using conventional analyses of samples from seed sites
- Having soil measurements at all sites reduces reliance on inferring soil properties from 'soil type'
  - Less need for pedologist in field for soil classification

# Digital Land Resource Mapping (DLRM)

## including Digital Soil Mapping (DSM)

Based on 4 pillars:

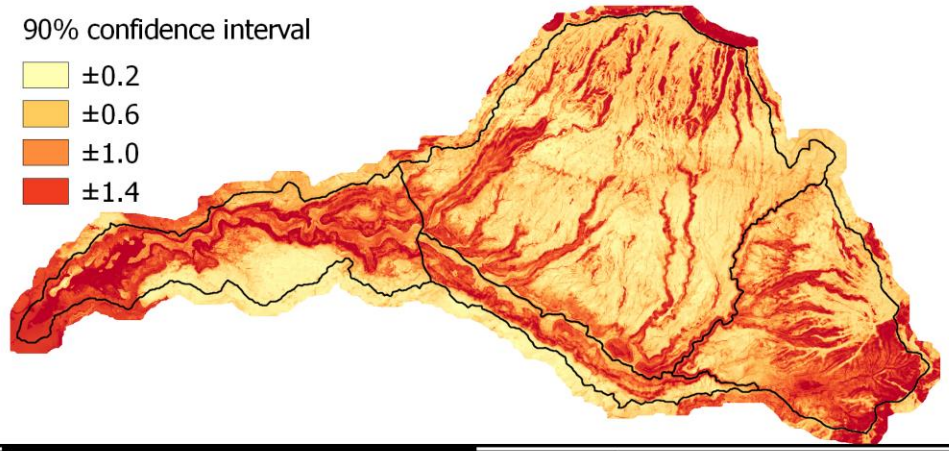
1. Statistically-based sampling strategy
2. Simplified site and soil profile methods
3. Rapid soil analysis
4. Mapping of soil and land properties using statistical models

# 4. Mapping of soil and land properties

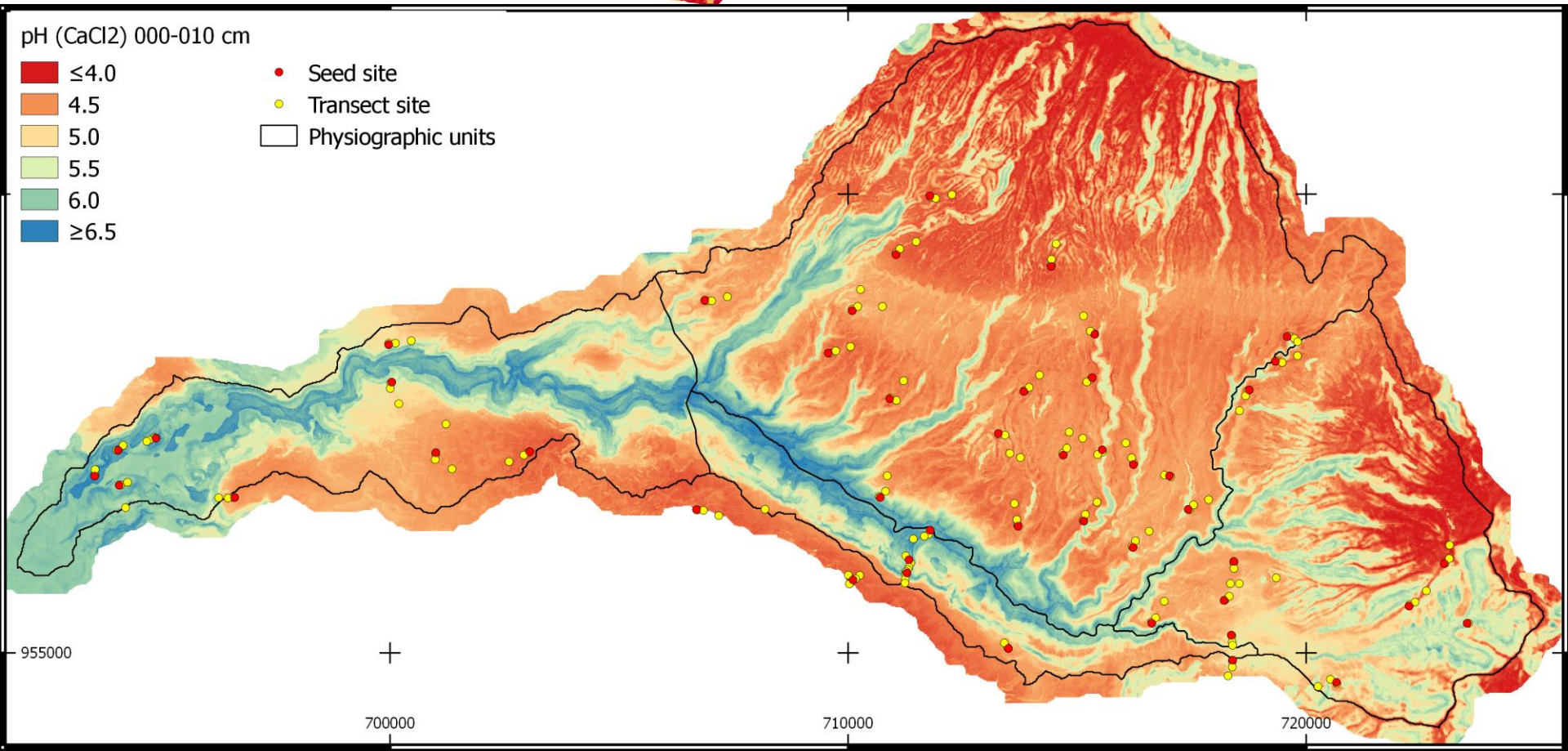
## Digital soil maps of each soil property

- Terrain attributes (from 20 m DEM) used as spatial covariates
- Uses Cubist
  - Random 20% transects removed for external validation
  - Bootstrapping with 50 iterations
  - Final estimate is mean of iterations
  - Uncertainty maps show 90% confidence interval of the iterations

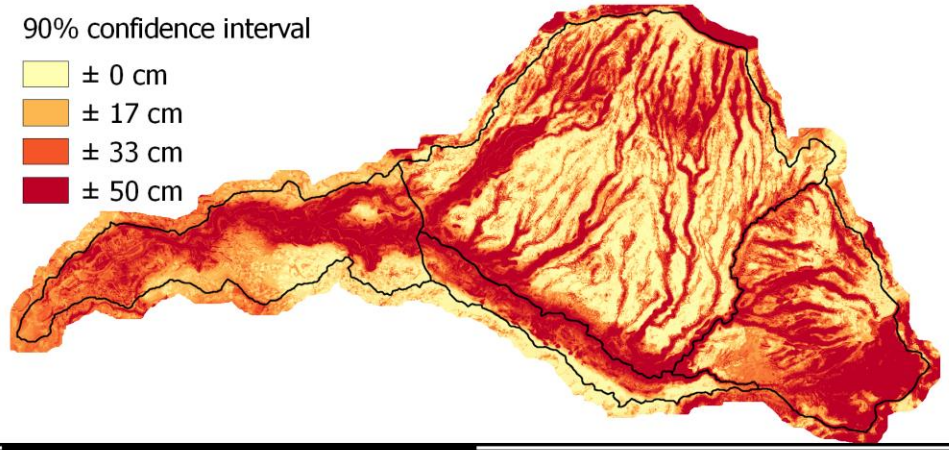
# Cabulig River catchment
# Northern Mindanao



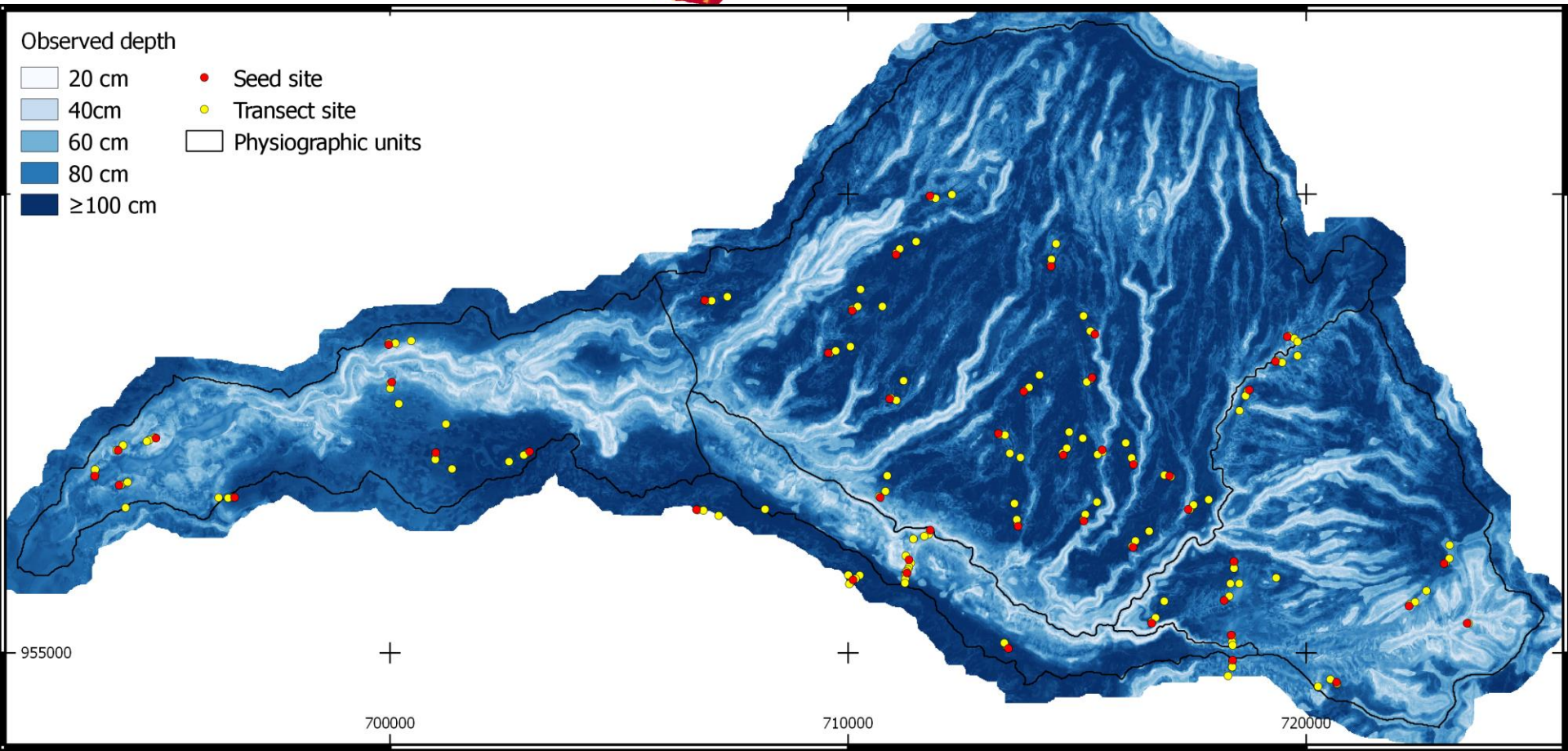

- pH ($CaCl_2$) 0-10 cm
  - External correlation 0.76
  - External concordance 0.86



# Cabulig River catchment
# Northern Mindanao




- Soil depth
  - External correlation 0.37
  - External concordance 0.59



# Survey organisation and local field teams

## A partnership to improve survey efficiency

### Survey organisation

- Reconnaissance survey
  - Develop landscape model
- Design statistically-based sampling
- Design simplified site description sheets
- Train local field teams

- MIR analysis of samples from **all** sites
  - Calibration using standard laboratory analysis of samples from a **small** subset of sites
- Produce maps of soil properties using spatial prediction

### Local field teams

- Provide local knowledge
  - Geography, land use, social/cultural expectations
- Liaise with local officials, land owners and other stakeholders

- Majority of field work
  - Locate sample sites using GPS
  - Simplified soil profile descriptions
  - Sample **all** layers at **all** sites
- Sample preparation

- On-going interpretation of outputs after completion to assist land use planning & agricultural extension

# Thank you

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