Spatial Analysis of Soil Related Environmental Risks in the Soyang Lake Watershed

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Bayceer

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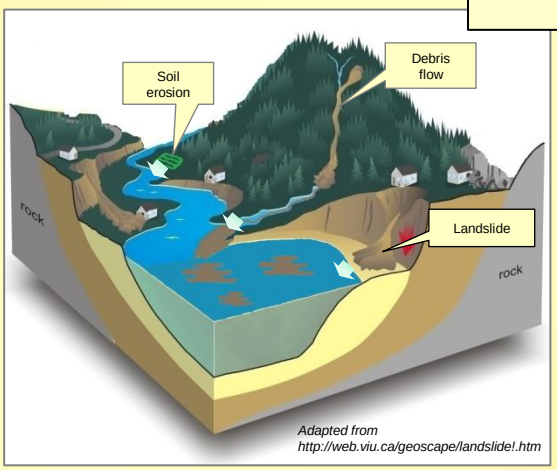
Introduction

Detailed spatial soil information allows us to assess the status of a particular landscape. Digital soil maps (DSM) will be developed to proceed towards a functional soil-landscape analysis in order to estimate environmental risks for ecosystem services of the mountain landscape in the Soyang Lake Watershed. This includes:

1) Development of an appropriate sampling design,
2) Analysis of the available digital terrain models (DTM),
3) Investigation of the impact of smoothing effects of the DTM derived terrain parameters on the DSM,
4) Development of DSM by supervised learning methods,
5) Development of pedotransfer functions to predict hydraulic soil properties (water retention, K_{sat}),
6) Assessing environmental risks related to soil.

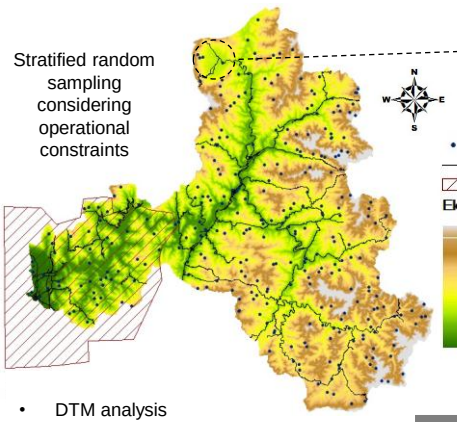


Mountain landscape influenced by slides and erosion

Methodology

Sampling design & DTM analysis

Stratified random sampling considering operational constraints



- DTM analysis
- Terrain smoothing effects on DSM
- Finding the appropriate scale for the analyses

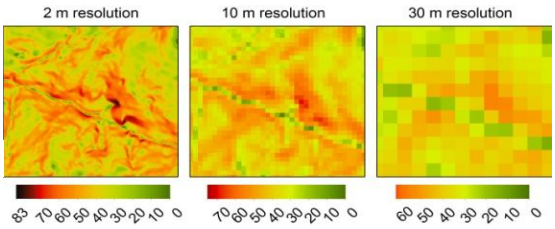
To obtain a representative dataset

Input data:
- Geological map
- Topographical map, DTM
- Satellite images
- Road and footpath network

Restrictions: accessibility & mine risk

Selection of about 400 sampling sites

Measured soil properties: soil depth, texture, cohesion, bulk density, water retention, K_{sat}



Smoothing effects of DTM resolution (e.g. slope [°])

DSM development

Soil = f(environmental variables)

Supervised learning methods:
- linear regression
- CART
- random forest,
- Boosting
- SVM

Pedotransfer functions

The K_{sat} will be predicted from texture, water retention etc. the area specific PTF will be compared to existing PTFs.

Risk assessment

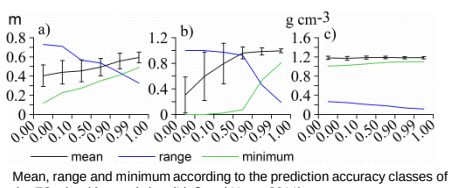
- Soil erosion
- Landslide
- Debris risk
- Soil degradation
- Groundwater pollution
- Impact of extreme weather events

Based on the Mohr-Coulomb criterion for shear strength, the factor of safety (FS) is defined as the critical soil shear ratio on a sliding surface (Vanacker et al. 2003)

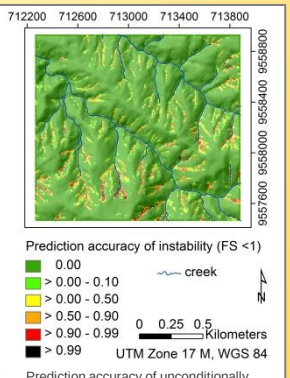
Sensitivity analysis concerning slope stability

$$FS = \frac{c' + \rho_s \cdot g \cdot z \cdot \cos^2 \alpha \cdot \tan \varphi'}{(\rho_s \cdot g + \rho_w \cdot g \cdot w) \cdot z \cdot \cos \alpha \cdot \sin \alpha} \qquad w = \left(\frac{q \cdot A}{b \cdot T \cdot \sin \alpha}\right)$$

c cohesion
φ soil internal friction
ρ_s bulk density
g gravitational constant
z depth of the failure plane
ρ_s density of water
w wetness
q net rainfall rate
A catchment area
T saturated soil transmissivity
α inclination
b cell size

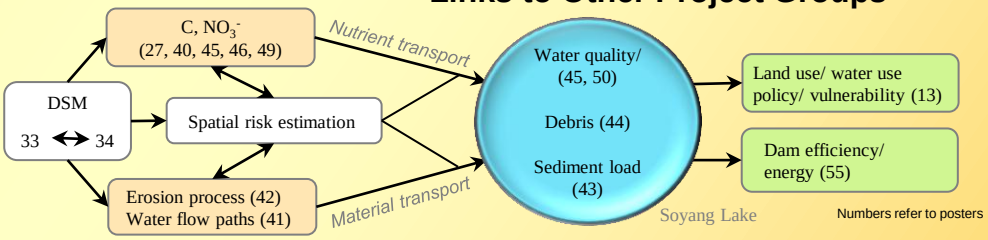


Mean, range and minimum according to the prediction accuracy classes of the FS: a) z, b) w and c) ρ_s (Ließ and Huwe 2011)



Prediction accuracy of unconditionally unstable slopes (Ließ and Huwe 2011).

Links to Other Project Groups



References

Ließ M, Huwe B (2011). Uncertainty in soil regionalisation and its influence on slope stability estimation. Book of Proceedings, Italian Workshop on Landslides 2011, Naples, Italy.

Vanacker V, Vanderschaeghe M, Govers G, Willems E, Poesen J, Deckers J, De Bievre B (2003). Linking hydrological, infinite slope stability and land-use change models through GIS for assessing the impact of deforestation on slope stability in high Andean watersheds. Geomorphology 52: 299–315.