Rapid soil mapping: Combining local soil knowledge and gamma spectrometry

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BACKGROUND

In central Tanzania, measure testing for cropping improvement was planned. Higher spatial resolution soil maps with local soil denomination are crucial related to research for development. No reliable soil map as basis existed; a rapid, low-cost mapping approach was required for two case study sites.

CONCLUSION

The method combination provided quick, reliable mapping results with sufficient spatial resolution for soil type specific recommendations and locally known soil names. Participatory action facilitated terrain overview, gamma spectrometry helped defining soil unit boundaries in the field.

GUIDELINE AND COMMENTS ON COMBINED PARTICIPATORY AND GAMMA RAY SOIL MAPPING

1. Village head chooses focus group members

→ Village head was elected by villagers, they trust him and participate

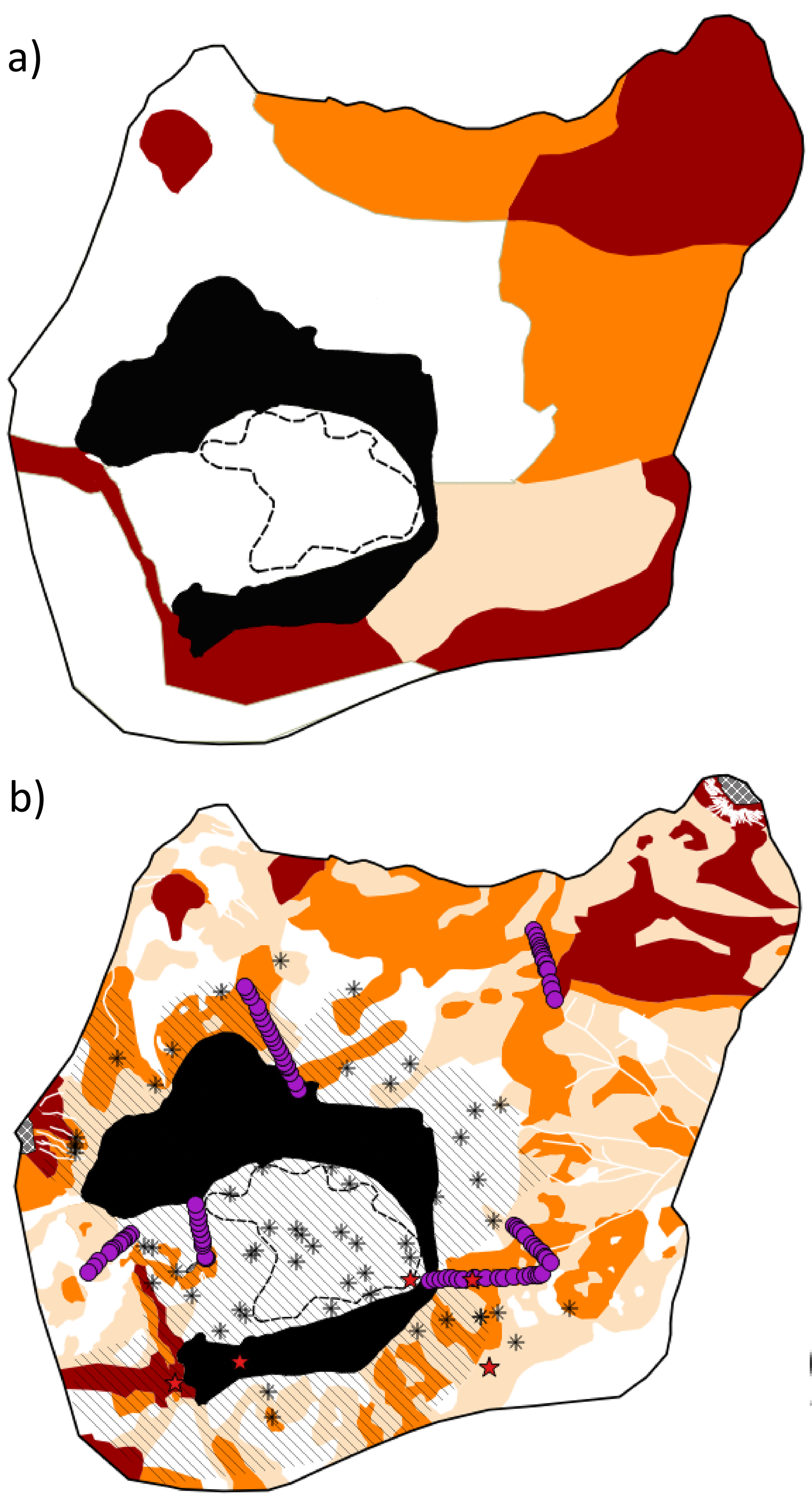
Pros : time-saving **Cons**: no info about selection criteria, only request: people from all sub-villages with good terrain knowledge

2. Focus group outlines village borders and soil units on a satellite image (Fig. 1a) and specifies soil types; researcher chooses key informant

→ Important: translator with good English and local tongue knowledge; resident farmers with sound terrain overview and local soil knowledge

→ Key informant: reputable farmer with outstanding terrain knowledge

Pros : improvements in terrain orientation via local knowledge, soil unit properties and diversity overview, local soil names; participatory action eased and accelerated field work **Cons**: in discussions: confusion due to limited local tongue skills of translator; variable soil knowledge of the group; women were too shy to share their knowledge



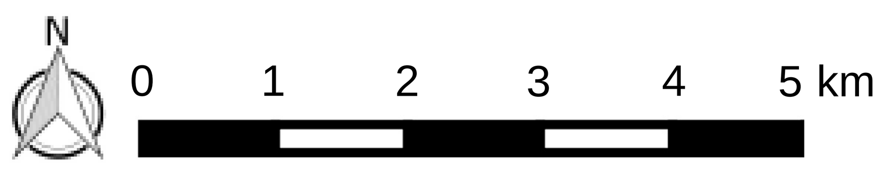


Fig. 1a Result from focus group discussions: local soil map
Fig. 1b Scientifically revised participatory soil map with Reference Soil Groups (IUSS 2015) (QGIS Version 2.12)
Legend: local denominations and WRB classifications(IUSS 2015) for agriculturally used soils

- Village borders
- Village settlement
- Reference profiles
- Transects
- On-farm trials
- Red sand/Chromic Lixisol hypereutric
- Red mixed sand/Chromic Lixisol
- Mixed sand/Chromic Lixisol loamic
- White sand/Haplic Acrisol
- Swamp/Sodic Vertisol hypereutric
- Hilltops/Leptosol
- Ephemeral riverbeds
- Deposits from Vertisol area

Table 1 Participatory soil mapping, sampling actions. N is the sampling point number

	N	Background	Reference	Involved
Soil profiles	5	Discussions/satellite image, field visits	Soil profiles	Focus group, key informants during visits
Transect samplings	92	Participatory map/ satellite image	Graef (1999), Milne (1935)	Key informants
On-farm trial sites	58	TransSEC workshops	Farmers` fields	Plot owners
Random spots	12	Field visits	Randomly	Key informants

Section	A	B	C	CD	D
Soil	Leptosol	Chromic Lixisol (hypereutric, profondic)	Chromic Lixisol	Parent material change	Cutanic, Stagnic Luvisol (hypereutric)
Top soil texture	LS	SCL - SL	L	LS	SCL
^{40}K [%]	0.88 ± 0.05	0.71 ± 0.03	0.56 ± 0.03	0.73 ± 0.09	1.32 ± 0.07
^{40}K/eTh	0.40 ± 0.03	0.25 ± 0.03	0.20 ± 0.04	0.20 ± 0.06	0.17 ± 0.01
N	4	12	12	12	8

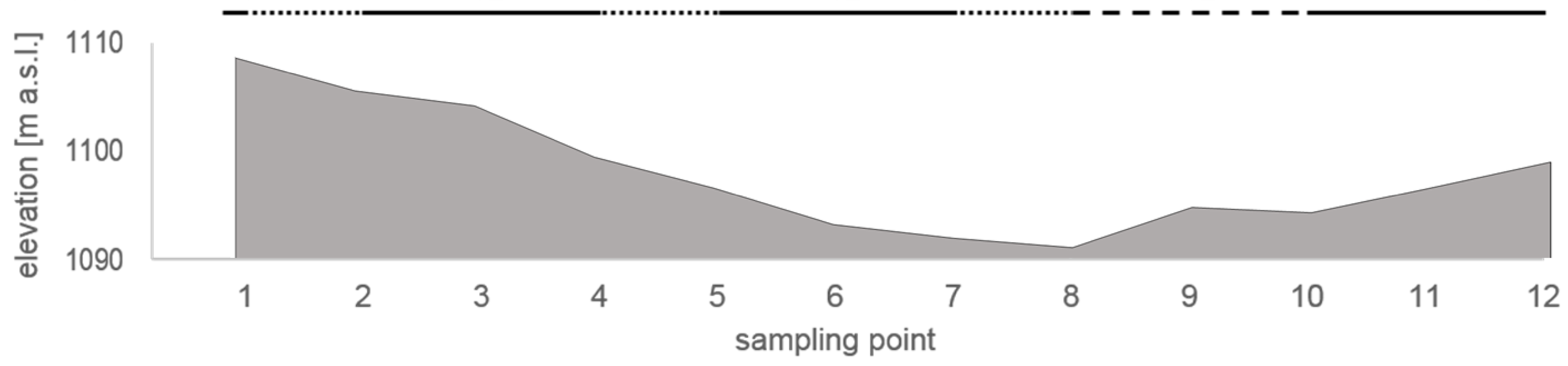


Fig. 2 Transect cross-section with gamma ray ^{40}K means ± standard deviation (SD) and ^{40}K/Th ratios. N is sample number. Means result from measurements within one soil type. Continuous bars merge points in one soil type, dotted bars soil type transitions. The dashed line depicts a parent material transition (C to D).

3. Researcher chooses soil reference profiles together with key informant, describes (Jahn et al. 2006) and samples (Tab. 1) profiles

Pros: key informant knows typical soil unit locations and respective land owners **Cons**: researcher has to rely on key informant knowledge

4. Focus group (ii): Field observations are discussed in relation to results from the first group meeting, notably soil unit and village boundaries

Pros: mostly, simple solutions due to farmers` knowledge **Cons**: farmers have variable levels of terrain knowledge, cross-checks are crucial

5. Researcher chooses transect locations with key informant, transect walks and on-farm trial sampling and gamma measurements are done

→ gamma spectrometry is helpful in difficult to access terrains

Pros : lab work for soil type distinction was partly redundant due to gamma spectrometry (Fig. 2) **Cons**: no unique fingerprint for soil units, at times difficult distinction by gamma spectrometry due to erosion

6. Focus group (iii): The soil map is discussed with the group

→ Important: to find out where agricultural activity is frequent

Pros: soil map with local and WRB denomination **Cons**: frequently cultivated areas are far better delineated than less cultivated regions

7. Supplemental soil chemical analyses are made, Reference Soil Group classification is done (IUSS 2015); then, the map is reviewed and corrected resulting in the scientifically revised local soil map (Fig. 1b)

Pros: local soil evaluation was scientifically proven useful as basis, gamma ray spectrometry served as soil unit distinction method **Cons**: not all gamma ray measurements end in clear soil type distinction

References

Graef, F. (1999). Evaluation of Agricultural Potentials in Semi-arid Niger – A Soil and Terrain (NiSOTER) Study. Dissertation. Hohenheim.

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Milne, G. (1935). Some suggested units for classification and mapping, particularly for East African soils. *Soil Research*, 4. 183-198.

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