Delineation of Site-Specific Management Zones Using Fuzzy Clustering Analysis for a Tobacco Field Based Hilly Land

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Outline

- Introduction
- Materials and methods
- Results and discussion
- Conclusions

Introduction

- **Numbers of studies carried out**
  - ➢Geostatistical applications for site-specific management
  - ➢Spatial variability of soil properties
  - ➢Numerous methods for defining management zones
- **Few studies for fertilizer management in tobacco field based hilly land**
- **Topography factors are limited**

Materials and methods

Study area description

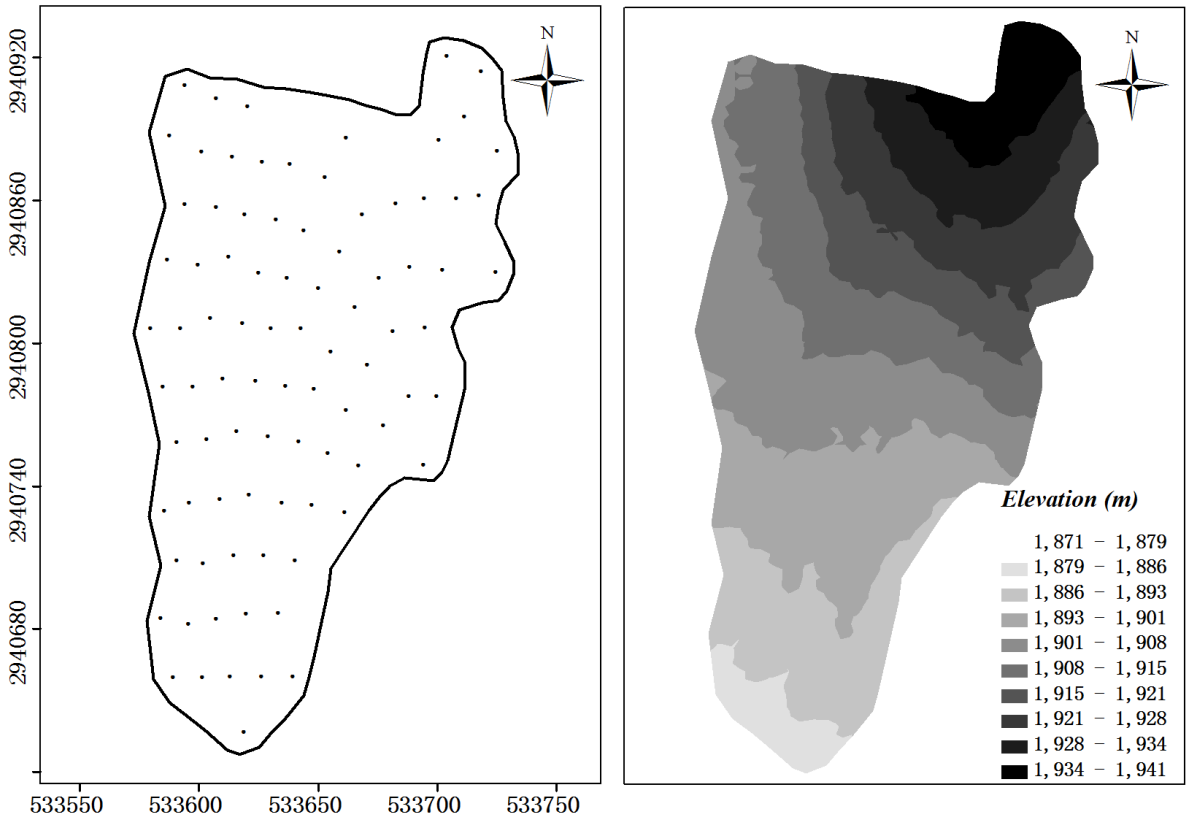

Fig. 1 Soil sampling points and elevation of study area

Materials and methods

- Measured soil properties included pH, OM, AN, AP, AK, TP, TK, Fe, Mn, Cu,Zn.
- Classical statistics and principal component analysis (PCA) by SPSS
- Geostatistical analysis by GS+ and ArcGIS
- Fuzzy clustering algorithm by MZA

Results and discussion

Table 1 Descriptive statistics of soil properties (n=88)

Variables[1)]	Mean	S.D	Max	Min	CV(%)	Skewness	$P_{K\text{-}S}$[2)]
pH	5.36	0.48	6.42	4.22	9.03	-0.41	0.153
OM (g kg^{-1})	8.89	4.02	15.93	0.76	45.24	-0.22	0.490
AN (mg kg^{-1})	26.76	10.37	49.53	10.70	38.76	0.39	0.220
AP (mg kg^{-1})	1.92	1.61	7.94	0.14	84.05	1.98	0.010
AK (mg kg^{-1})	130.23	30.18	208.42	72.91	23.17	0.60	0.260
TP (g kg^{-1})	0.28	0.19	1.43	0.02	67.59	2.59	0.143
TK (g kg^{-1})	12.76	2.92	28.86	6.37	22.89	1.68	0.342
Available Fe (mg kg^{-1})	10.86	4.45	23.64	2.69	40.95	0.68	0.081
Available Mn (mg kg^{-1})	34.12	17.99	108.70	11.62	52.72	1.23	0.169
Available Cu (mg kg^{-1})	0.30	0.10	0.62	0.10	34.21	0.80	0.468
Available Zn (mg kg^{-1})	1.13	0.98	6.86	0.29	86.72	3.34	0.002

[1)]OM, organic matter; AN, alkalytic nitrogen; AP, available phosphorous; AK, available potassium; TP, total phosphorous; TK, total potassium. The same as below.

[2)]The normal distribution probability of Kolmogorov-Smironov (K-S), $P_{k\text{-}s}>0.05$ indicates the variable is normally distributed.

Results and discussion

Table 2 Theoretical models and corresponding parameters of semivariograms for soil nutrients

Variables	Model[1)]	C_0[2)]	C_0+C[2)]	Nugget[3)] %	Spatial class[4)]	Range(m)	R^2	RSS
pH	E	0.086	0.262	32.8	M	75.0	0.939	2.48E-04
OM	E	4.93	15.95	30.9	M	61.8	0.954	0.639
AN	S	43.4	115.2	37.7	M	76.3	0.989	17.44
AP	S	0.157	0.595	26.4	M	70.5	0.975	1.40E-03
AK	E	320	1029	31.1	M	57.0	0.943	2838
TP	S	0.017	0.039	43.6	M	65.0	0.931	9.24E-06
TK	E	2.82	9.063	31.1	M	37.5	0.838	0.258
Available Fe	E	7.29	26.06	28.0	M	189.6	0.955	3.63
Available Mn	S	190.6	438.3	43.5	M	221.4	0.996	60.19
Available Cu	S	0.002	0.01	20.0	S	40.2	0.972	2.01E-07
Available Zn	E	0.139	0.586	23.7	S	199.2	0.990	4.23E-04

[1)]E = exponential model; S = spherical model.

[2)]C_0 = nugget variance; C = structural variance.

[3)]Nugget % = $C_0/(C_0+C)\times100$.

[4)]M = moderate spatial dependence (% nugget between 20 and 75); S = strong spatial dependence (% nugget < 25).

Results and discussion

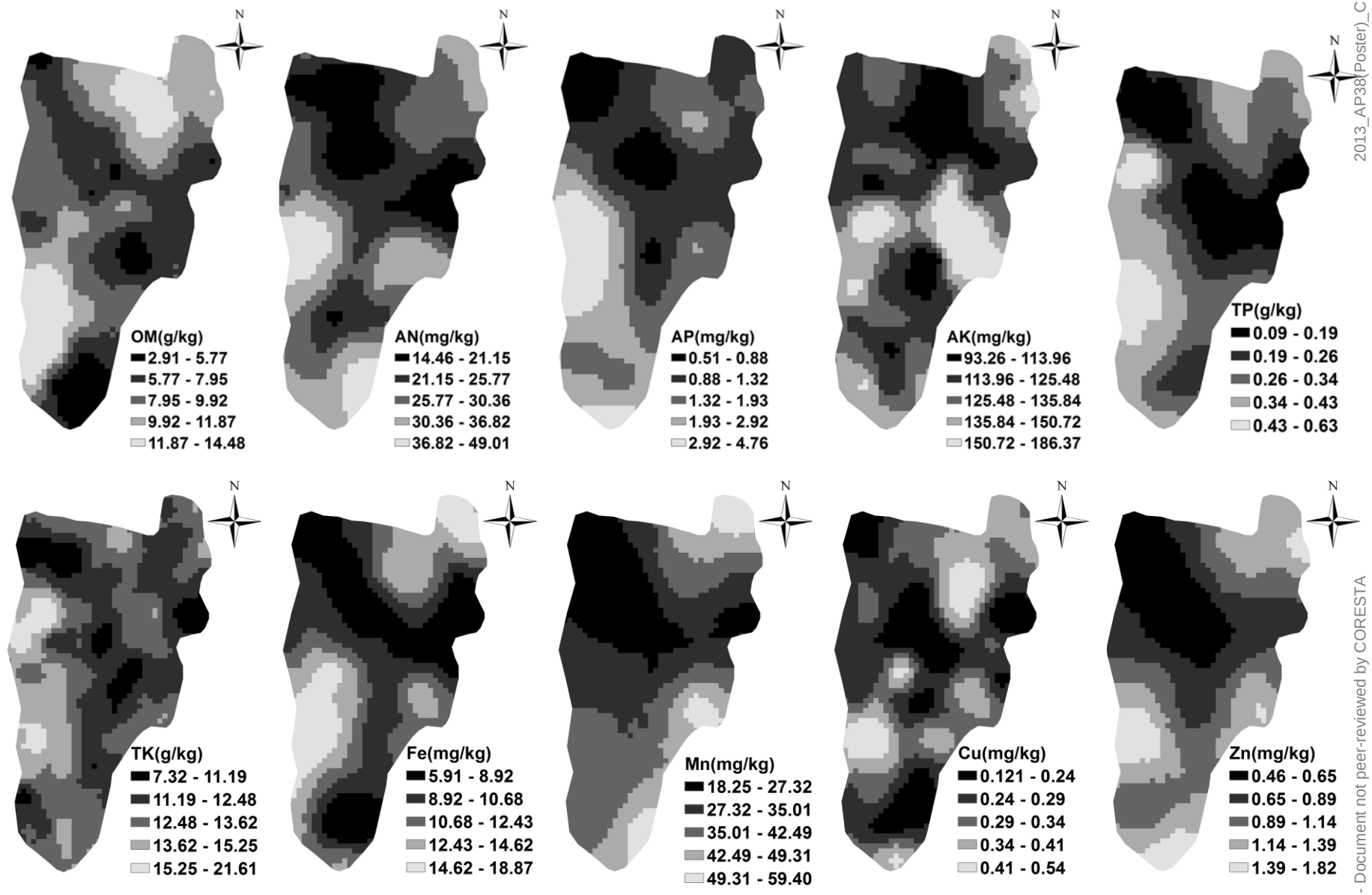

Fig. 2 Spatial distribution maps produced by ordinary kriging for soil properties

Results and discussion

Table 3 Principal component analysis of soil properties

Principal components	Attribute value	Contribution rate (%)	Accumulative contribution rate(%)
PC1	4.29	39.01	39.01
PC2	1.65	15.03	54.04
PC3	1.31	11.95	66.00
PC4	0.92	8.33	74.33
PC5	0.74	6.69	81.02
PC6	0.60	5.44	86.46
PC7	0.46	4.22	90.67
PC8	0.43	3.88	94.55
PC9	0.30	2.74	97.30
PC10	0.17	1.54	98.84
PC11	0.13	1.16	100.00

Principal contribution rate for each variable

Variables	pH	AN	AP	AK	OM	TP	TK	Fe	Mn	Cu	Zn
PC1	-0.05	0.50	0.73	0.38	0.57	0.69	0.54	0.86	0.65	0.76	0.71
PC2	0.75	-0.64	-0.27	-0.29	0.53	0.29	0.28	0.00	-0.21	0.19	0.00
PC3	0.39	0.00	-0.10	0.14	0.18	-0.59	-0.71	0.19	0.28	0.24	0.29

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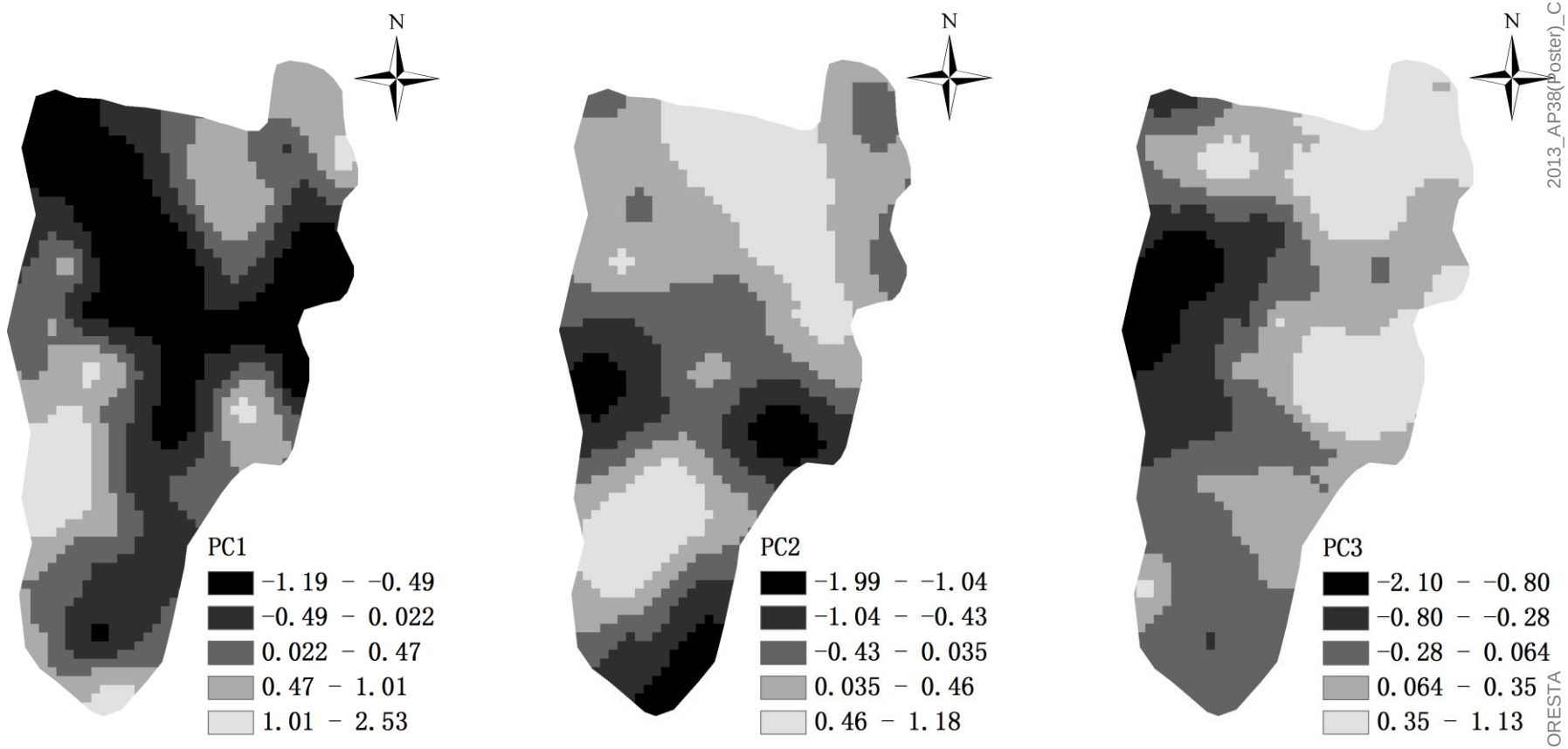

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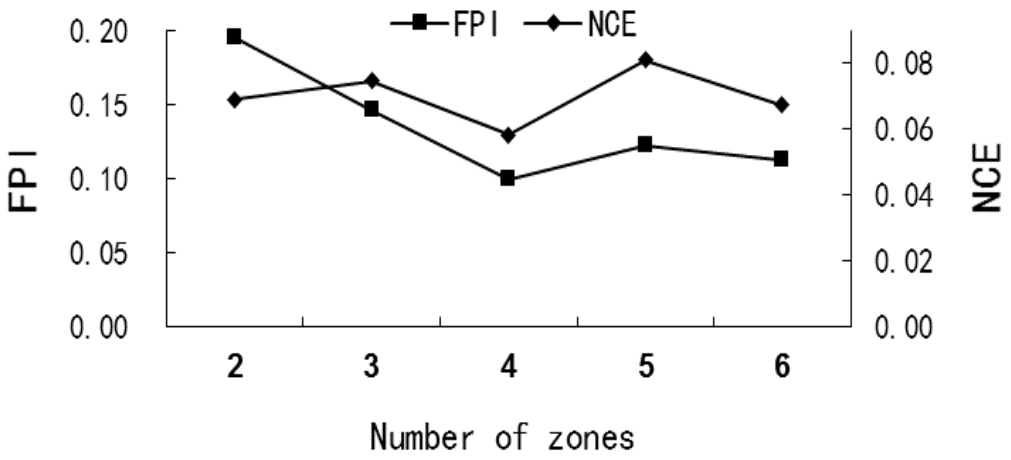
Classify the first three principal component and elevation images into management zones.

Results and discussion



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Grouping the data into four classes allowed both FPI and NCE indexes to be minimized.

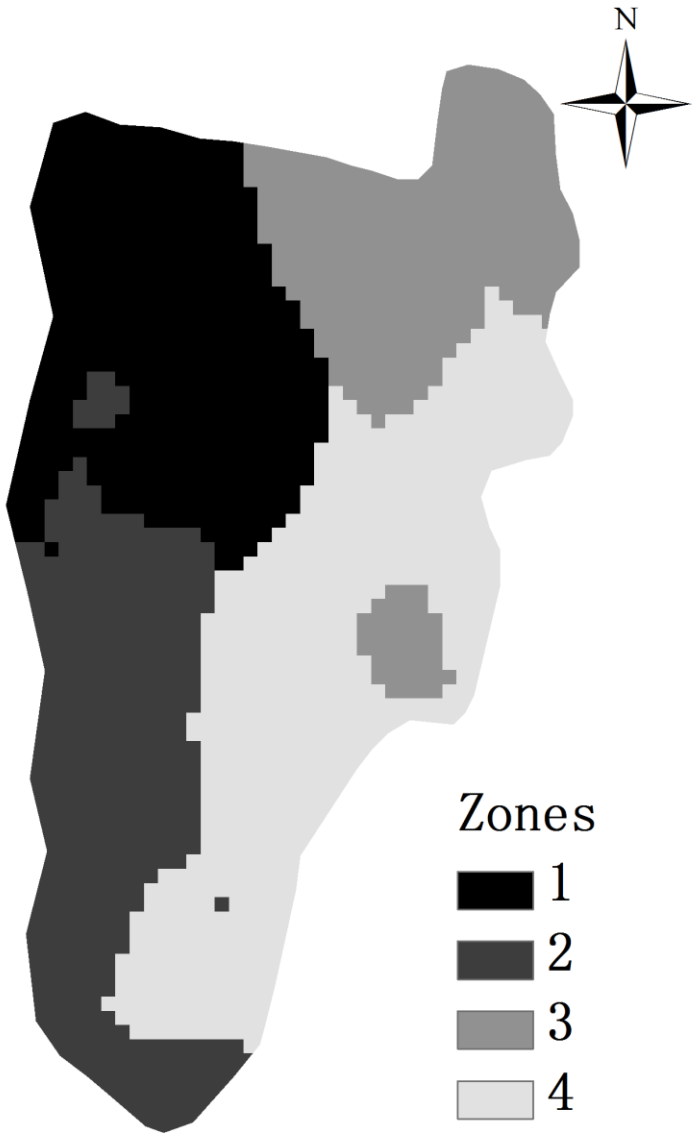

Fig. 5 Management zones map

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MZs	n	pH	OM (g kg^{-1})	AN(mg kg^{-1})	AP(mg kg^{-1})	AK(mg kg^{-1})	Fe(mg kg^{-1})	Mn(mg kg^{-1})	Cu(mg kg^{-1})	Zn(mg kg^{-1})	Elevation(m)
1	24	5.25	7.44	20.24	0.94	117.20	8.20	21.75	0.25	0.55	1914.29
2	20	5.23	11.57	33.23	3.75	141.00	15.20	36.61	0.36	1.52	1894.95
3	13	5.55	11.65	30.67	1.97	138.85	14.96	54.63	0.38	2.10	1922.62
4	31	5.45	7.12	26.00	1.47	129.77	8.39	33.50	0.26	0.91	1905.26
F-Value		1.95	10.76	7.98	20.54	2.87	34.94	13.76	13.48	11.96	8.82
Prob> F		0.13	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00

Conclusions

- The definition of site-specific management zones only rely on soil nutrients is not enough, topographic attributes have wide correlation with soil properties, so spatial variations of some soil properties and elevation were quantified by geostatistical tools and aggregated into management zones using fuzzy clustering analysis.
- The classified management zones can be used to characterize spatial variability of soil nutrients and improve the continuity of the corresponding management zone map. This would provide a method for managing mountain tobacco-planted fields.

Thank you for your attention!

AP 38 (Poster)

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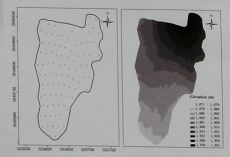

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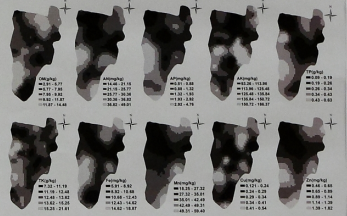

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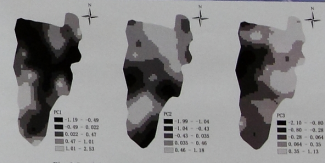

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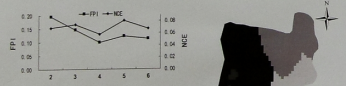

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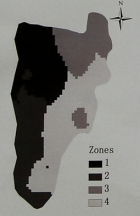

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