

## Regional Soil Indicators on the North China Plain

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**Abstract:** Indicators are measurable attributes of the environment that can be monitored via field observation, field sampling, remote sensing, or compilation of existing data. Different users have different concerned issues and purposes. A set of indicators in different scales (farmland, county, region) selected should meet requirement of users and indicate the problems affecting the their purpose. For the farmers, some simple morphological properties such as soil color, soil texture and structure of profile were selected. These properties are summarized with 6 Chinese characters based on farmer's experiences in Luancheng County. The 6 Chinese Characters are Huang(yellow), Hei(black), Hui (grey), Sha(sand), Jia(buried soil layer) and Jian(calcareous concretion). For the decision maker in county level, a set of indicators should include soil morphological and physical properties, chemical properties, biological properties and productivity properties. Soil color, texture, bulk density, field capacity, wilting point are useful physical indicators. TOM, TN, AP, AK and trace elements are important chemical indicators. Yield, profit and product quality are productivity indicators. Water table is most important environmental indicator. The result of overall judge from the set of indicators show that soil quality is going well on the whole in Luancheng county (a case study).

**Keywords:** indicators, soil health and North China Plain

### 1 The procedure of indicators selected

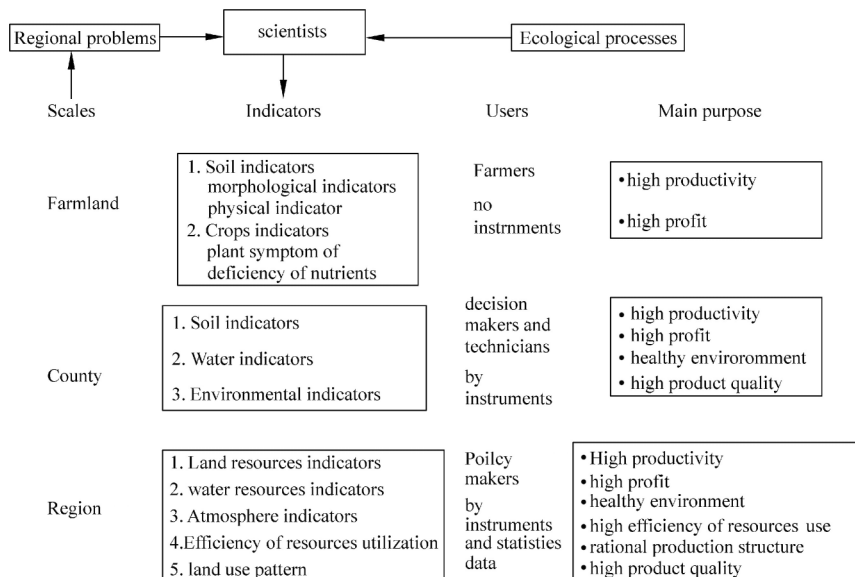
Indicators are measurable attributes of the environment that can be monitored via field observation, field sampling, remote sensing, or compilation of existing data.(Meyer *et al.*, 1992). Each indicator is precise and accurate in describing a particular function of the environment and will serve to signal desirable or undesirable changes that have occurred, or may occur in the future.(Landres, 1992). Different users have different concerned issues and purposes. A set of indicators in different scales (farmland, county, region) selected should meet requirement of users and indicate the problems affecting the their purpose. The indicators should be considered the possibility of indicators collection for users, for example, the direct symptom of soil and crops such as soil color, texture and leaf color is suitable to farmers. Some observation data by instruments could be selected as indicators for county scale. The duty of scientists is to develop a set of indicators suitable to definite scales based on their research on the ecological process related to environmental problems. The procedures of indicators selected shows in the Fig. 1.

### 2 Indicators of soil selected in farmland for farmers

For the farmland scale, the main soil indicators should include soil color, texture, bulk density, field capacity, wilting point, TOM, TN, AP and AK. Actually, the some simple morphological properties such as soil color, soil texture and structure of profile are very useful indicators for farmers to assess the health of the land. In the Luancheng County on Piedmont Plain of Mt. Taihang, the soil fertility and health (including soil fertility degree, soil tilth index, perviousness and conservation of soil water and nutrition) can be described with 6 Chinese characters based on farmer's experiences. The 6 Chinese Characters are Huang (yellow), Hei(black), Hui(grey), Sha(sand), Jia(buried soil layer) and Jian(calcareous concretion). The 6 Chinese characters are the most simple and useful indicators to assess soil health for peasants.

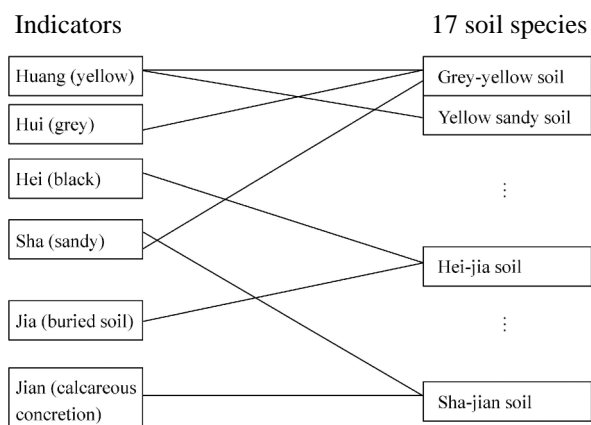
Huang is soil color and represents good water drainage, good tilth and pretty good. Black is soil color and represents high soil organic content. Grey is soil color with little dark and represents higher soil

organic content. Sand represents the soil texture with sandy, low nutrition content, bad conservation capacity of soil water and nutrition, but perviousness is good. Jia represents soil with buried soil layer, the soil texture is clay, soil property for tilth is not so good, and with little restriction to growth of seedling, but better to aged shoot. Jian represents the soil with calcareous concretion or Ca horizon, has restriction to growth of roots.



**Fig.1** Principles and procedure of Indicators selected

According to soil classification, soil in Luancheng County is typical cinnamon soil with thin humus layer and middle or thick solum. The buried layer, clay course, calcareous concretion layer, sand soil layer and plowed layer are the standard diagnostic horizon for soil species classification. The soil can be divided 17 soil species. The 17 soil species are named with combined the 6 Chinese Words as below Fig.2 showed.



**Fig. 2** Soil species in Luancheng County

### 3 A case analysis: Grey-yellow soil

From the name of the soil, farmer can judge that this kind of soil has good soil body structure, good soil tillage properties, good soil moisture capacity, but the there exist a plowpan with high bulk density. The follow data will support the judgement.

**Table 1 Main morphological indicators of Grey-yellow soil in Luancheng County**

Layer	Thickness(cm)	Consistence	Color	Texture	Roots(cm/cm <sup>3</sup> )	
					wheat	corn
A <sub>1</sub>	0—17	soft	gray brown	sandy loam	3.49	1.12
A <sub>1</sub> B	17—30	very hard	light brown	sandy loam	1.63	0.48
B <sub>1</sub>	30—65	farm	dark brown	loam	0.51	0.26
B <sub>2</sub>	65—90	farm	dark brown	loam	0.34	0.25
BK	90—145	very hard	light yellow	light clay	0.16	0.12
B <sub>3</sub>	145—170	very hard	gray yellow	light clay	0.18	
BC	170—190	very hard	light yellow	medium clay		

**Table 2 Main physical indicators of Grey-yellow soil in Luancheng County**

Layer	Thickness (cm)	field capacity (cm <sup>3</sup> • cm <sup>-3</sup> )	wilting point (cm <sup>3</sup> • cm <sup>-3</sup> )	Plant available water (cm <sup>3</sup> • cm <sup>-3</sup> )	Bulk density (g • cm <sup>-3</sup> )	Total porosity (%)	Air-filled porosity (%)
A <sub>1</sub>	0—17	36.35	9.63	26.73	1.41	46.42	10.07
A <sub>1</sub> B	17—30	34.86	11.37	23.49	1.51	42.62	7.76
B <sub>1</sub>	30—65	33.25	13.92	19.33	1.47	44.14	10.89
B <sub>2</sub>	65—90	34.28	13.91	20.37	1.51	42.62	8.34
BK	90—145	34.36	12.95	21.41	1.54	41.48	7.12
B <sub>3</sub>	145—170	38.98	13.87	25.11	1.64	37.68	1.42
BC	170—190	38.05	16.44	21.61	1.59	39.58	1.53

**Table 3 Soil nutrients contents in Luancheng County**

year	TO TN TP TK				TZn TCu TPb TCd AP AK AFe ACu AZn AMn									
	(g/kg)				(mg/kg)									
1998	15.0	0.95	0.8	12.2	58	19.4	12.8	0.63	9.78	63.2	9.0	1.75	1.66	9.0

\* T Means total, A means available. For example, TN means total nitrogen contents, AMn means available Mn.

We can get the Interpretation from results from tables

- Soil body structure (soil profile): surface soil layer with light loam, bottom with heavy loam.
- Soil tilth: good
- Bulk density: light; water permeability and aeration good.
- Plowpan: bulk density high, hard, restriction to roots growth and water movement.
- Water store capacity: good
- Nutrition status: fair.

#### 4 Trends and regional indicators of soil for soil health assessment

For assessment of regional soil quality changes, we selected 3 sets of data in different year to compare the changes. The results from Table4 show that generally soil nutrition status is improved for 20 years, but available potassium has obviously decreased rapidly as less potassium fertilizer has been added to soil during the past three decades. Another potential ecological problem is nitrate leaching with much more nitrogen fertilizer application to farmland.

For spatial distribution of soil quality on a region, we may select multi-indicators or single indicator to assess the spatial difference of soil health according to the classification standard of the indicators.

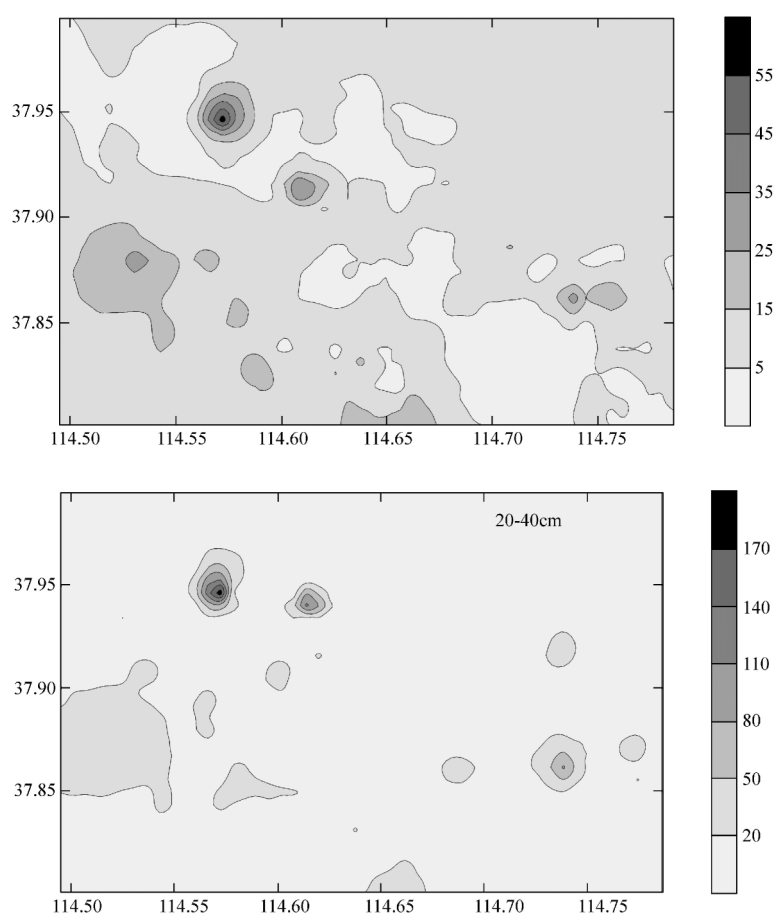
We sampled 300 soil samples every 1km×1km and analyzed the content of N, P, K and organic matter. We can judge the spatial distribution of soil health from the indicators. For example, the Fig.3 are

the soil nitrate spatial distribution in Lucheng County. We can assess the status nitrate leaching from grades of nitrate status.

**Table 4 Soil nutrients contents in Luancheng County**

year	TO TN TP TK				TZn TCu TPb TCd AP AK AFe ACu AZn AMn									
	(g/kg)				(mg/kg)									
1978	11.0	0.77	1.5	22.8	—	—	—	—	10	208	8.38	0.95	0.40	8.20
1989	14.6	0.91	—	—	54.8	16	23.6	0.11	8.9	112	7.51	0.89	1.35	7.51
1998	15.0	0.95	0.8	12.2	58.0	19.4	12.8	0.63	9.78	63.2	9.0	1.75	1.66	9.0

\*T Means total, A means available. For example, TN means total nitrogen contents, AMn means available Mn.



**Fig.3** Spatial distribution of soil nitrate at 0cm—20cm and 20cm—40cm in Luancheng

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