Legacy soil data from China national soil survey

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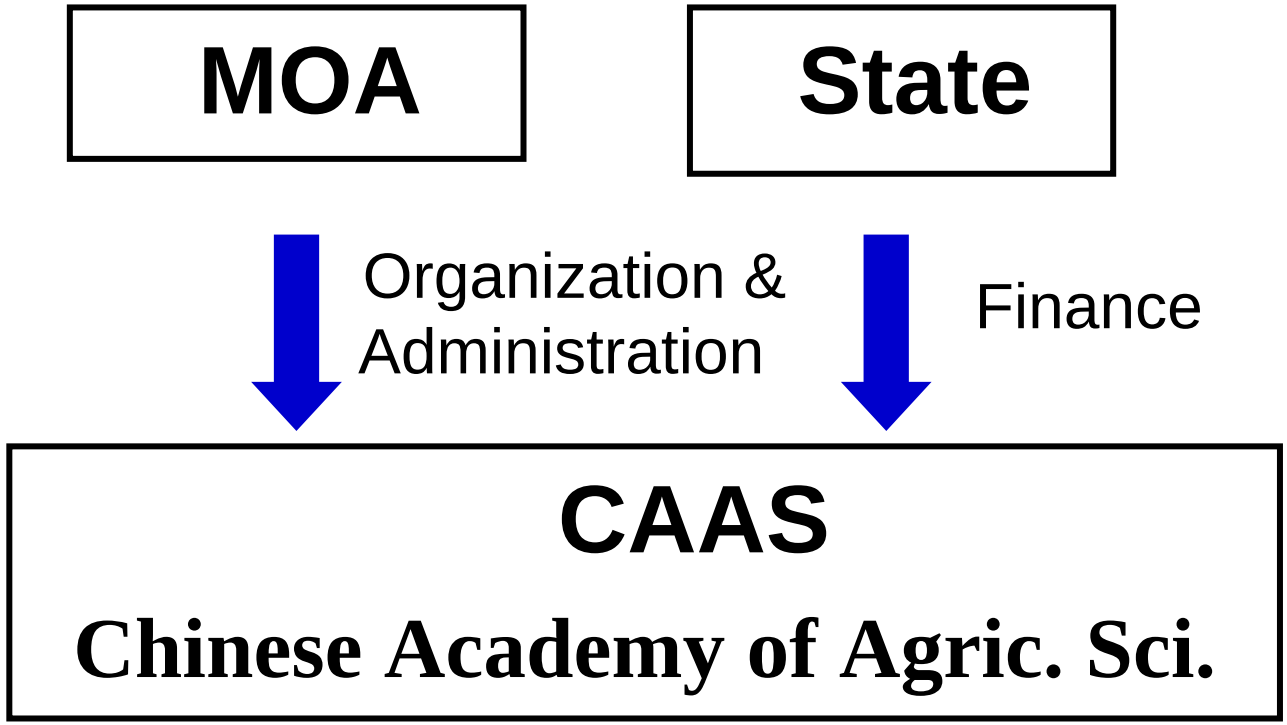
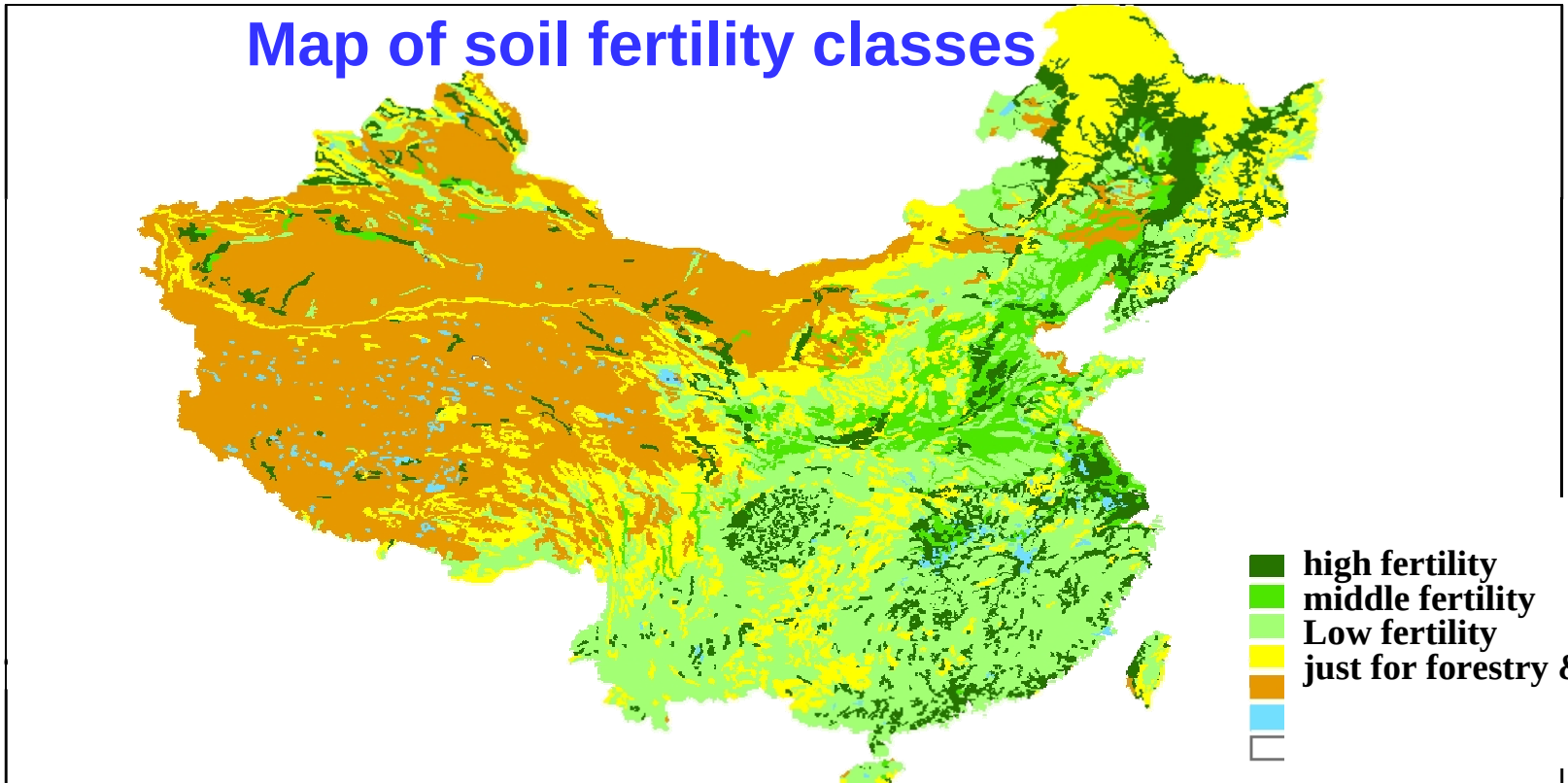

MOA
State
Organization &
Administration
Finance
CAAS
Chinese Academy of Agric. Sci.

Legacy soil data from China national soil survey

1. China soil survey in recent years
2. The 2nd national soil survey of China
3. Development of China soil geo-data base at 1:50,000 scale based on legacy soil data
4. Discussion (revision of China soil classification system)

China has limited arable land resources

- **arable land resource per person less than 40% of the world average**
- **only 30% belongs to fertile soil**
- **keep decreasing since 1996, especially fertile soil resources**



1. China soil survey in recent years

High priority was always paid on understanding soil quality for food security by the central government

- 1958-1960: 1st national soil survey (MOA)
- 1979-1986: 2nd national soil survey (MOA,2亿元)
- 2006-now: Soil pollution investigation(MOE MOL,10亿元）
- 1999-2009: Investigation and classification of land resources for agricultural use （MOL,4亿元）
- 2002-now: Investigation and evaluation of arable land fertility （MOA,2亿元）
- 2005-now: Investigation of soil nutrient status (MOA,10亿元/年)
- 2007-2009: 2nd national land resource survey (MOL,150亿元)
- 2002-now: Investigation of land elements （MOG）

2. The 2nd national soil survey of China(1979-1986)

Sampling plans were made by using 1:10,000 scale topographic maps.

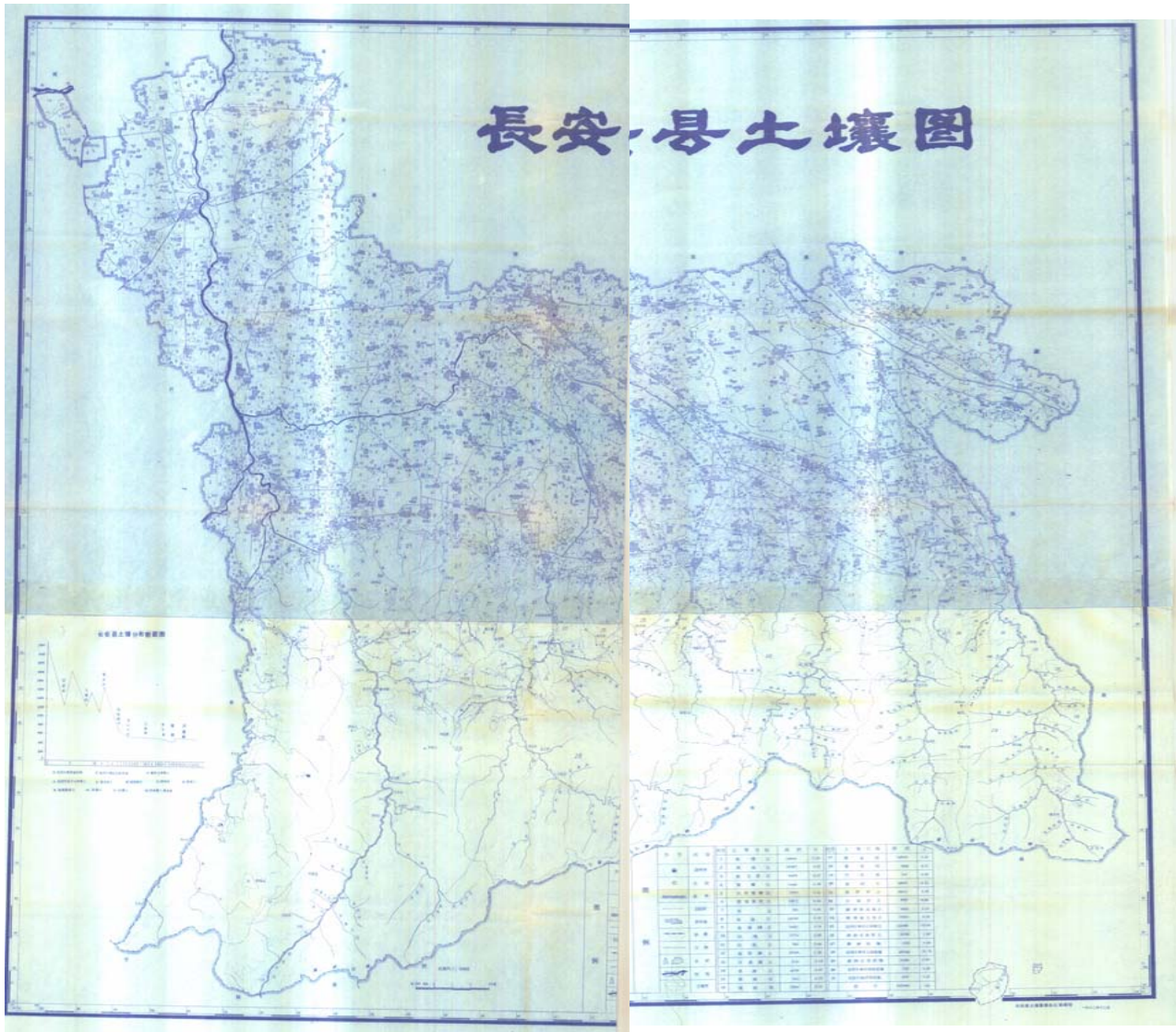
- **5 million** soil profiles were observed, parent materials, morphological and other soil feature were recorded.
- **200 thousand profiles** were sampled, soil texture, OM, pH, EC, N, P, K, micro nutrient contents, depth and other soil physical and chemical properties of each profile layer were analyzed and recorded
- **2 million soil samplings of tillage layer** were sampled and analyzed.

2. The 2nd national soil survey of China(1979-1986)

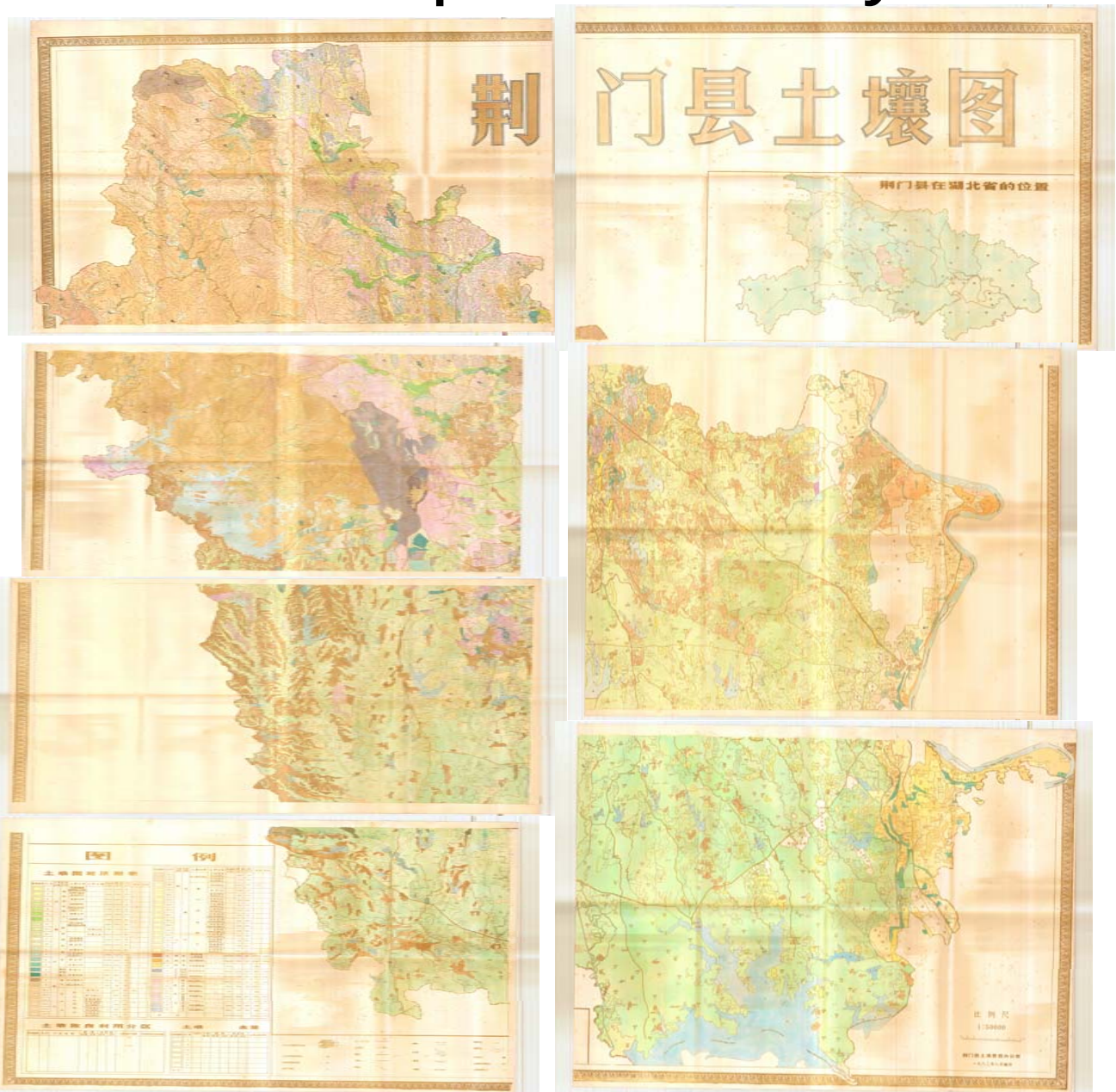
Maps at 1:50,000 scale for 2400 counties were drafted based on observations

Soil map
Soil organic matter
Soil total nitrogen
Soil available phosphorus
Soil available potassium
Soil pH

Soil map of a county

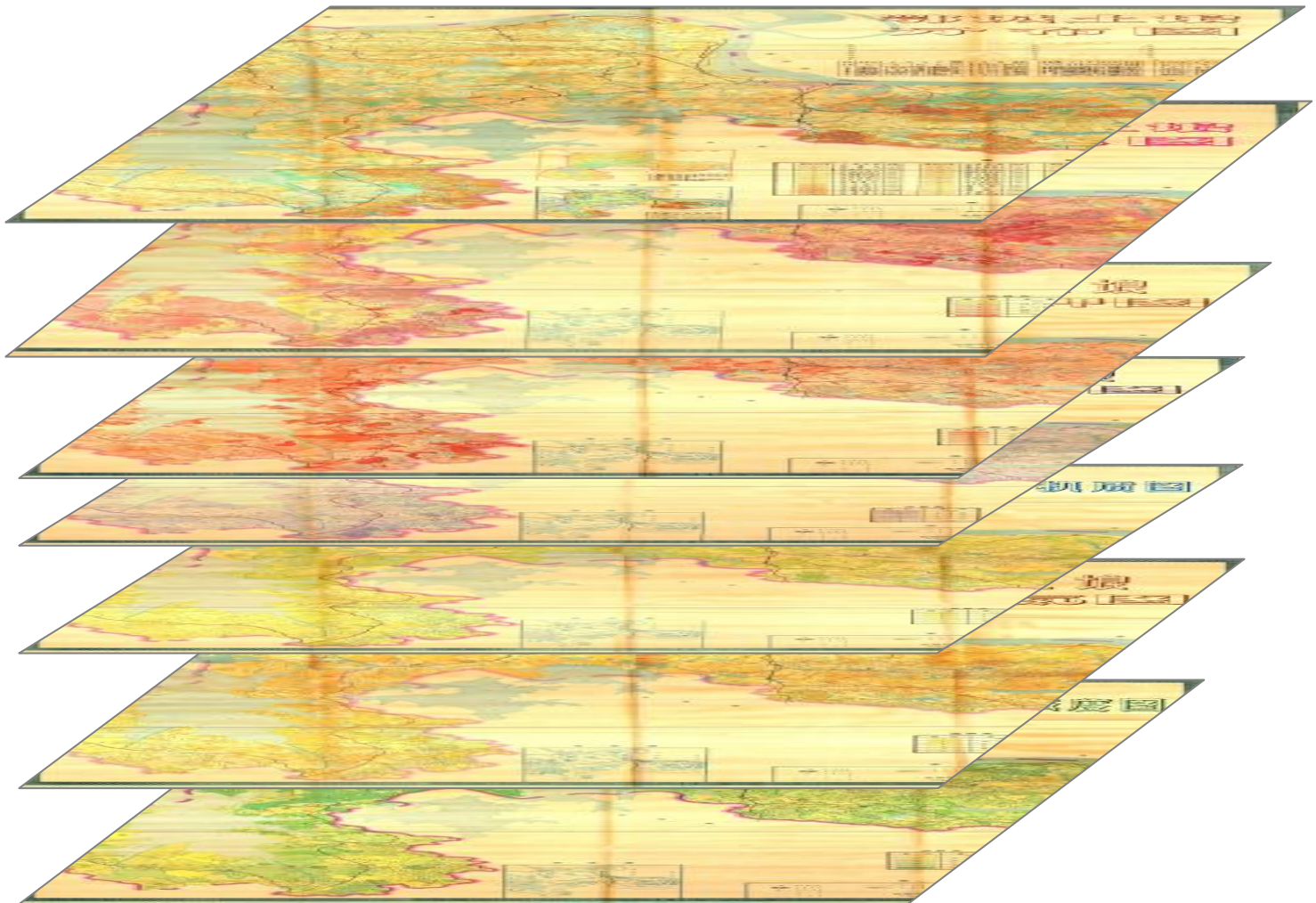


Soil map of a county



Soil and soil property maps of a county

湖北省鄂城县（7个专题图）



Soil Map

OM

Total N

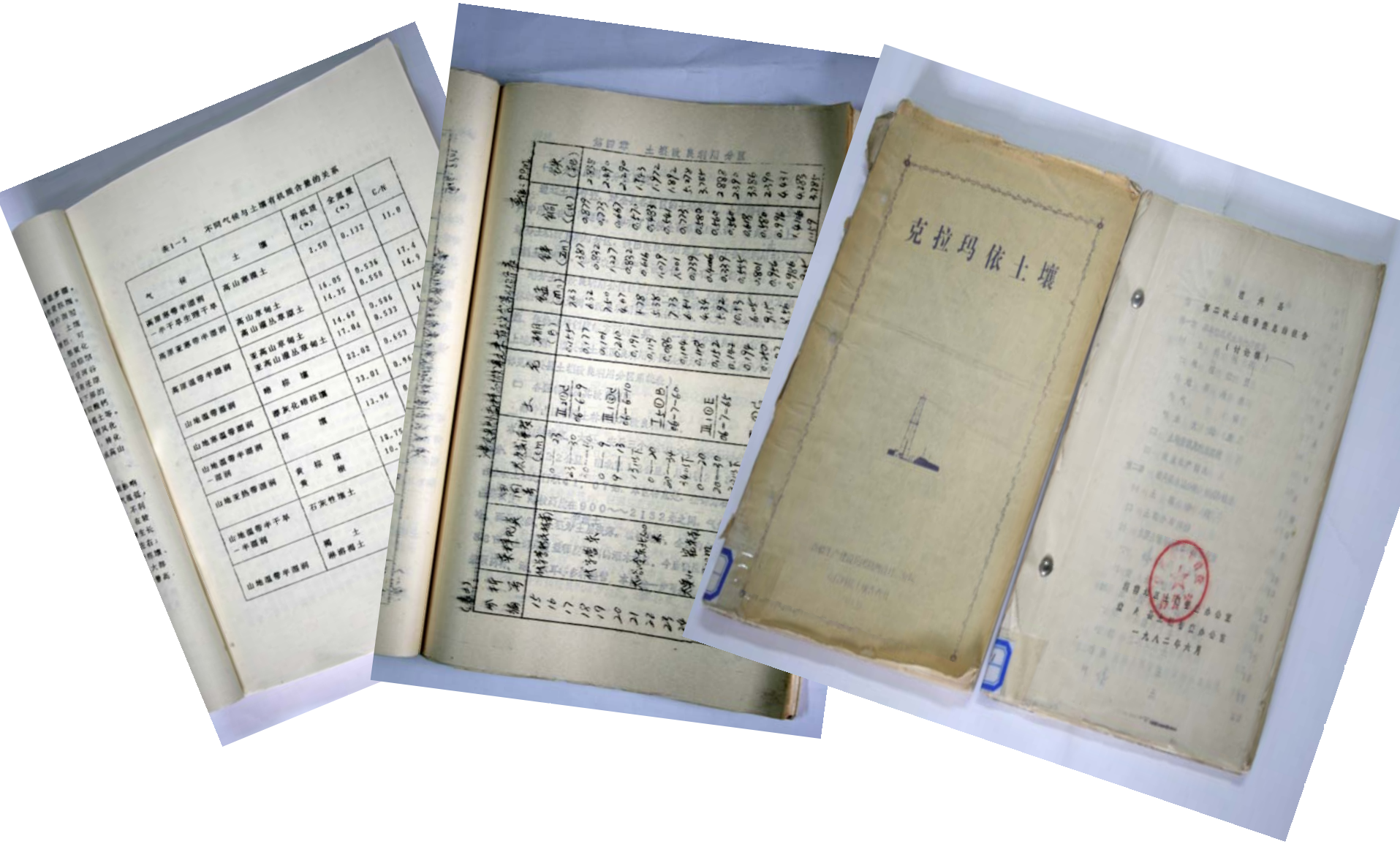
Available K

Available P

Available N

pH

- **Description of physical and chemical properties of soil profile**



Description of physical and chemical properties of soil profile

2. The 2nd national soil survey of China

Long-term changing soil property: texture, parent materials, morphological and other physical soil feature

2. The 2nd national soil survey of China

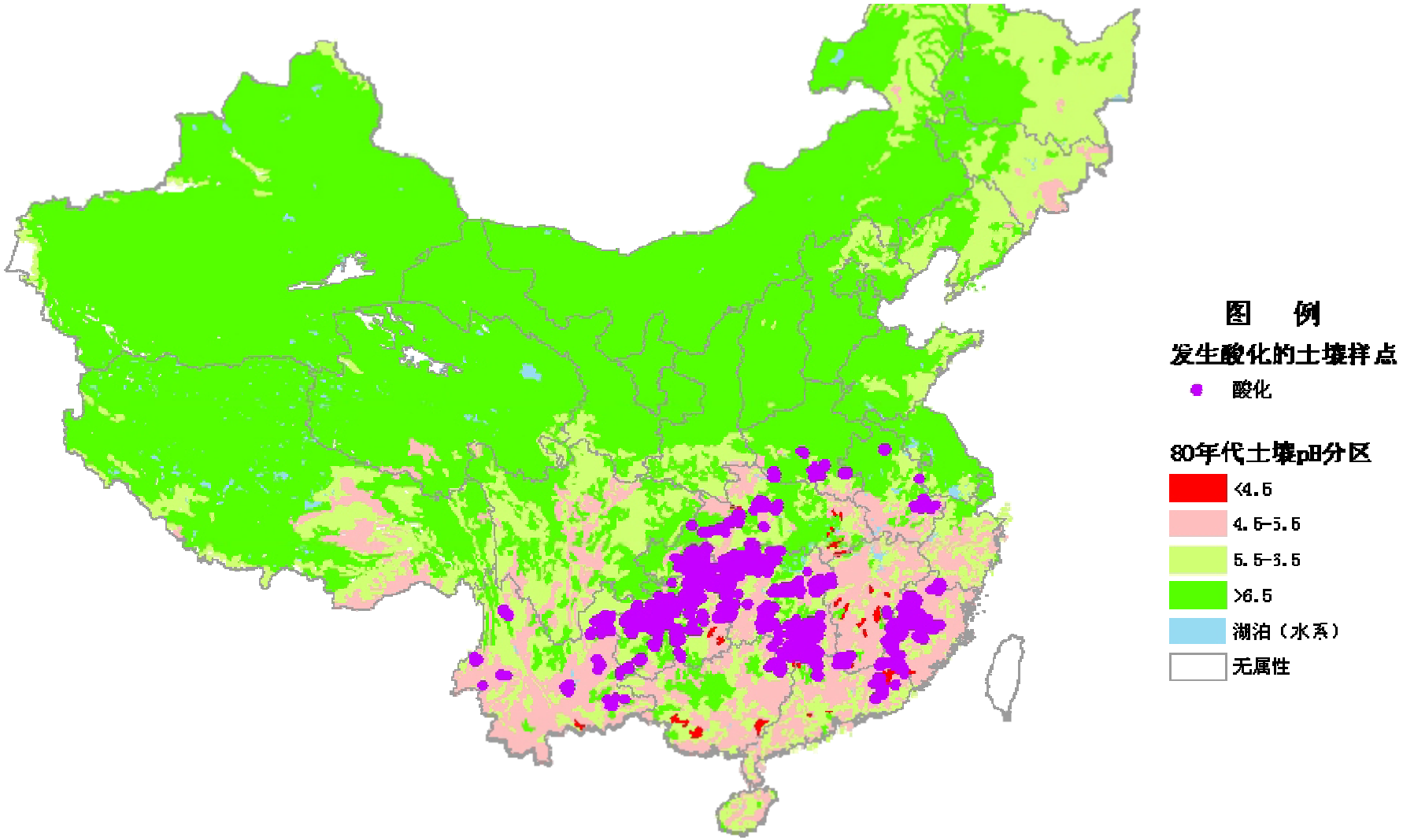
Short-term changing soil property: OM, nutrient, tillage depth, tighten, salting etc. important for evaluate soil quality changes.

Change of soil OM, available P and K in China

Soil parameters	1979 - 1985	n	2005-2010	n	increase（%）
OM (%)	1.82	1,151,366	2.42	85,512	**33%**
Available P (mg/kg)	7.9	907,502	18.8	56,515	138%
Available K (mg/kg)	105	667,673	119.08	45225	13%

It means 139.9 million tons CO_2 was additionally fixed in arable land annually during last 25 years..

Regions with significant soil acidification from 1980s to 2010s

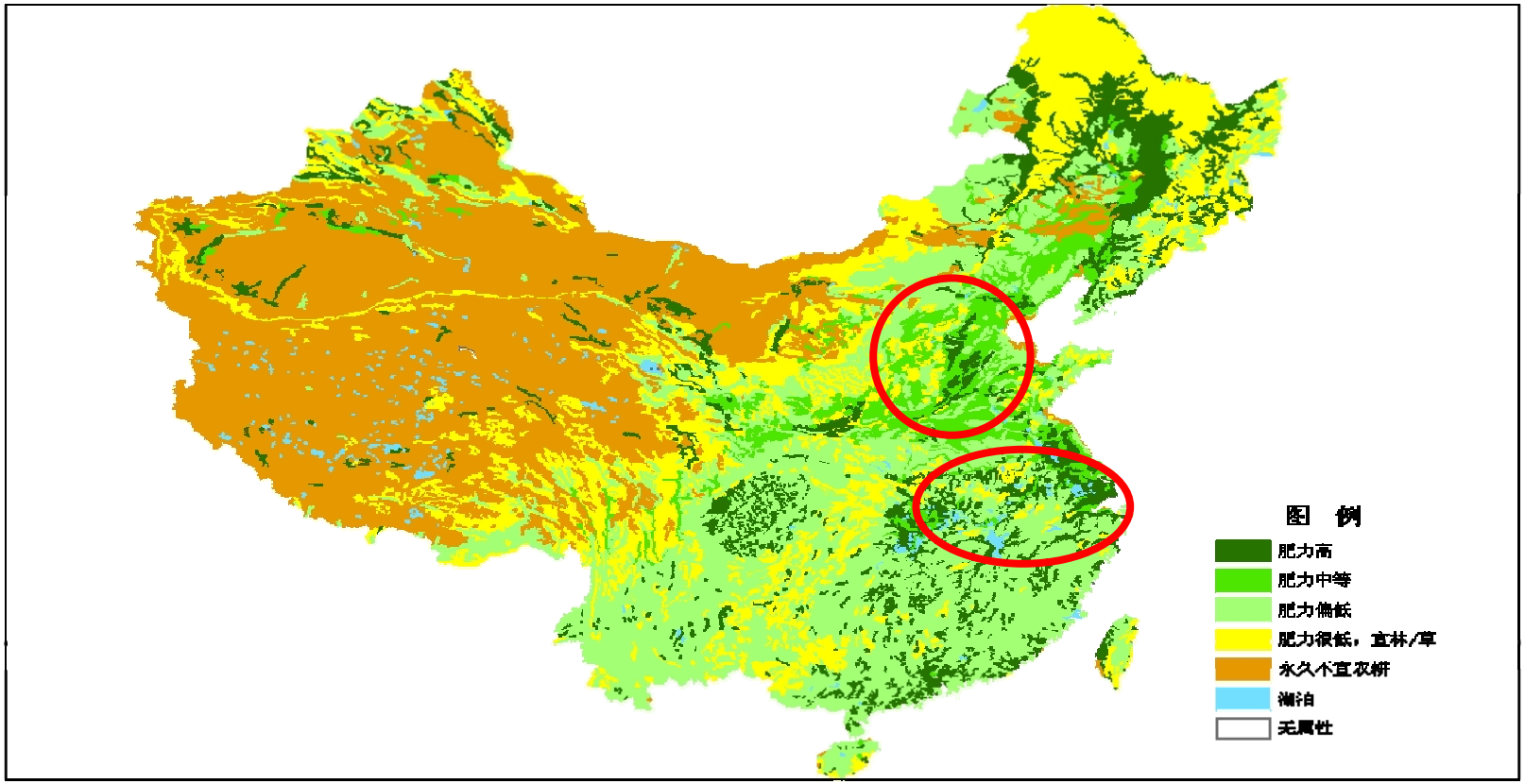


2. The 2nd national soil survey of China

Main advantages of legacy soil data from 2nd soil survey

① Large quantity of field survey, field sampling and laboratory analysis

Main cropping area: one observation profile/2-7 ha



Soil profile with detailed records of soil texture, OM, pH, EC, N, P, K, micro nutrient contents, depth and other soil physical and chemical properties of each profile layer

Country	Soil profiles number
China	100,000 (available)
New Zealand	2,500
Australia	160,000
Belgium	15,000
Denmark	8,000
Germany	160,000
France	540
Italy	several thousands
Spain	453
England	6,000

2. The 2nd national soil survey of China

Main advantages of legacy soil data from 2nd soil survey

② One standardized approach for sampling planning, sampling, laboratory analysis, recording and mapping
Clear objectives: soil resources (soil type) and fertility (fertility related property)

③ Relatively precise operation by experts.

剖 面 观 察

编绘成果图件

2. The 2nd national soil survey of China

Problems

① Valuable records and maps deposited separately at provinces or counties were heavily loosed and damaged and difficult to be applied.

2. The 2nd national soil survey of China

Problems

② Rules of soil type naming in some region varied a lot. However, main items of profile description among different regions were same.

Soil type	State issued	Existing
Great group	61	312
Sub group	229	1872
Species/Family	663	15600
Variety	3000	62400

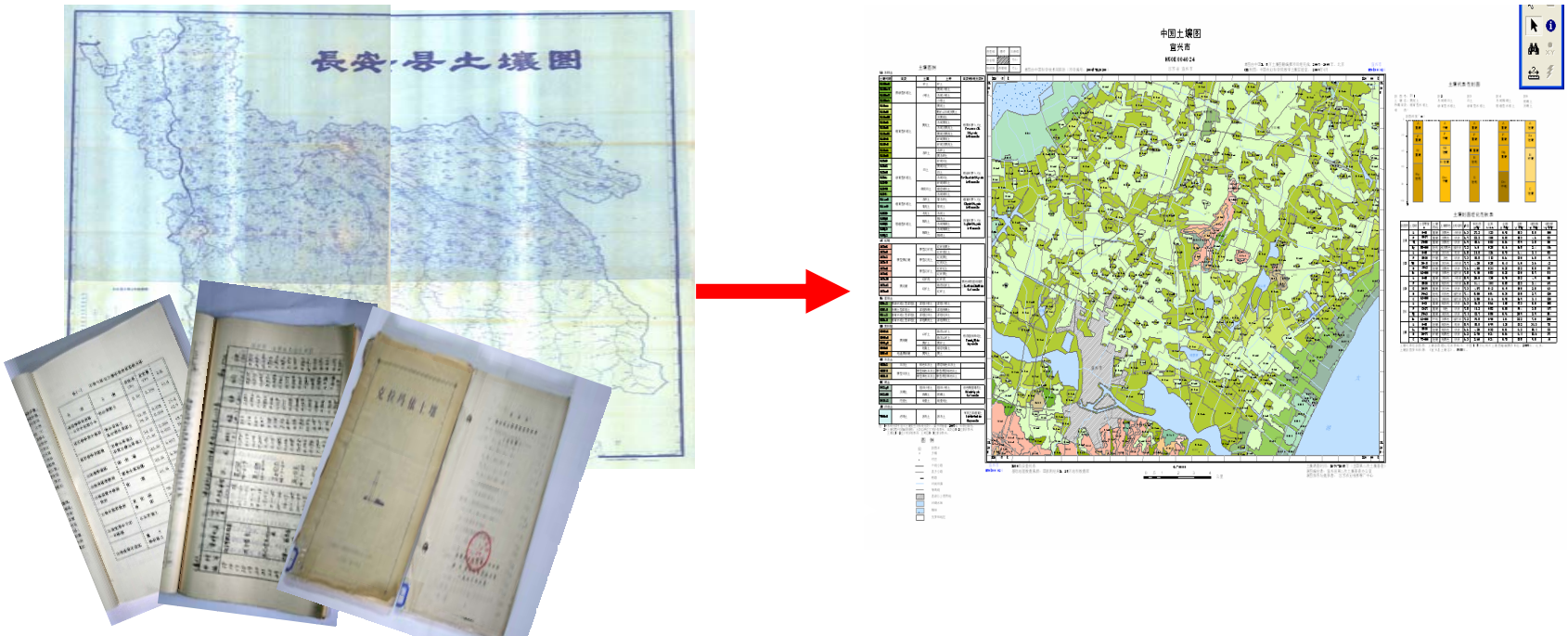
3. Development of China soil geo-data base at 1:50,000 scale based on legacy soil data

- Supported by many famous scientists in China and founded by MOST, development of China digital soil map at 1:50,000 scale was officially started since 2006.

China digital soil map at 1:50,000 scale

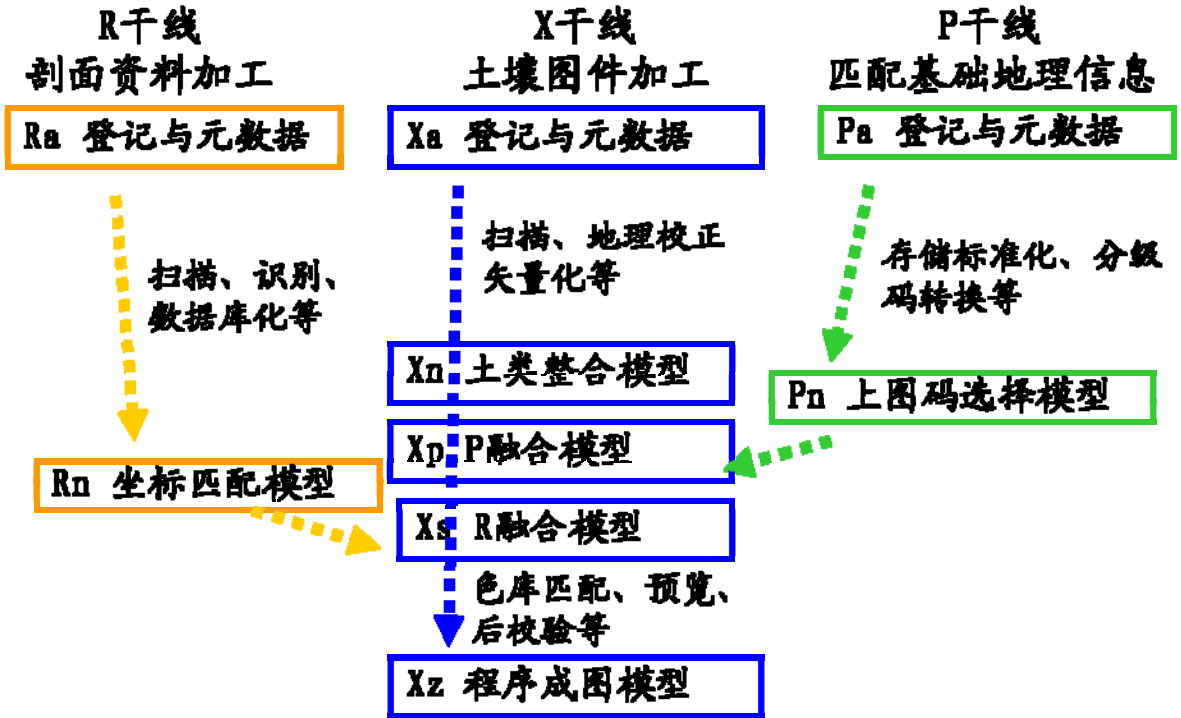
Main difficulties

- time consuming, each map contains 1,000-9,000 polygons, 50-150 soil types and 20-50 basic geo-info grades
- bad map conditions (image blurring, coordinates absence, etc.)
- Difference in soil type nomination



3. Development of China soil geo-data base at 1:50,000 scale based on legacy soil data

- **human-computer interactive data processing** were developed, which consists 106 sections
- To connect each sections of the whole flow, a soil geo-data base **interface** was established



Data processing flow which consists 106 sections

1: Xa
图件登记与
元数据建库

2: Xb
原图修复

3: Xc
扫描

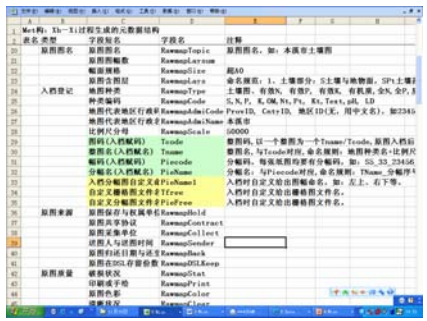
4: Xd
图像文件处理

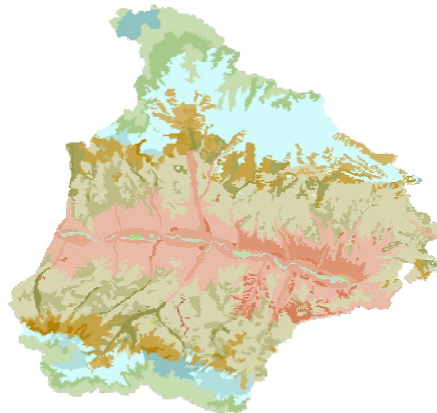
5: Xe
建图像文件数据库

6: Xf
矢量数据
元数据建库

7-12: X1-6
配准、矢量化，建
基准库、底图库等

13: Xg
图层标准化
多专题图层拆分



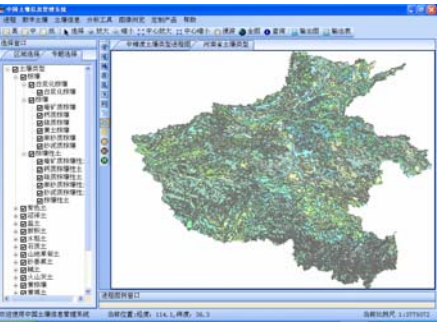


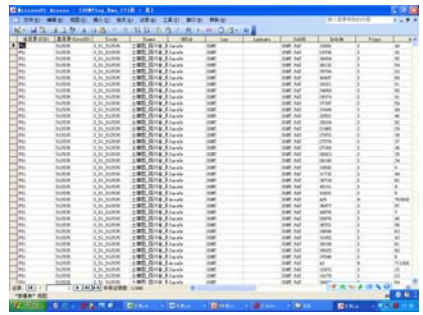
14: Xh
矢量数据
格式标准化

15: Xi
坐标标准化

16: Xj
境界标准化

17: Xk
属性表与
字段标准化



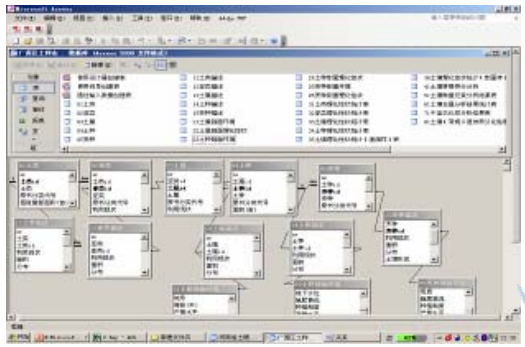


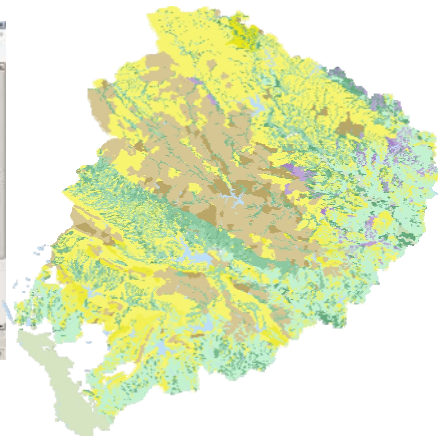
18: X1
存储目录标准化

19: Xm
三元表达式

20: Xm1
原图再现

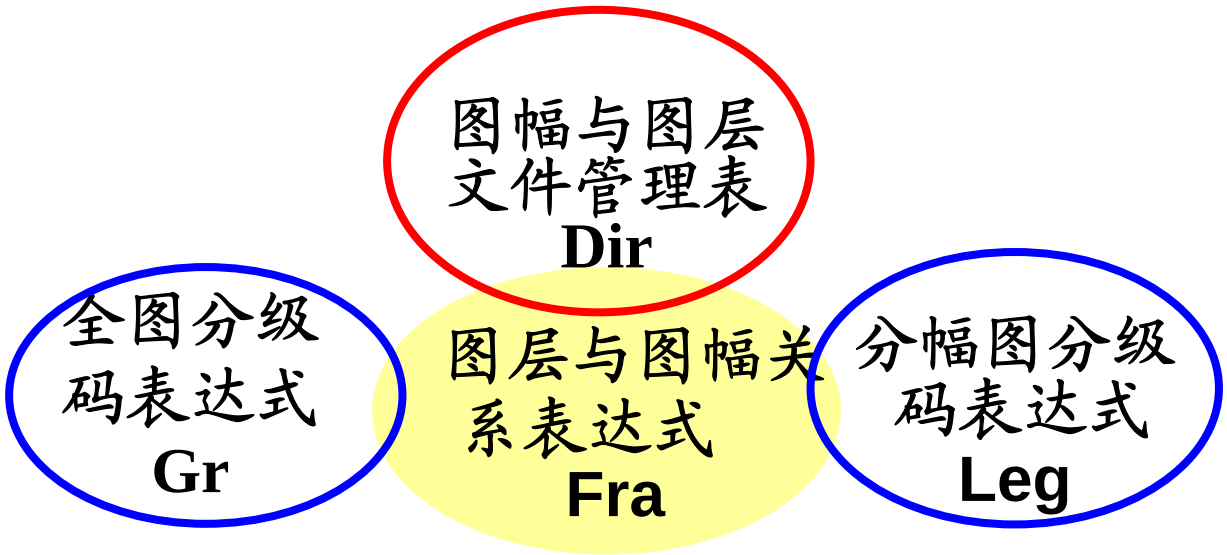
21: Xn
土类整合模型



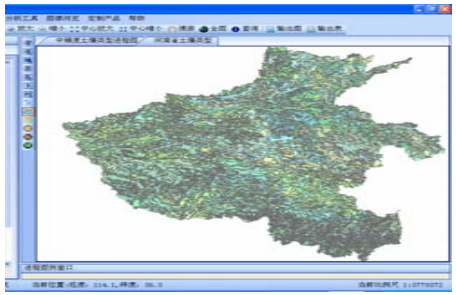


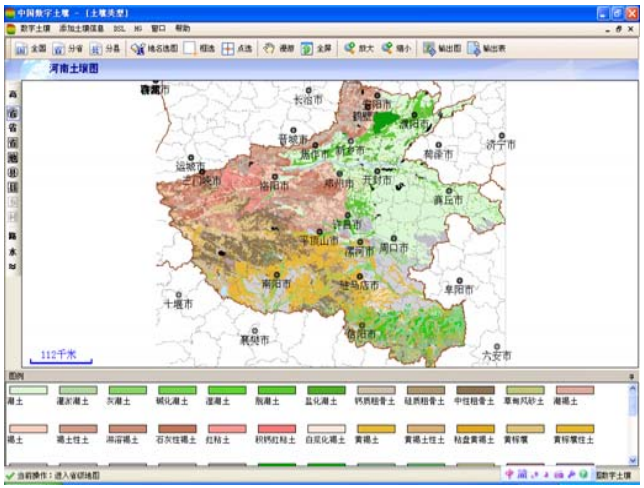
soil geo-data base interface

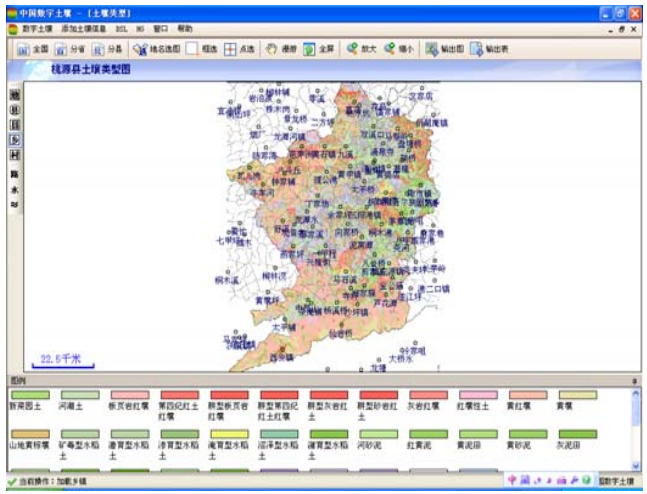
- contains 4 normalized documents
- be able to characterize specialties and differentia of each intermediate and the final product exactly.



By using soil geo-data base interface, a series software tools for data processing were developed

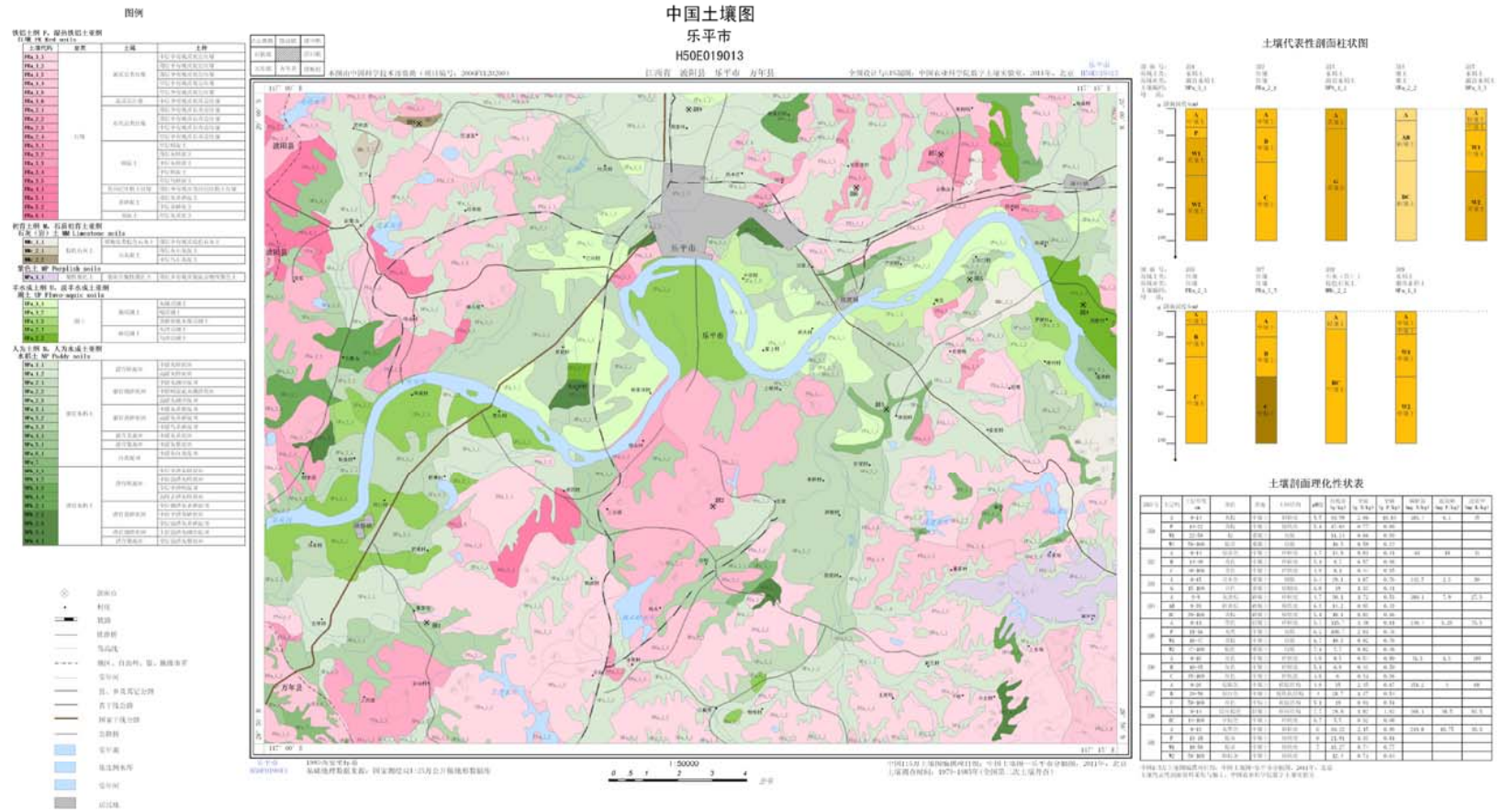






3. Development of China soil geo-data base at 1:50,000 scale based on legacy soil data

Now: integrated 1218 counties



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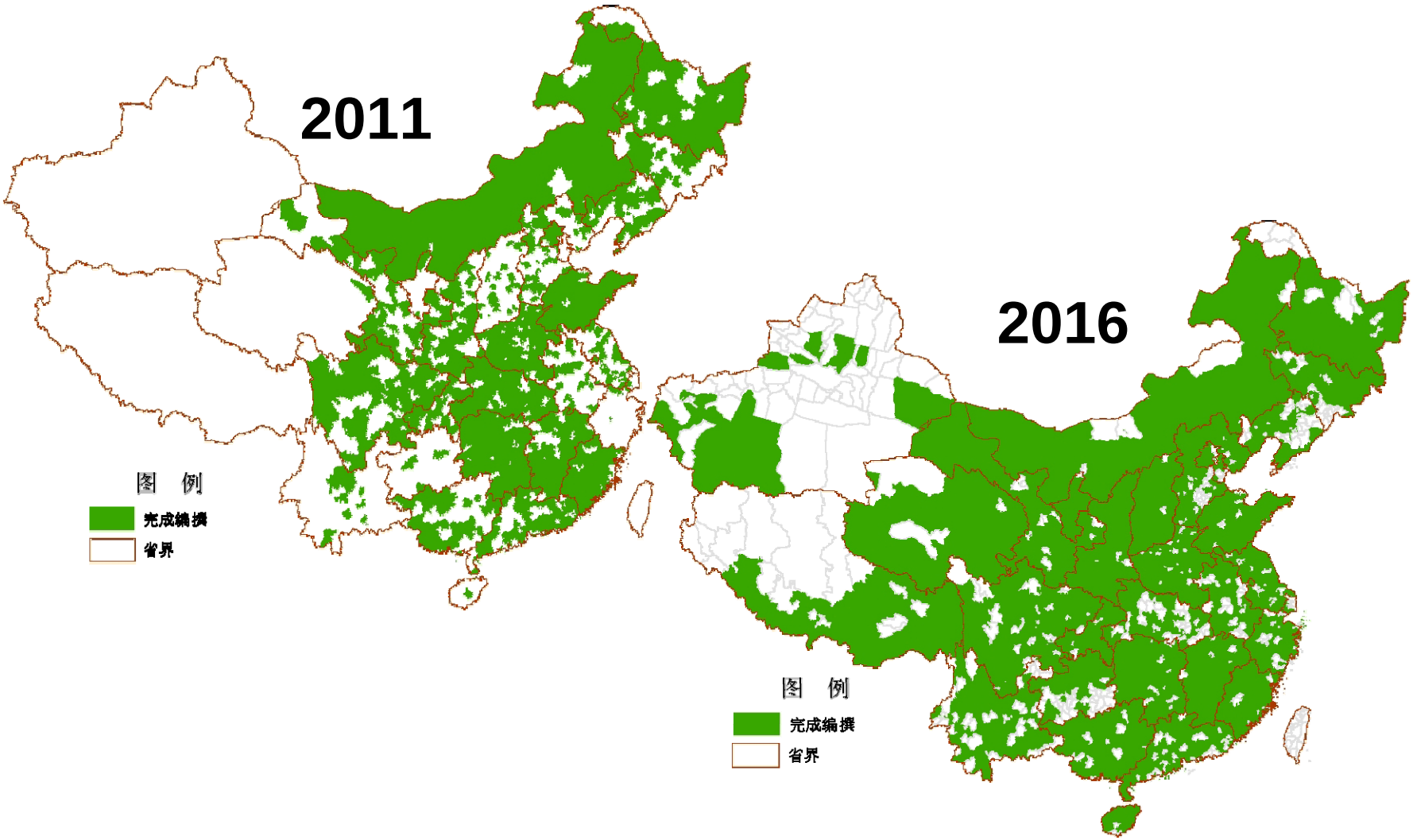


w17 wlzhang, 2011-10-20

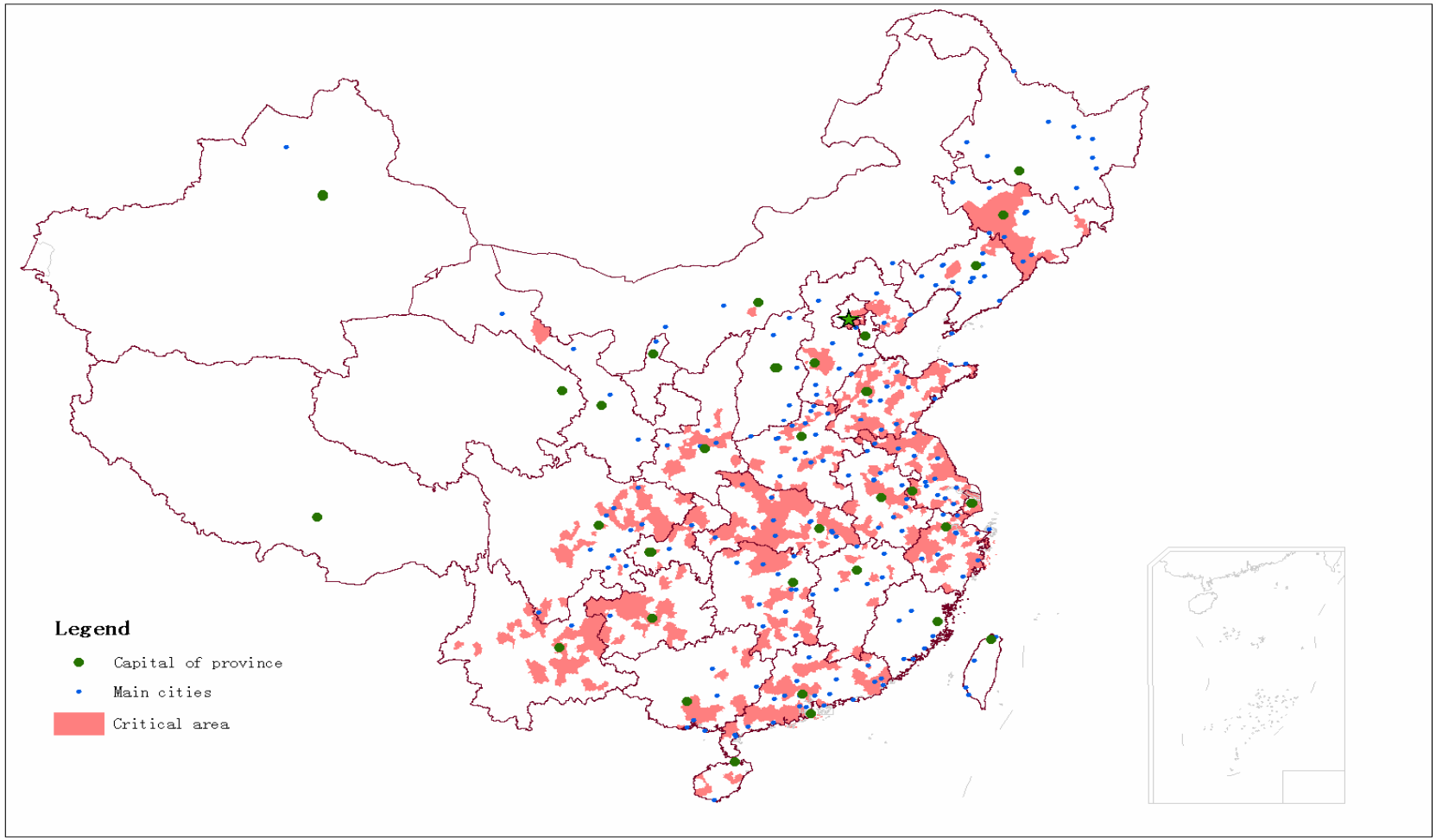
Data share

up to now: already supplied to 23 provinces, 1218 counties and dozens of universities and research institutes

- **Land soil quality evaluation**
- **Nutrient and fertilizer management**
- **Water pollution study**
- **Air pollution study**

2013: Partly internet opening

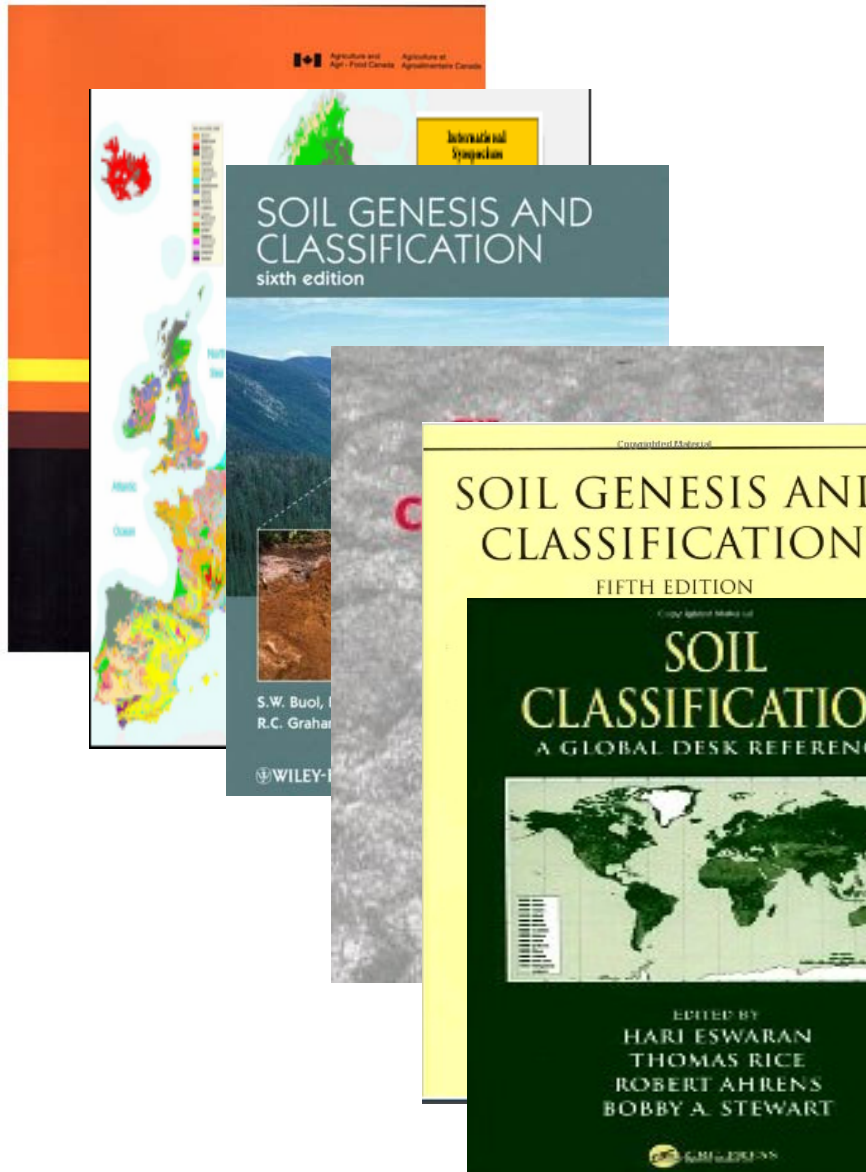
High risk Regions of groundwater Nitrate in China evaluated by use of China soil geo-data base at 1:50,000 scale



4. Discussion:
Revision of China soil classification system

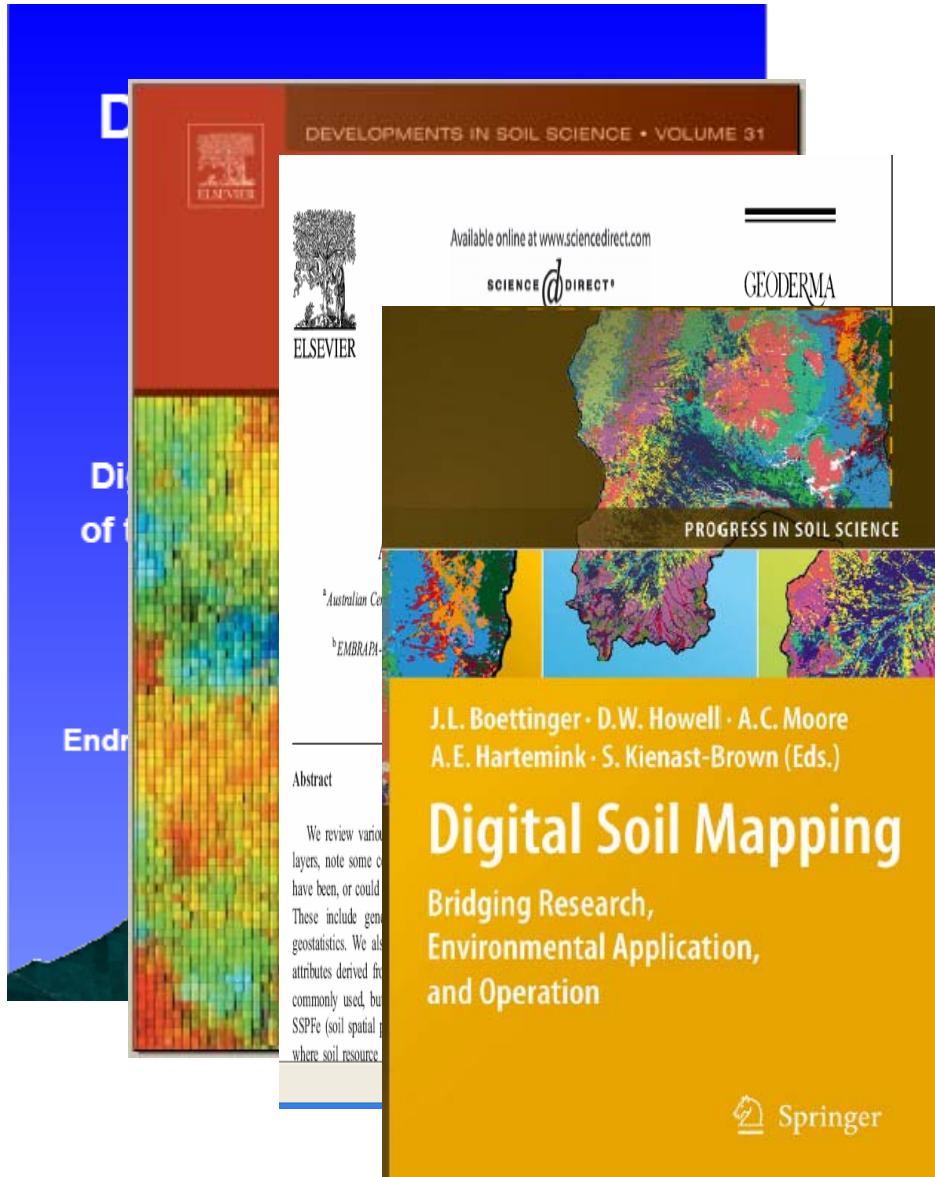
♦ Importance

- 《 Soil Classification 》
  2001, European Soil Burean
- 《 Soil Genesis and Classificatio
  5th 6th Edition 2003,2010, Buol
- 《The Canadian System of
  Soil Classification》
  3rd edition, 2011
- 《 Soil Taxonomy》 USDA,
  Second Edition, 1999
- 《Soil Classification: A Global
  Desk Reference》, 2003
- Australian Soil Classification



Digital Soil Mapping

- 《Digital Soil Mapping》 EU Digital Soil Mapping WG, 2005，262页
- 《Digital Soil Mapping, An Introductory Perspective》 2007, 659页
- 《Digital Soil Mapping Bridging Research, Environment Application, and Operation》 2010，462页
- On digital soil mapping McBratney, Geoderma 2003



The 2nd national soil survey of China

Classification system	State issued (3rd edition)	Existing
Great group	61	**312**
Sub group	229	**1872**
Species/Family	663	**15600**
Variety	3000	**62400**

Comparison of current soil classification system of different country

System	China (issued)		USA		Germany	
	Nr.	Exam.	Nr.	Exam.	Nr.	Exam.
Order	**12**	钙层土	12	**Entisols**	**4**	**Terrestrische Böden**
Sub order	**31**	半干暖温钙层土	60	**Fluvents**	**21**	**Schwarzerden**
Great group	**61**	栗褐土	270	**Torrifluvents**	**56**	**Kalktschernosem**
Sub group	**229**	潮栗褐土	2500	**Typic Torrifluvents**	**220**	**Braunerde-Kalktschernosem**
Family/species	**663**	轻壤质洪淤土	—	**(Multiple) Fine-loamy, mixed,superactive,calcareous, mesic**	—	**(40 items) md, mr, o, n, u， d, k, e, v, ku**
Variety/ Series	**3000**	厚粘体轻壤洪淤土	**19000**	**Jocity Youngston**		

Soil classification system

System	China (issued)		USA		Germany	
	Nr.	Exam.	Nr.	Exam.	Nr.	Exam.
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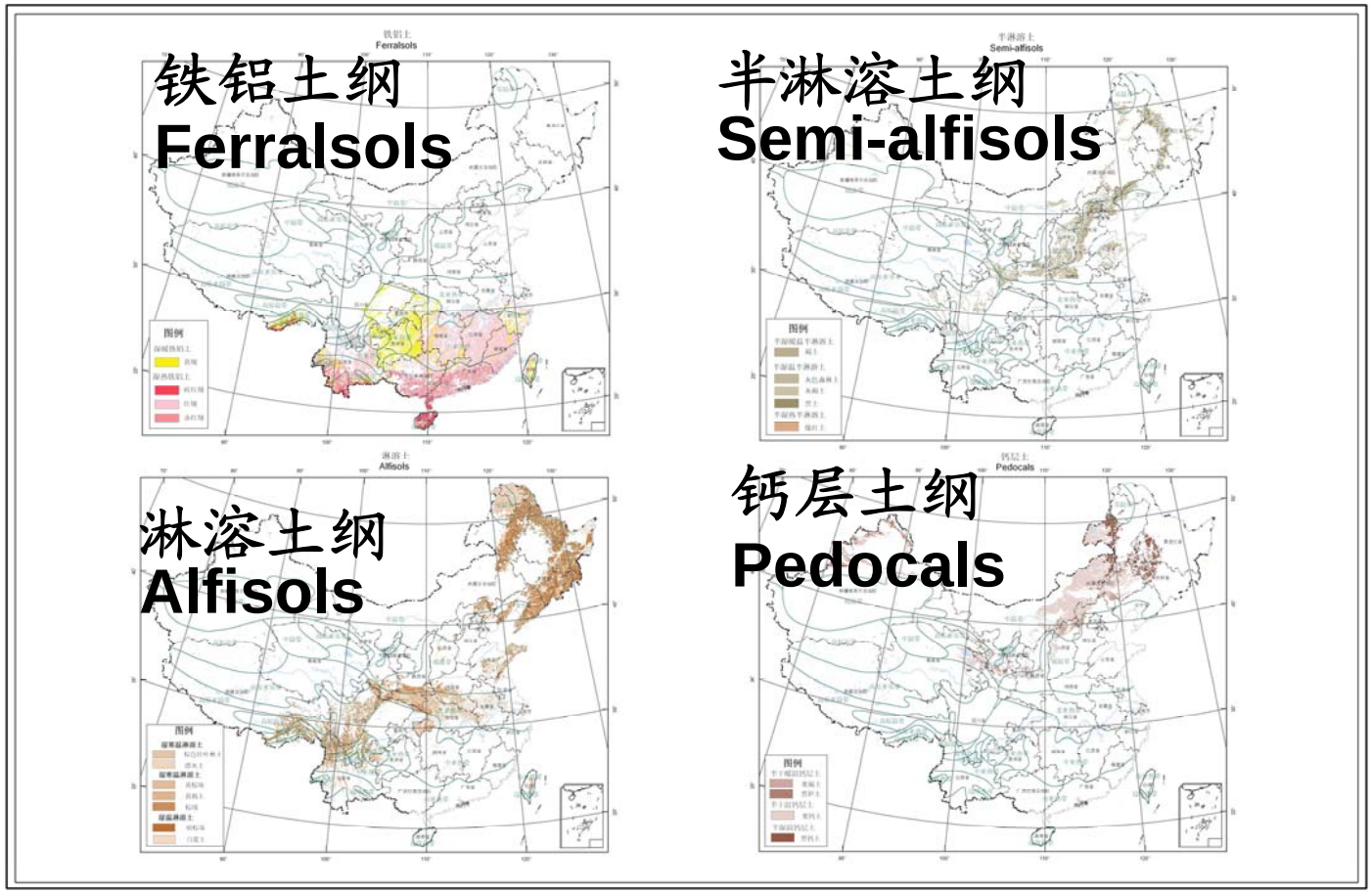
USA: Formative element

Order	12
Sub order	28
Great group	57

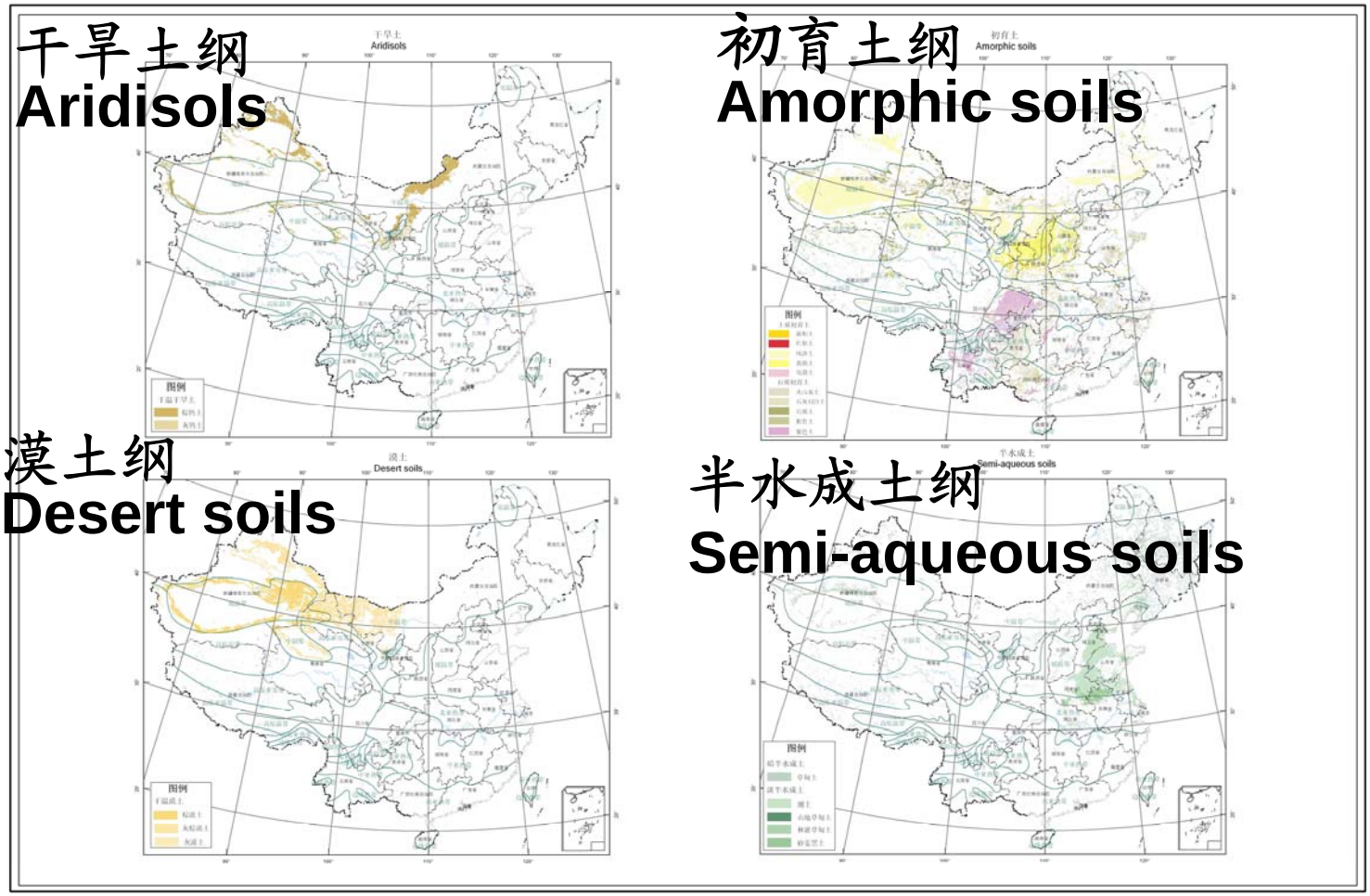
Basic thoughts for revision

1. Soil classification system should be not more complicated for soil scientists to distinguish the main soil forming process
2. Upper classes should focused on main soil forming process or elements



铁铝土	热带、亚热带，多雨，脱硅富铁铝风化
淋溶土	热带至寒温带林区，游离石灰遭充分淋洗
半淋溶土	亚热带至温带，弱淋溶，处于脱钙阶段，土体尚含游离性石灰
钙层土	温带、暖温带，半干旱与半湿润区草原土壤，腐殖质累积，有明显积钙层

中国土纲分布图(二)
Soil Order Maps of China (2)

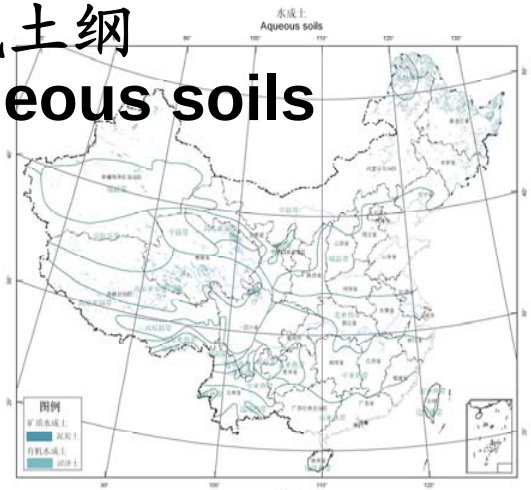


中国农业科学院农业资源与农业区划研究所数字土壤实验室编制　　比例尺：1:20,000,000

干旱土	干旱，年降雨量100～300mm
漠土	极端干旱，年降水量仅50～100mm
初育土	处于成土初期的土状物质，基本为母质，无B层，有机质累积微弱
半水成土	地下水升降活动频繁

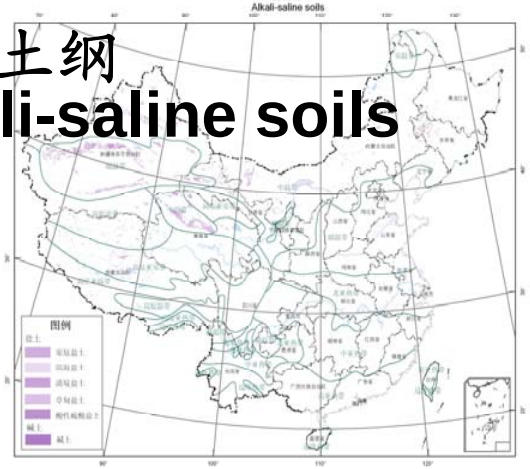
中国土纲分布图(三)
Soil Order Maps of China (3)

水成土纲
Aqueous soils

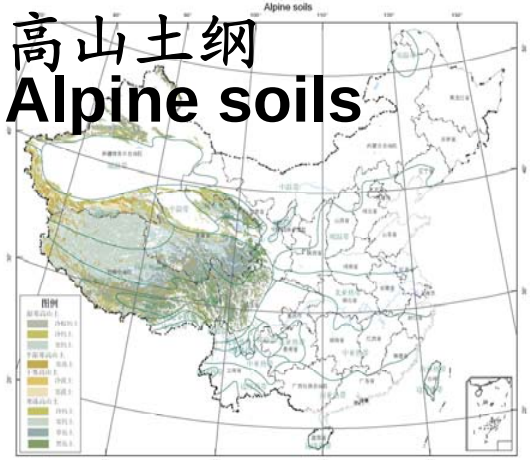


人为土纲
Anthrosols

盐碱土纲
Alkali-saline soils

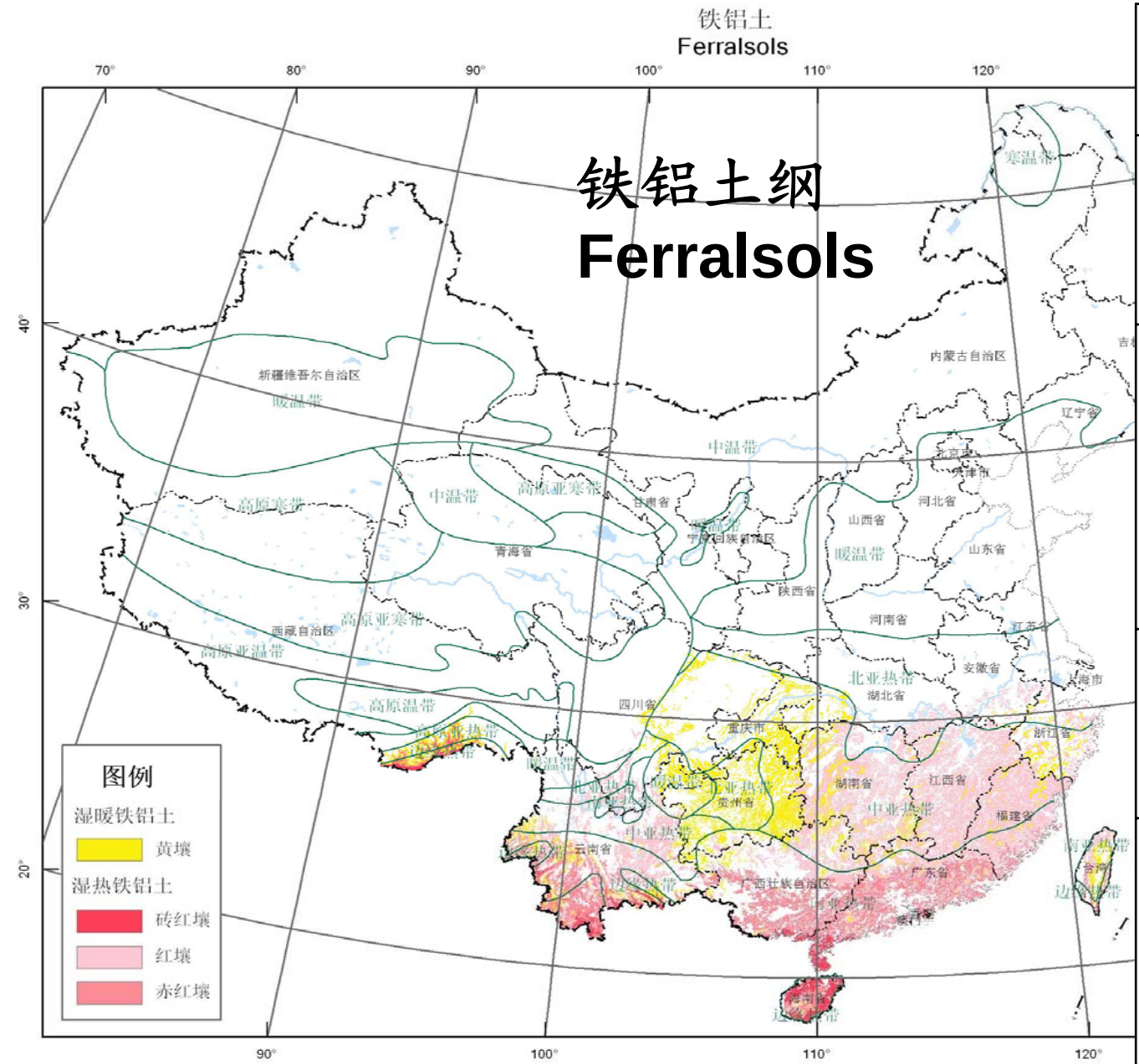


高山土纲
Alpine soils



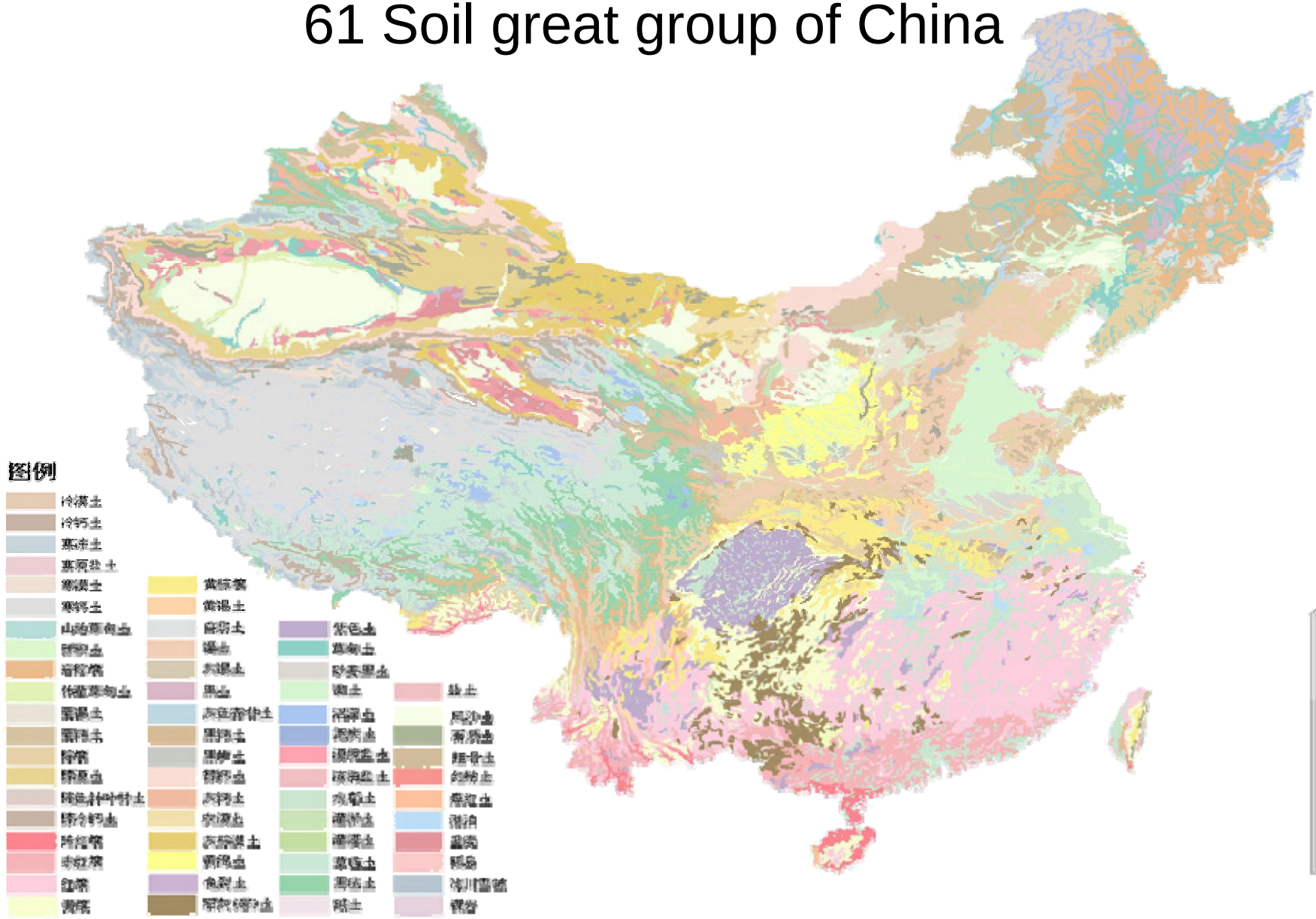
中国农业科学院农业资源与农业区划研究所数字土壤实验室绘制　　比例尺：1:20,000,000

半水成土	地下水升降活动频繁
盐碱土	土壤盐分累积或交换性钠含量高
人为土	长期人为生产活动，引起土壤性质发生了质的变化
高山土	青藏高原



土类	主要特征
砖红壤	热带雨林、季雨林下，强烈脱硅富铝风化
赤红壤	南亚热带季雨林，脱硅富铝风化程度仅次于砖红壤，比红壤强
红壤	中亚热带绿阔叶林，中度脱硅富铝风化
黄壤	亚热带湿润条件，多见于700—1200m山区，中度富铝风化

61 Soil great group of China



Basic thoughts for revision

1. Soil classification system should be not more complicated for soil scientists to distinguish the main soil forming process
2. Upper classes should focused on main soil forming process or elements
3. **Upper classes should remain certain stability.**
4. **Under classes (related with functional properties) tend to be described quantitatively or classified to grades to satisfy demands on soil information in future. Just try to keep original description.**

40 indexes of soil family in Germany

	Index	Code		Index	Code
Humusform	(Mull)x	mu	Färbung	braune(r)	b
	(Moder)	mo		graubraune(r)	gb
	(Rohhumus)	ro		graue(r)	gr
	(Tangel)	ta		rötliche(r)	rt
	(Feuchtmull)	mf	Ausfäll.	eisenreiche(r)	ei
	(Feuchtmoder)	md		sulfatreiche(r)	sf
	(Feuchtrohhumus)	mr		verfestigte(r)	vf
	(Anmmor)	o	geogen	(Organo) 1	og
	(Niedermoor)3	n		kalkhaltige(r) 1 x x	c
	(Übergangsmoor)3	u		salzhaltige(r) 1	z
	(Hochmoor)3	h	weit. pedog. Merkm.	nassgebleichte(r)	i
Basizität	basenreiche(r)2x x x	eu		humusreiche(r)	x
	mittelbasische(r)2x x x	m		podsolige(r)2	p
	basenarme(r)2x x x	dy		lessivierte(r)	l
Wasserhaush.	pseudovergleyte(r)2	s		verfahlte(r)	d
	vergleyte(r)2	g		kolluviale(r)1x x x	k
	(Auen)	a		erodierte(r)x	e
	reliktische(r) (entwässerte(r))	r	Nutz.	(Acker)1	v

Revision of China soil classification system

Category	State Issued	Existing	Revised
Order	12		12
Sub order	31		31
Great group	61	312	61
Sub group	229	1872	800
Species/Family	663	15600	11000
Variety	3000	62400	48000

Main contributions of China soil geo-data base at 1:50,000 scale: 16 institutes together

Main works of the team in future

1. **Finish whole data base**
2. **Develop soil property data important for crop production and food security**
   - **Soil texture (for crop nutrient management etc.)**
   - **Soil features for irrigation equipments and agricultural machines by use of soil morphological and other property,**

Thanks !

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