矿山生态安全教育部工程研究中心
Engineering Research Center of Mining Environment & Ecological Safety, Ministry of Education

土地复垦与生态重建研究所
Institute of Land Reclamation and Ecological Restoration

NEW SOIL RECONSTRUCTION METHOD FOR RECLAIMING SUBSIDED LAND WITH YELLOW RIVER SEDIMENTS

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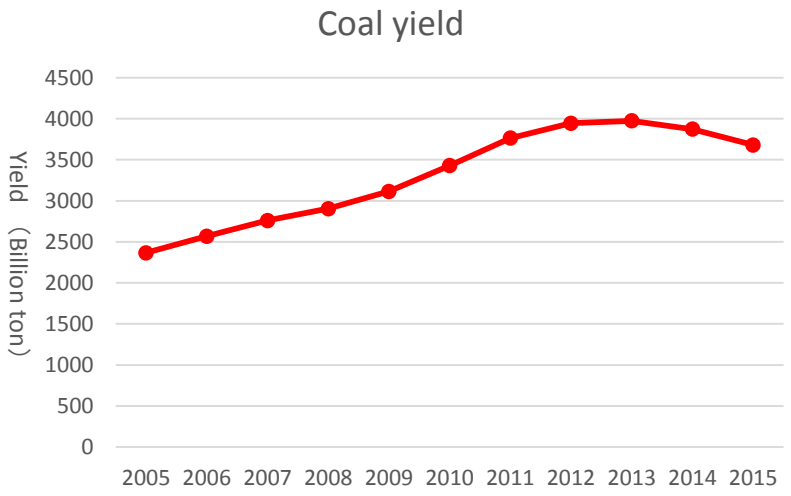
National Key Technology Research and Development Program (2012BAC04B03)

中国矿业大学（北京）
China University of Mining & Technology, Beijing

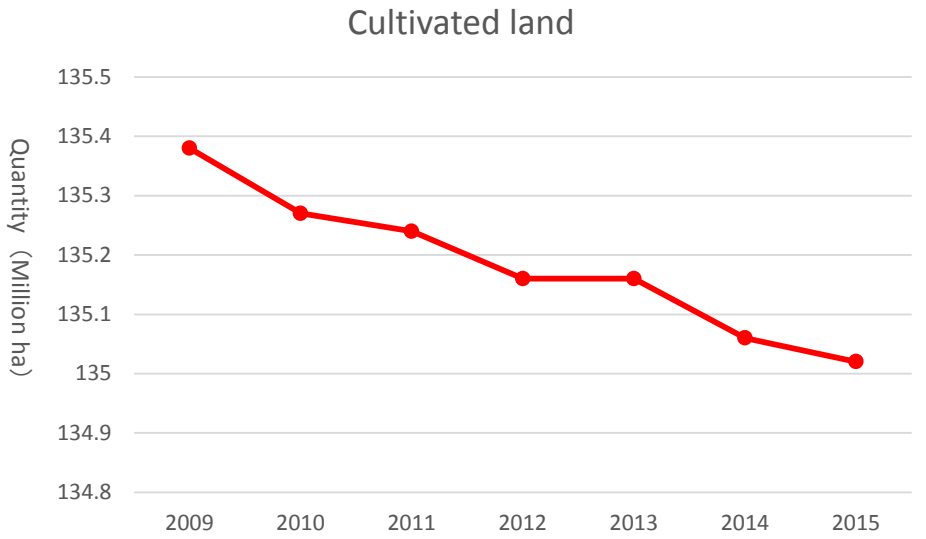
Outline

- ✓*Background*
- ✓*Problems of filling reclamation*
- ✓ *A new reconstruction method for reclaiming subsided land with Yellow River Sediments*
- ✓*Conclusions*
- ✓ **Information about the 2nd International Symposium on Land Reclamation and Ecological Restoration in October**

1. Background



Coal yield and growth rate from 2005 to 2015 in China



Cultivated land quantity variation from 2009 to 2015 in China

Coal is the most important resource in China, accounting for about 70% of energy consumption.
China's coal output was 3.68 billion tons in 2015.
About 90% was from underground mining.

Damaged land due to mining subsidence

- **Subsidence: over 1 million hectare of subsided land; 70 thousands ha of land is subsided every year (estimated in 2011)**

Coal Mining and Mining Subsidence in China

Eastern China

Relatively Flat Terrain

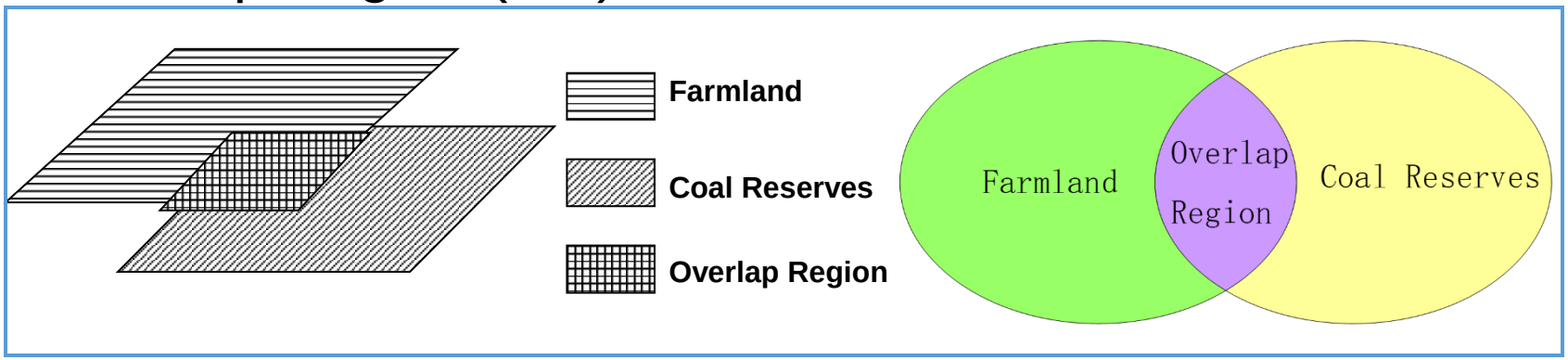
High Quality Farmland

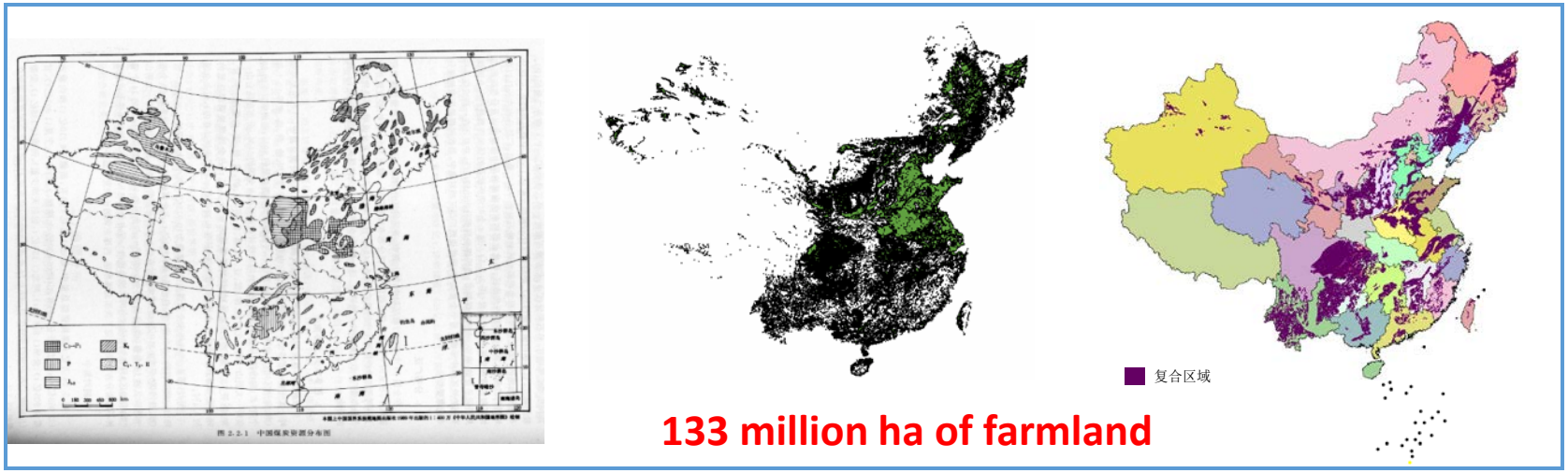
High Underground Water Table

Created many lakes and wetlands, 85% of which was cultivated land before mining

Coal Mining and Mining Subsidence in China

The Overlap Region (OR)





PROVEN COAL RESERVES | FARMLAND DISTRIBUTION | OVERLAP REGION

Overlap Region (OR) covers about 10.8% of the farmland in China

Reclamation of farmland is extreme important in China

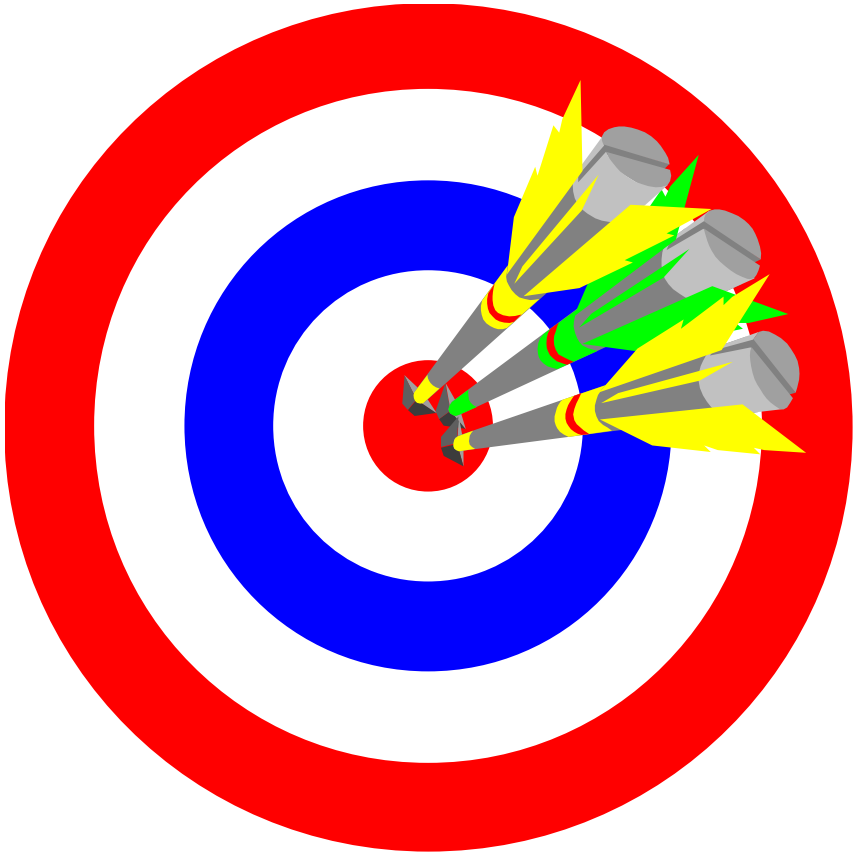
Problem:

- ***Large overlapping areas of crop and coal production base, a lot of prime farmland damaged or to be damaged***
- ***high density population***
- ***Shortage of land is serious***

It's very urgent to restore farmland as much as possible!!

In General,

Farmland Reclamation

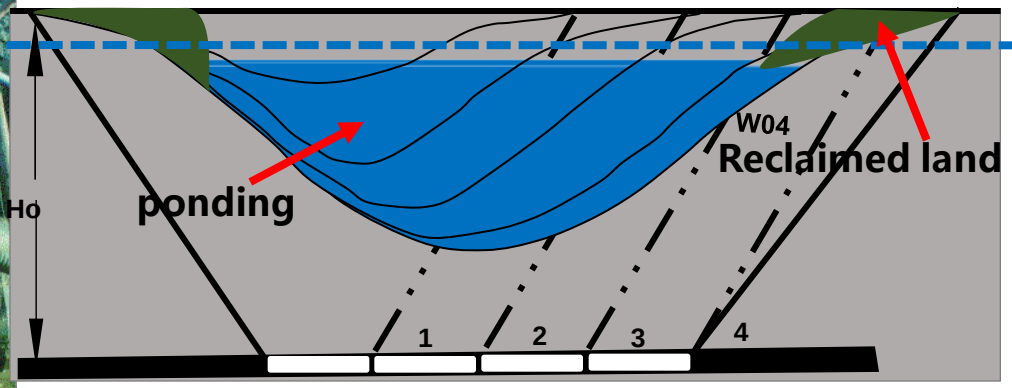


has become an urgent task in China

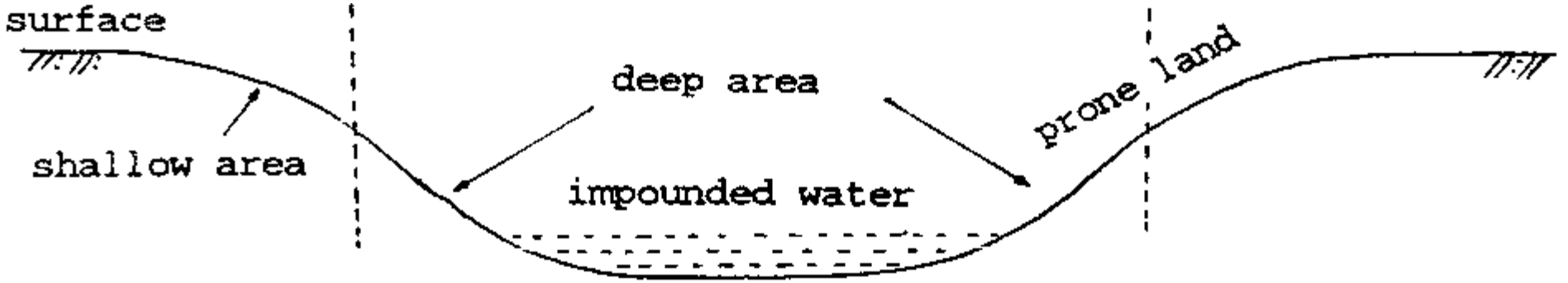
2. Problems of filling reclamation

Subsidence land reclamation in China: non filling and filling reclamation

Traditional non-filing reclamation could restore less farmland due to high ground water lever and a lot of land sink into water



Traditional reclamation



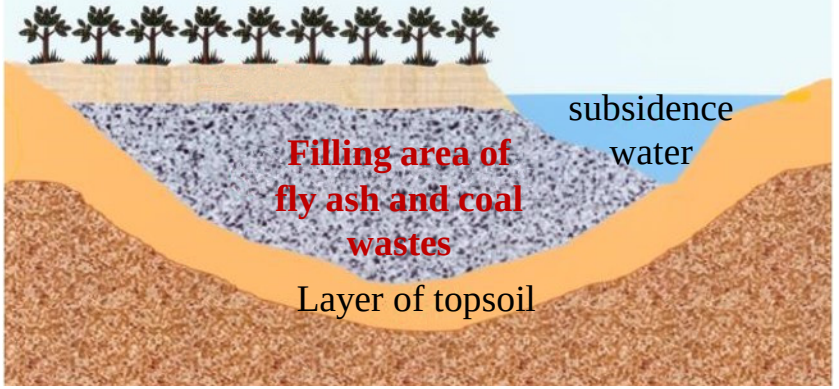
2. Problems of filling reclamation

Filing reclamation is an effective measure to restore much more land (more than 90% farmland)

Filling reclamation with coal wastes

Filling reclamation with fly ash

Land reclamation diagram in the coal mining subsidence area



Disadvantage of *filling reclamation with coal wastes and fly ash*

- *Filling reclamation needs lots of reclaimed materials, but coal wastes and fly ash has been almost recycled in coal mine area now, there are no enough reclaimed materials*
- *The heavy metal contained in reclaimed materials may cause pollution on the quality of crop products, soil, surface water and underground water*

Filling reclamation with coal wastes

Try to find good and enough filling materials.

YELLOW RIVER

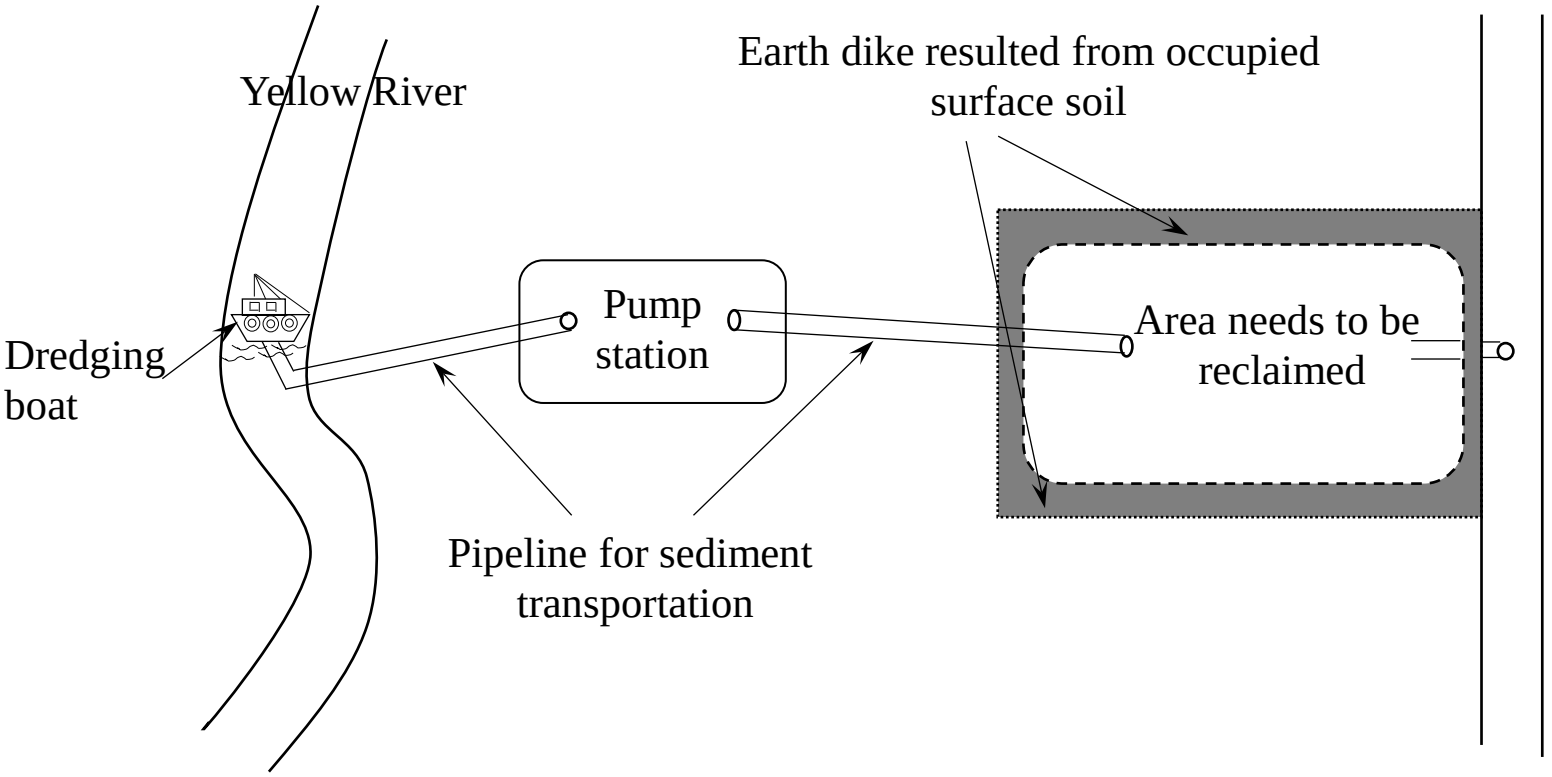
The sediment concentration in Yellow River water is high, and Yellow River has become a river on the ground, which seriously threaten the life and property safety of the masses along the river

Therefore, Yellow River sediments could be the potential filling materials for reclaiming subsidence land

Advantage of *filling reclamation with Yellow River sediments*

- *enough sediment*
- *Less risk of pollution*
- *Increase farmland significantly*
- *Reduce the elevation of Yellow River bed, improve the river's flood control, turn the wastes to useful materials*

Process of one-time filling reclamation of mining subsidence land with Yellow River sediment.



The technical process of one-time filling reclamation of mining subsidence land with Yellow River sediment.

Wheat field(normal control farmland)

Wheat field(reclaimed farmland)

Grow well

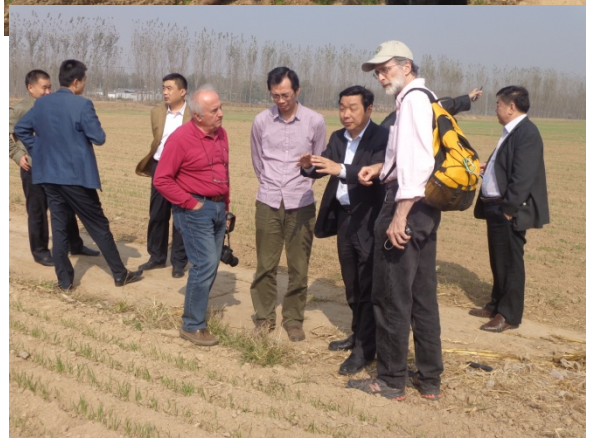
50% yield

Grow bad (not enough thickness of covering soil)

Treatments	Serial number	Plant number per square meter	Grain number per plant	Plant height per plant/ (cm)	Root length per plant/ (cm)	Dry weigh per plant (g)	Thousand kernel weight (g)	Estimated yield/ ($kg \cdot hm^{-2}$)
Control farmland	1	635	38.37	70.9	76	2.59	29.8	7365.9 a
	2	598	39.96	72.7	82	2.59	30.14	
	3	613	40.07	71.6	84	2.7	30.58	
	4	625	39.3	73.1	86	2.88	-	
	5	604	40.67	71.4	81	2.48	-	
	Mean	615 a	39.67 a	71.94 a	81.8 a	2.65 a	30.17 a	
	Standard deviation	13.52	0.78	0.83	3.37	0.14	0.32	
Reclaimed farmland	1	515	20.67	59.3	50.24	1.51	27.74	3551.7 b
	2	570	18.37	54.71	42.46	0.89	27.88	
	3	566	25.93	67.99	58.4	2.12	27.7	
	4	553	18.35	55.28	46.5	1.06	-	
	5	537	21.14	62.43	51.48	1.95	-	
	Mean	548.2b	20.89b	59.94b	49.82 b	1.50b	27.77b	
	Standard deviation	20.21	2.77	4.91	5.32	0.48	0.08	

WHY?

Soil properties of reclaimed land filled with Yellow river sediments



Normal control farmland

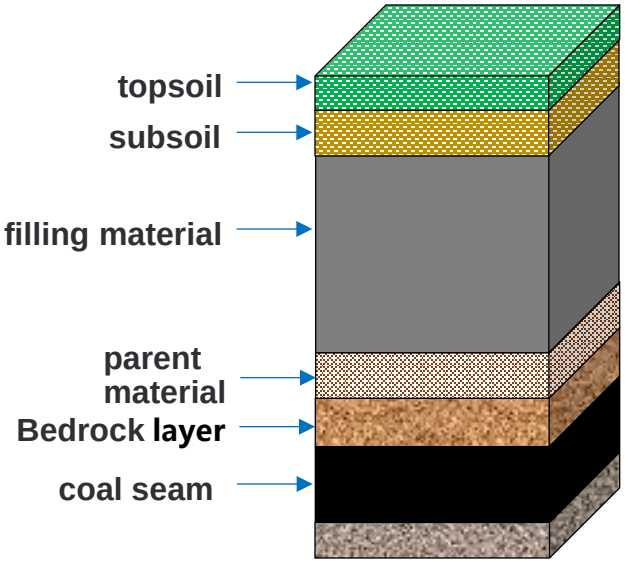
Reclaimed farmland

Soil profile pattern is the KEY

Problems of traditional filling reclamation method

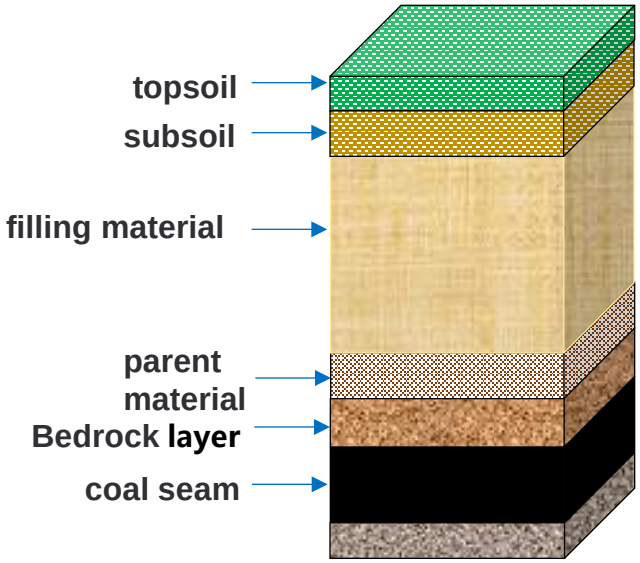
Traditional filling reclamation method was: 1) stripping the soils to be reclaimed land; 2) filling the subsided land materials at once; 3) backfilling the soils. This kind of **simple soil profile is an unfavorable profile type in pedology**, **resulting in poor productivity.**

Filling reclamation with coal wastes



pollution risk

Filling reclamation with Yellow River sediment



limited capacity to retain water and nutrients

Diagram of Traditional filling soil-sediment profiles

3. A new reconstruction method for reclaiming subsided land with Yellow River Sediments

Multilayered soil profiles were favorable for maize growth, water-holding and storage capacity and nutrient preserving capability.

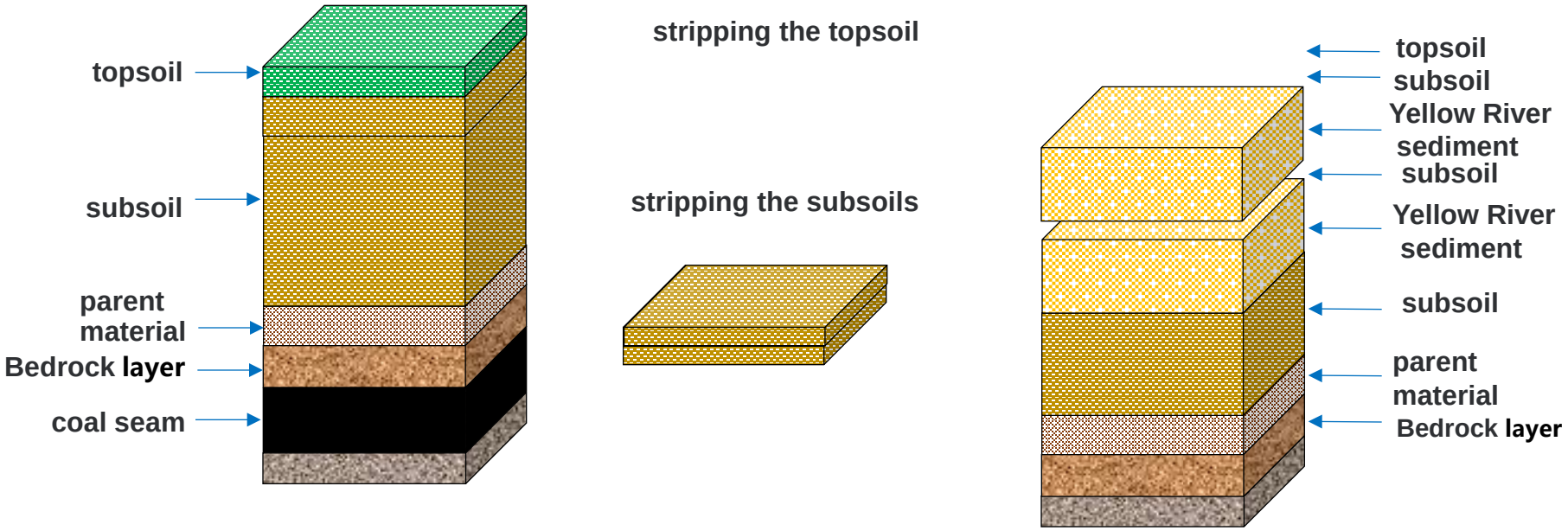
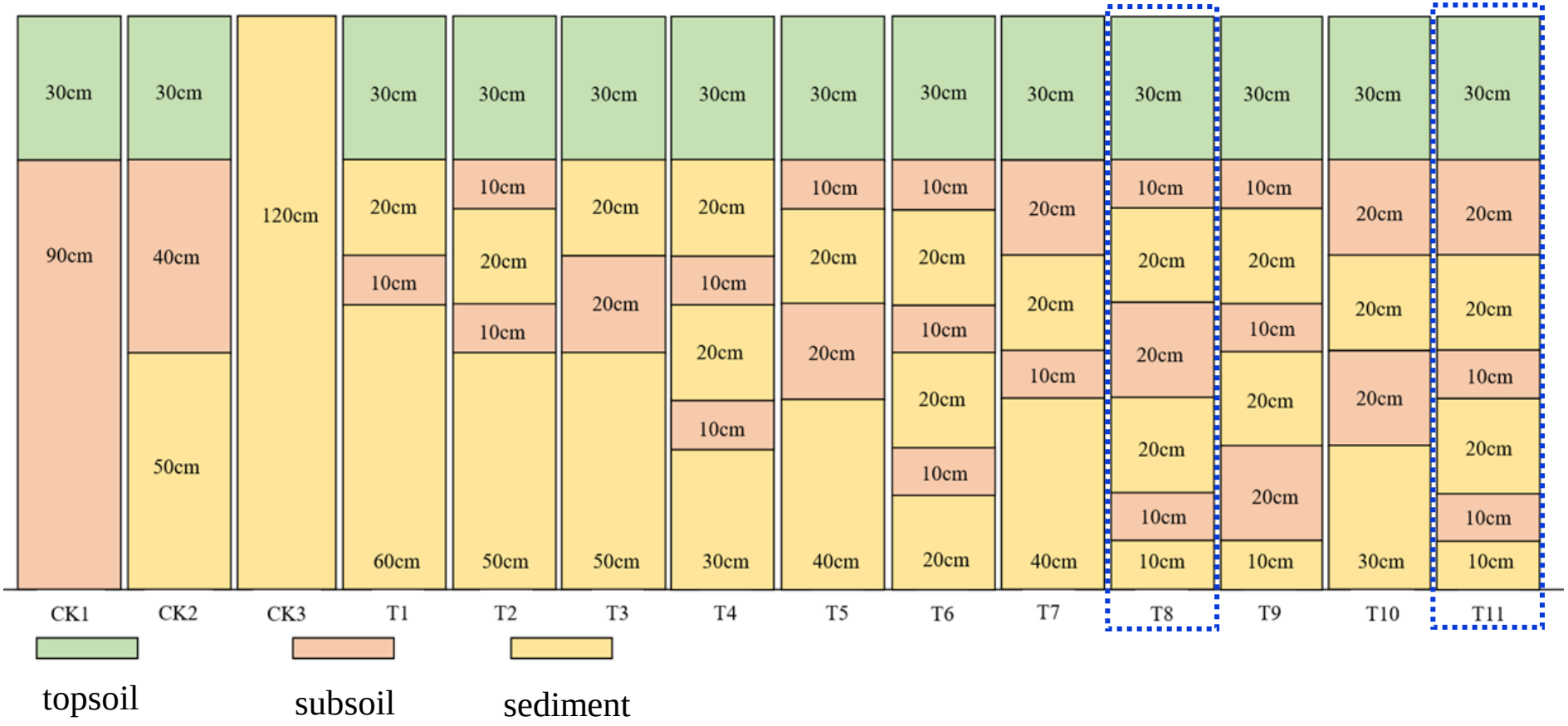


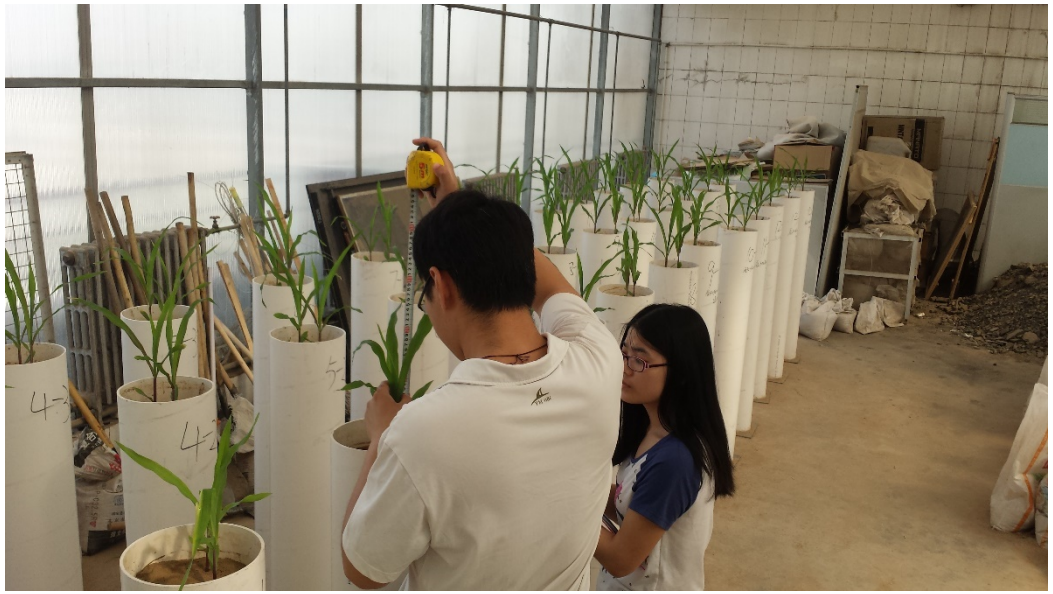
Diagram of multilayered soil-sediment profiles

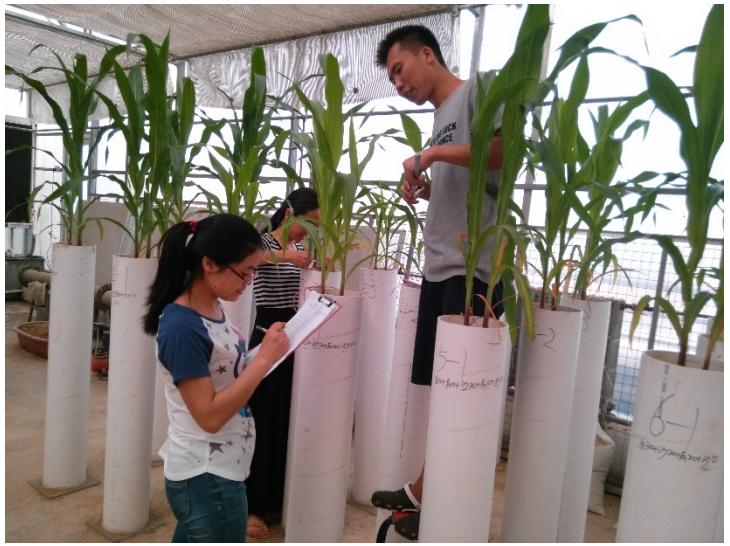
Laboratory simulation test

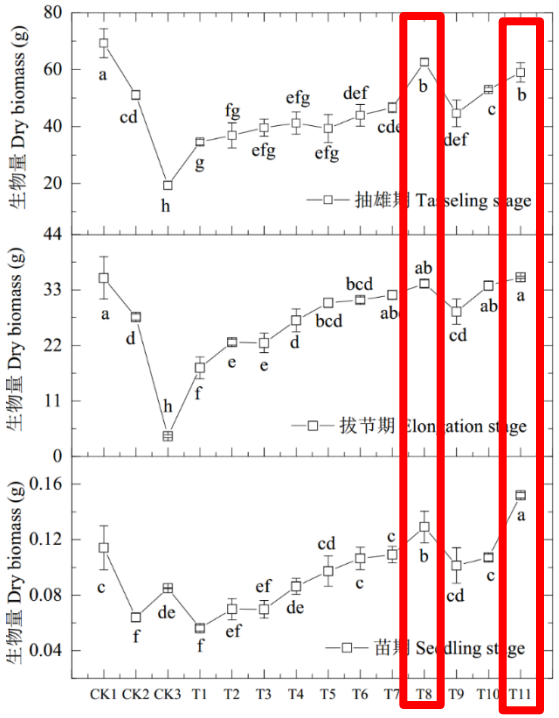


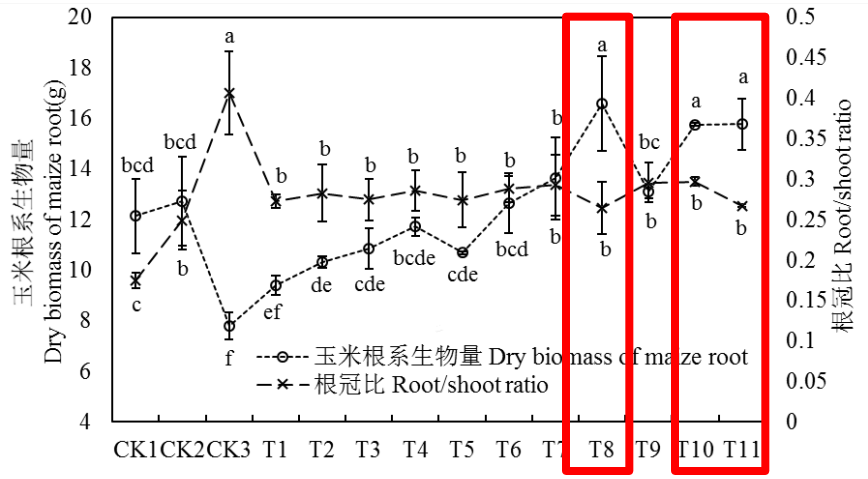
laboratory simulation test design of different multilayered soil-sediment profiles

Joint training a Ph. D student with Prof. Kevin McSweeney (UIUC)









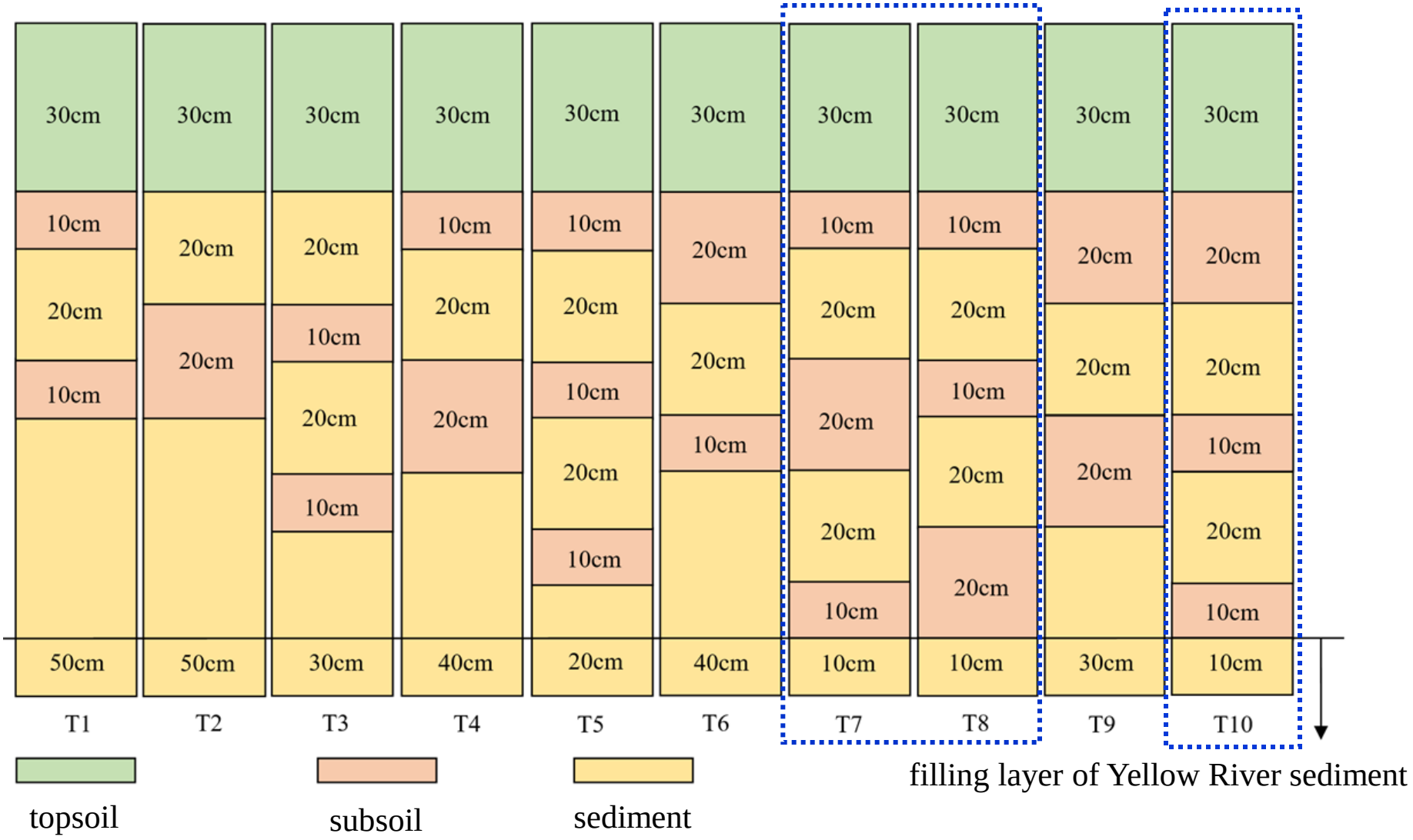
Results and Discussion：Compared to CK2 (traditional soil reconstructed profile, i.e. filling materials of Yellow river sediment cover with 70cm soil), T8 and T11 had an increase of 22.60%, 15.50% for plant growth, respectively.

Compared to CK1, T8, T10, T11 had an increase of dry biomass of root system at 36.64%, 29.78%, 29.96%.

The results illustrate that multilayer soil profiles were favorable for maize seed germination and root growth.

- 70cm soil cover
- Multilayer soil profile

Field test



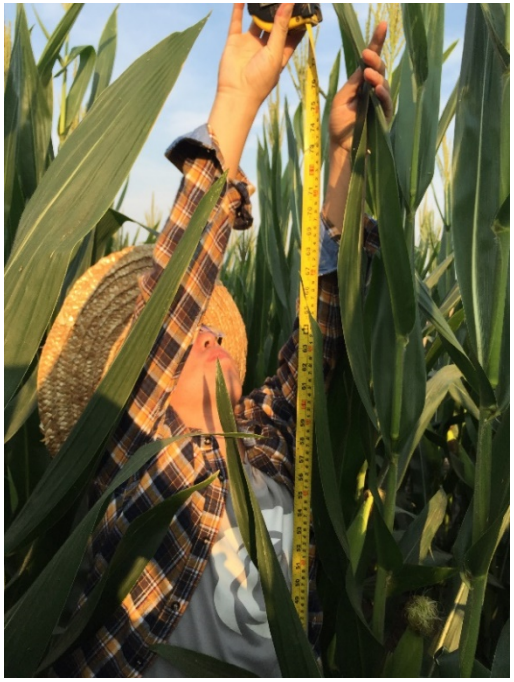
Field test design of different multilayered soil-sediment profiles

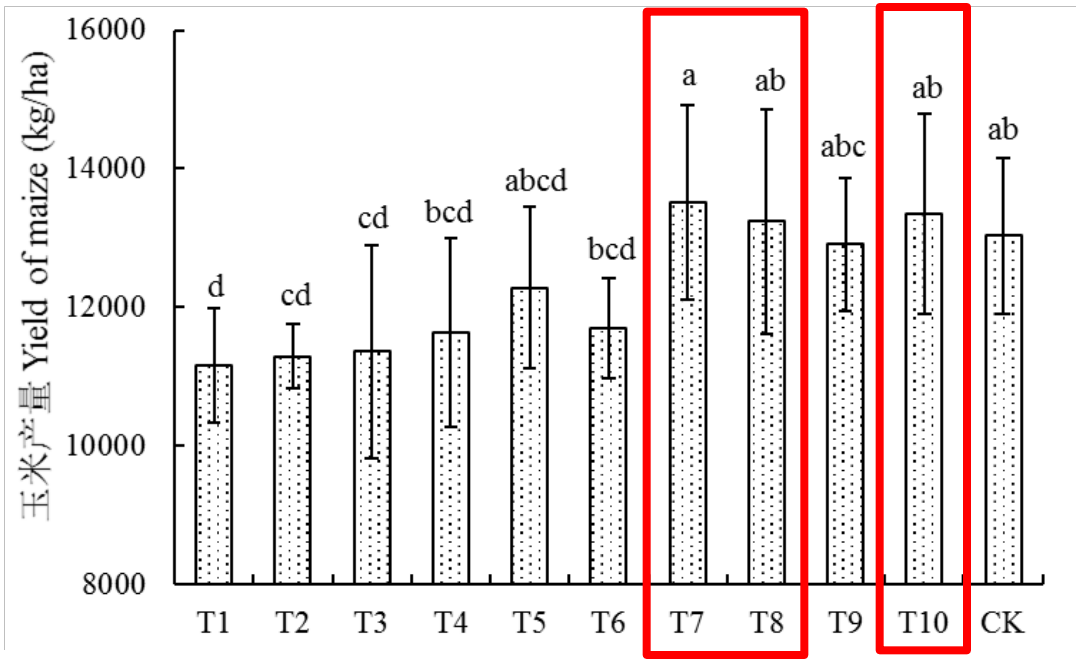
There was no difference between filling reclamation and normal control farmland

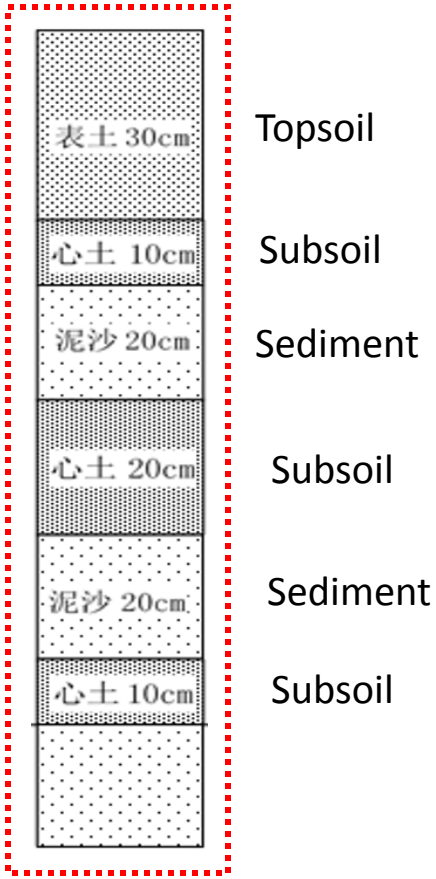
Before filling reclamation

After filling reclamation

normal control farmland







Results and Discussion： Compared to contrast(traditional soil reconstructed profile, i.e. filling materials of Yellow river sediment cover with 70cm soil), T7,T8 and T10 had an increase of 3.68%,1.59%, 2.42% for maize yield, respectively.

T7 is the best

= Laboratory test T8

Laboratory and field test have got the same result.

Process of multiple filling reclamation of mining subsidence land with Yellow River sediment.

A new filling technology is created.

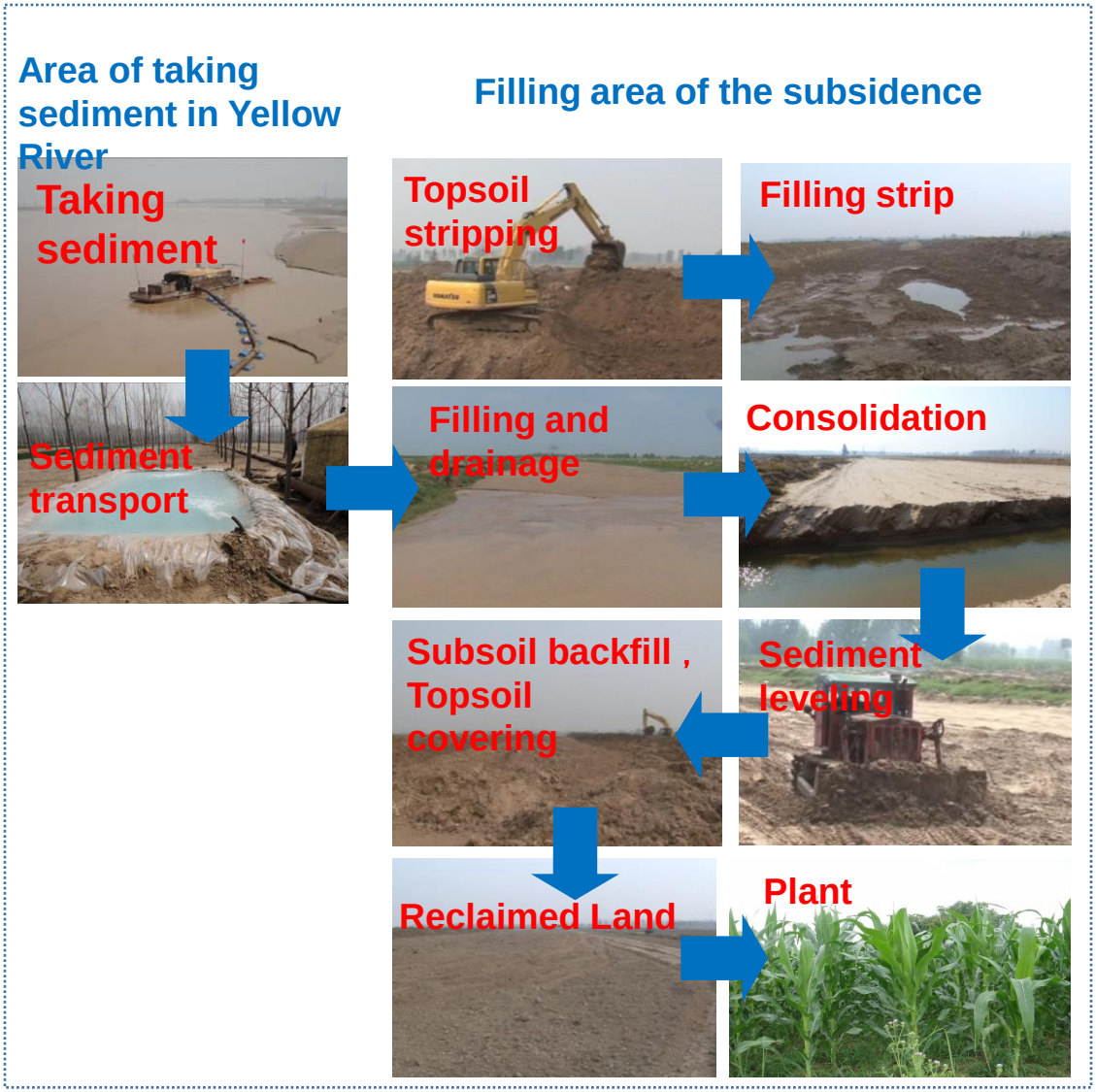
This technology focus on:

soil stripping,

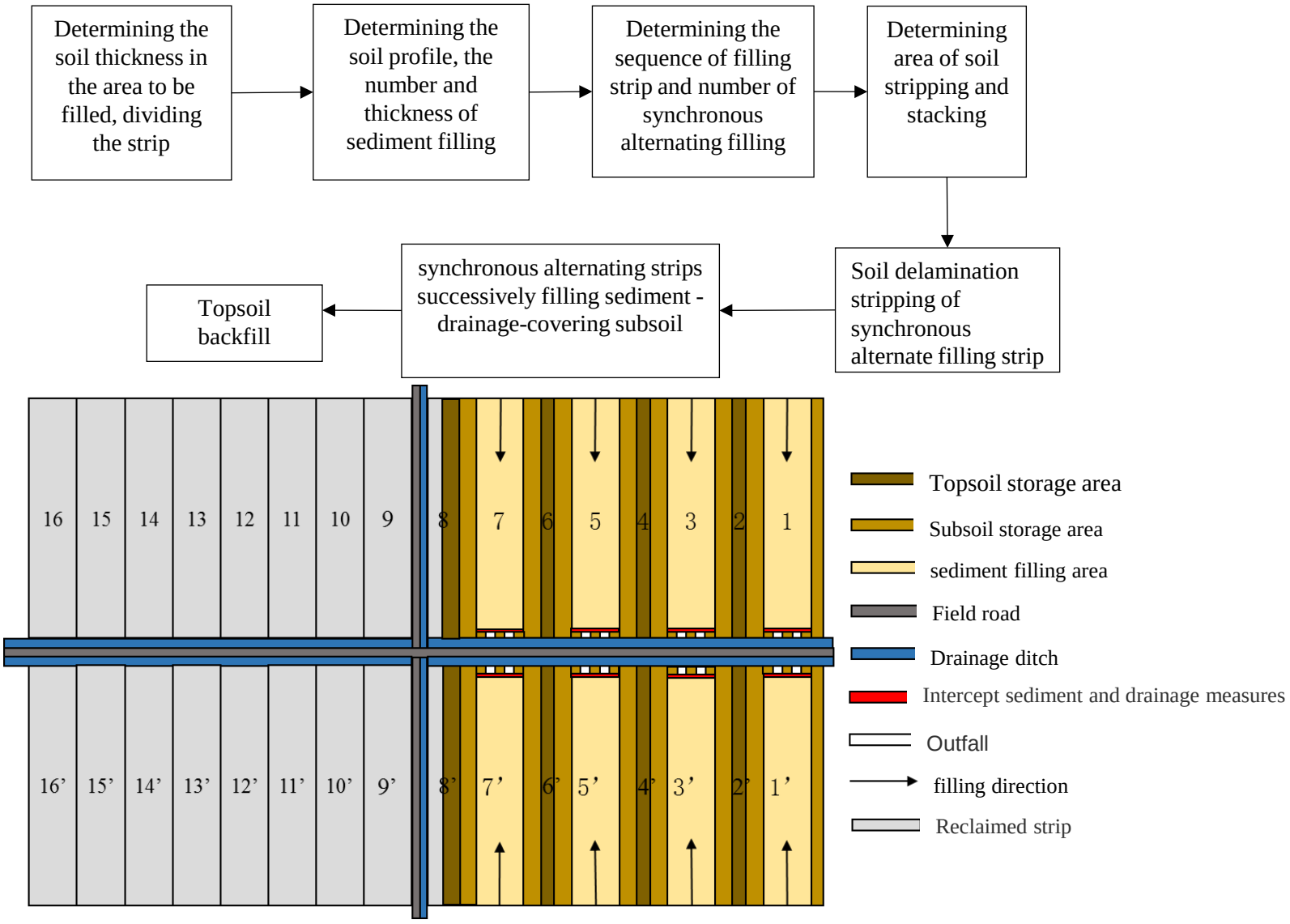
multiple filling,

multiple backfill,

leveling and others



Process of multiple filling reclamation of mining subsidence land with Yellow River sediment.

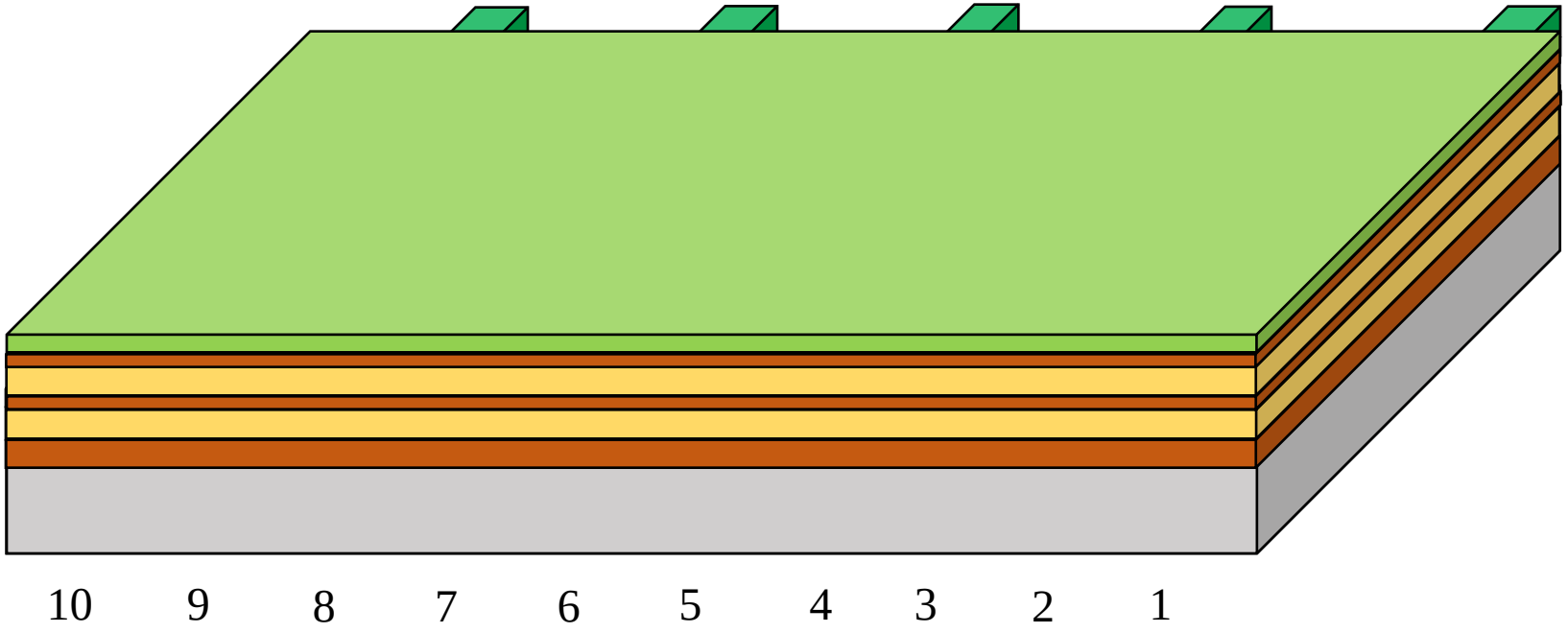


Created by Zhenqi HU, Chinese Patent: ZL201510752726.5

Technology of alternating multiple filling reclamation

synchronous alternating strips successively filling sediment -drainage-covering subsoil

Co Div A s Strip St lay lay lay la **Land leveling** ively alternate filling



Created by Zhenqi HU, Chinese Patent: ZL201510752726.5

4. Conclusions

A new reconstruction method for reclaiming subsided land with Yellow River Sediments is created.

✓For single filling layer, 70cm soil cover is needed.

✓Multilayered soil profiles is benefit for retaining water and fertilizer, resulting in good growth of crops, which is the effective measure to restore high quality farmland for filing reclamation.

✓The technical process for multilayered soil profile is alternating strips and filling, multi-filling.

Welcome to XI'AN to attend our conference

The 2nd International Symposium on Land Reclamation and Ecological Restoration

October 20-23, 2017, Holiday Inn Xi'an Big Wild Goose Pagoda

Theme: Land Reclamation in Ecological Fragile Areas

Host

China Coal Society

China University of Mining and Technology (Beijing)

Organizers

Committee of Land Reclamation and Ecological Restoration, China Coal Society

Xi'an University of Science and Technology

Chinese Ecological Restoration Network (www.ER-CHINA.com)

Co-Organizers

International Affiliation of Land Reclamationists

American Society of Mining and Reclamation

International Journal of Mining, Reclamation and Environment

International Journal of Coal Science & Technology

China Industry Alliance of Mine Environment Restoration

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The 2nd International Symposium on Land Reclamation and Ecological Restoration
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Honorary Chair：
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Zhenqi Hu, China University of Mining and Technology-Beijing

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Raj Singhal, International Journal of Mining, Reclamation and Environment, Canada

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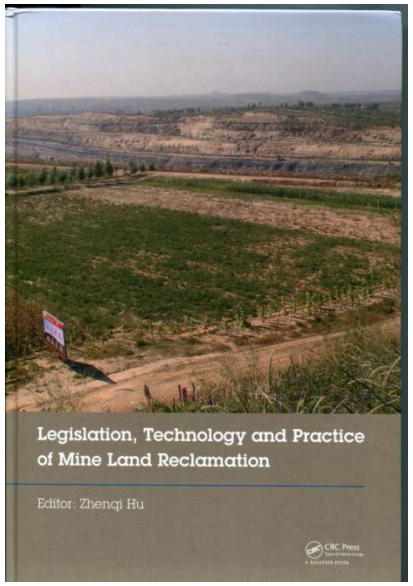
Welcome to XI'AN to attend our conference

The symposium on land reclamation and ecological rehabilitation is a series of international conference, held every three years. The first symposium was held successfully on 16th - 19th October, 2014 in Beijing, China. Nearly 60 foreign scholars from 15 countries and more than 300 domestic scholars to participate the symposium. The deep discussion and communication of mine restoration and land reclamation in China including legislation and practice, technology and theory and so on, promote the development of the mining area ecological environment and land reclamation.

16- 19 October, 2014, Beijing, China



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Major topics covered by the Conference, but not limited, are as follows:

Mining impact on environment
Monitoring, prediction and assessment of mining impact on land environment
Mining methods and measurements to minimize the land and environment impact
Mining and reclamation policies, regulations and standard
AMD treatment
Soil and landscape reconstruction
Revegetation and biodiversity protection
Subsidence land reclamation and ecological restoration
Surface mined land reclamation and ecological restoration
Solid wastes management, waste dump and tailings pond restoration
Case study
Abandoned mine land reclamation and ecological restoration
Contaminated land remediation
Reclaimed land monitoring and evaluation
Land reclamation supervision
Products and industrialization
Education, technology transfer and international cooperation of mine land reclamation
"The Belt and Road Initiative" and mine land Restoration

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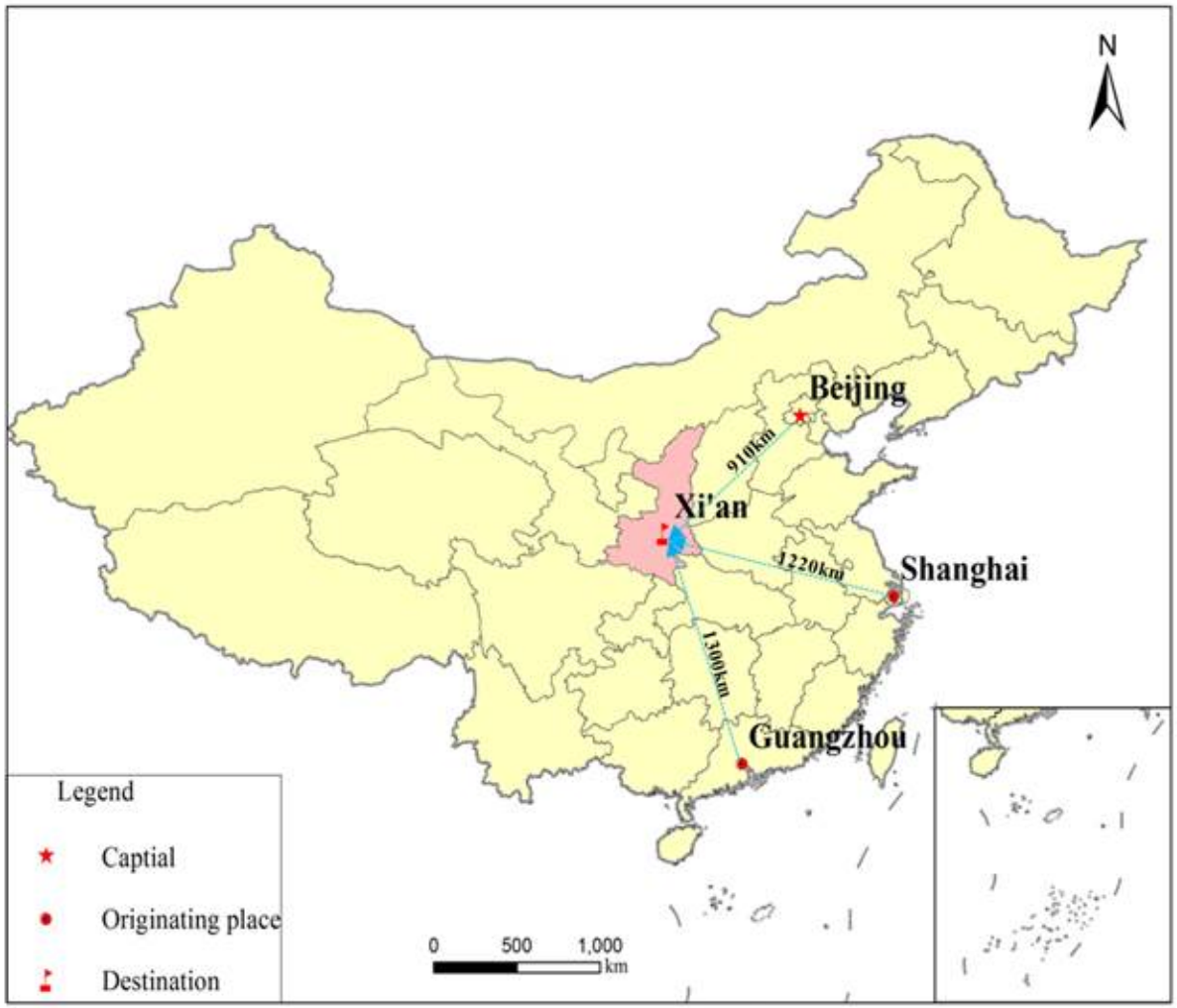

Emperor Qin's Terra Cotta Warriors

The famous historic and cultural city

Interesting places and good food

矿山生态安全教育部工程研究中心
Engineering Research Center of Mining Environment & Ecological Safety, Ministry of Education

土地复垦与生态重建研究所
Institute of Land Reclamation and Ecological Restoration

THANK YOU FOR YOUR ATTENTION!

QUESTIONS OR COMMENTS

Welcome to Institute of Land Reclamation & Ecological Restoration, China University of Mining and Technology (Beijing), and Engineering Research Center of Mining Environment & Ecological Safety, Ministry of Education

National Key Technology Research and Development Program (2012BAC04B03)

中国矿业大学（北京）
China University of Mining & Technology, Beijing