Yuqiao Reservoir and Its Nutrient Management

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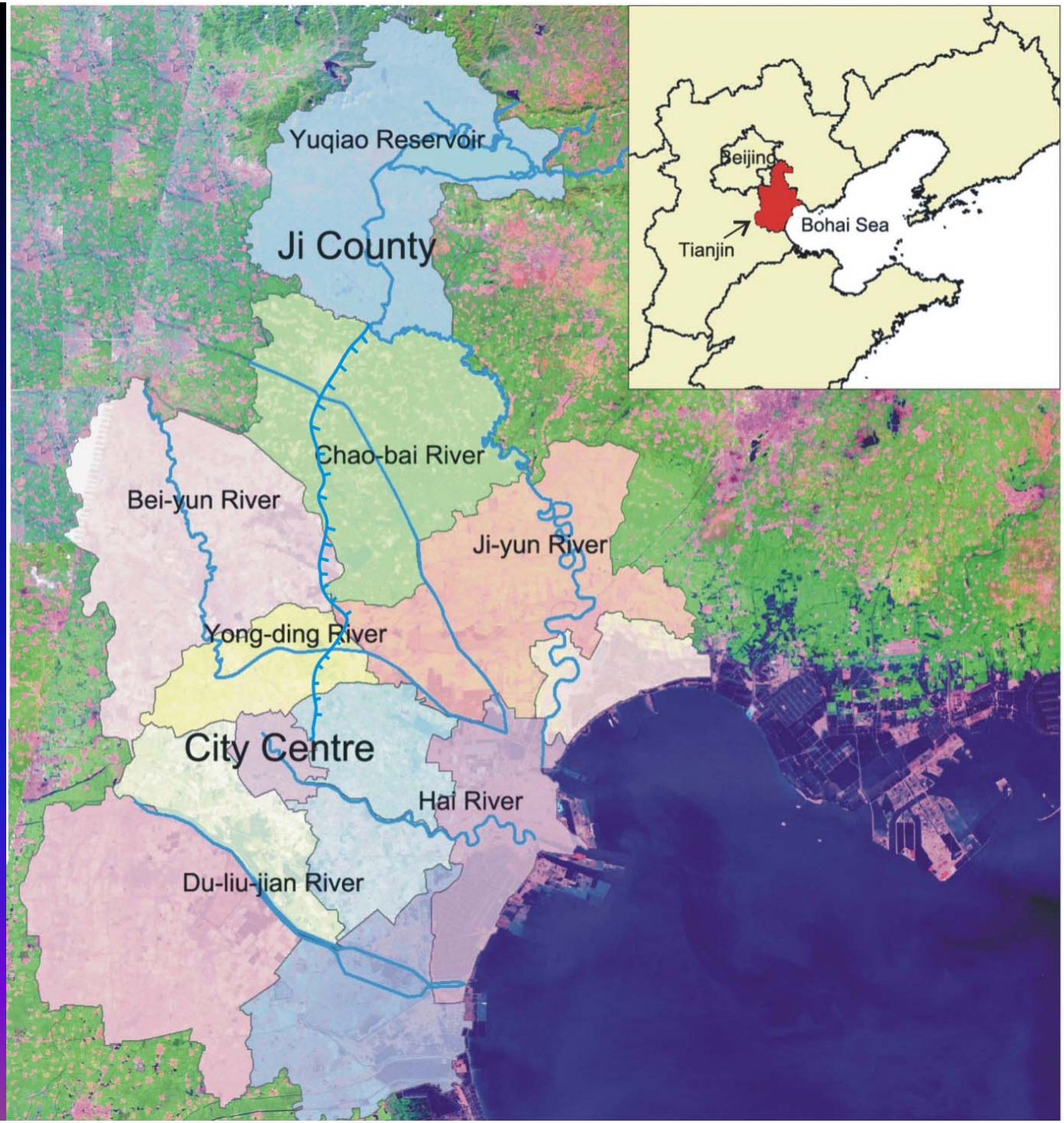
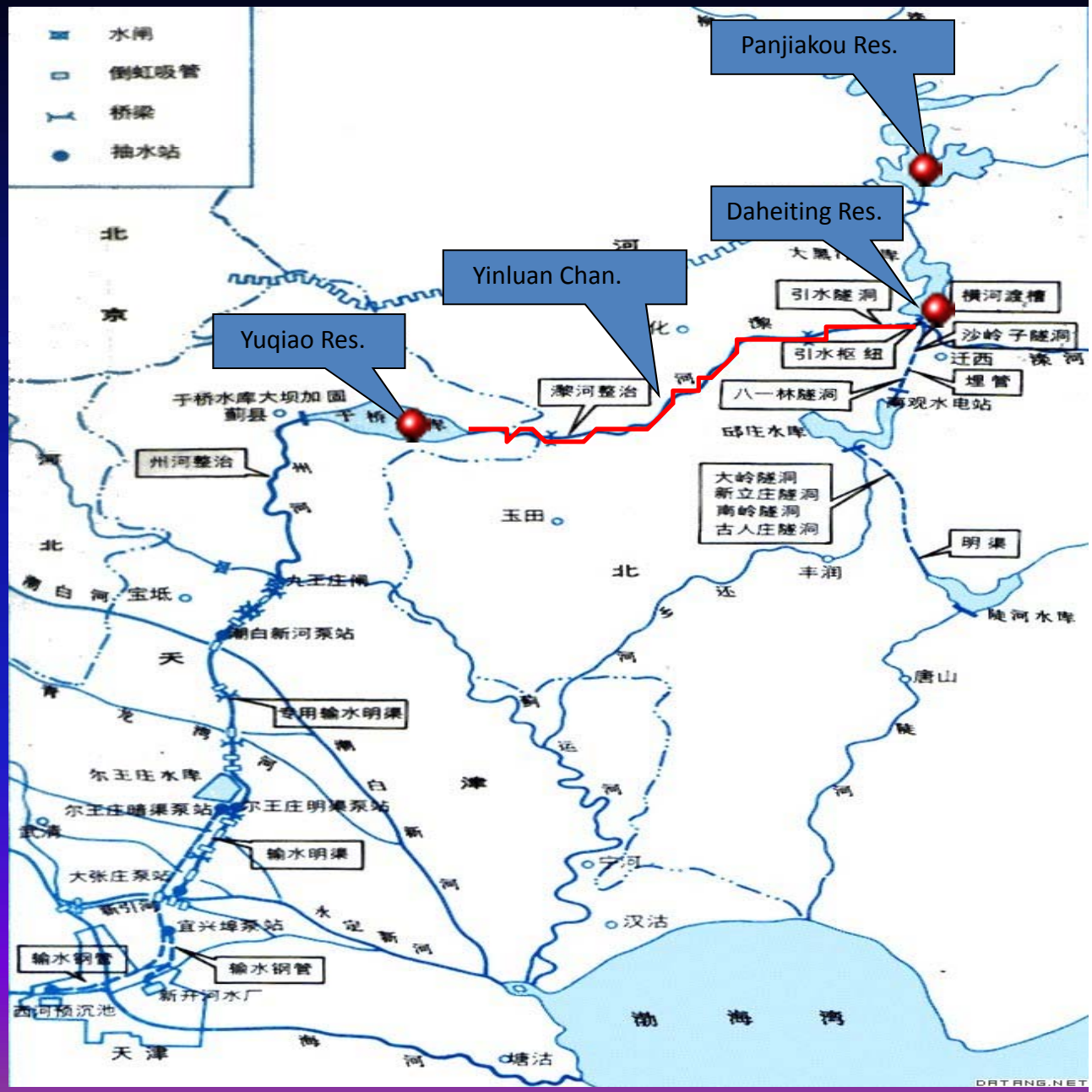
Background of Yuqiao Reservoir

Location


Yuqiao Reservoir
Ji County
Chao-bai River
Bei-yun River
Ji-yun River
Yong-ding River
City Centre
Hai River
Du-liu-jian River
Beijing
Tianjin
Bohai Sea

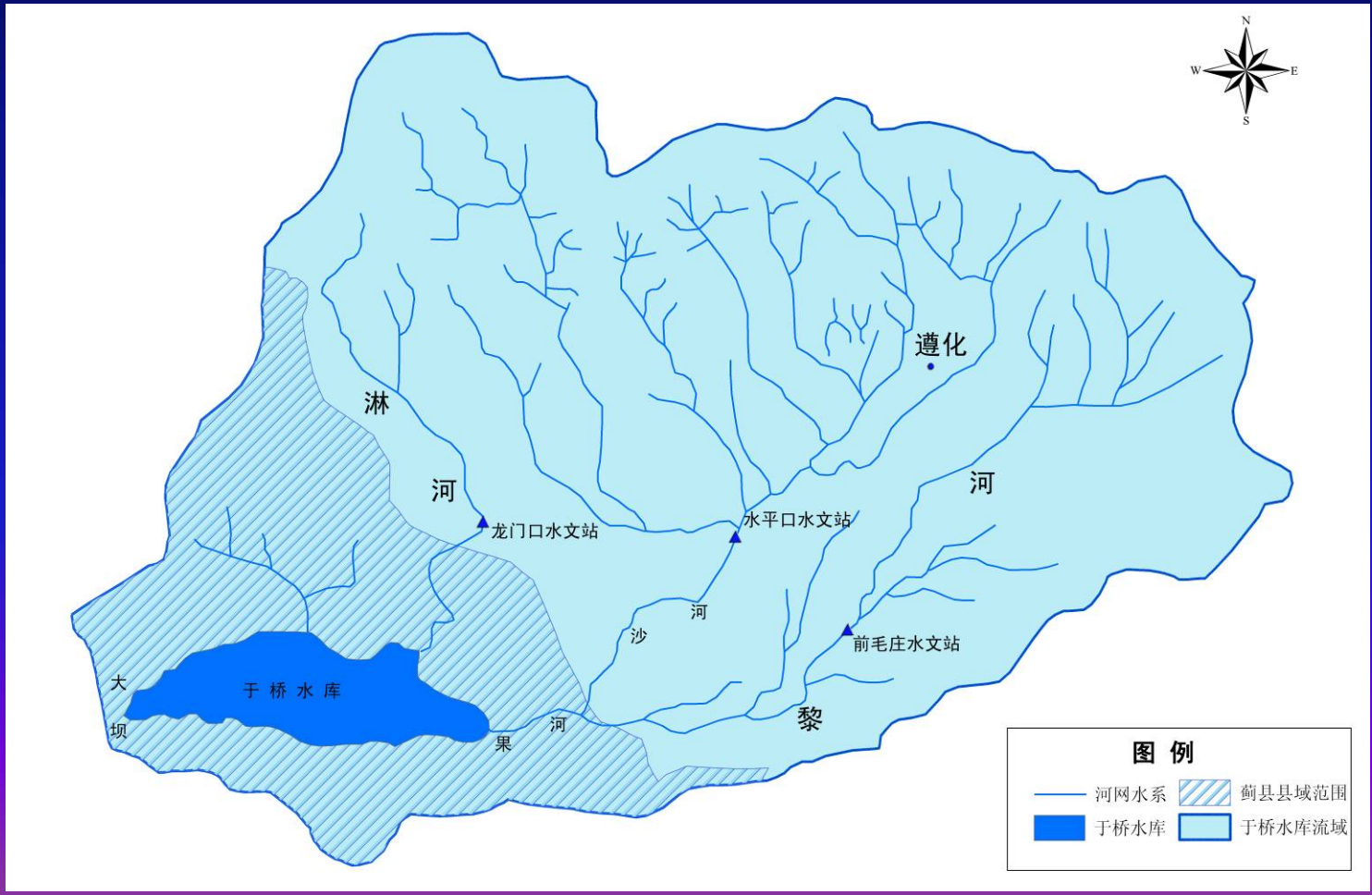
Yinluan Project: Luan River Diversion Project

Yinluan Project started to supply drinking water from Panjiakou and Daheiting Reservoirs of Hebei Province to Tianjin through Yinluan Chanel and Li River in 1983



Yuqiao Reservoir and its watershed

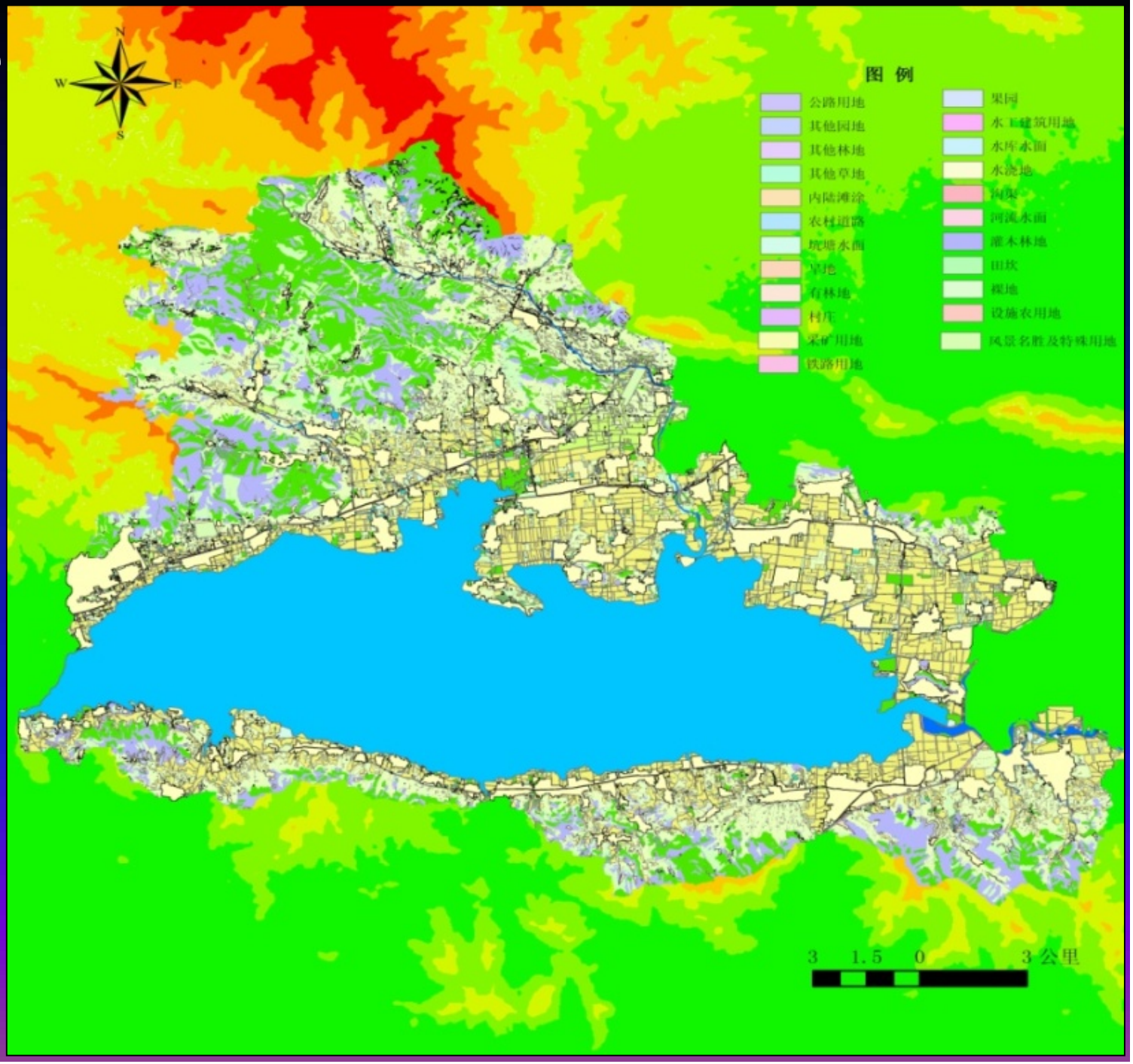
Yuqiao Reservoir was first built in 1959. It became a transfer reservoir for the Luanhe River water diversion project in 1983. With a total area of 2,060 km^2 , the Yuqiao Reservoir watershed mainly includes the Lihe River, the Shahe River, and the Linhe River. The Lihe River and the Shahe River gather into Guohe River 10 km away from the Reservoir.



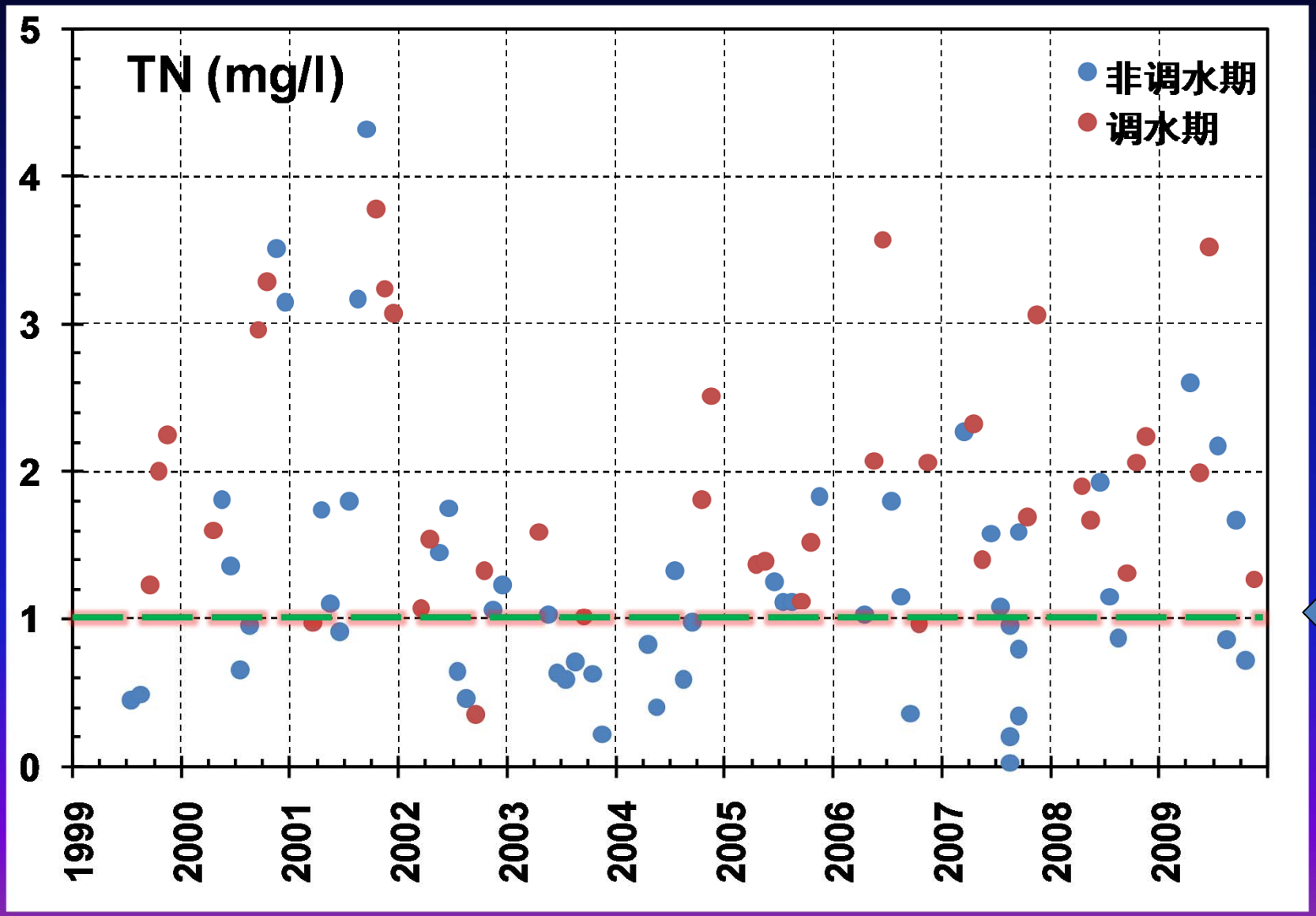
Characteristics of Yuqiao Reservoir

Normal water level: 21.16m; Surface: 86.6 km^2
Utilizable capacity: 385 million m^3; Total capacity: 1.56 billion m^3;
Dead storage: 360 million m^3 Maximum length: 30 km;
Maximum width: 8 km Maximum depth: 12 m;
Mean depth: 4.6m Population: 150,000 people

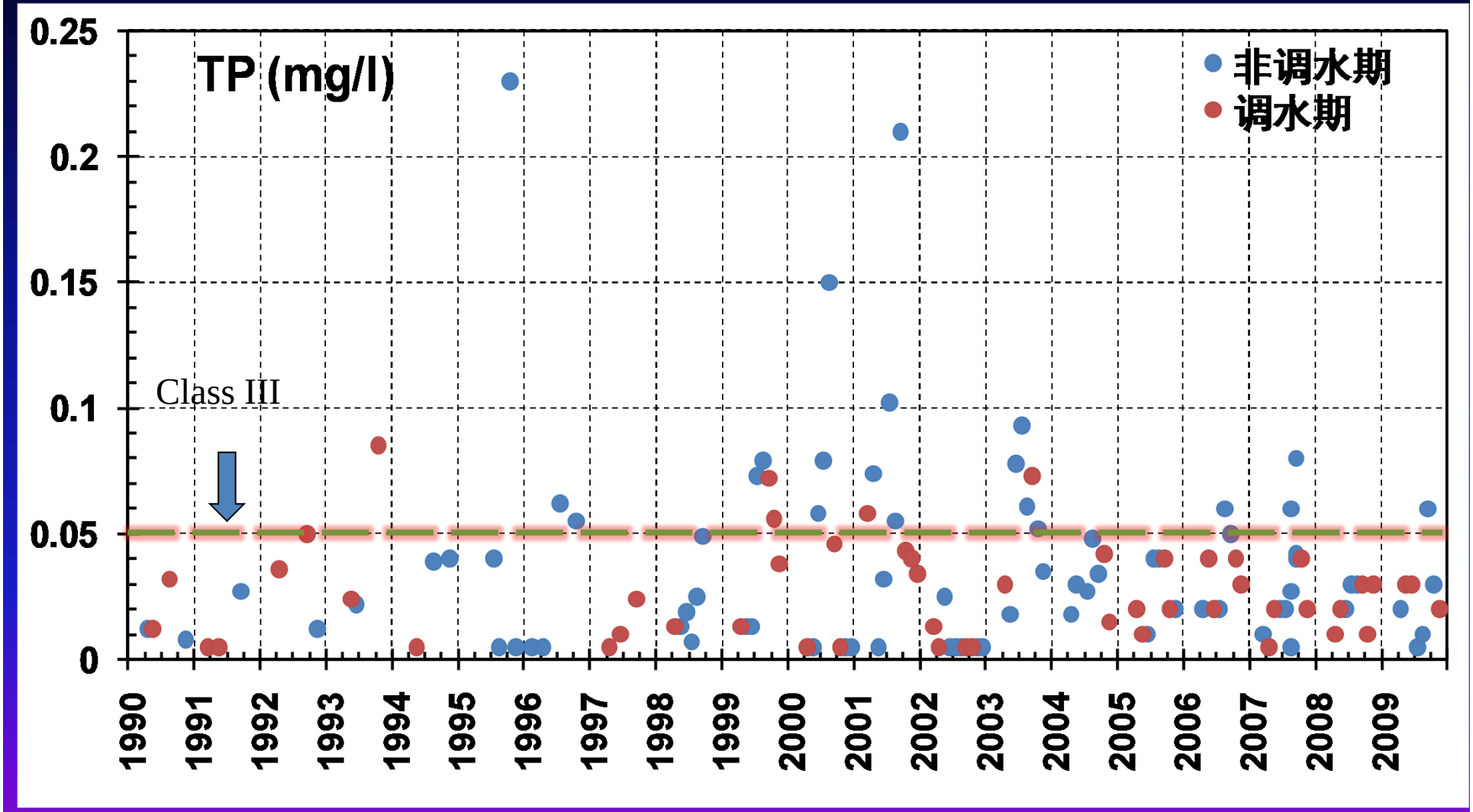
Landscape


N
W
E
S
图 例
公路用地
其他园地
其他林地
其他草地
内陆滩涂
农村道路
坑塘水面
旱地
有林地
村庄
采矿用地
铁路用地
果园
水工建筑用地
水库水面
水浇地
沟渠
河流水面
灌木林地
田坎
裸地
设施农用地
风景名胜及特殊用地
3 1.5 0 3 公里

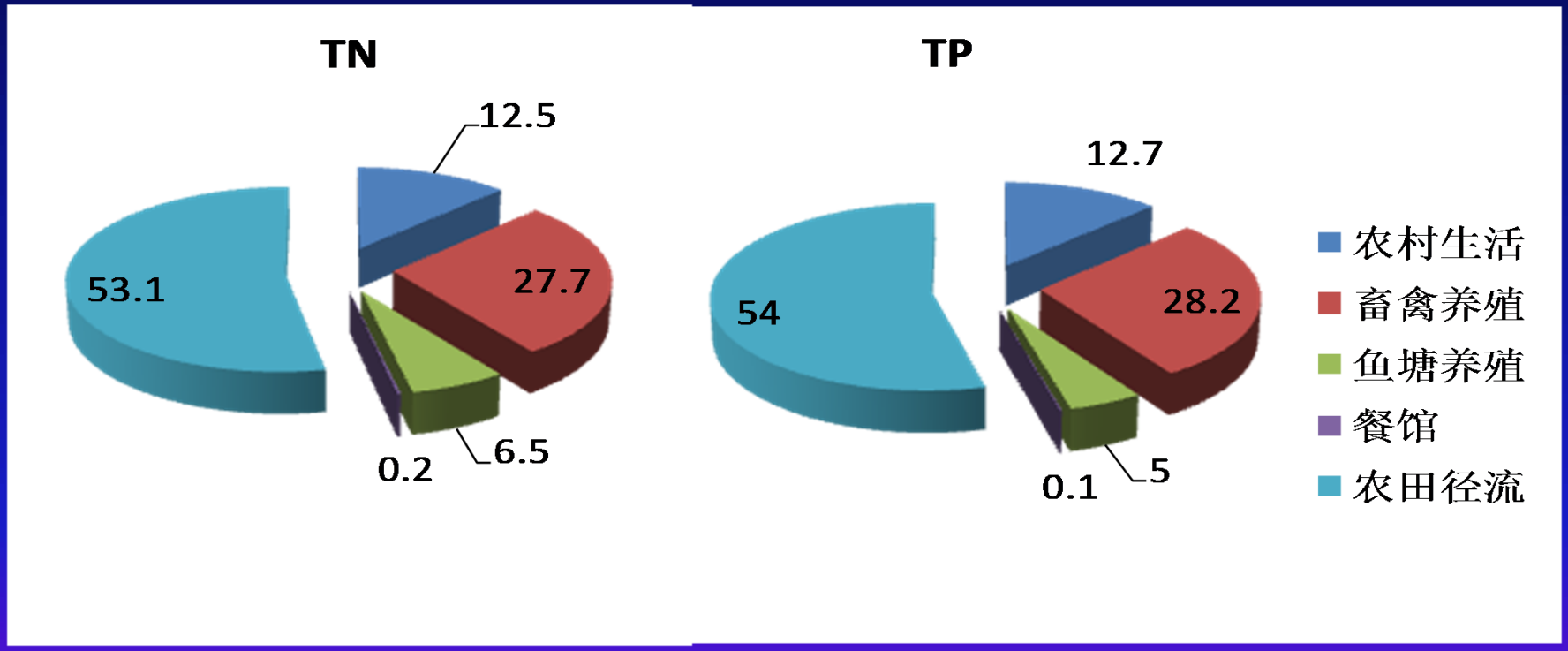
Water quality of Yuqiao Reservoir



Water quality of Yuqiao Reservoir



Pollution sources



Identification of nutrient vulnerable zone and its application

USLE

$$A = R \times K \times LS \times C \times P$$

A: the potential long term average annual soil loss in tons per acre per year;

R: the rainfall and runoff factor by geographic location;

K: the soil erodibility factor;

LS: the slope length-gradient factor;

C: the crop/vegetation and management factor;

P: the support practice factor.

Modified USLE

$$A = R \times K \times LS \times C \times P \times Z$$

A: the potential long term average annual soil loss in tons per acre per year;

R: the distance factor;

K: the soil erodibility factor;

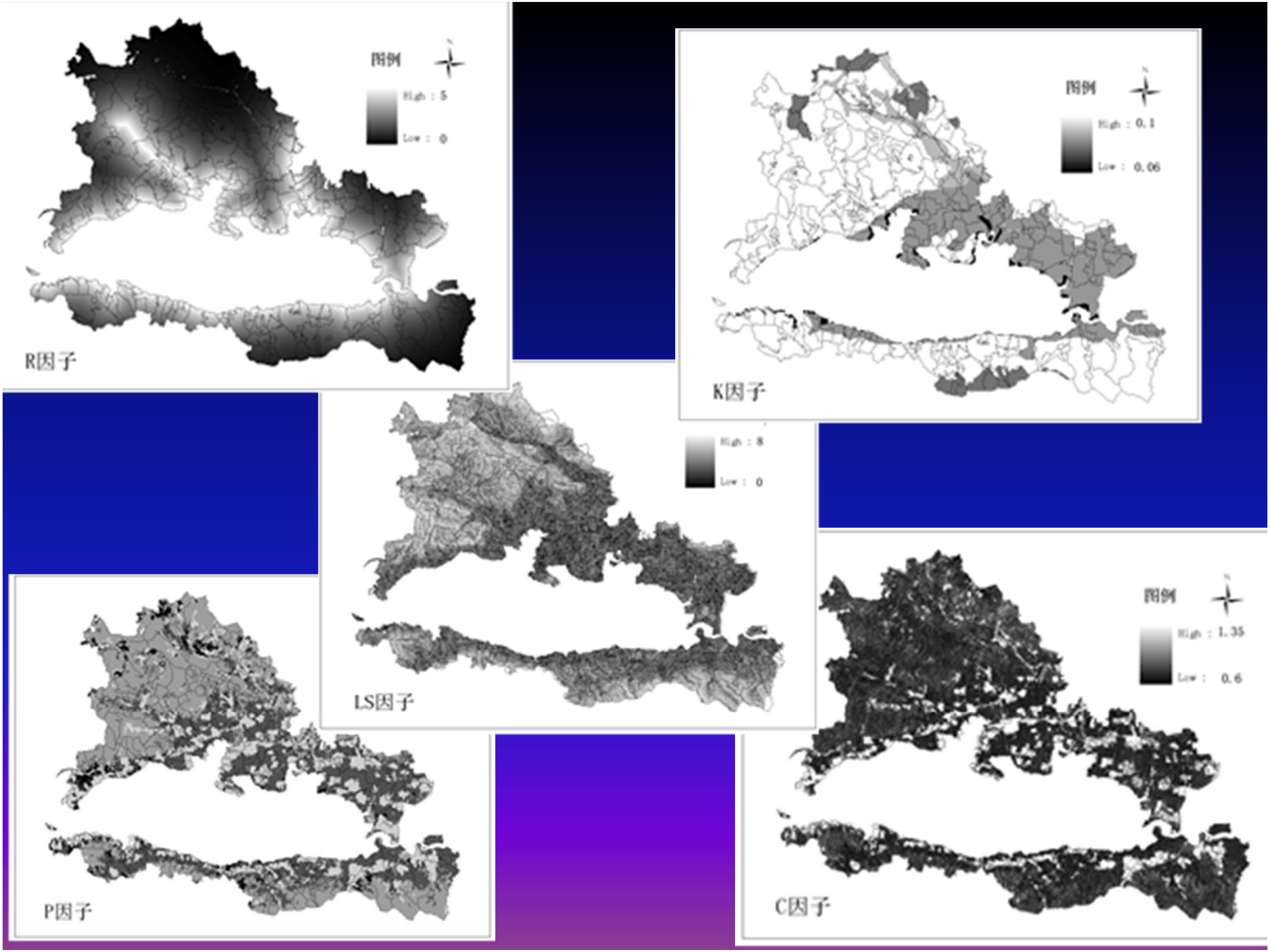
LS: the slope length-gradient factor;

C: the crop/vegetation and management factor;

P: the support practice factor;

Z: the self-purification factor.

$$Z = 0.705e^{0.029x}$$

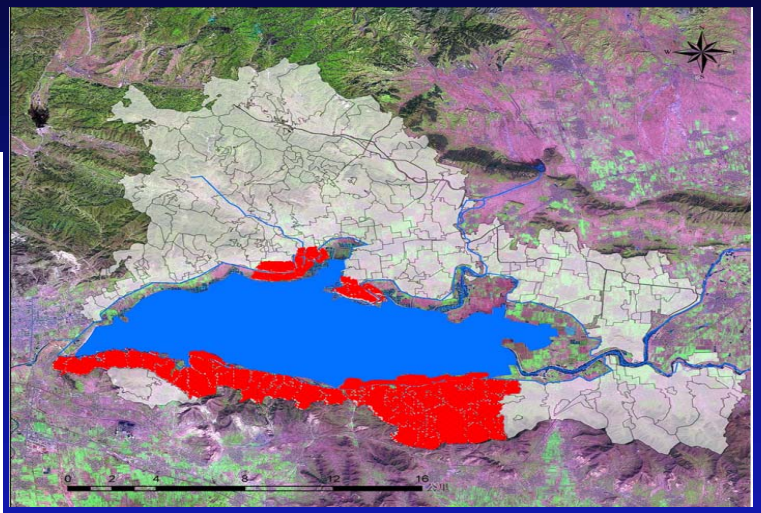

图例
High : 5
Low : 0
R因子
图例
High : 0.1
Low : 0.06
K因子
High : 8
Low : 0
LS因子
P因子
图例
High : 1.35
Low : 0.6
C因子

Application: Resettlement

Decision Support

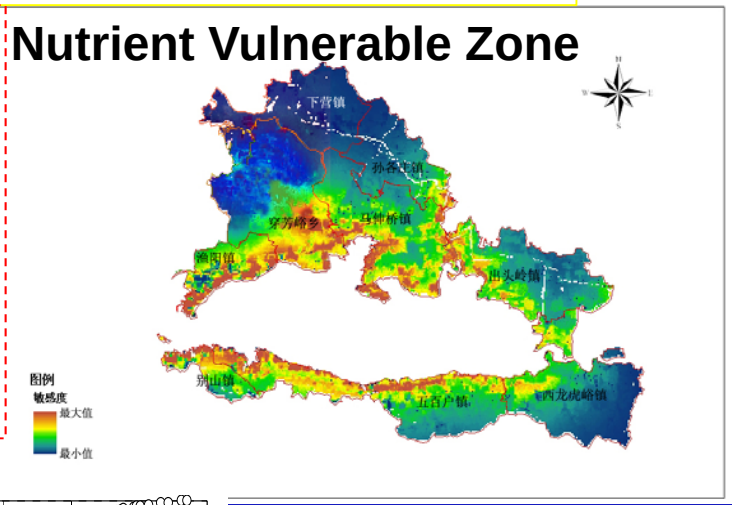
1. How many people to resettle for removal of 80% of the nutrients?
2. How many nutrients can be removed if resettle 30,000 people?
3. How to resettle?

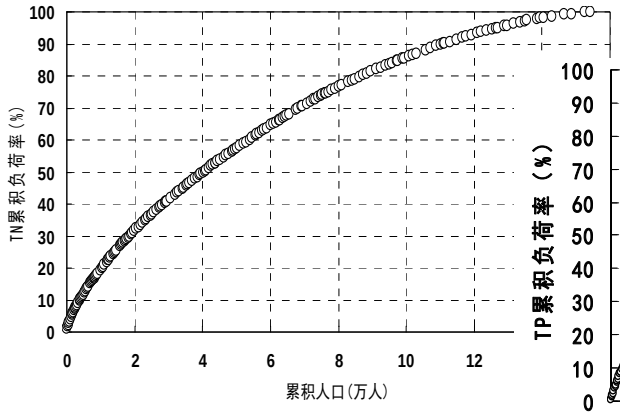
Involved: 10 townships, 200 villages, 150,000 people

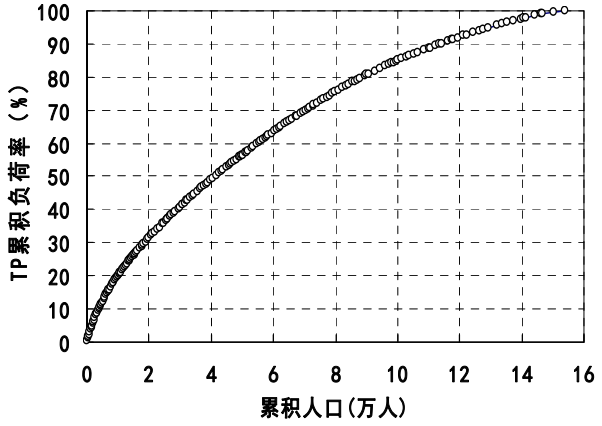


1. 28,000 people, removal of TN34%, TP32%。

2. “South resettlement North management





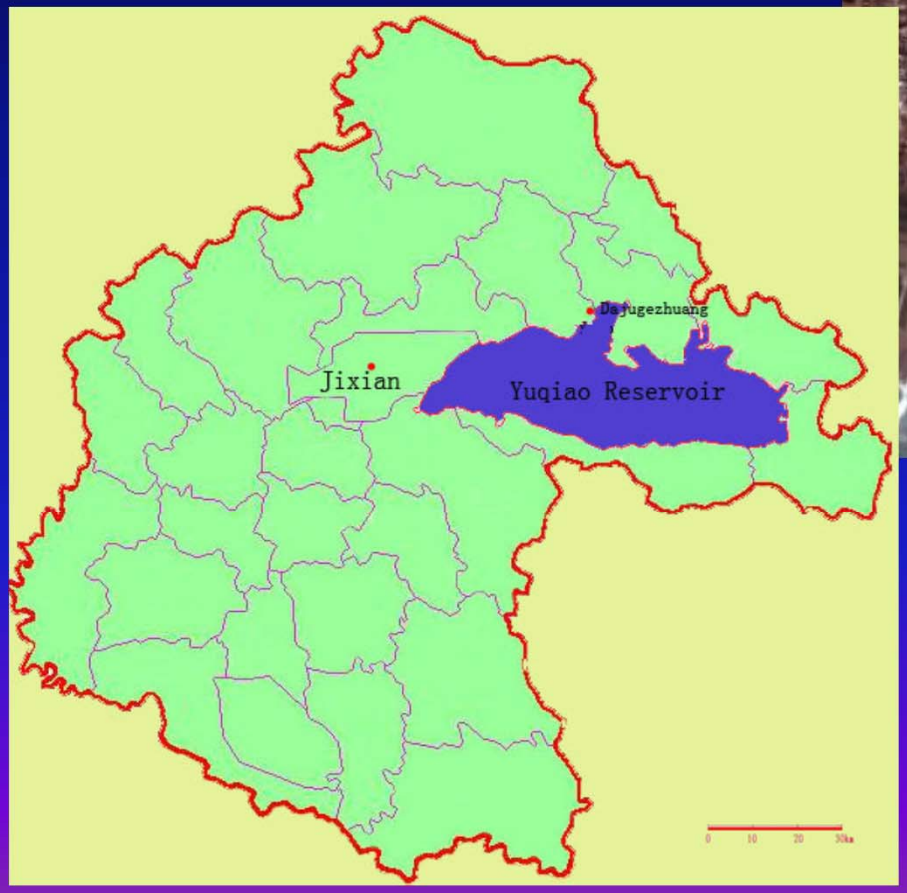


	previous	now	difference
Pollution removal	34%	34%	0
people	54,400	28,000	26,400
Cost RMB	13.6 billion	7.0 Billion	6.6 billion

Nutrient Management Plan:

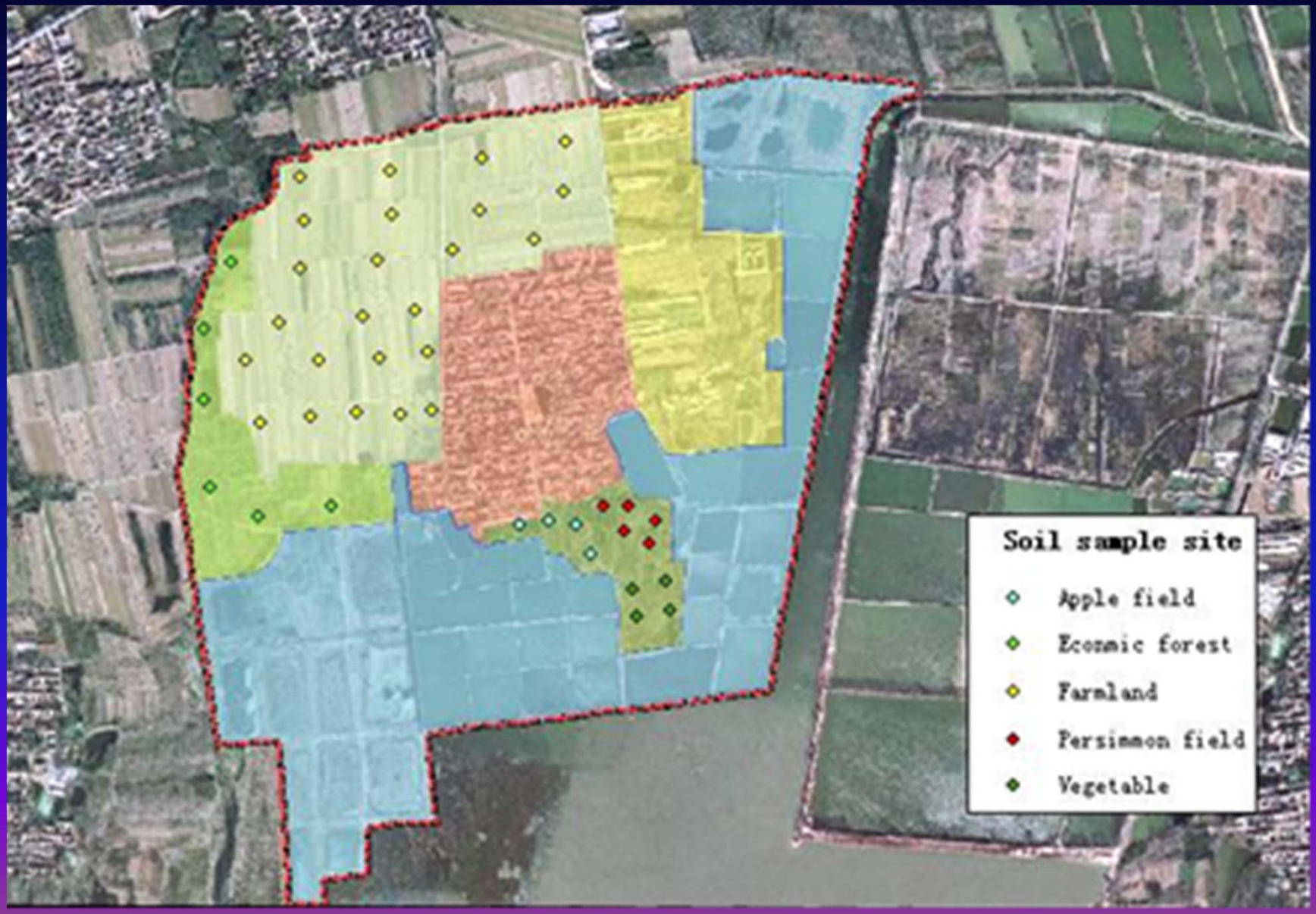
from a village to a watershed

Dajugezhuang village



Population: 1150
Families: 254 families

Nutrient background: sampling



Nutrient background

Planting pattern	type	Sample number	TN mean (kg/mu)	TP mean (kg/mu)
Main farmland	Wheat	72	33.15	26.60
	Corn	72	44.46	22.36
Vegetables	Tomato	12	32.34	20.17
	Cucumber	12	35.21	18.52
Orchard	Apple	12	25.12	6.21
	Persimmon	15	18.35	6.14
Forest	Fast-growing Poplar	18	42.81	10.35

Nutrient demand

Planting pattern	type	Yield goal (kg/mu)	TN bioavail-ability (%)*	TP bioavail-ability (%)*	TN demand (kg/mu)	TP demand (kg/mu)
Main farmland	Wheat	500	30	10	**16.85**	**0.7**
	Corn	750	35	12	**10.63**	**1.14**
Vegetables	Tomato	500	40	20	**23.04**	**33.1**
	Cucumber	800	50	30	**28.79**	**22.25**
Orchard	Apple	3000	32.5	15	**2.57**	**0.79**
	Persimmon	2000	30	16	**20.98**	**1.49**
Forest	Fast-growing Poplar	805	25	15	**28.79**	**4.85**

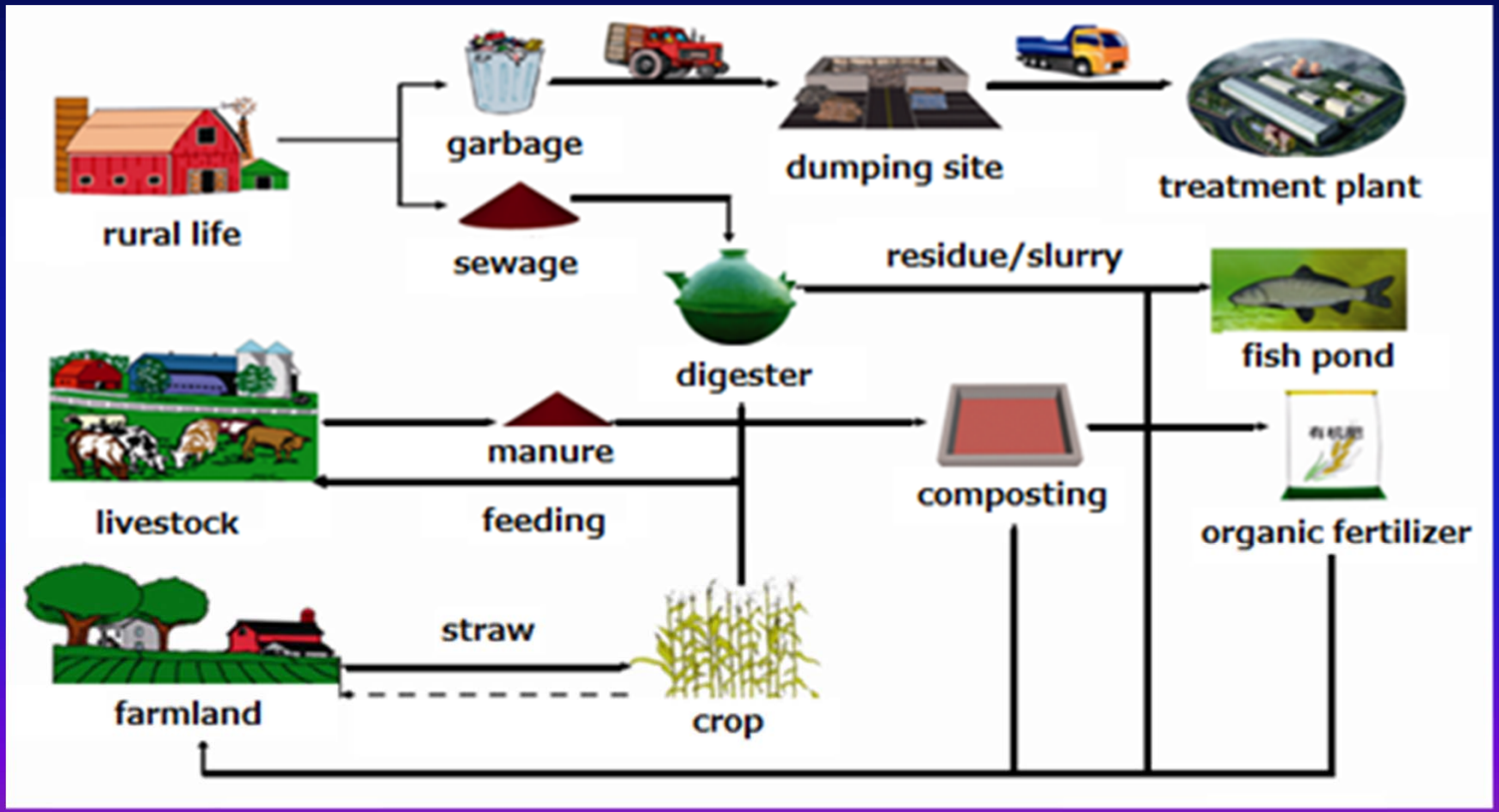
Fish ponds: TN 12.5kg/mu; TP 7.5kg/mu;
Digesters: TN 1890kg/y.

***(Tang, 2003)**

Nutrient balance

Nutrient consumption	Type			TN	TP
	Farmland		Wheat	9099	378
			Corn	5740.2	615.6
	Vegetables		Tomato	460.8	662
			Cucumber	575.8	445
	Orchard		Apple	64.25	19.75
			Persimmon	524.5	37.25
	Forest		Fg-pollar	4836.72	814.8
	Fish ponds			13125	7875
	digesters			1890	-
	Total：TN: 21301.27kg; TP: 2972.4kg				
Nutrient production	type			TN	TP
	Internal	Rural life	Garbage	925	883
			Sewage	1414.74	83.22
		Poultry & livestock	Manure	19421	6252
	External	Planting	Fertilizer	20378.4	2014.11
		Fish ponds	Feed	13125.00	7875.00
	total：TN: 55264.14kg，TP:17107.33kg				
Total excess	TN：33962.87 kg/y; TP:14134.93 kg/y				

Circular economy for rural area



Estimate of green house gas emissions and reduction for Yaobaizhuang

IPCC, 2006

Source	GHG Emission		Estimated Reduction in GHG Emissions (ton $CO_{2equivalent}/y$)
	CH_4/N_2O kg/y)	(ton $CO_{2equivalent}/y$)	
Enteric Fermentation: CH_4	4000	100	0
Manure Management:			
• CH_4	8300	208	170
• N_2O: Direct	154	46	37
• N_2O: Indirect	270	81	65
Managed Soils:			
• N_2O: Direct	292	87	78
• N_2O: Indirect	66	20	18
TOTAL GHG Emissions (ton $CO_{2equivalent}/y$)		541	368

Towards watershed NMP

$$Ri = \left(\frac{P_{townᵢ}}{P_0} \times Wp + \frac{L_{townᵢ}}{L_0} \times W_l + \frac{F_{townᵢ}}{F_0} \times W_f\right) \times R_0$$

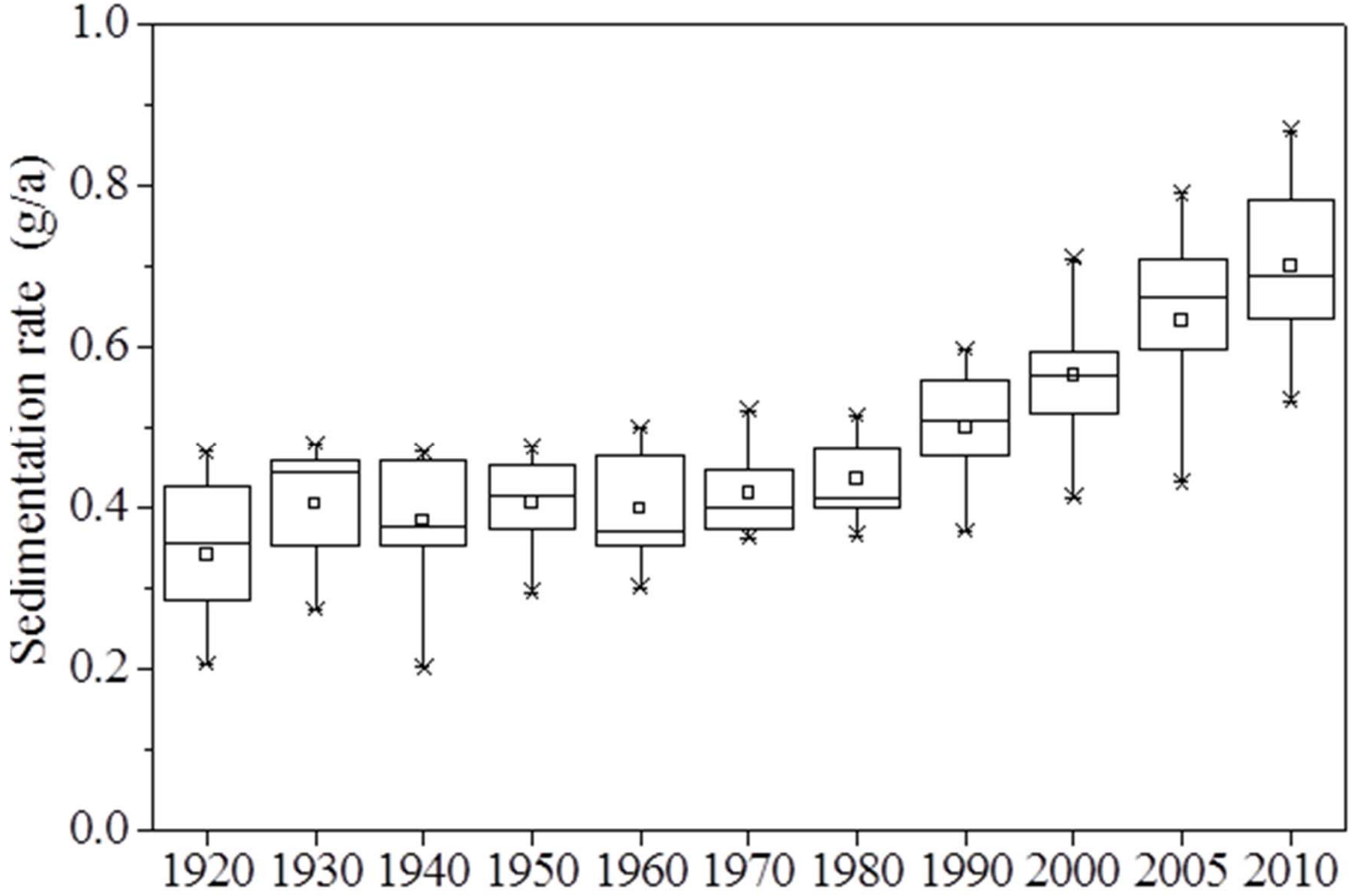
- Ri： nutrient reduction (ton/y)
- R0： nutrient reduction of a village (Dajugezhuang)
- P_{town}: population
- P_0: village population
- L_{town}: number of poultry and livestock
- L_0: number of poultry and livestock in a village
- F_{town}: farmland area (mu)
- F_0: village farmland(mu)
- W_P, W_l and W_f are percentages of rural life, poultry and livestock raising, farming

Estimation for townships

Townships	Village number	Nutrient reduction (ton/year)	
		TN	TP
Chuangguan	70	12.36	3.38
Chuanfangyu	26	4.59	1.25
Mashenqiao	37	6.53	1.78
Chutouling	43	7.59	2.07
Total	176	31.07	8.48

About next…

Oslo, 27 April, 2009



Effect of allelochemicals under eutrophication conditions
Riverine “pulse” input
Resuspension of reclamation

Thank you!