# Simulation of Nitrogen Balance in Xiaoqinghe Watershed Consisting of Cropland and Livestock Farms Using Manure-DNDC Model

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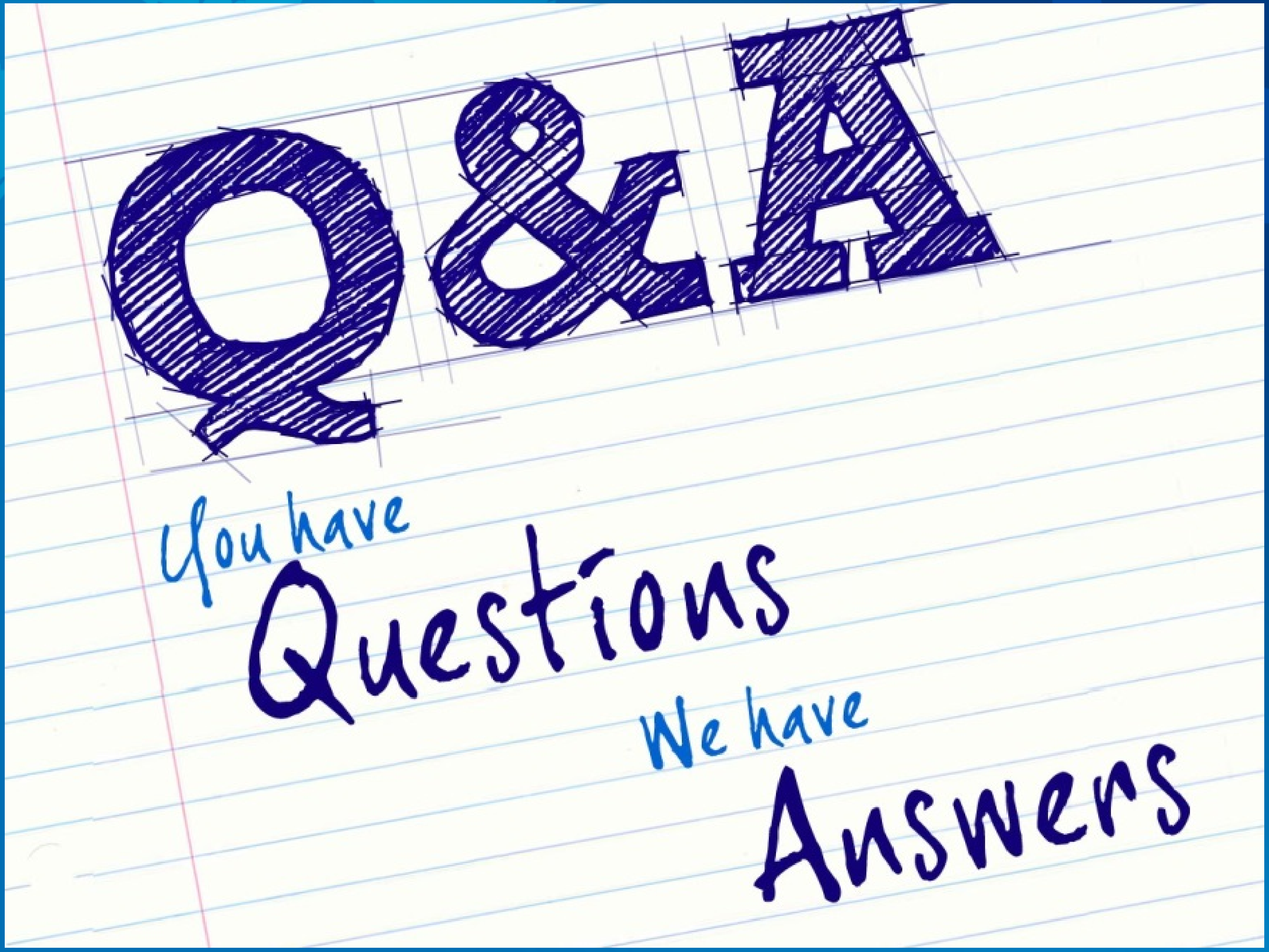
# Hi, I'm the girl who sent you many emails for the conference information.



# Please stop me if you have any question !

# Outline

1. Introduction
2. Watershed Description
3. Spatial Database Construction
4. Results and analysis
5. Conclusions

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# Why it is important?

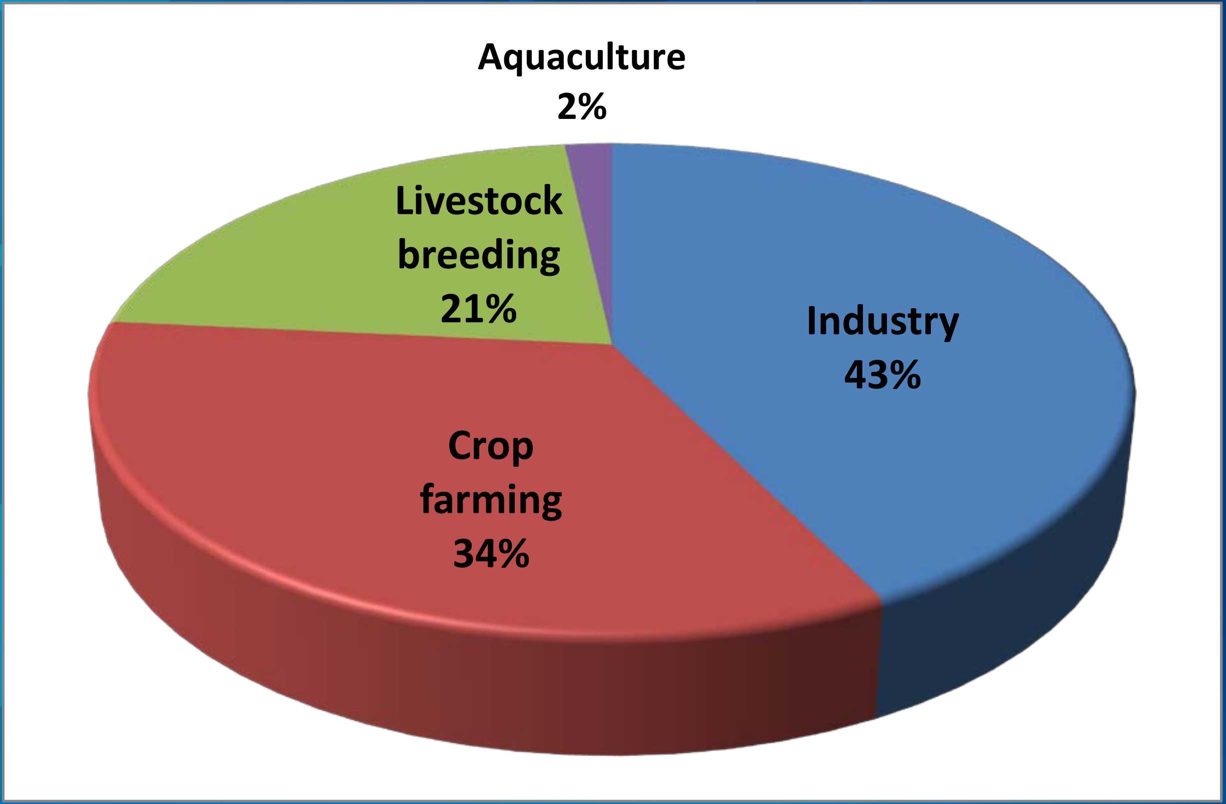
- The degradation of water quality has becoming more and more serious.
- Overuse of nitrogenous fertilizer in arable land and discharge of livestock effluent play important role



# Nitrogen Discharge in China 2007

| | |
|---|---|
| Industry | 2.02 |
| Crop farming | 1.60 |
| Livestock breeding | 1.02 |
| Aquaculture | 0.08 |

units: million t




The Bulletin on the First National Census on Pollution Sources 2010

# livestock excreta in the world

- About 100 million ton of N from livestock excreta was produced in the world and only 1/3 of them was recovered as manure

- Nitrogen losses during livestock breeding and manure management played an important role in agricultural nonpoint source pollution

# Status and Prospect

- Lots of modeling work has been done on nitrogen balance in arable land.
- Few work has been done on modeling of livestock breeding and manure management process

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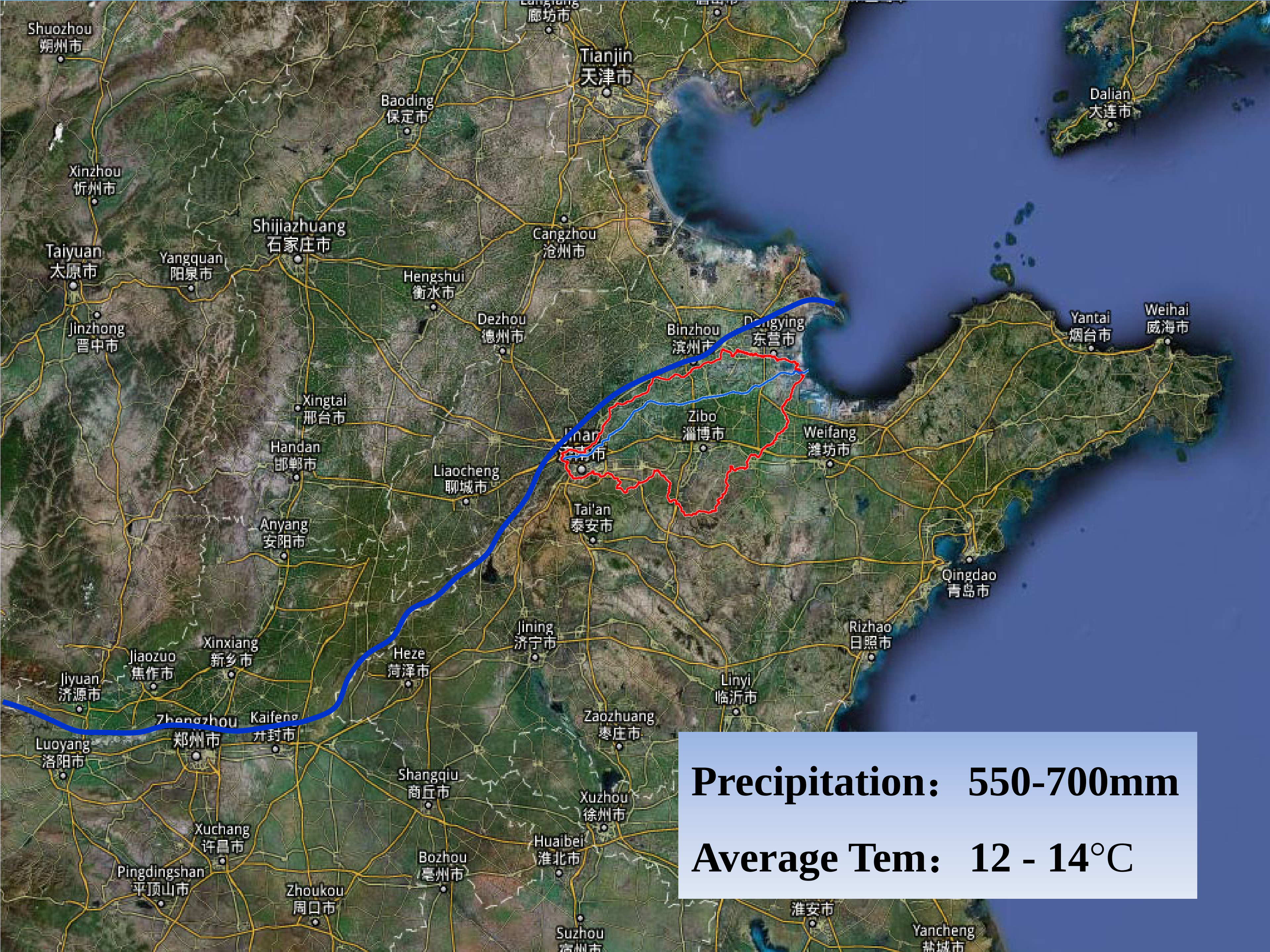
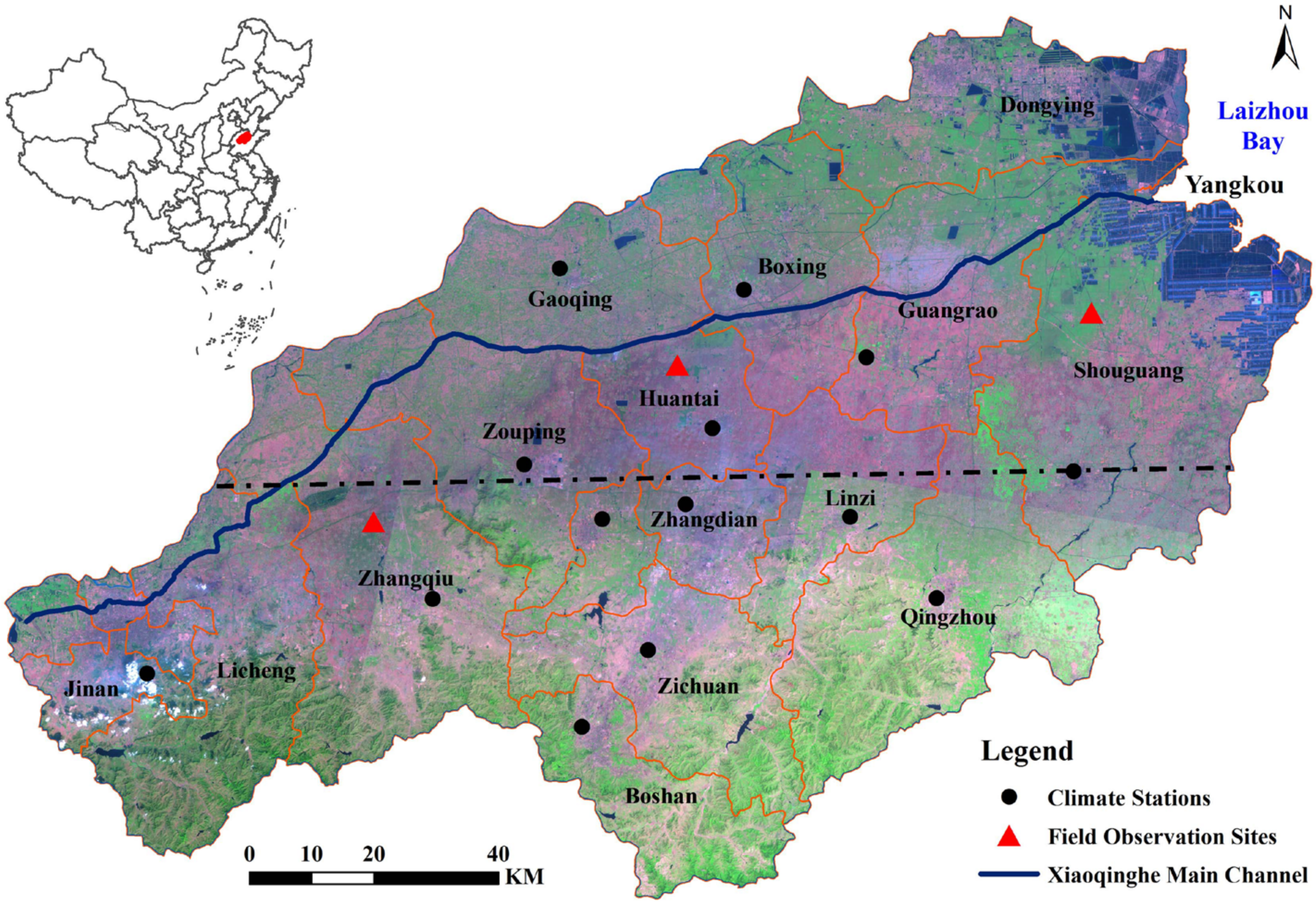



**Precipitation：550-700mm**

**Average Tem：12 - 14°C**


N
Laizhou Bay
Yangkou
Dongying
Boxing
Gaoqing
Guangrao
Shouguang
Huantai
Zouping
Linzi
Zhangdian
Zhangqiu
Qingzhou
Licheng
Jinan
Zichuan
Boshan
0 10 20 40
KM
Legend
Climate Stations
Field Observation Sites
Xiaoqinghe Main Channel

# Watershed description

- Xiaoqinghe means “Small Clean River” in Chinese. Actually, this river is neither small nor clean any more.

- Xiaoqinghe has been severely polluted and loaded 9600 tons of N into the Pacific Ocean every year.

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# Spatial Discretization

- When Manure-DNDC was used to conduct regional or watershed simulations, the whole study region was divided into many grid cells.

- All the attributes in each grid cell were assumed to be uniform.

# Database Construction

- To simulate N transport and transformation in the Xiaoqinghe watershed, we developed a database to hold all the input information required for the regional model runs.

# List of Input data

| File Name | Main parameters |
|---|---|
| Xiaoqinghe_1 | ID, Region, Name, Latitude, Climate ID station, N dep, max and min SOC, Clay content, pH, bulk density |
| Xiaoqinghe_2 | Crop area for every cropping system |
| Xiaoqinghe_3 | Fertilizer rate |
| Xiaoqinghe_4 | Percent of crop area irrigated |
| Xiaoqinghe_5 | Planting and harvest dates for each cropping system |
| Xiaoqinghe_6 | Fertilizer application dates |
| Xiaoqinghe_7 | Manure application dates and C/N ratio |
| Xiaoqinghe_8 | Tilling date and depth |
| Xiaoqinghe_9 | Livestock farm number, farm ID, Animal type, Animal heads, Feed rate, Crude protein, Floor area, Storage days, Applied area |
| Xiaoqinghe_10 | Topography parameters including CN2, Slope length, Channel length, and so on. |
| Xiaoqinghe_11 | Fraction of above-ground residue incorporated in soil |

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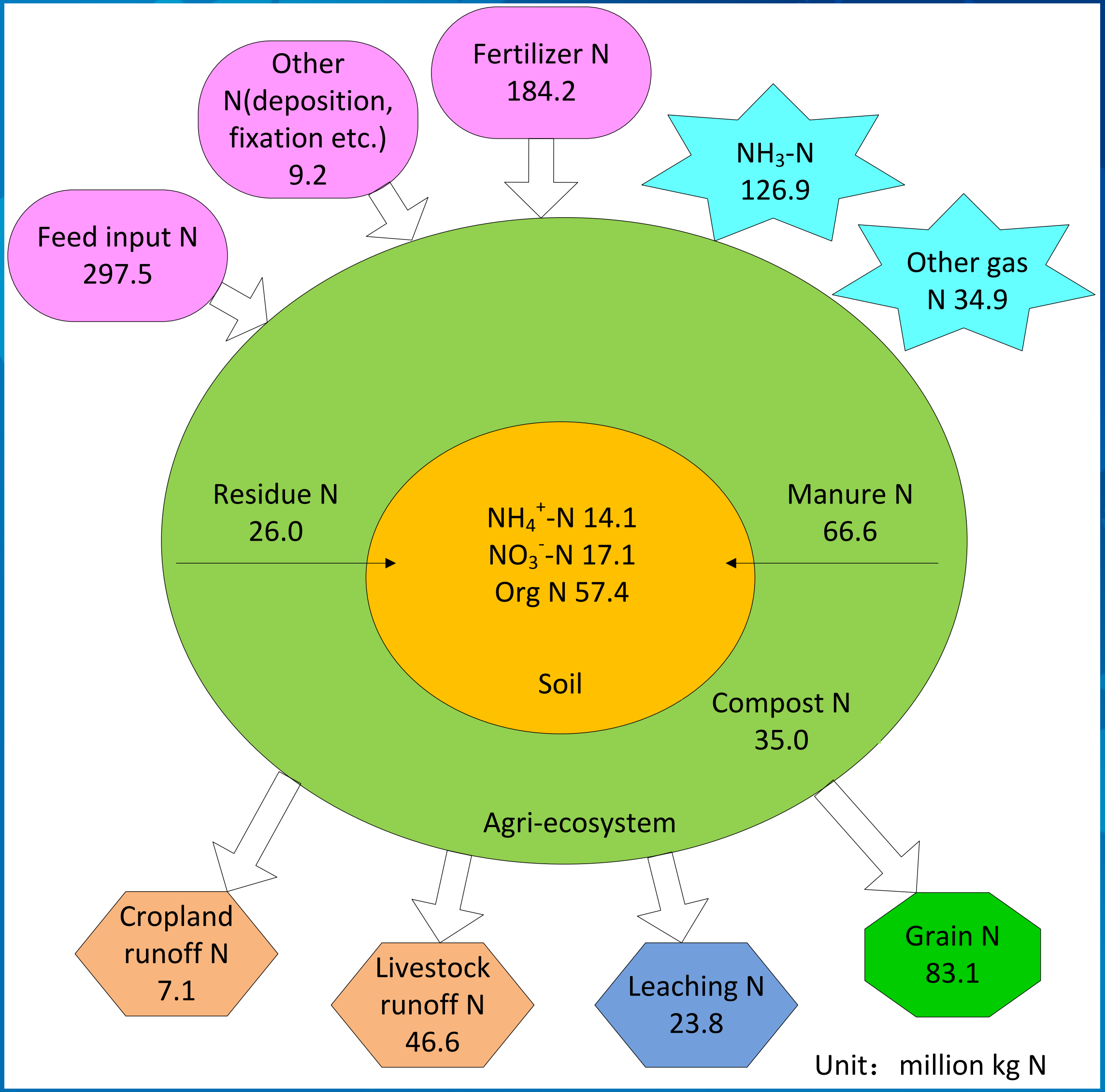
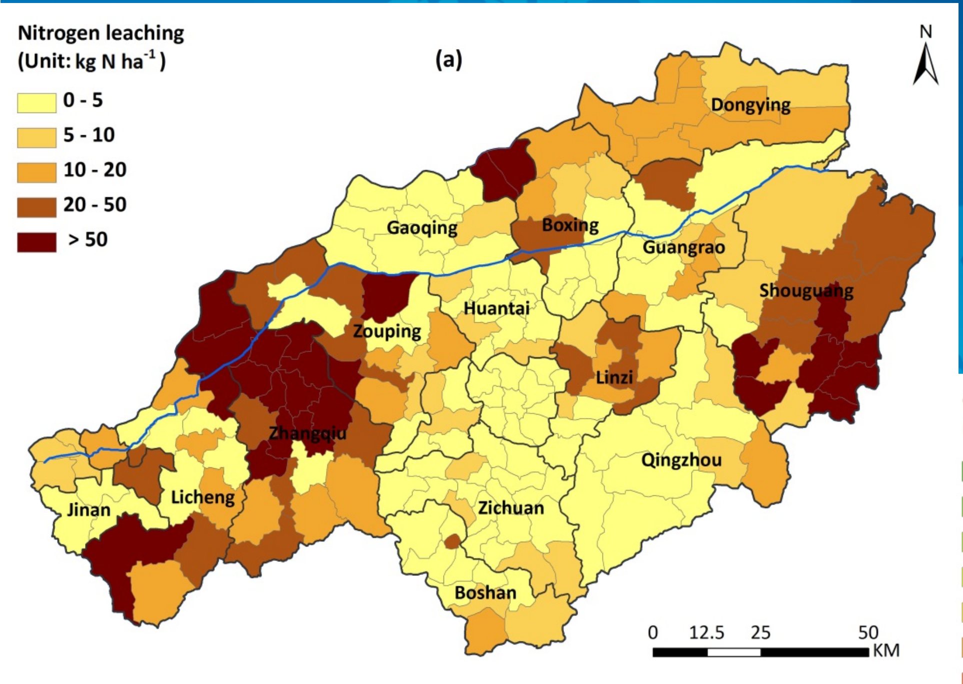
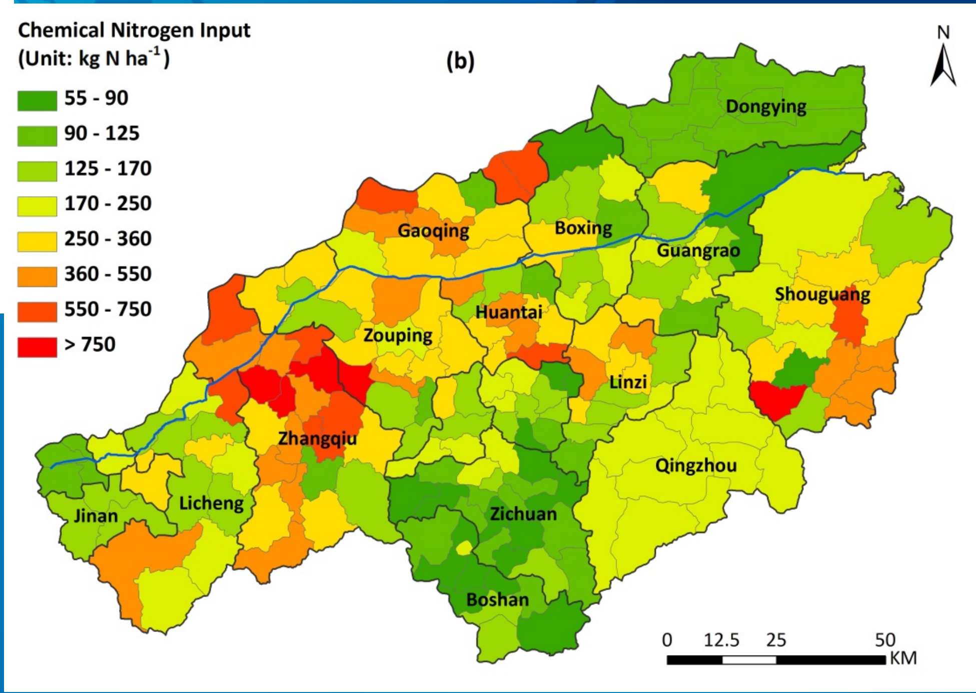
# Nitrogen cycle of agricultural eco-system in Xiaoqinghe watershed in 2008

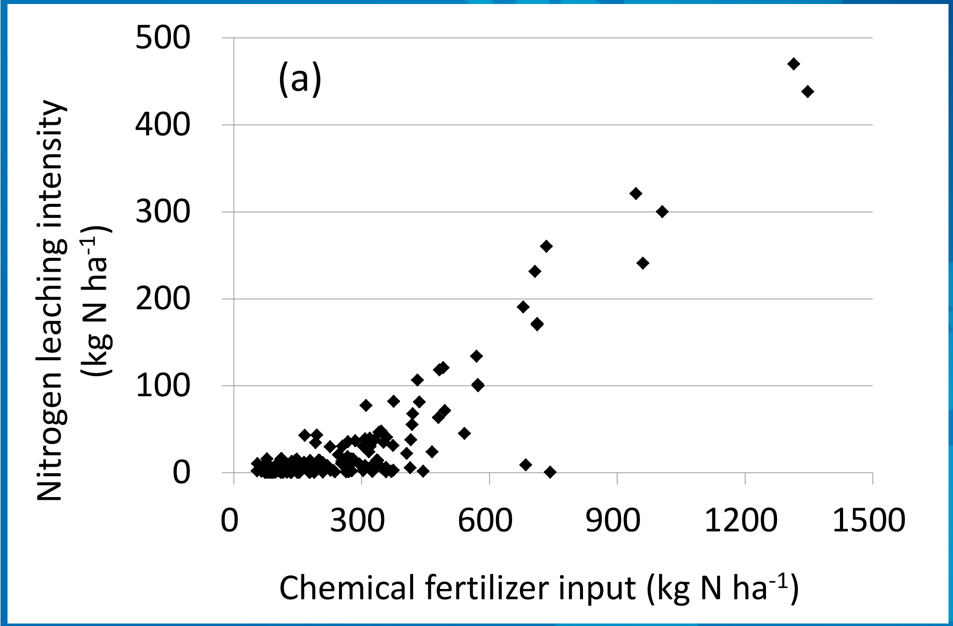


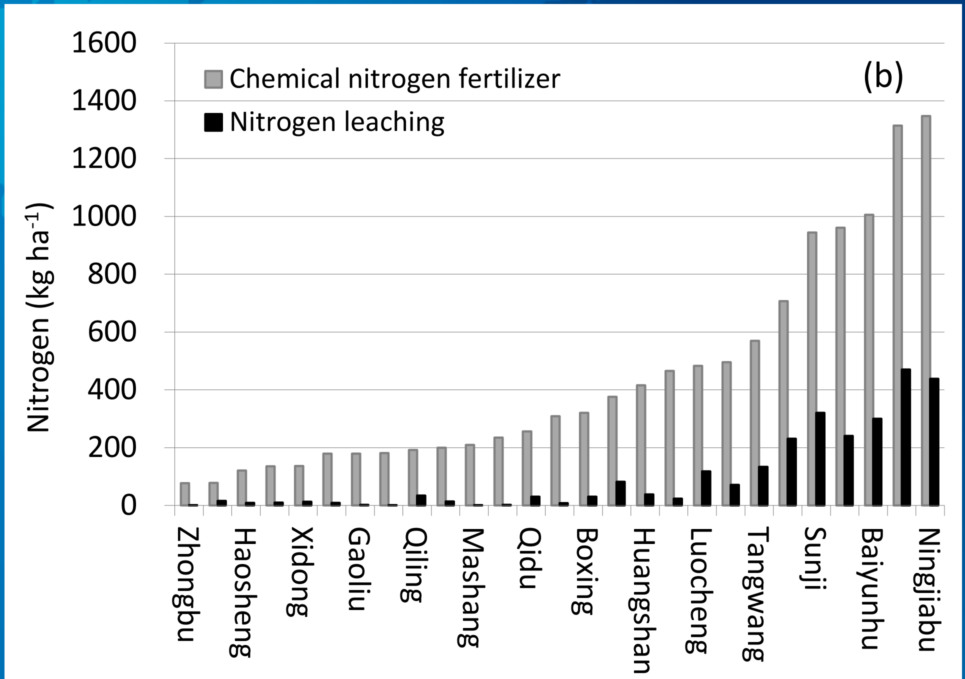
# Nitrogen leaching and fertilizer application rates



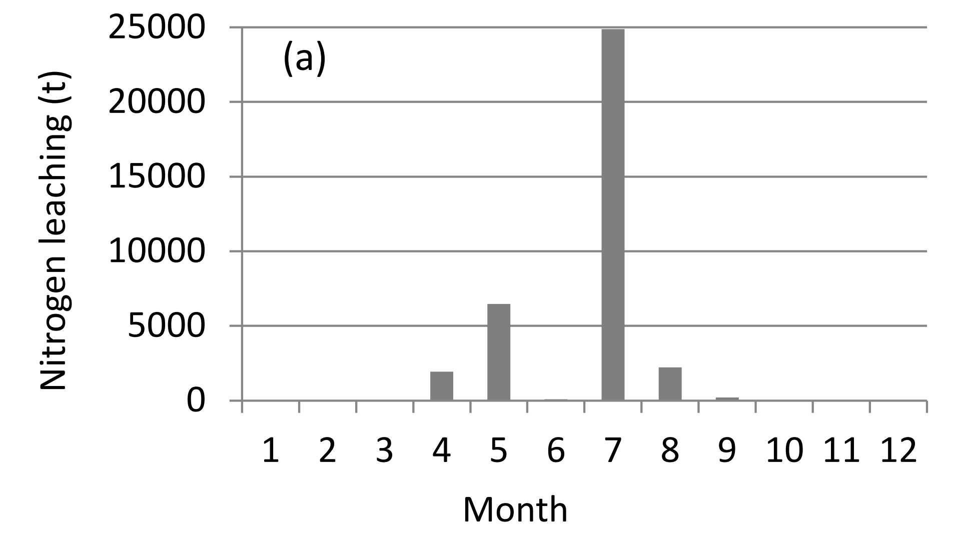



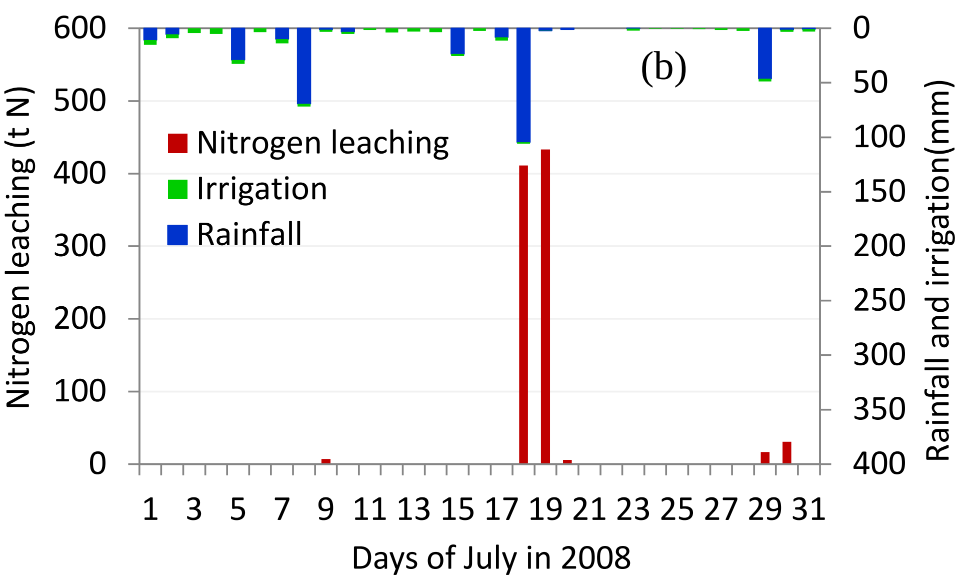
# Relationship between nitrogen leaching and fertilizer input in cropland for all the towns (a) and typical towns (b)



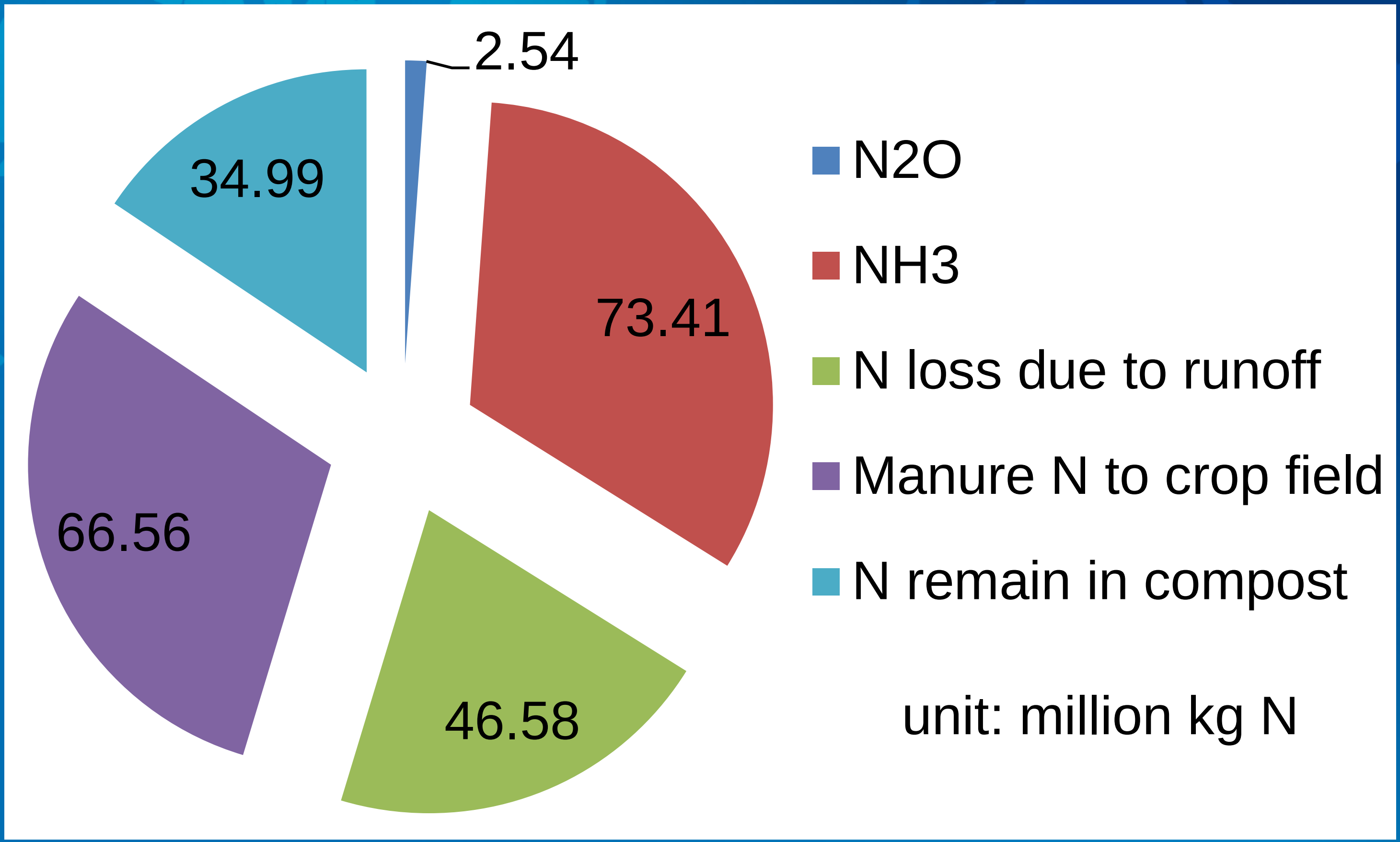



# Modelled monthly nitrogen leaching loading rates (a) and relationship between nitrogen leaching and rainfall plus irrigation (b)

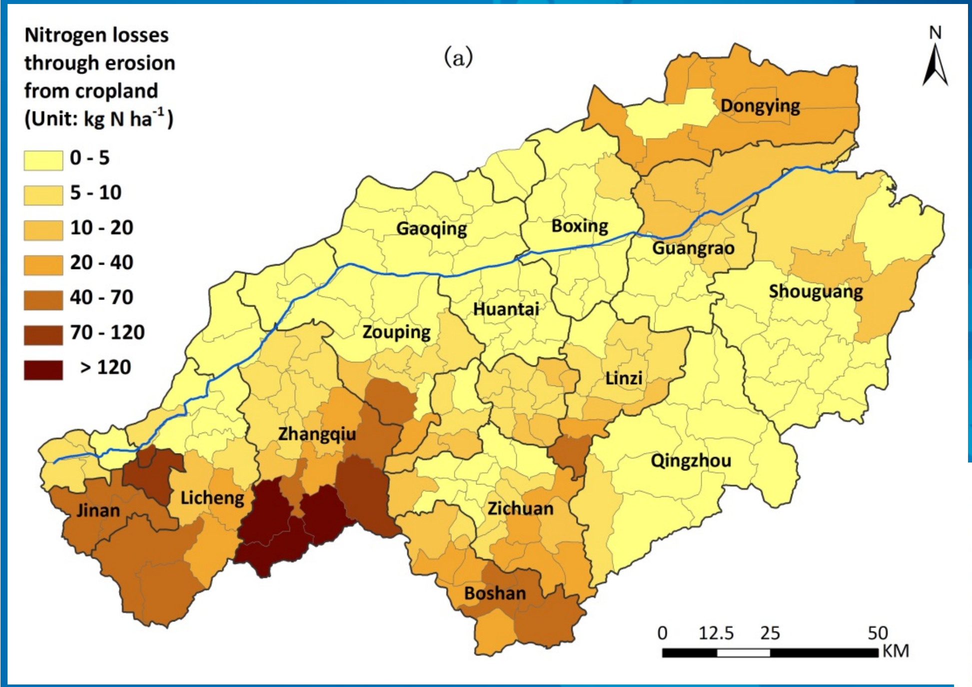


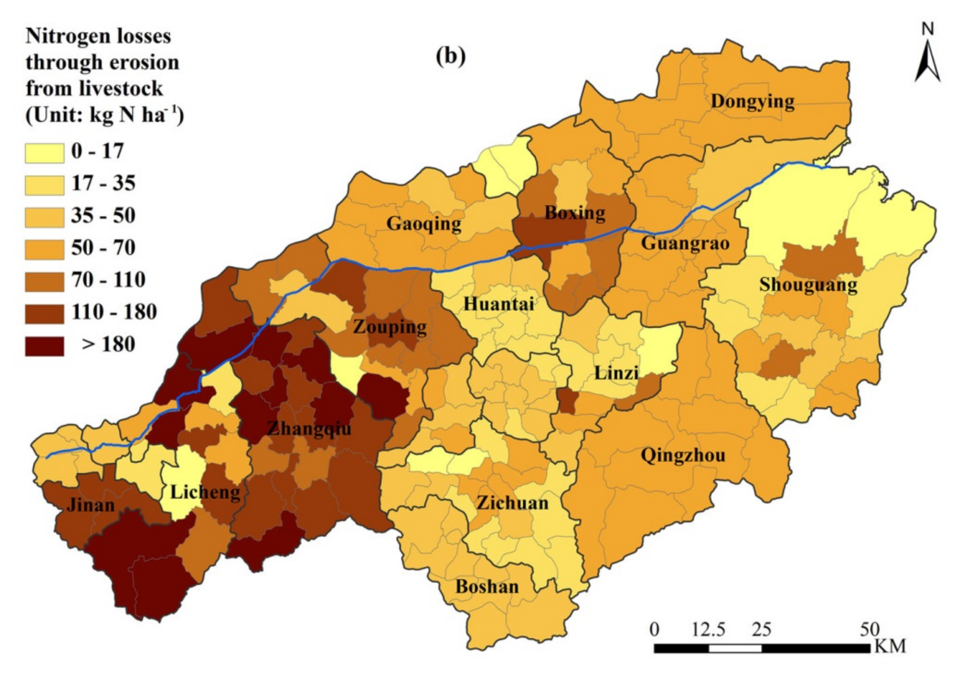



# Nitrogen balance for livestock breeding in Xiaoqinghe watershed



# Distribution of nitrogen losses through runoff and soil erosion from cropland (a) and livestock (b)

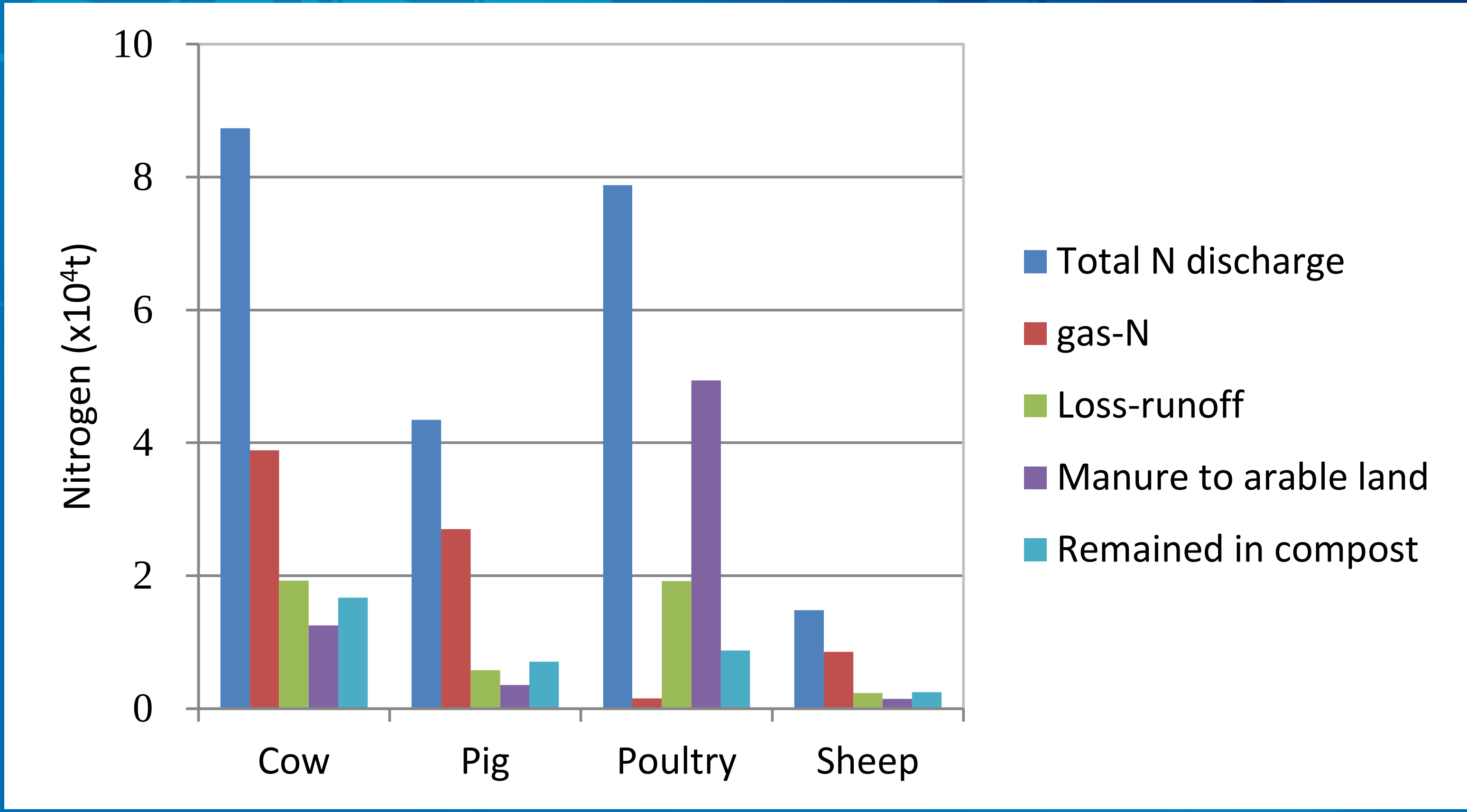


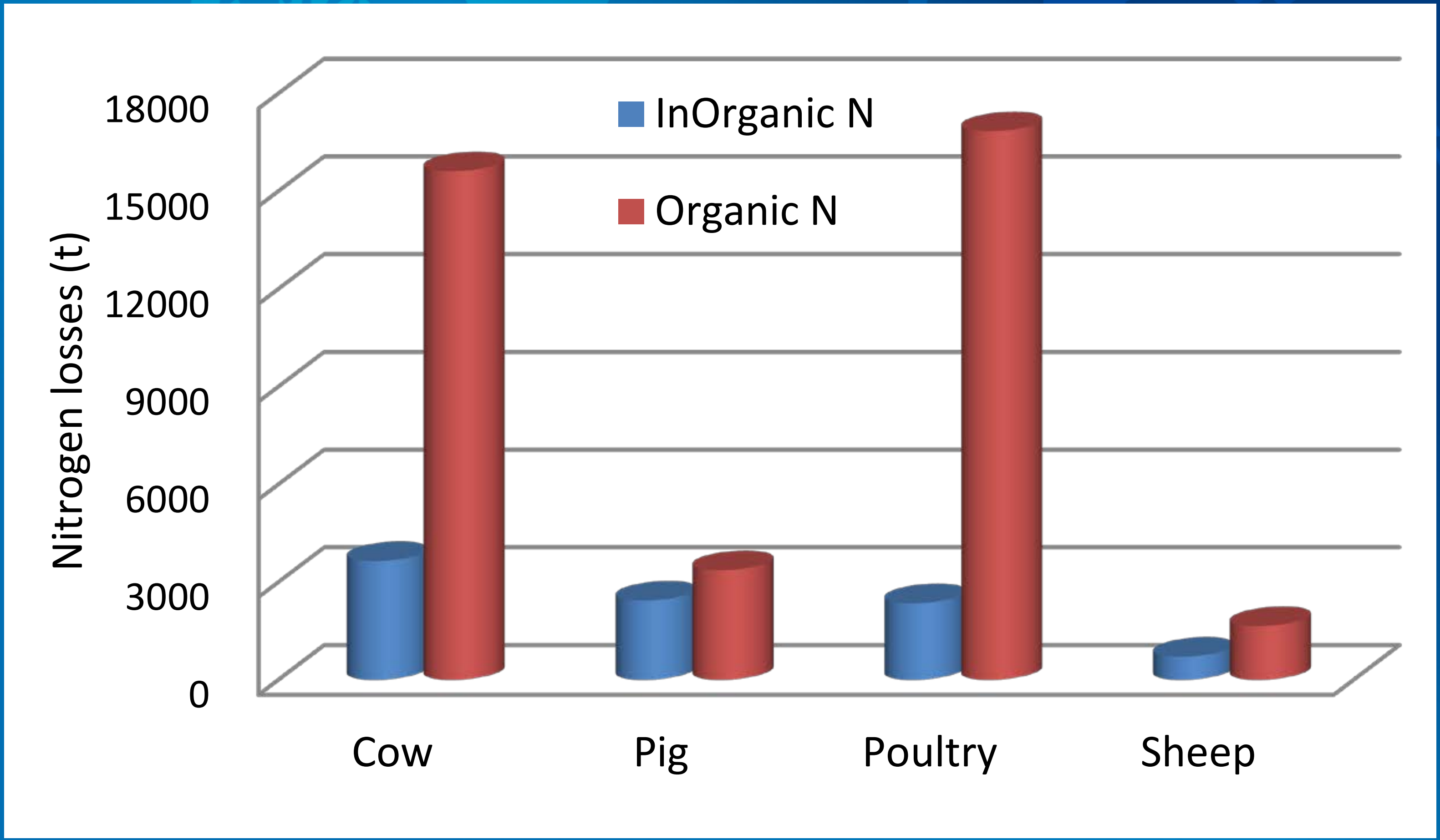
# Sources and major forms of nitrogen losses from runoff and soil erosion

| Sources | Forms | Losses(t N) | Percentage(%) |
|---|---|---|---|
| Arable land | Org-N | 6739.84 | 12.56 |
| | NH4-N | 162.30 | 0.30 |
| | NO3-N | 162.99 | 0.30 |
| **Livestock farms** | **Org-N** | **37452.26** | **69.82** |
| | **Inorg-N** | **9126.30** | **17.01** |

# Nitrogen discharge by different types of livestock and poultry

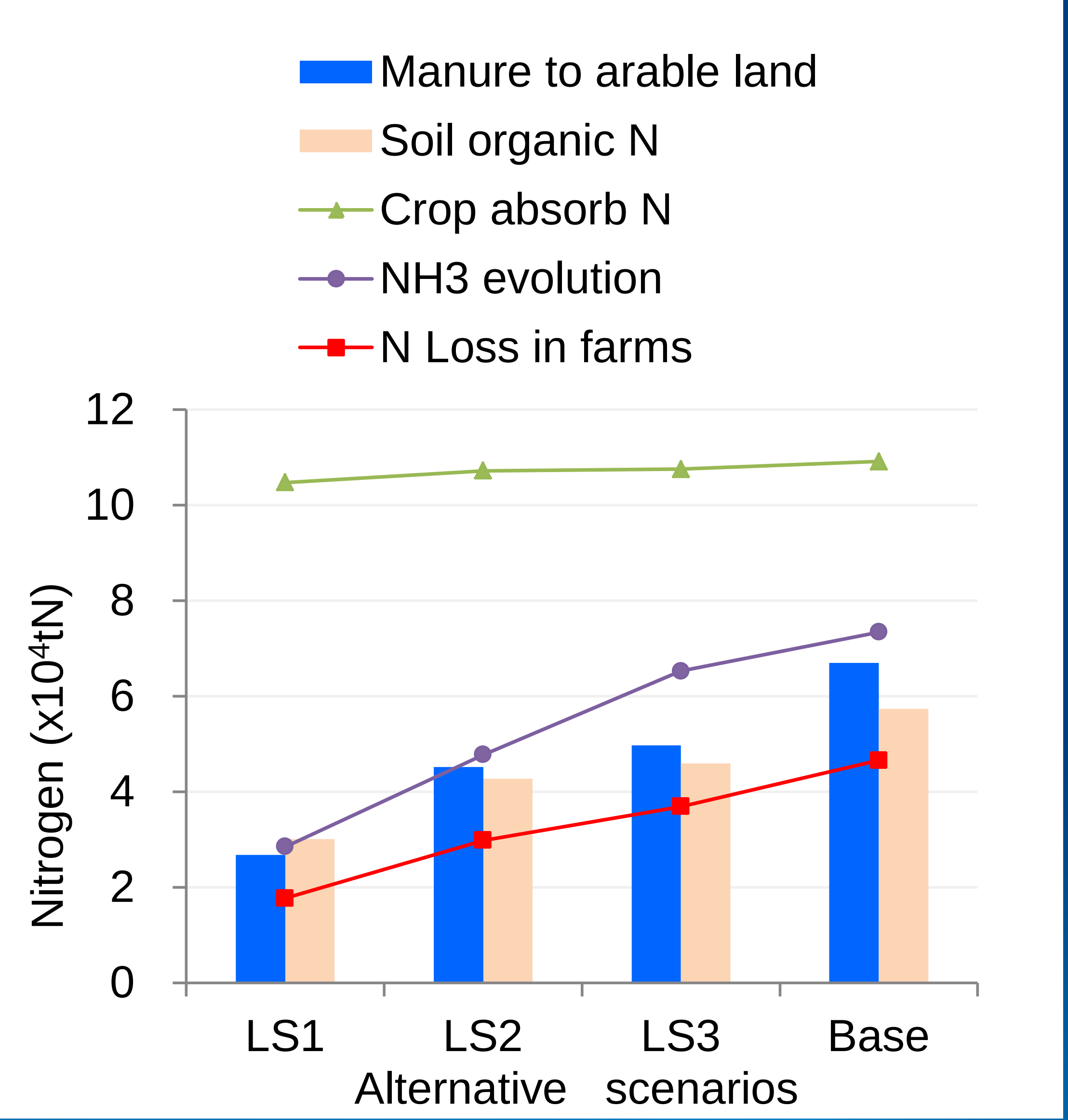


# Nitrogen losses through surface runoff and soil erosion



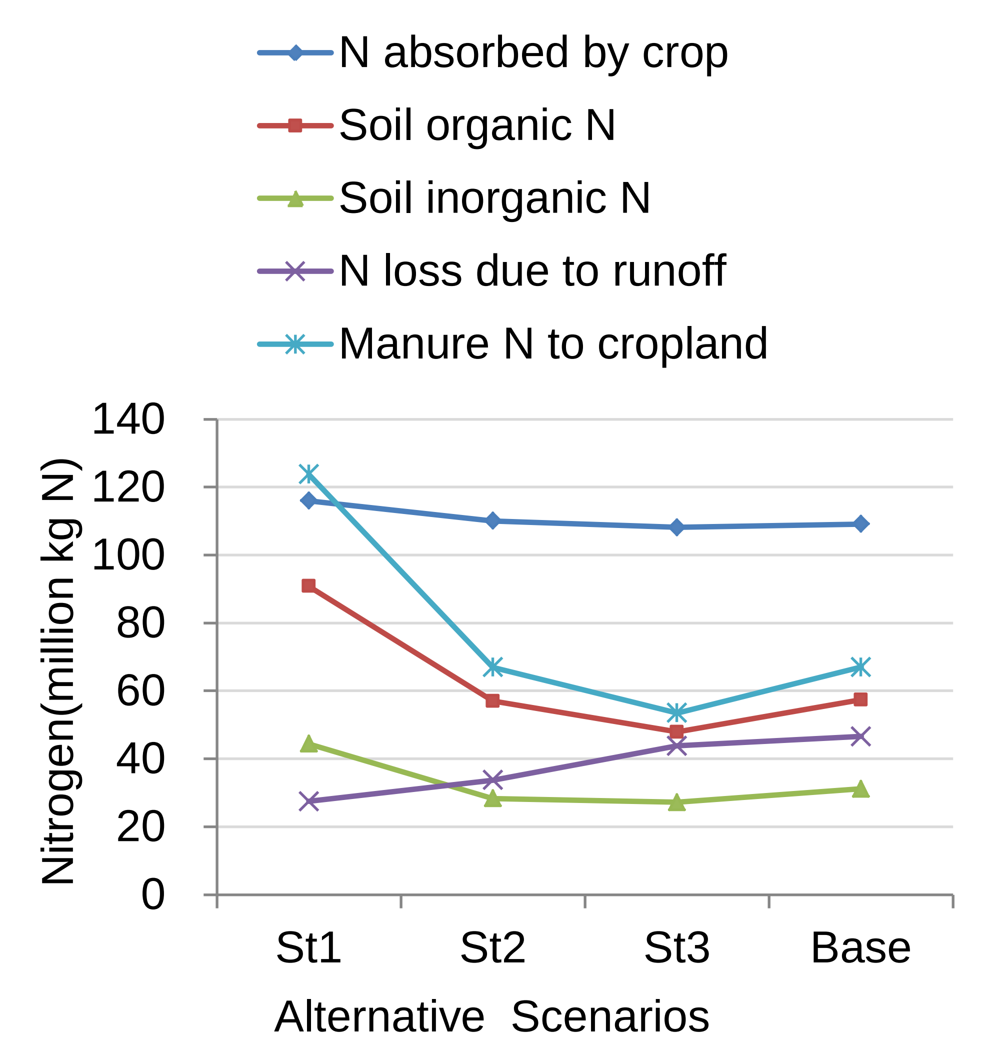
# Alternative scenarios for maximum livestock on every hectare cropland

| Types \ Scenarios | LS1 | LS2 | LS3 |
|---|---|---|---|
| Cow | 0.5 | 1 | 2 |
| Pig | 2 | 4.5 | 9 |
| Sheep | 0.8 | 1.5 | 3 |
| Poultry | 50 | 100 | 200 |



# Alternative scenarios for changing storage times

| Scenarios / Types | St1 | St2 | St3 | Base |
|---|---|---|---|---|
| Cow | 120 | 190 | 250 | 273 |
| Pig | 120 | 190 | 250 | 273 |
| Sheep | 120 | 190 | 250 | 273 |
| Poultry | 70 | 100 | 130 | 162 |



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# 5. Conclusions

- Quantitative tools is critical to precisely describe the nutrient cycles across the agricultural systems and analyze the nutrient complementation between cropping and livestock systems.
- The N loads to surface water from livestock farms and crop fields were 47 and 7 million kg N, respectively.
- About 24 million kg nitrate-N was leached from the cropping systems.

# 5. Conclusions

- Under current management conditions, only 30% of livestock waste N was applied to the crop fields. If the number increases to 80%, there will be 112 million kg N of synthetic fertilizer saved, which accounts for 61% of the current fertilizer use in the watershed.
- There could be huge potentials to improve the nutrient complementation between cropping and livestock systems. The win-win strategy should enhance sustainability of the Chinese agriculture.

- Thank you for your attention!

- Any questions ?