XVIII World Water Congress
International Water Resources Association (IWRA)

Mitigation measures to alleviate the adverse impacts of drought-flood abrupt alternation on summer maize farmland systems

Wuxia Bi

China Institute of Water Resources and Hydropower Research

XVIII WORLD WATER CONGRESS
Water for All
Harmony between Humans and Nature
第18届 世界水资源大会
水与万物：人与自然和谐共生

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Introduction

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The increasing frequency and intensity of extreme droughts and floods have caused enormous socio-economic losses.

Global droughts

Since the 1970s, the covered area of extreme droughts has increased by 1.5 times

Global loss
163,651 deaths, 3.5 billion affected people, 780 billion US dollars loss

Drought events occurred in 2 to 3 years, the frequency of major and extreme drought events has increased

Droughts in China

Global floods

In the past 100 years, more than 2800 floods occurred, causing 7 million deaths

From 1950 to 2017, floods caused 4155 deaths, and the direct socio-economic loss was 150,522 million yuan

Floods in China

Global DFAA

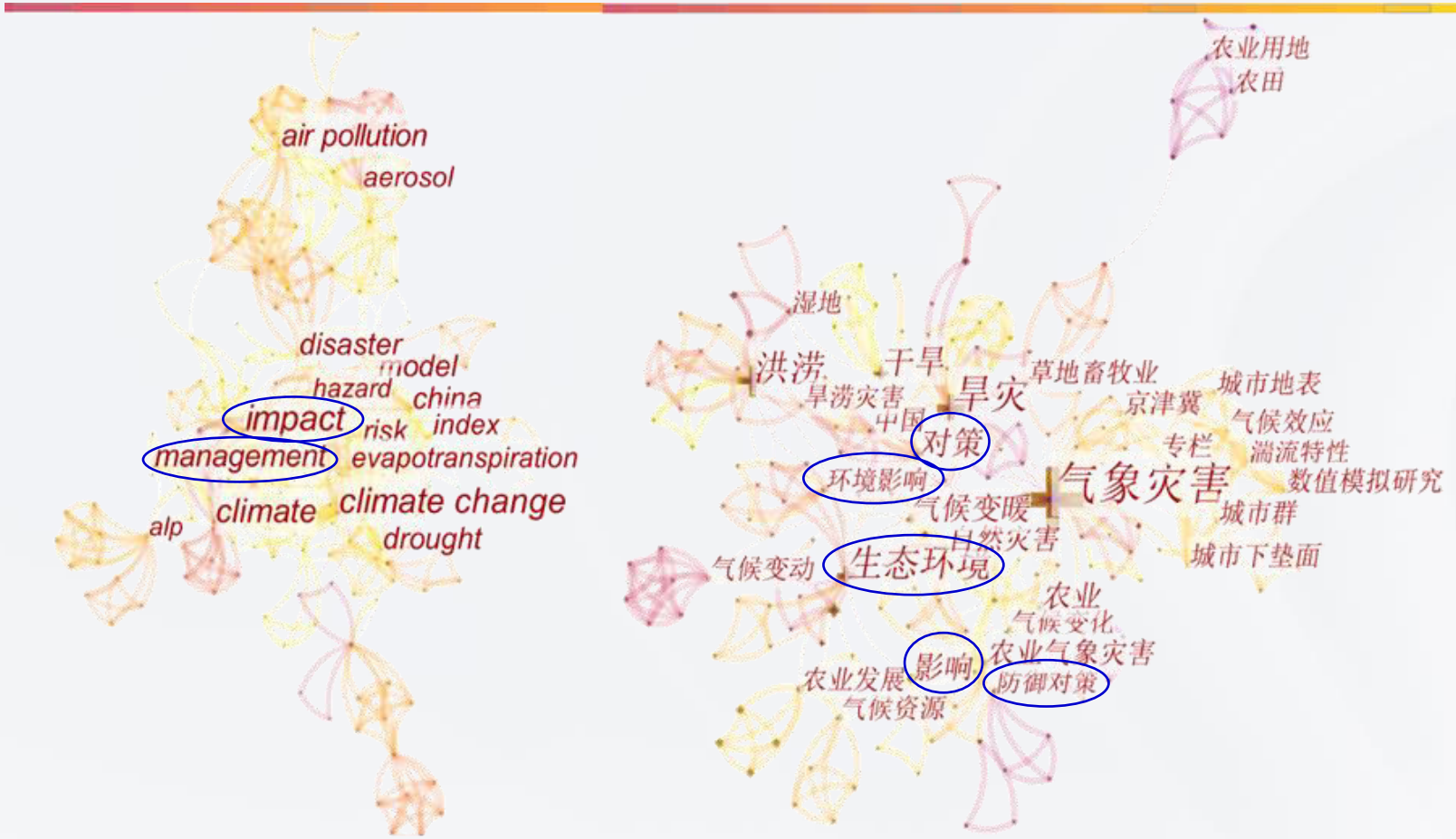
In 2018, Kenya experienced a severe drought-flood abrupt alternation, resulting in nearly 200 deaths

Mainly occurring in the South of China (Yangtze River Basin, Huai River Basin, and Southwest China), with frequency of every 4 years

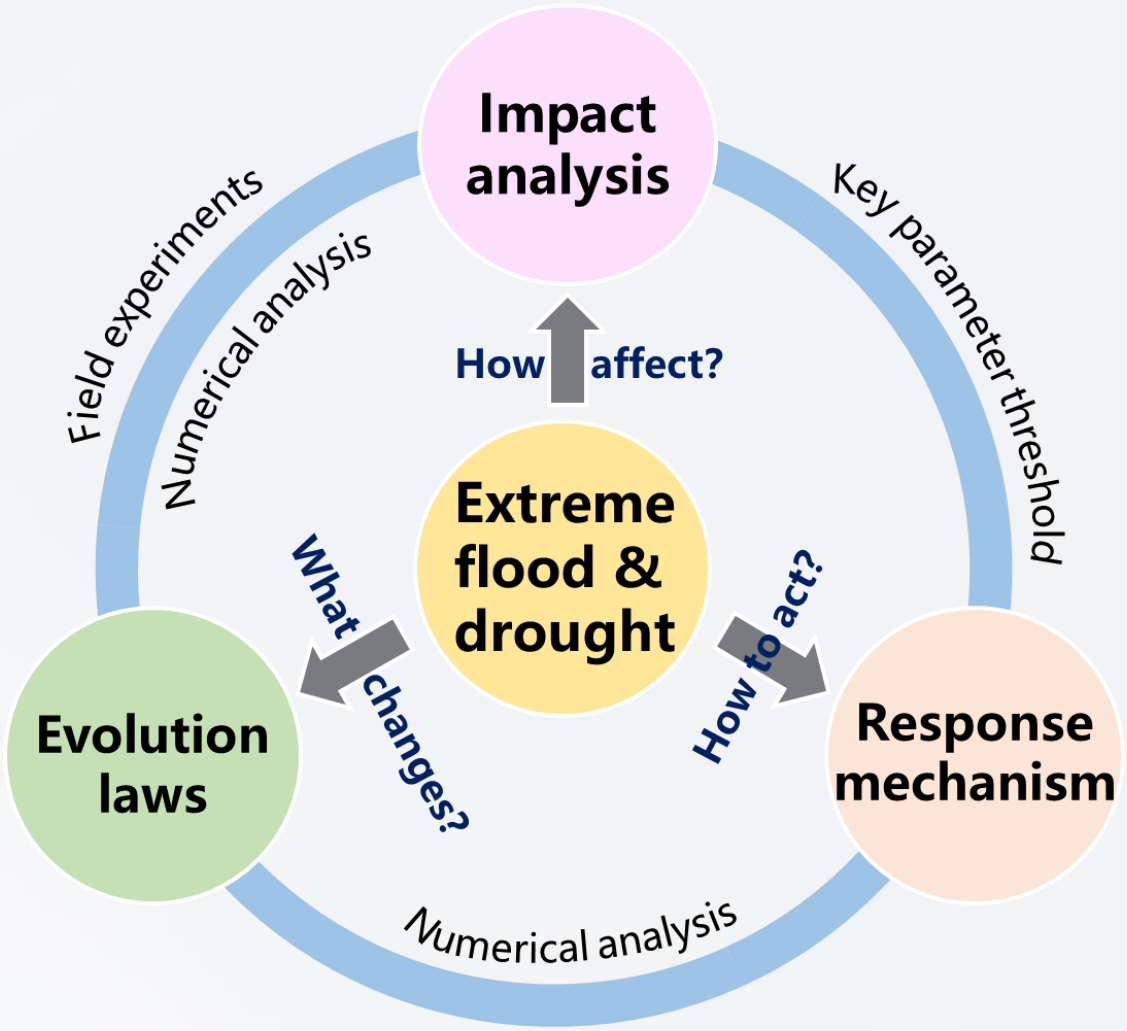
DFAA in China

Introduction

The eco-environmental effects and mitigation measures of drought-flood abrupt alternation are currently a research hotspot, belonging to interdisciplinary research.



Introduction



Main objectives:

- Quantifying the adverse impacts of drought-flood abrupt alternation on summer maize yield and water quality (soil phosphorus loss)
- Exploring the mitigation effects on summer maize yield and water quality under different scenarios in the history and future

Materials & Methods

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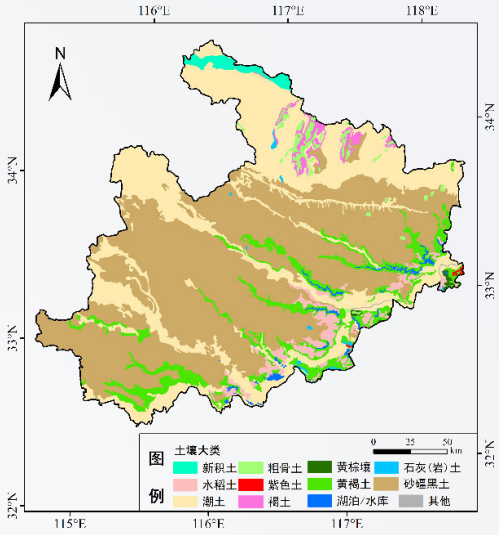
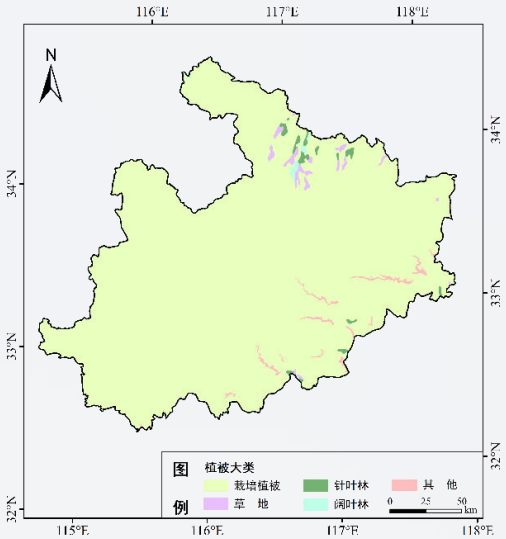
Study area

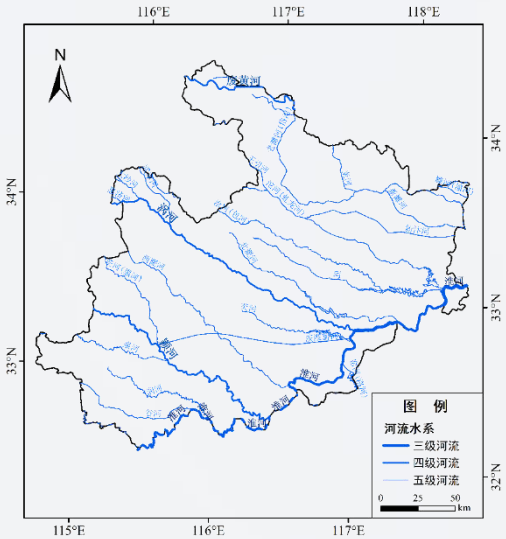
- The area of farmland is large, especially the dry farmland, accounting for 75%
- The main soil is dark-hydromorphic clay loam, accounting for 52.2%
- The planting area of summer maize accounts for 26.8% of the total grain planting area



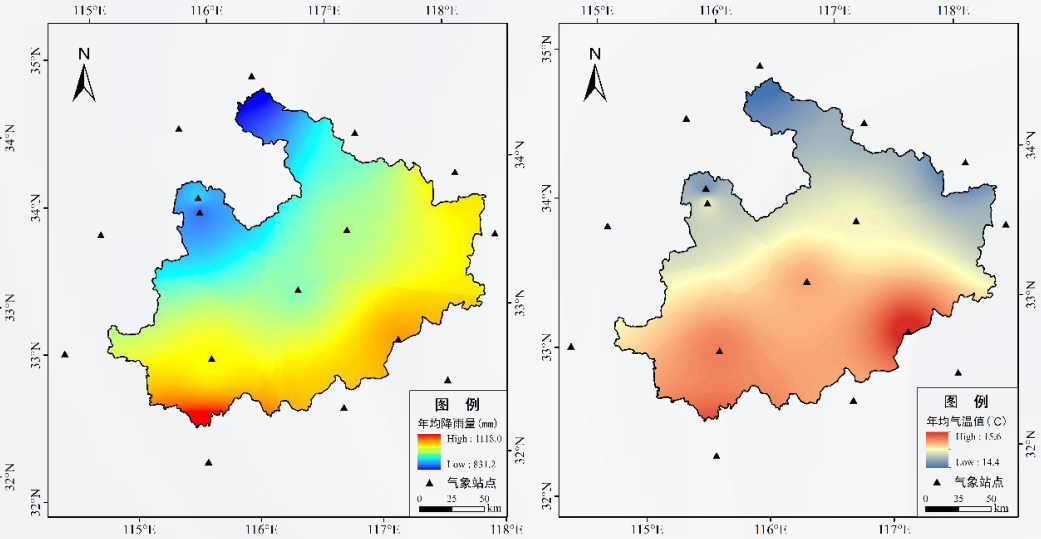
Soil distribution map



Plant distribution map



River systems



Multi-year average precipitation, average temperature

Materials & Methods

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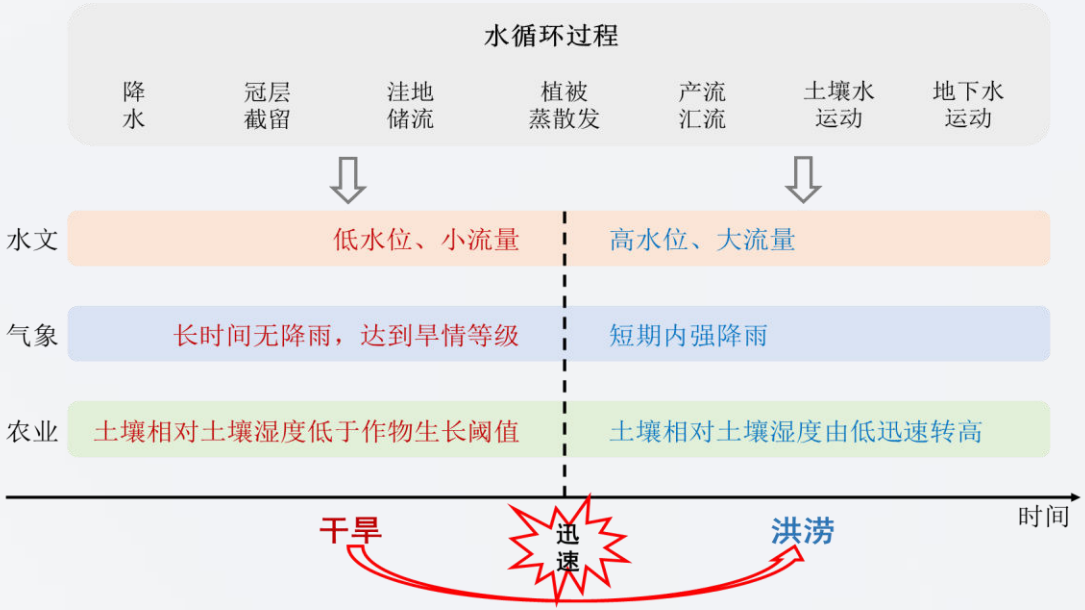
Method

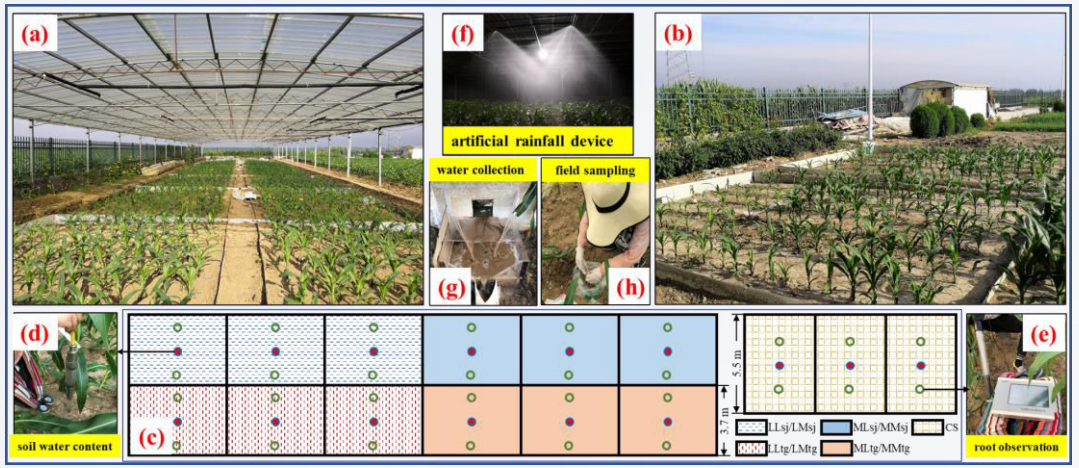
Theoretical Method



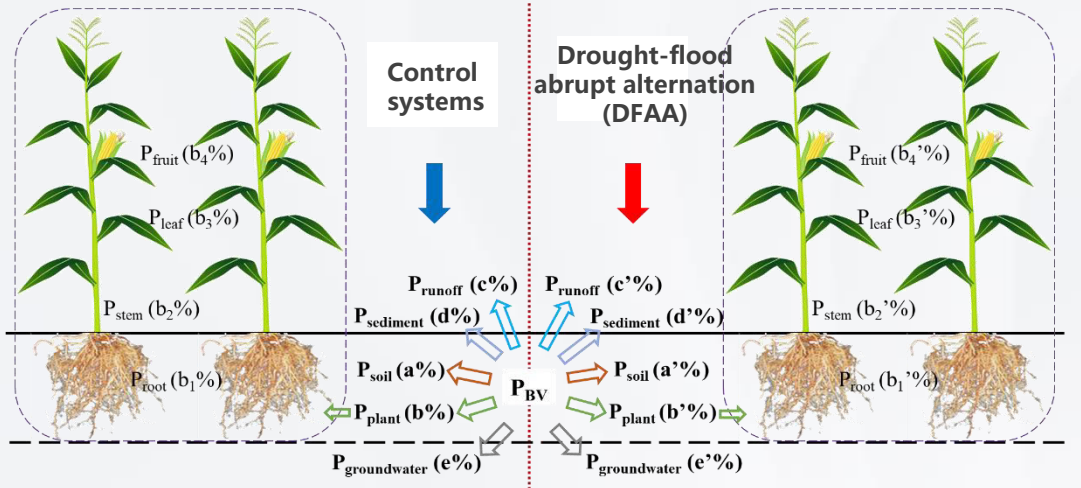
$$DFAA_L = \begin{cases} \sum_{j-i}^{j} P_{d,l1} = 0, W_{d,l1,m} = \dfrac{\theta_{d,l1,m}}{F_c} \times 100 \\ \sum_{j}^{j+n-1} P_{f,l2} \end{cases}$$

rainless days + soil moisture + intensity + duration

Field Experiments

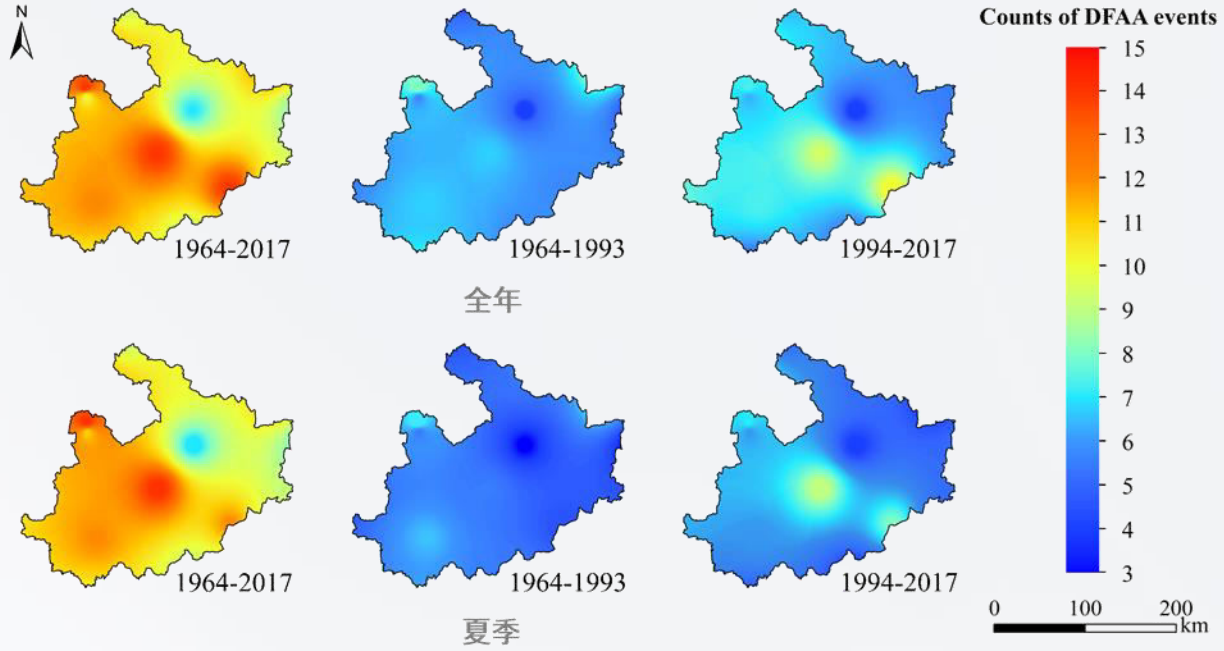


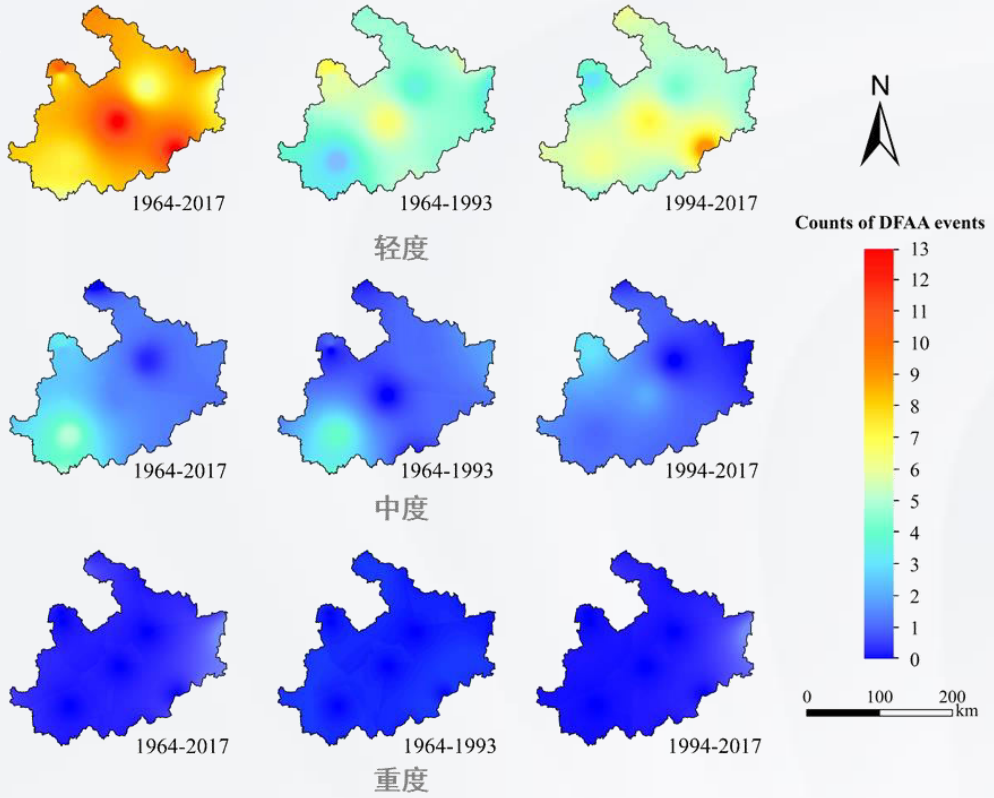
Numerical Analysis



Evolution laws

- Drought-flood abrupt alternation occurred every 3 to 4 years
- Over 85% of DFAA events occurred in summer
- Over 85% of DFAA events were in light level



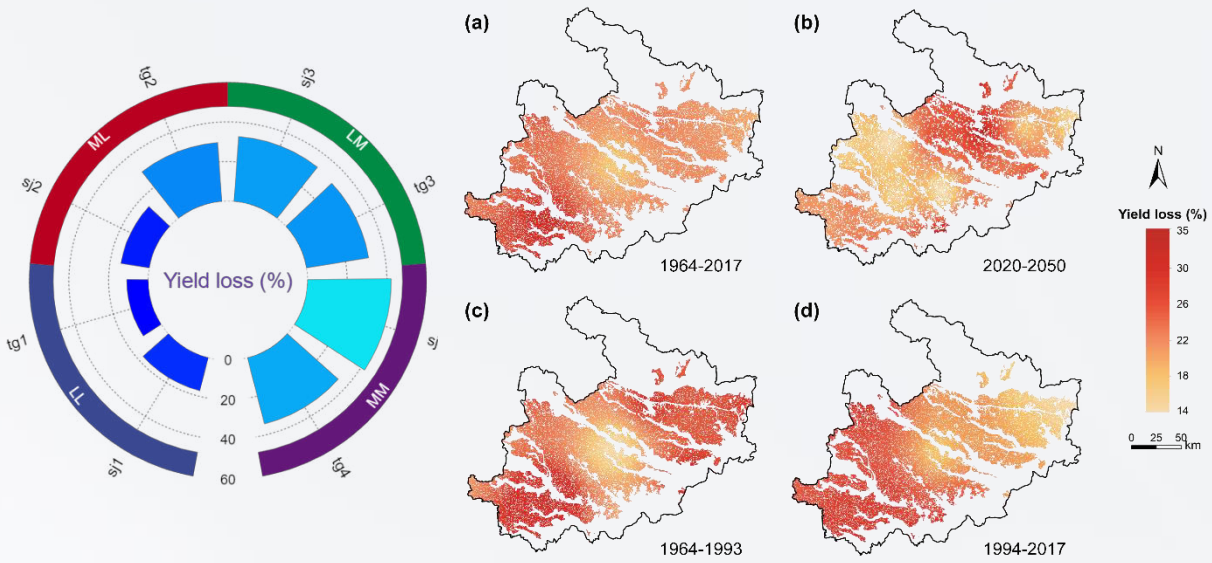


Impact analysis

Agriculture——yield

- **Field:** yield reduced by 14% to 38% compared with CS
- **Region:**

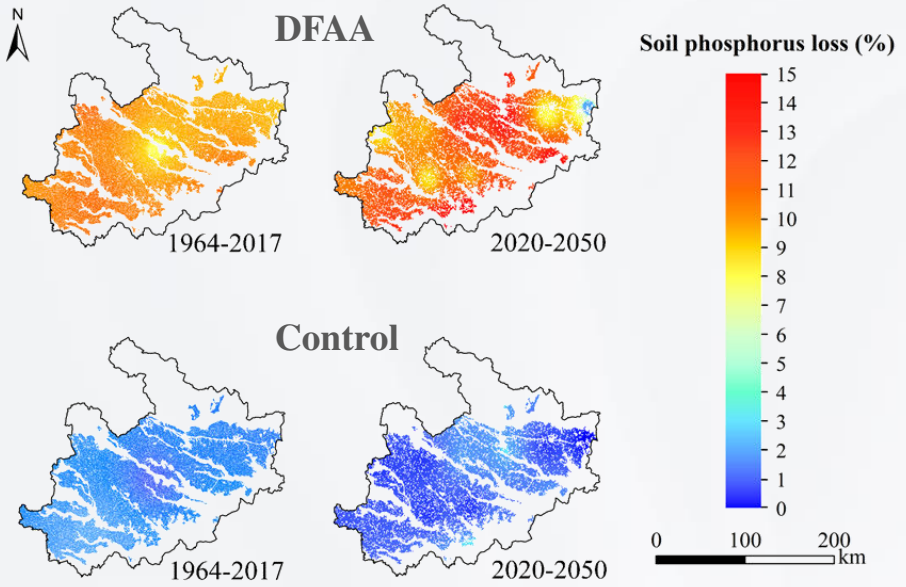
  annual average yield loss was 24.9% in the past 60 years, and will increase by 7.8% in the next 30 years



Environment——soil nutrient loss

- **Field:** soil phosphorus (P) loss was 3.1% to 16.5%
- **Region:**

  annual soil P loss was 9.2% in the past 60 years, and will increase by 37% in the next 30 years



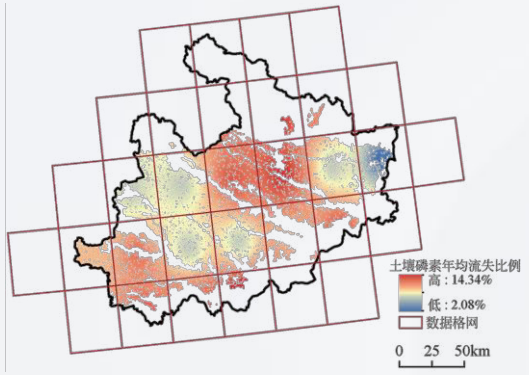
Mitigation effects

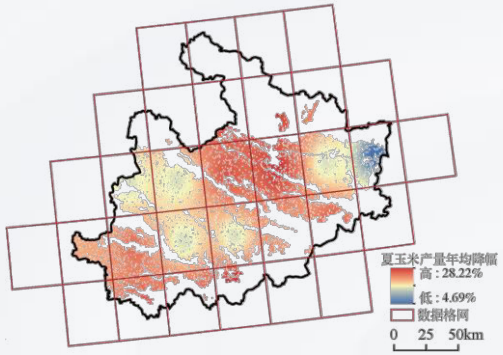
The mitigation measures on drought level degradation and flood level degradation could decrease the yield reduction of summer maize and soil phosphorus loss.

Scenario 1：

Artificial irrigation and other drought level degradation measures

- **History:** decrease the yield reduction of summer maize by 9%, no significant reduction on soil phosphorus loss
- **Future:** decrease the yield reduction of summer maize and soil phosphorus loss by 8.4% and -0.5%

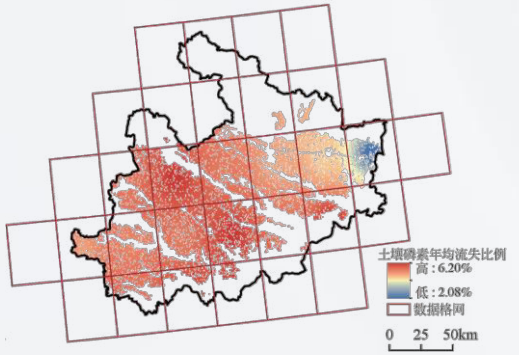


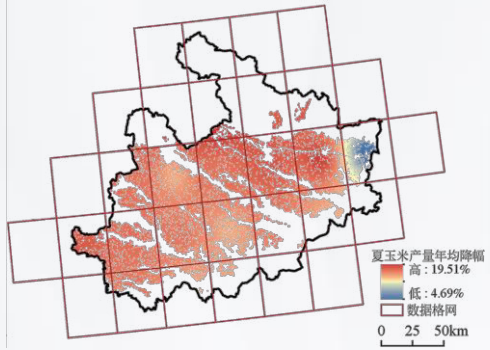


Scenario 2：

Artificial detention and other flood level degradation measures

- **History:** decrease the yield reduction of summer maize and soil phosphorus loss by 32% and 41%
- **Future:** decrease the yield reduction of summer maize and soil phosphorus loss by 31% and 56%





Conclusions

Evolution laws

- Drought-flood abrupt alternation events occurred every 3 to 4 years
- Over 85% of DFAA events occurred in summer
- Over 85% of DFAA events were in light level

Impact analysis

- DFAA reduced summer maize yield by 14% to 38%
- Soil phosphorus loss was 3.1% to 16.5% under DFAA

Mitigation effects

- Drought level degradation measures decreased the yield reduction of summer maize by 9% and 8.4% in history and in the future
- Flood level degradation measures decreased the yield reduction of summer maize by 32% and 31% in history and in the future, and decrease soil phosphorus loss by 41% and 56% in history and in the future

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Thank you for your attention!

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E-mail: biwx@iwhr.com

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