iPRRG
11th Meeting of the International Pest Risk Research Group
Predictability and Uncertainty in Pest Risk Analysis
29th August –1st September 2017
Ottawa, Canada

Predicting the potential distribution in China of *Euwallacea fornicatus* (Eichhoff) under current and future climate conditions

Euwallacea fornicatus Eichhoff

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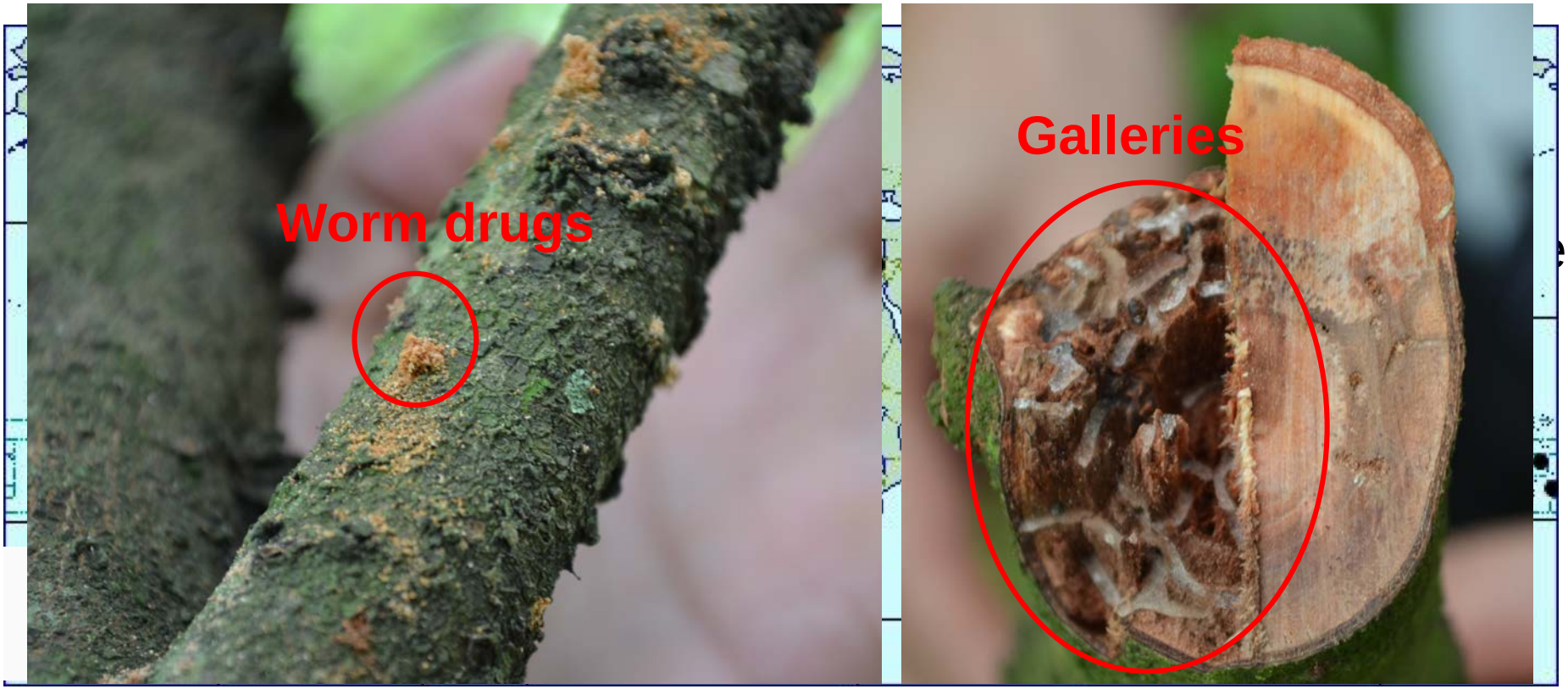
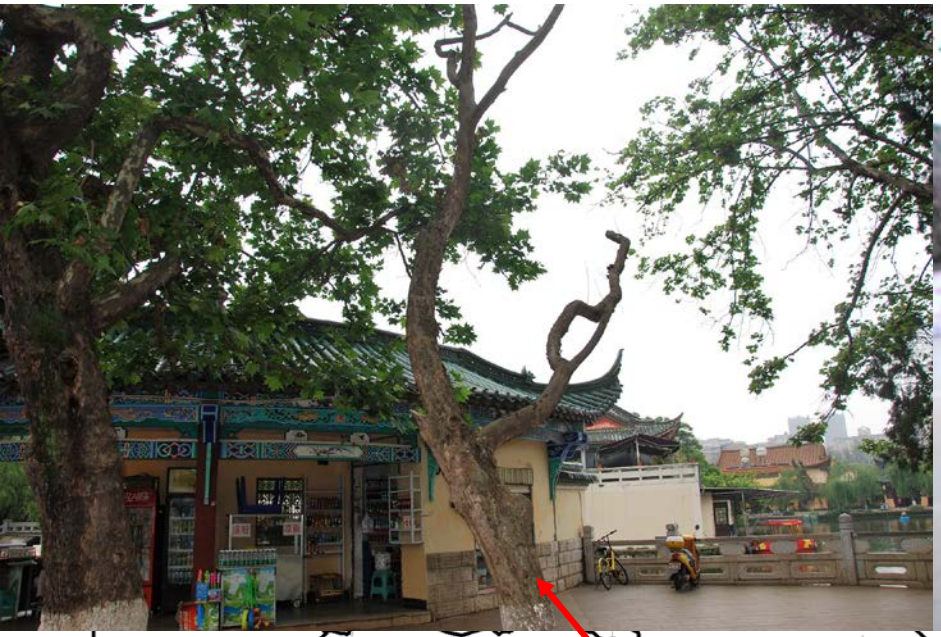
1 Background

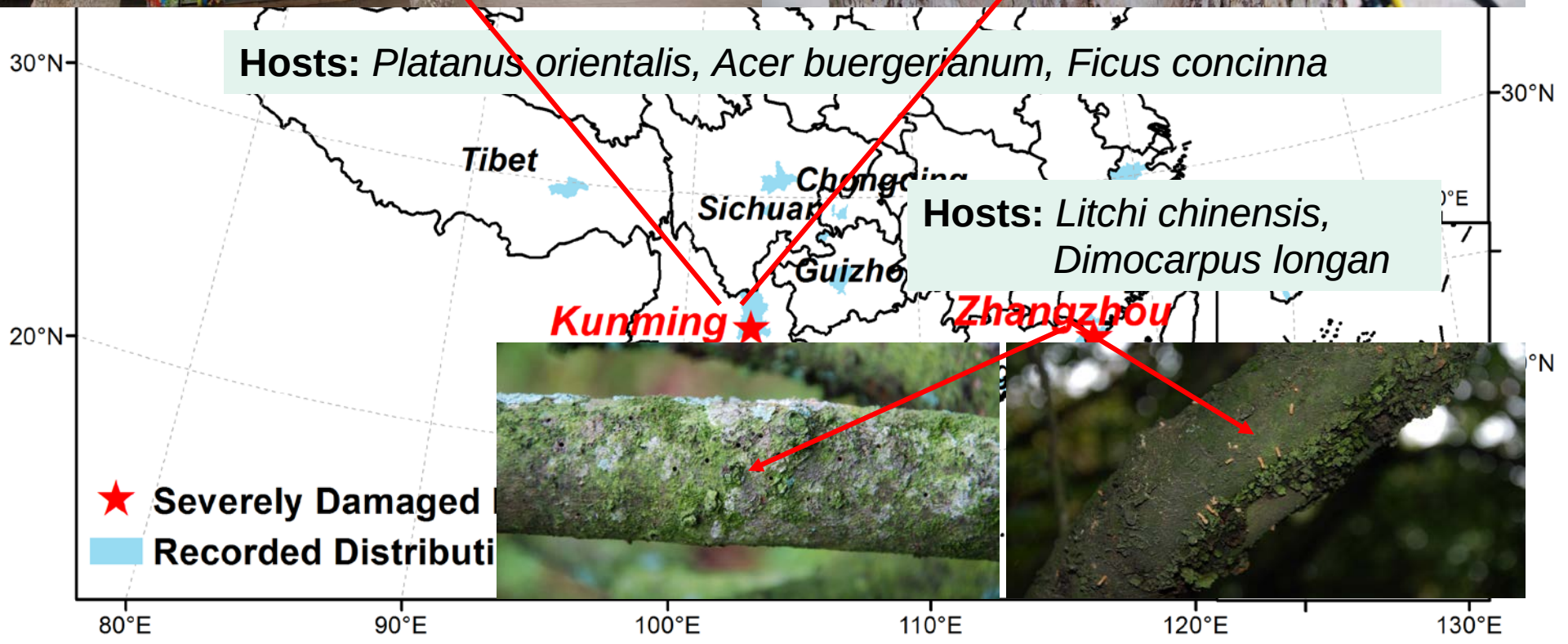
1.1 Damage caused by *E. fornicatus*



- Severely damaged in America, Vietnam, China.
- Looks to be a major problem in urban forests, commercial food, and forests once it gets there.



Hosts: *Platanus orientalis, Acer buergerianum, Ficus concinna*



Hosts: *Litchi chinensis, Dimocarpus longan*

1.2 Climate change

➢ Global climate warming — an indisputable fact

IPCC AR5
(September **2013**)

Relative to the period 1986-2005, the global mean surface air temperature will rise **0.3~0.7 ℃** in 2016-2035, **0.3~4.8 ℃** by the end of the 21st century.

COP20: UN Climate Change Conference in Lima
(December **2014**)

By the end of the 21st century, , the global mean surface air temperature of China will rise **1.3~5.0 ℃**, which is above the global average.

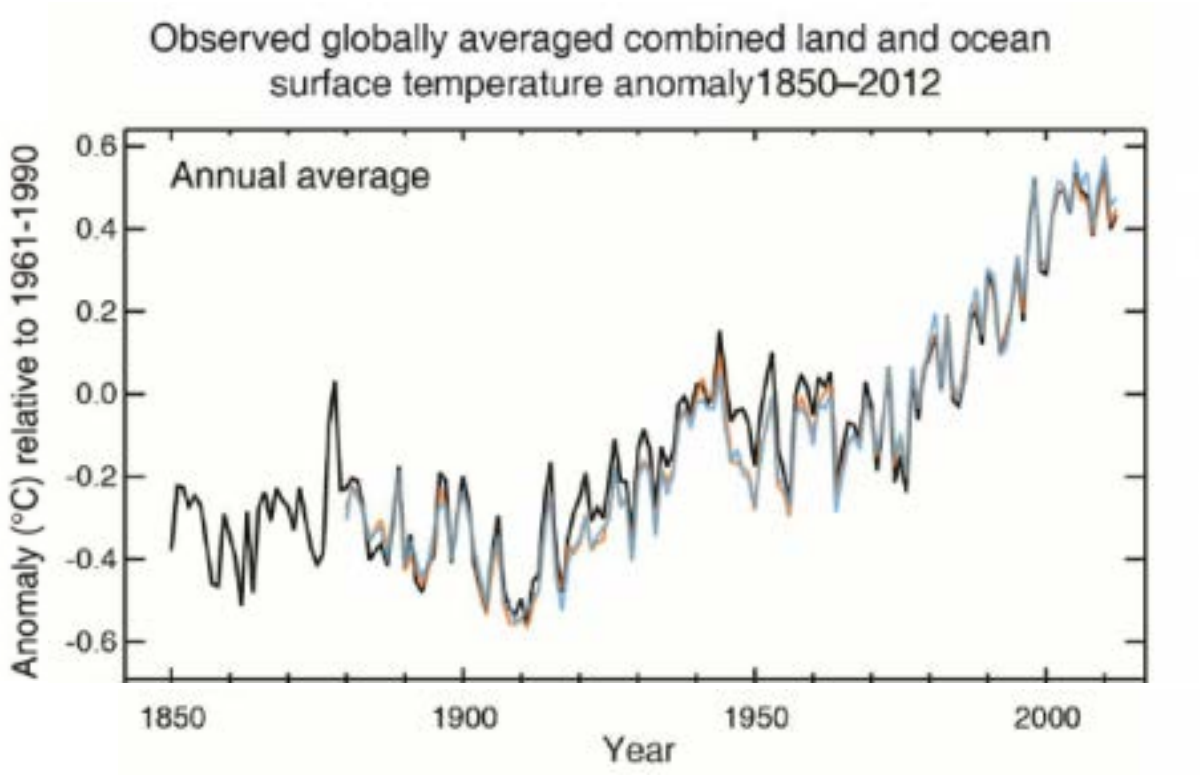
(The 3rd National Assessment of Climate change)

COP21: UN Climate Change Conference in Paris
(December **2015)**

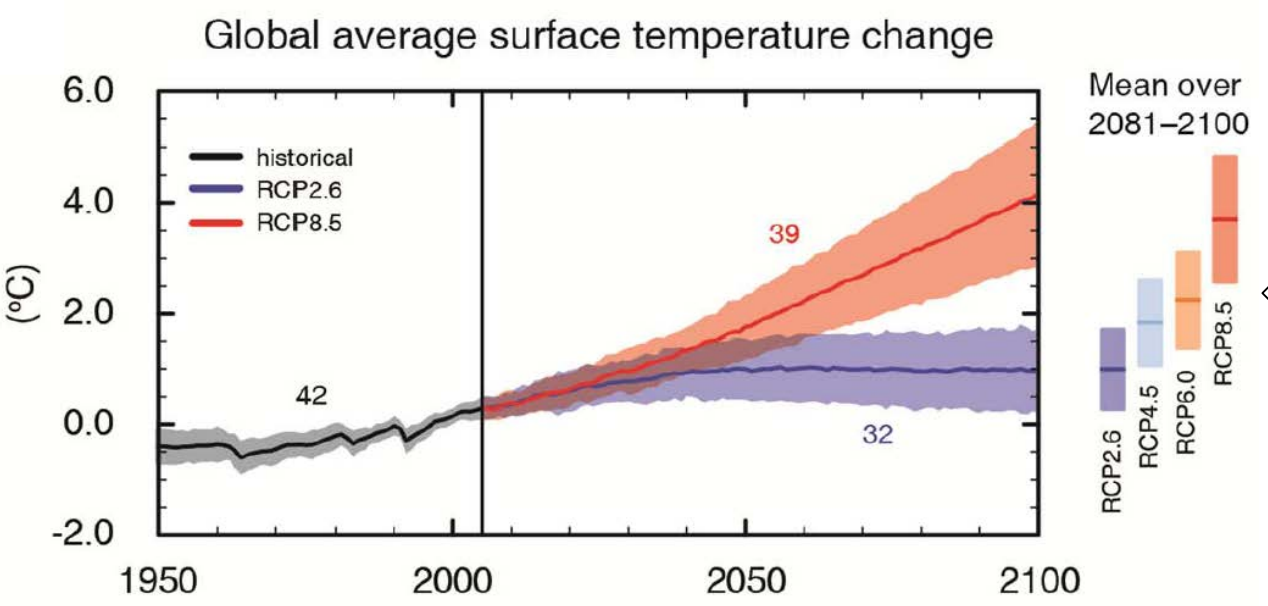
Every country published its plan to reduce emissions, in order to control the global temperature rise within **2 ℃**.

COP22: UN Climate Change Conference in Marrakech
(November **2016)**

In 2011-2015, this period is the world's **warmest** five years on record, the average temperature is **0.57 ℃** higher than the period of 1961-1990.



Observation of Changes in Temperature

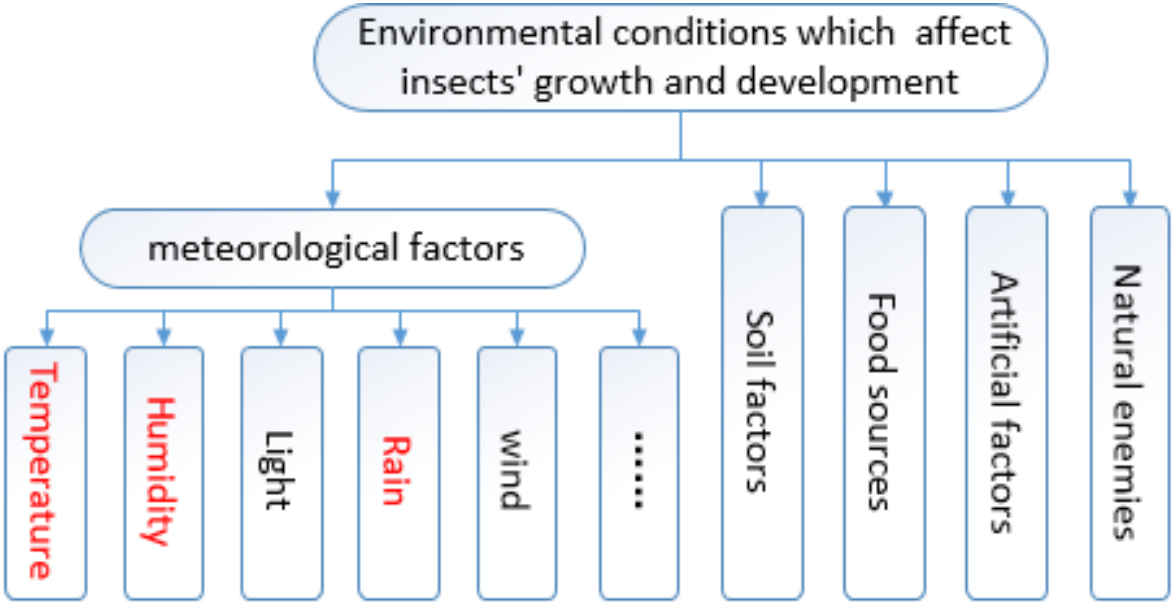


Long-Term Projections of Changes in Temperature

IPCC AR5

1.3 Climate change impacts on forest pests

- **Distribution:** range of potential distribution…
- **Development:** occurrence period, generations…
- **Intraspecific and interspecific competitions:** population quantity, population density…
- **Relationship with hosts:** hosts preference, synchronicity with hosts…



Aim of Our Research

- Use CLIMEX 4.0 and ArcGIS10.2 to predict the potential distribution of *E. fornicatus* in China under the current and future climate conditions.

  ➡ Provide a reference and guide to facilitate its control in China.

- Discuss the climate change impacts on the potential distribution of the pest.

  ➡ Serve as an example of the study on the climate change impacts on forest pests in China.

2 Research Method

Current Climate Data (1981-2010)

- **Data source**
  China Surface Climate Monthly Standard Values dataset (1866 meteorological stations)
- **Data process**
  Select the related meteorological data
  Interpolate into high resolution data-**8km*8km** (ANUSPLIN)
  Sort the data format into CLIMEX requires

Future Climate Data (2011-2040)

- **Data source**
  Coupled Model Intercomparison Project phase 5 **(CMIP5)** (CSIRO-Mk3-6-0, RCP8.5)
- **Data process (Same as before)**

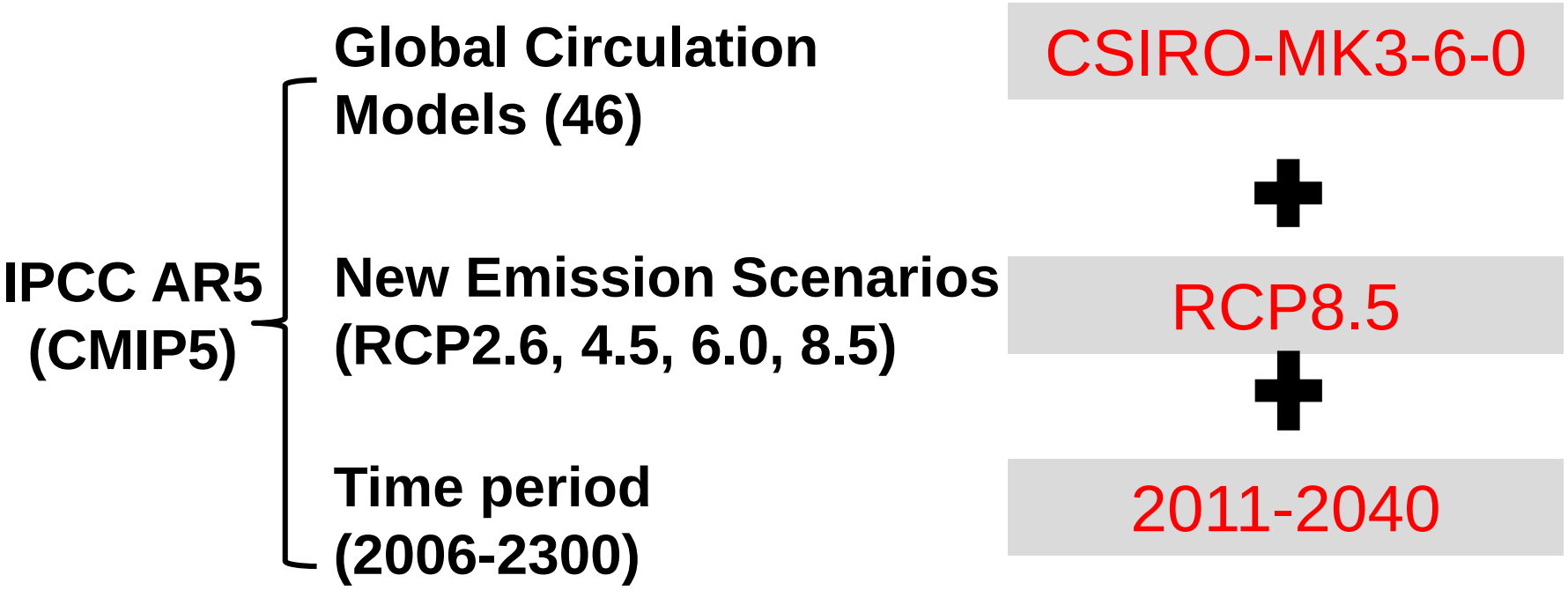
FCD=CCD+△SCD

△SCD=SFCD-SHCD

FCD: Future Climate Data
CCD: Current Climate Data
△SCD: Change value of simulated climate data
SFCD: Simulated future climate data
SHCD: Simulated historical climate data

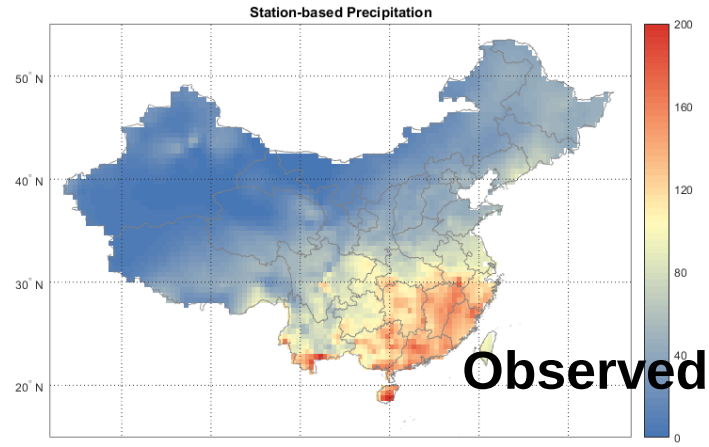
Supplementary Information

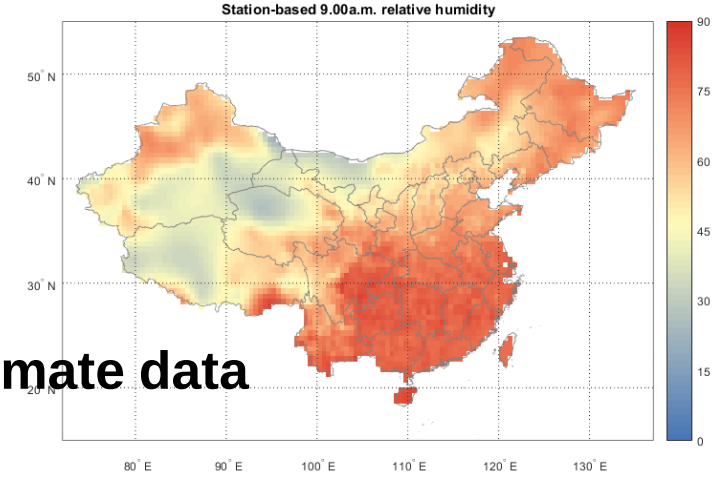
(1) Select appropriate simulated future climate data



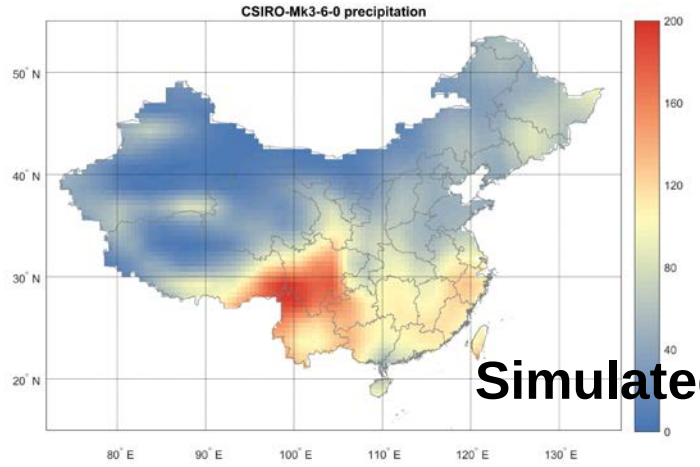
Supplementary Information

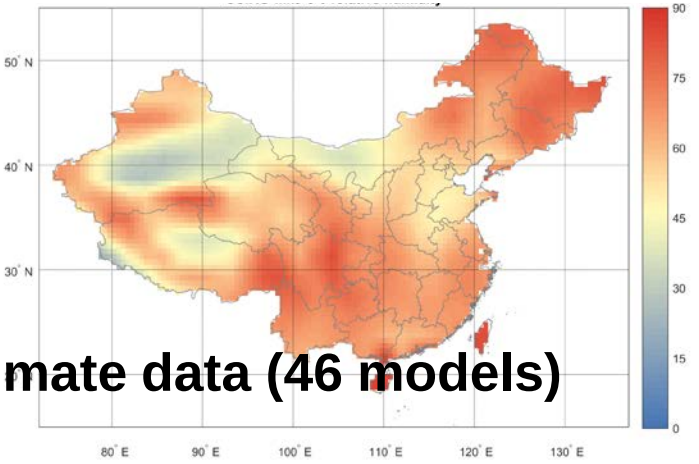
(2) Select appropriate model





Observed climate data

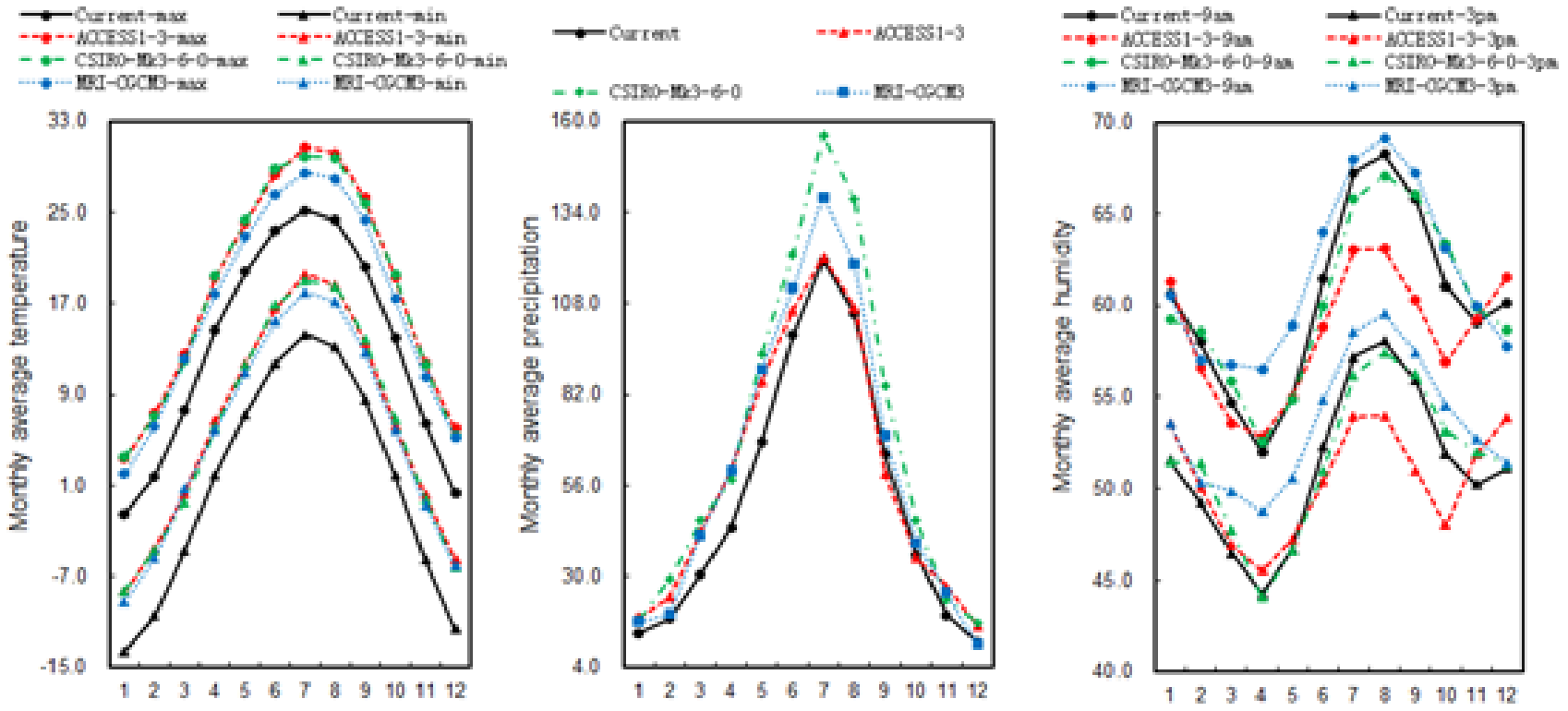


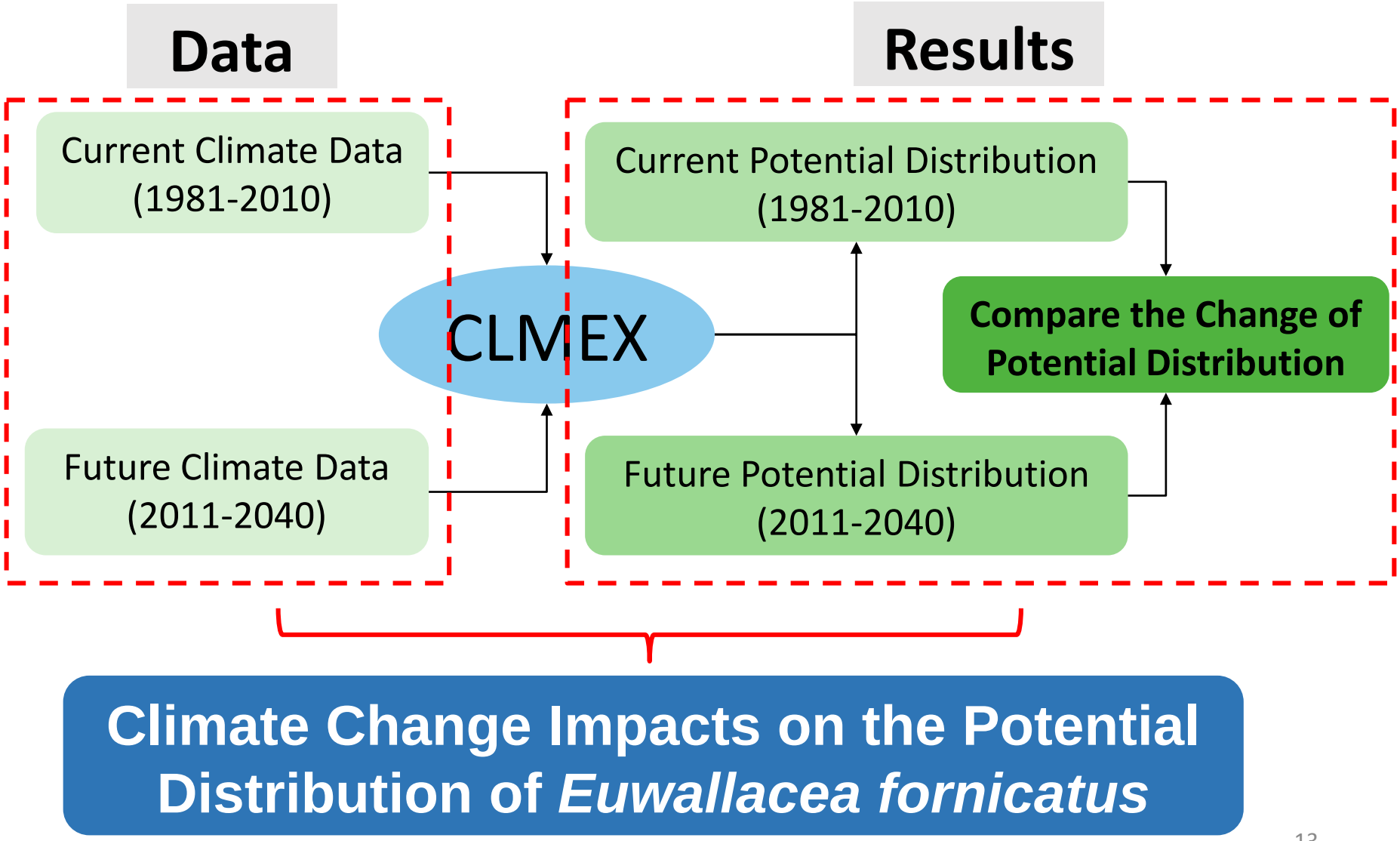


Simulated climate data (46 models)

Supplementary Information

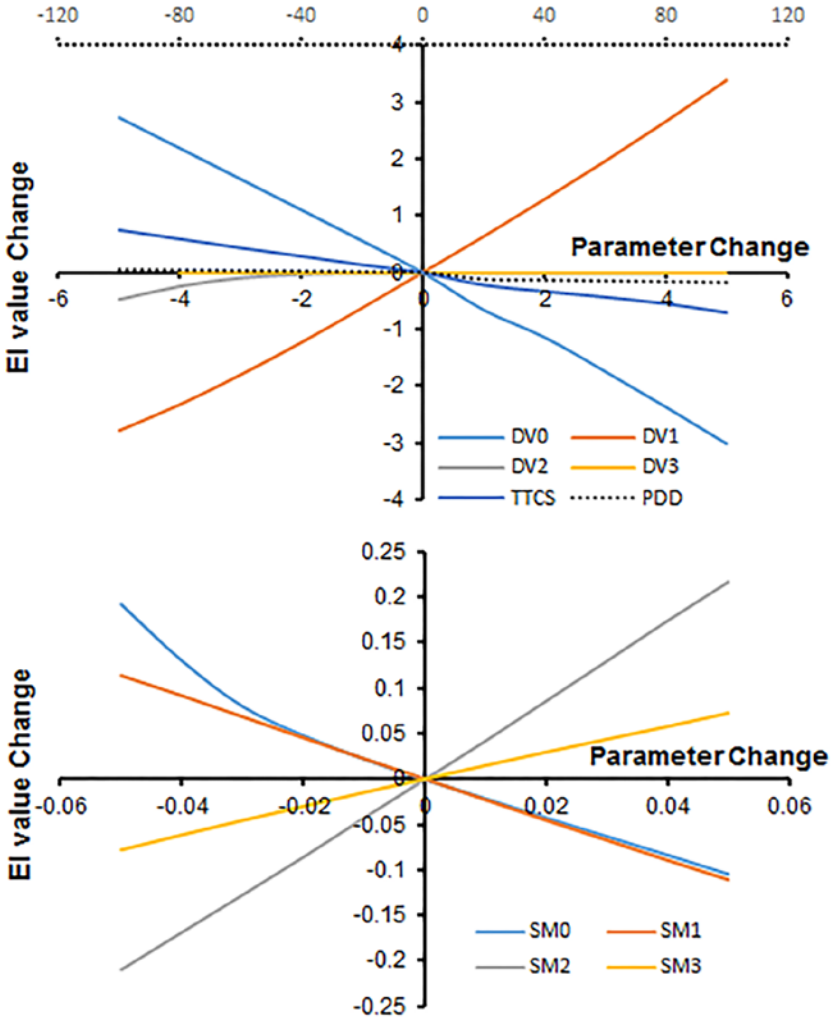
(2) Select appropriate model




Data
Results
Current Climate Data
(1981-2010)
Future Climate Data
(2011-2040)
CLMEX
Current Potential Distribution
(1981-2010)
Future Potential Distribution
(2011-2040)
Compare the Change of
Potential Distribution
Climate Change Impacts on the Potential Distribution of *Euwallacea fornicatus*

3 Research Results

3.1 Sensitivity analysis of CLIMEX parameters



Temperature-related parameters

- **Negative correlation-DV0**
  (Lower temperature threshold)
- **Positive correlation-DV1**
  (Lower optimum temperature)

Mositure-related parameters

- **Negative correlation-SM0, SM1**
  (SM0-Lower soil moisture threshold)
  (SM1-Lower optimal soil moisture)
- **Positive correlation-SM2, SM3**
  (SM2-Upper optimal soil moisture)
  (SM2-Upper soil moisture threshold)

Fig. 1. Sensitivity analysis of the selected parameters in CLIMEX for *E. fornicatus* as change in average EI value.

3.2 Driving variables

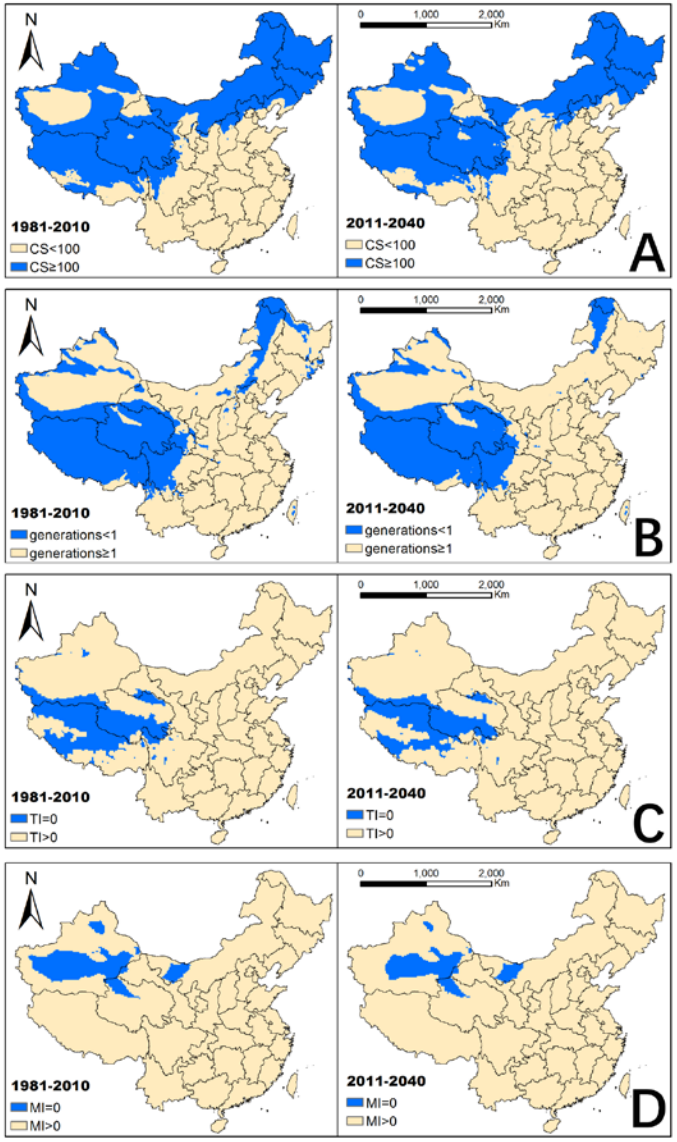


Fig. 2. Limiting distribution maps of four different conditions.

- **CS-**Northeast China and Inner Mongolia
- **PDD & CS-**Northwest China
- **TI-**Tibet and Qinghai
- **MI-**central Xinjiang and western Inner Mongolia

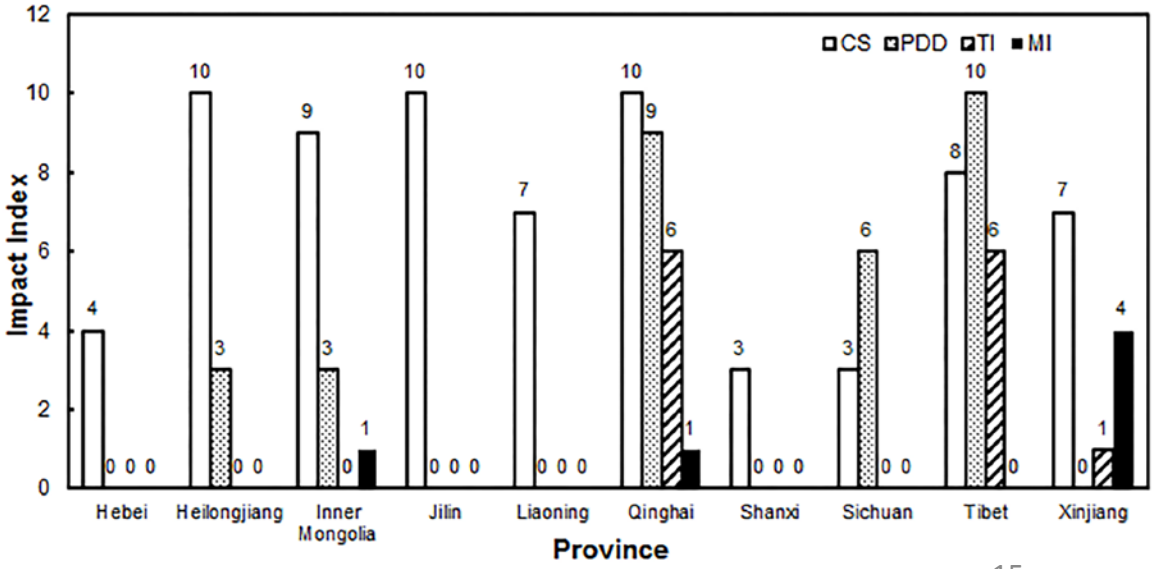


Fig. 3. Impact Index in different provinces of the four factors.

3.3 Potential distribution under two climate conditions

- **Mainly located in southern China**

  Current-3.76 million km2, 39.1% of the total area of mainland China;

  Future-4.16 million km2, or 43.4% of the total mainland area.

- **Similar distributed range, some big changes in local regions.**

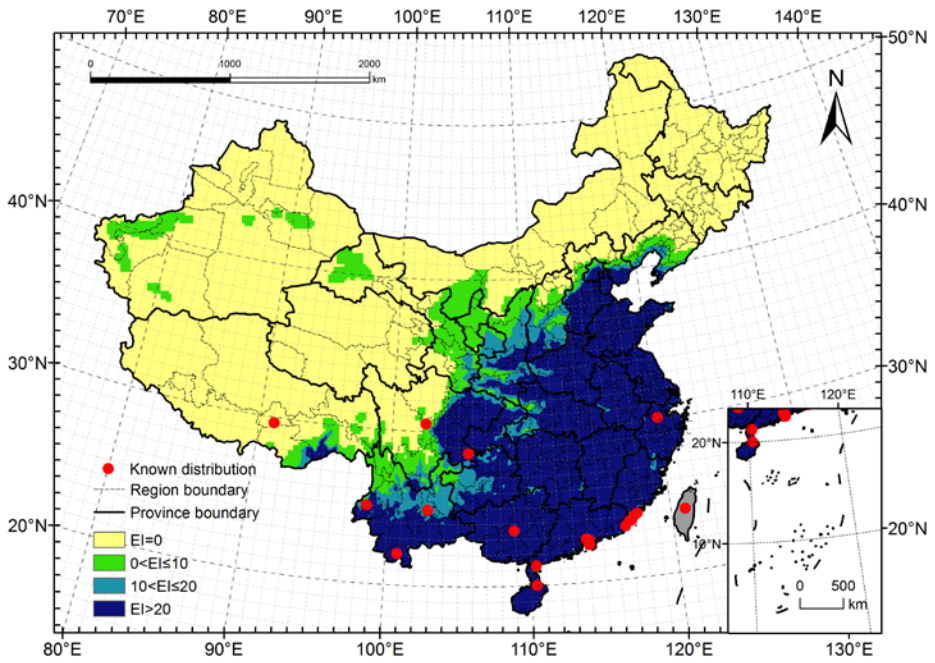


Fig. 4. Potential distribution for *E. fornicatus* under the current climate (1981–2010).

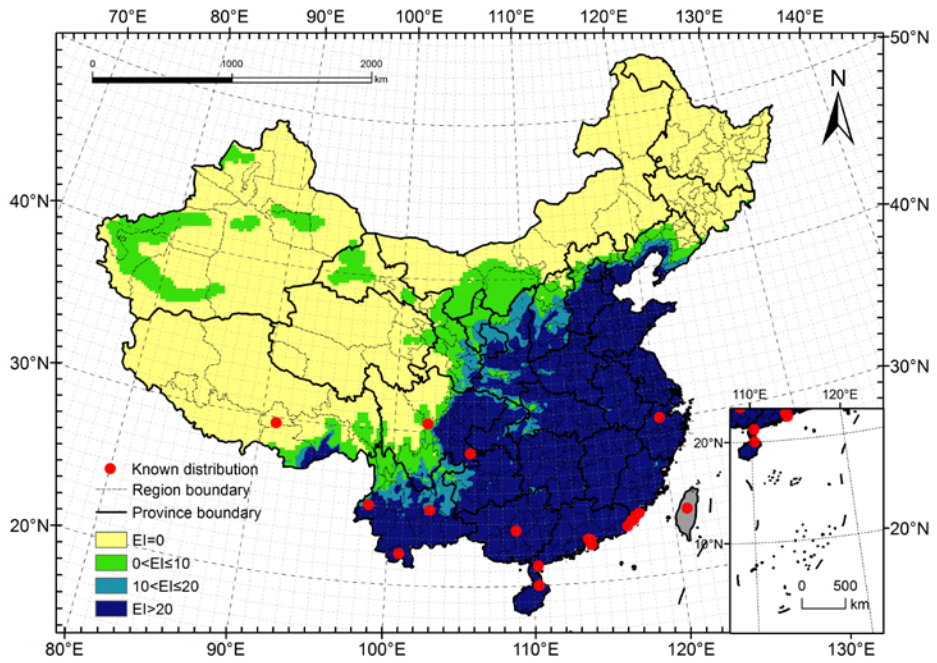


Fig. 5. Potential distribution for *E. fornicatus* under the future climate (2011–2040).

3.4 Distributions' comparison under two climate conditions

- **Area**：Main change predicted is an increase in highly favourable habitat.
- **Changes of climate favourability** are significant in several provinces.
- **Favourability** over most of the potential distribution is projected to increase.

EI values may increase by 2~5 units on average (EI difference：-2.7~15.5)

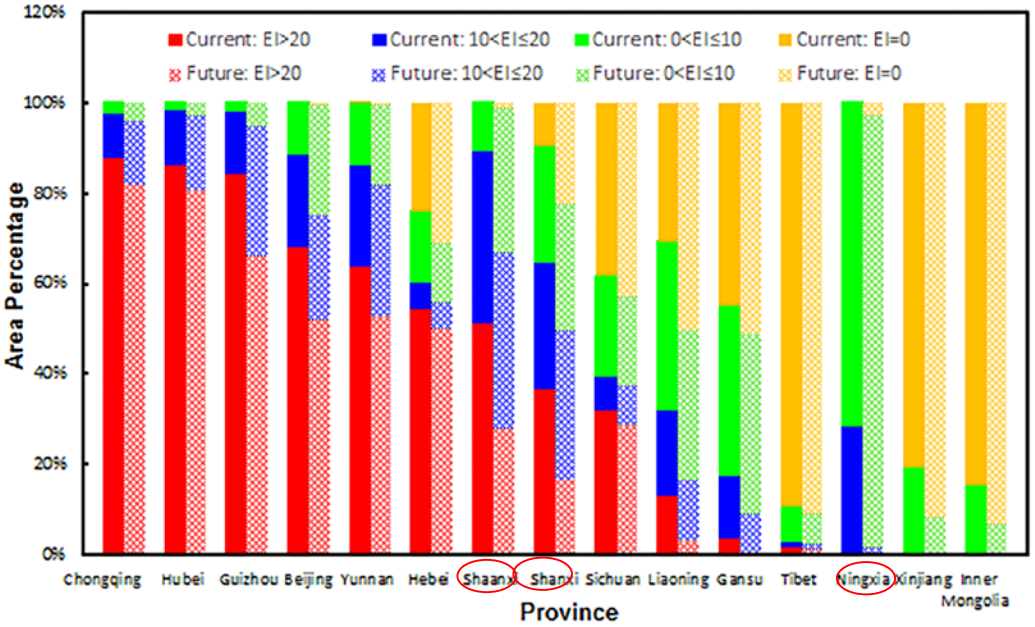


Fig. 6. Area changes of different ranges of EI value in different provinces for *E. fornicatus* under the current and future conditions.

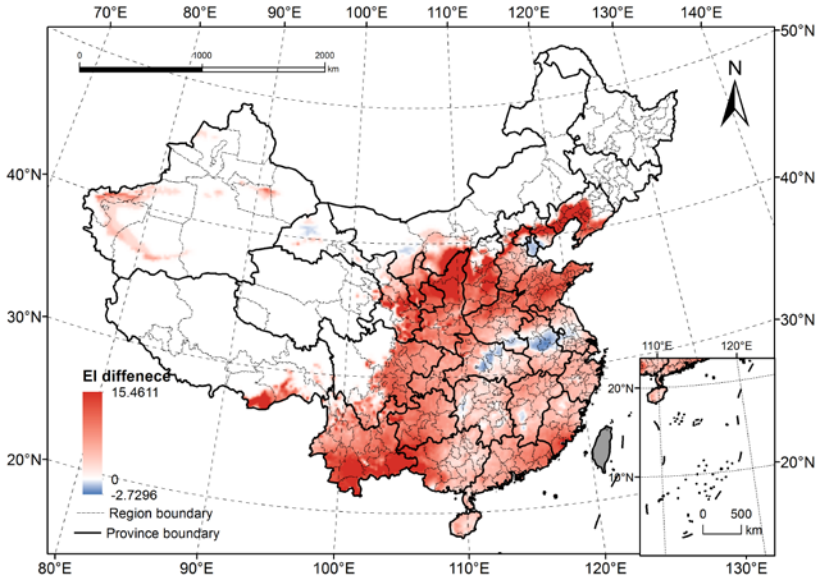


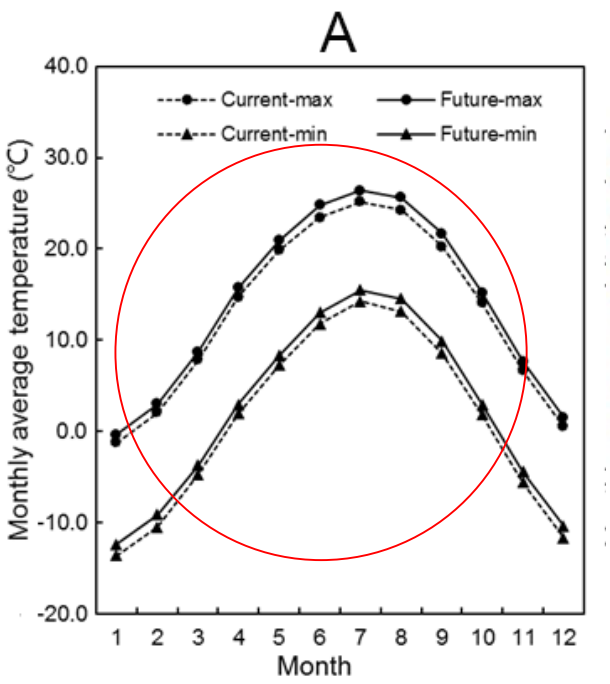
Fig. 7. Change of the EI values under current (1981-2010) and future (2011-2040) conditions in China.

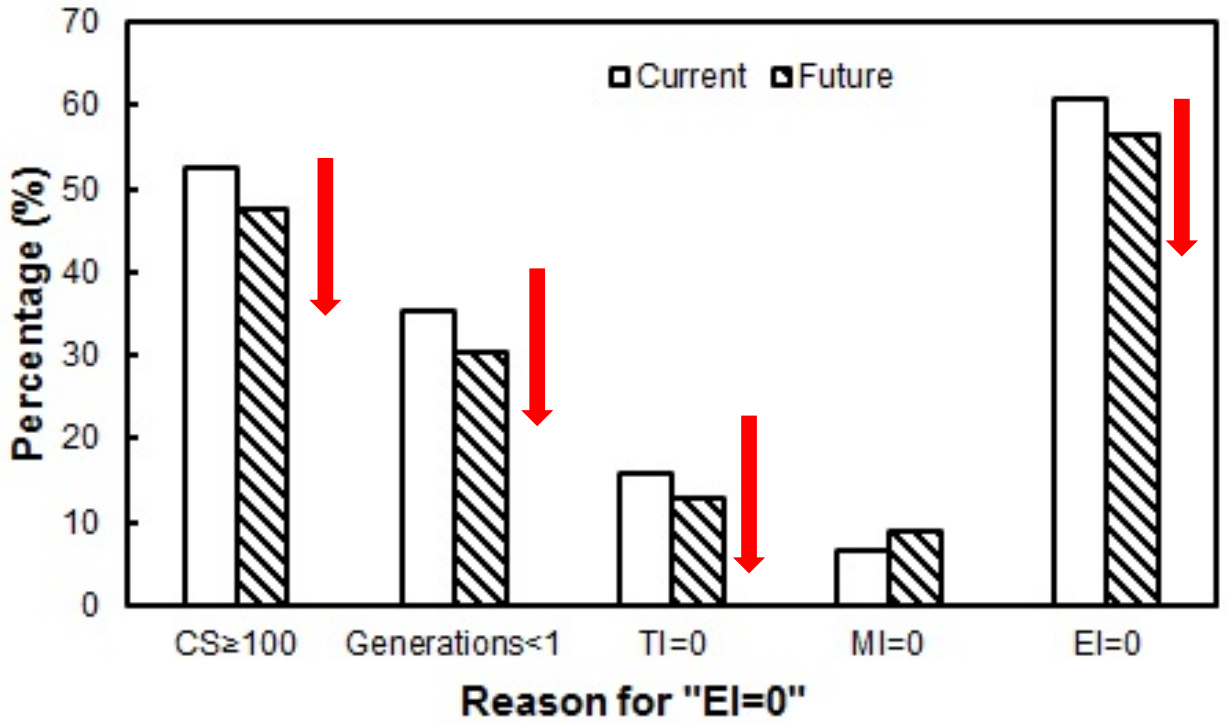
4 Discussion

Change of climate data mainly showed in Temperature

- Warmer weather in Winter → CS⩾100
- Increase of yearly accumulate temperature → Generation<1
- Increase of daily temperature → TI=0

→ EI=0





4 Discussion

South Region + North Region

- **Boundary A (purple line):** divided north and northwest regions approximately by the 400mm isohyet.
- **Boundary B (yellow line):** divided south and North Region mainly by isothermal line of 0℃ in January and 800mm isohyet.
- **Boundary C (red line):** separates the Qinghai-Tibet Region from the other three regions, mainly divided by terrain.

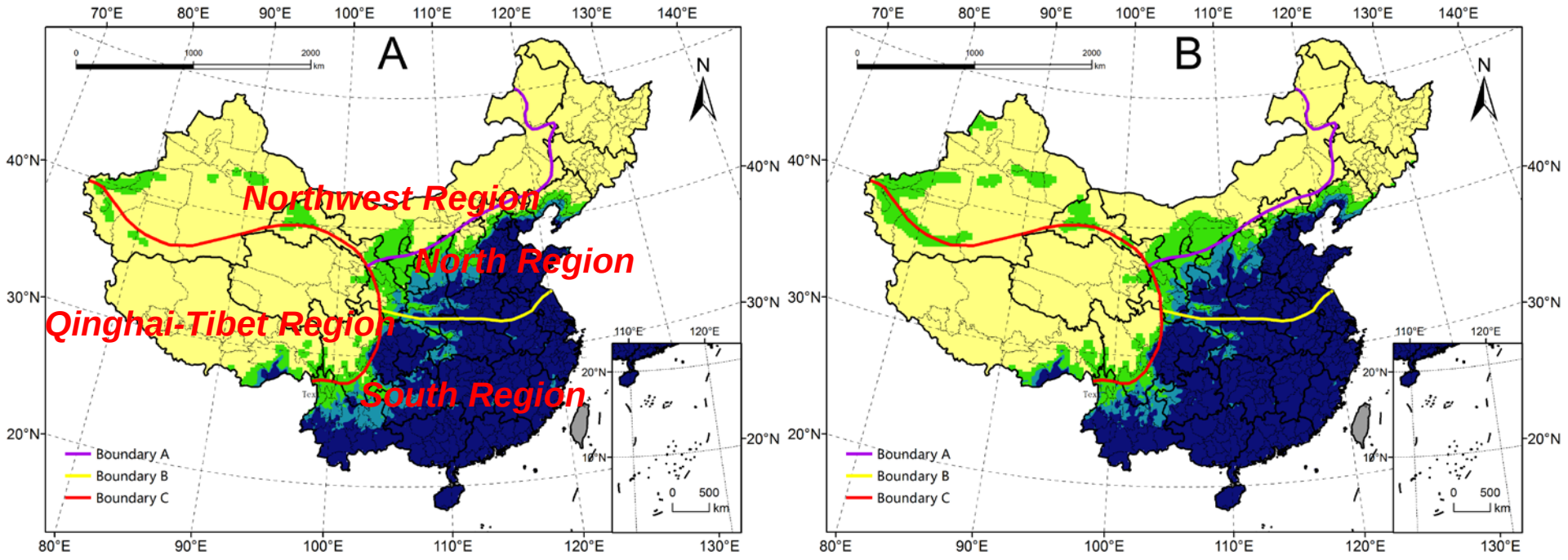
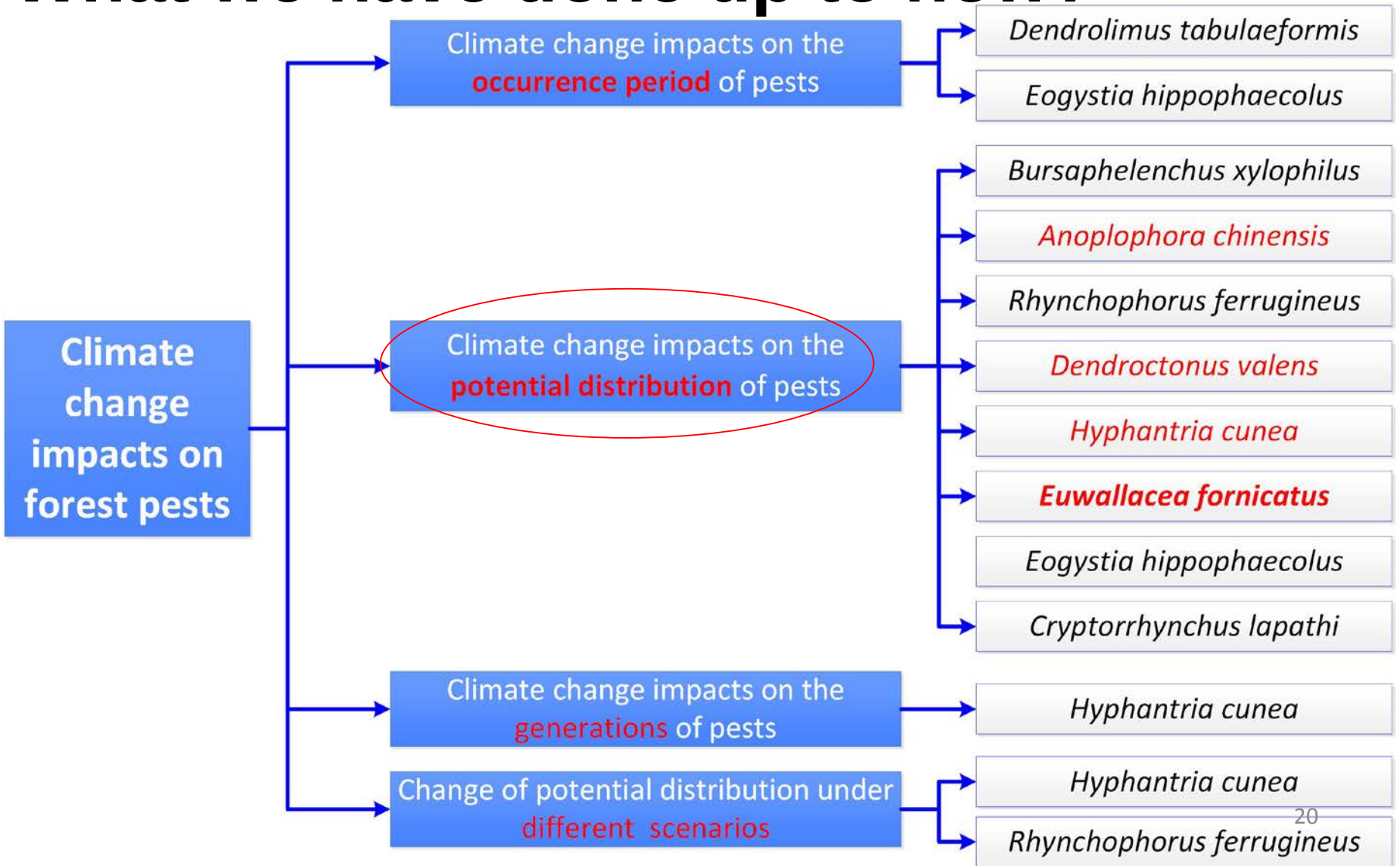
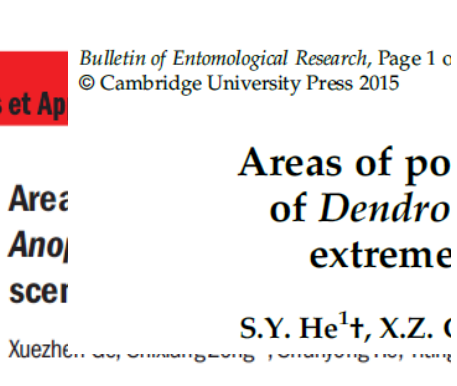


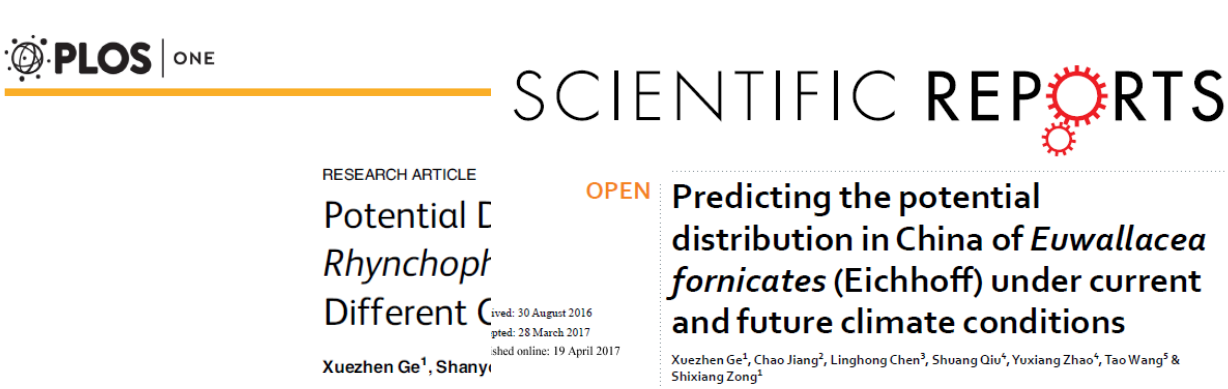
Fig. 8. Potential distribution with geographic boundary lines.

5 Focus of Future Research

What we have done up to now?







1. **Ge, X.,** Jiang, C., Chen, L., Qiu, S., Zhao, Y., & Wang, T., et al. (2017). Predicting the potential distribution in china of *Euwallacea fornicatus* (Eichhoff) under current and future climate conditions. **Scientific Reports**, 7(1).
2. **Ge, X.,** He, S., Wang, T., Yan, W., & Zong, S. (2015). Potential distribution predicted for *Rhynchophorus ferrugineus* in china under different climate warming scenarios. **Plos One**, 10(10), e0141111.
3. **Ge, X.,** Zong, S., He, S., Liu, Y., & Kong, X. (2015). Areas of china predicted to have a suitable climate for *Anoplophora chinensis* under a climate-warming scenario. **Entomologia Experimentalis et Applicata**, 153(3), 256-265.
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5. **Ge, X.,** Yao, G., Luo, Y., Wang, T., He S., & Zong, S. (2013). The influence of varied temperature on adult occurrence period of *Holcocerus hippophaecolus*. **Plant Protection**, 39(4), 10-15. (Chinese)
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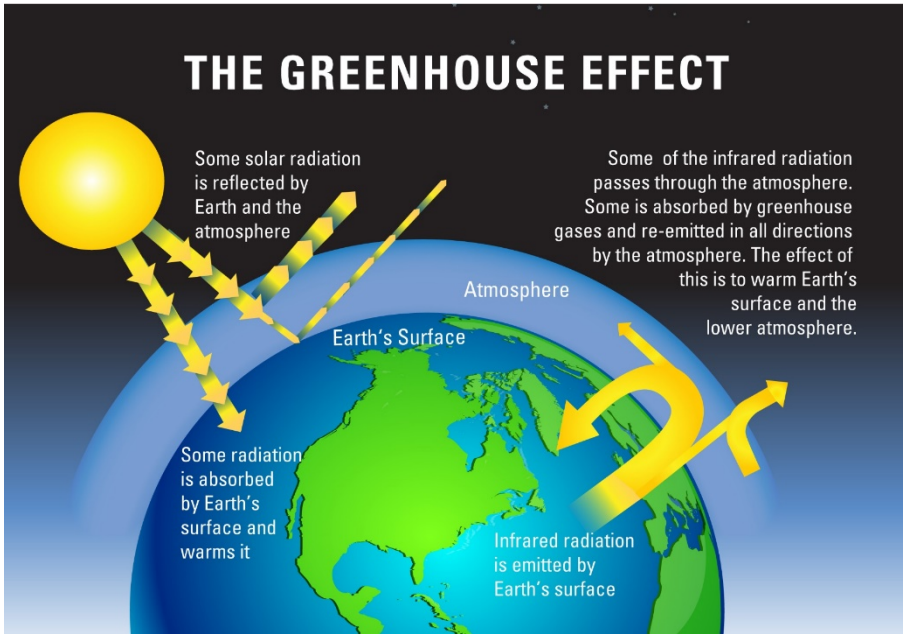
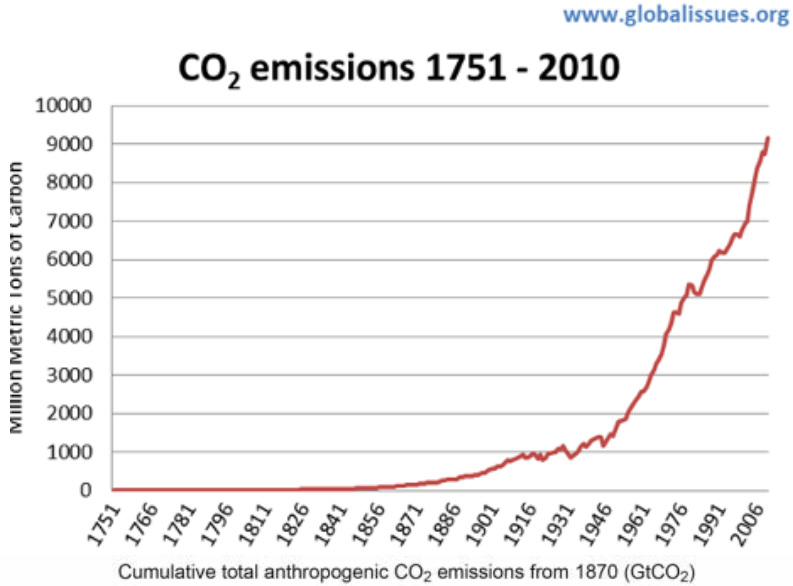
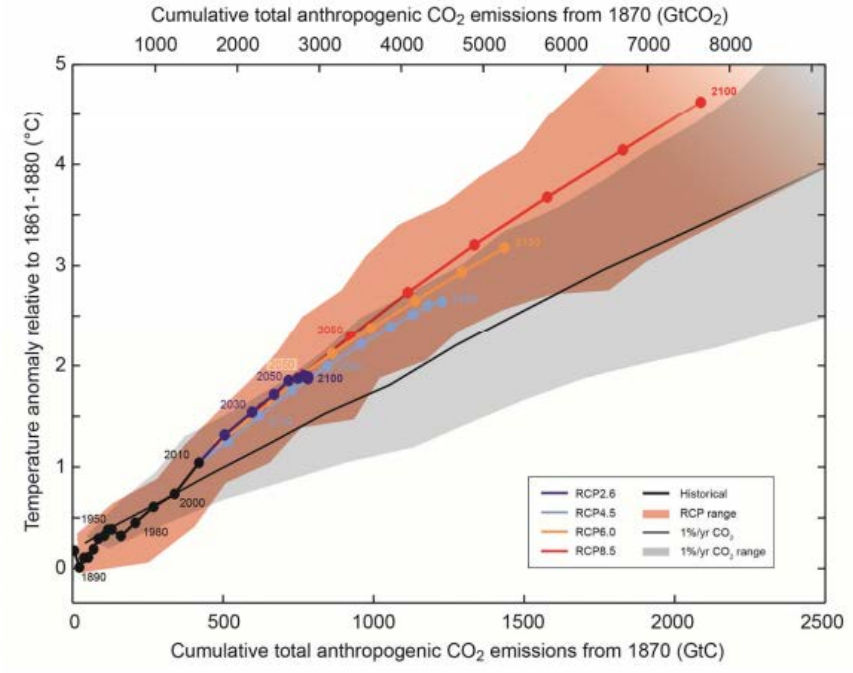
7. He, S., Wen, J., Luo, Y., Zong, S, Zhao, Y. & Han, J. (2012). The predicted geographical distribution of *Bursaphelenchus xylophilus* in China under climate warming. **Chinese Bulletin of Entomology**, 49(1), 236-243. (Chinese)

What we want to do in the future?

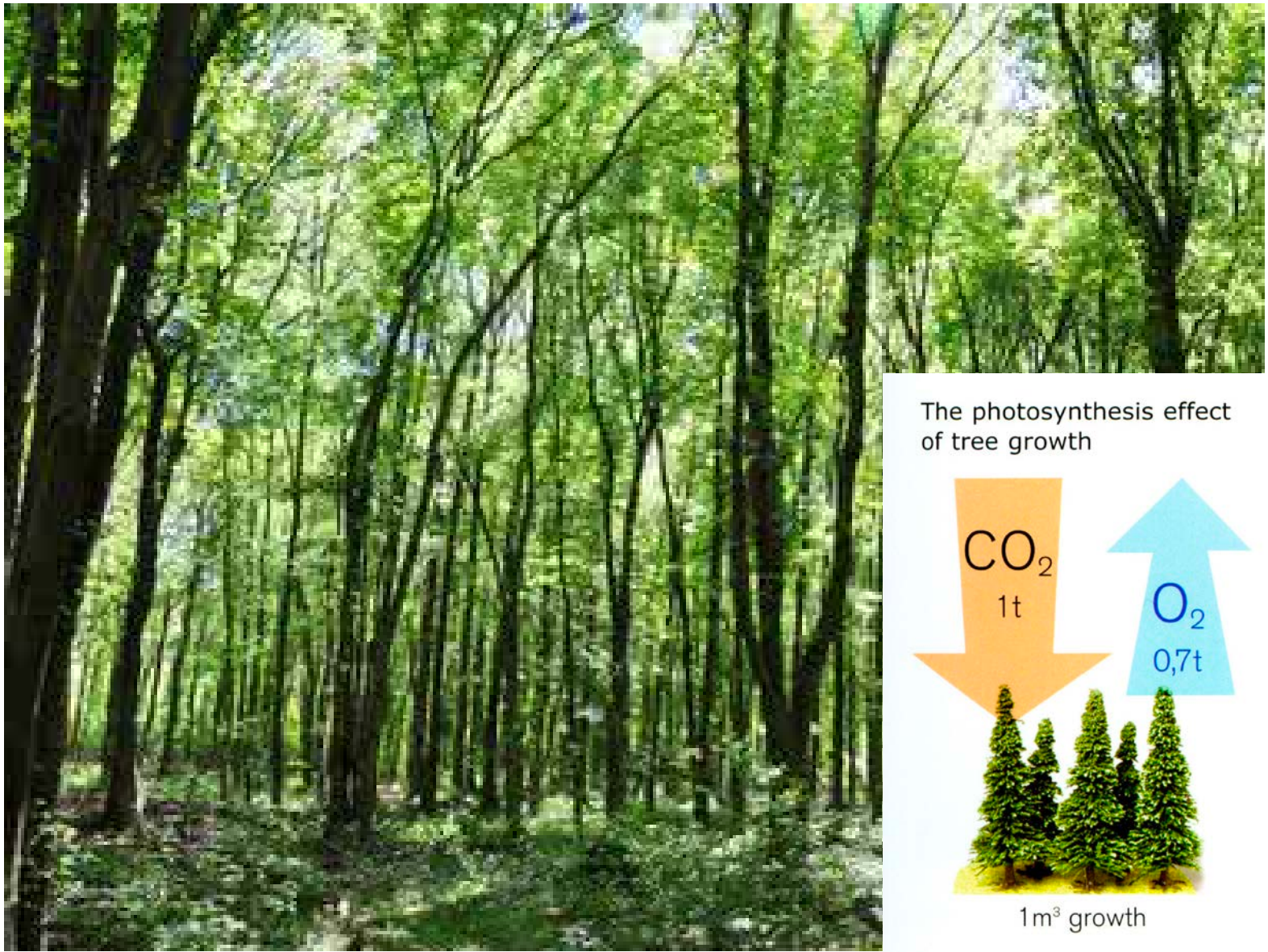
(1) Increased CO_2 emission is the main reason lead to global climate warming.







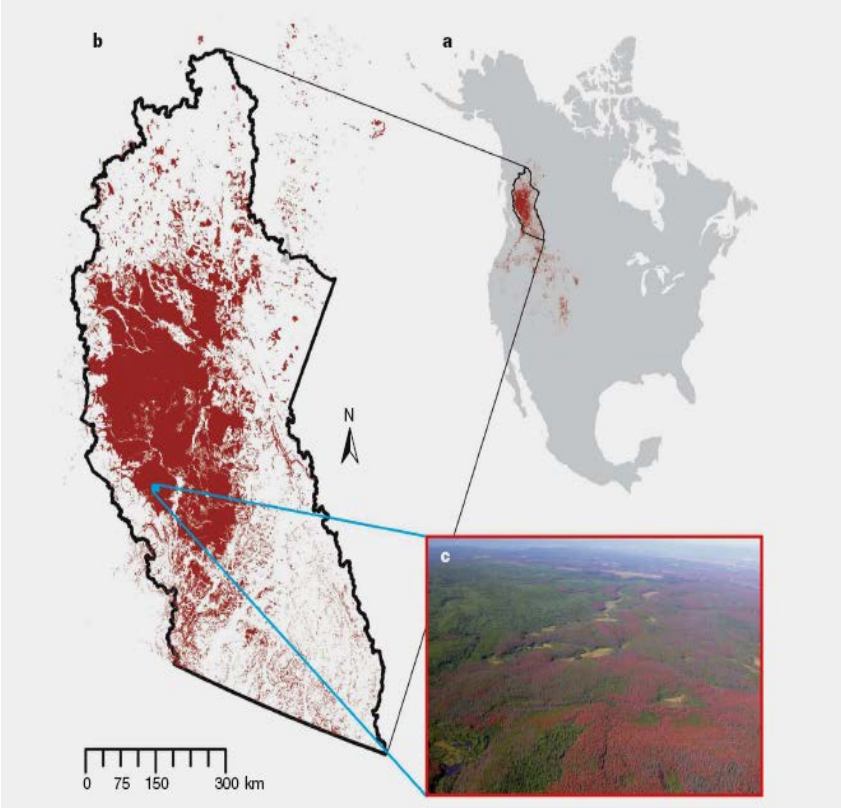
(2) Forest plays an important role in reducing the CO_2 concentration– Carbon Sink.

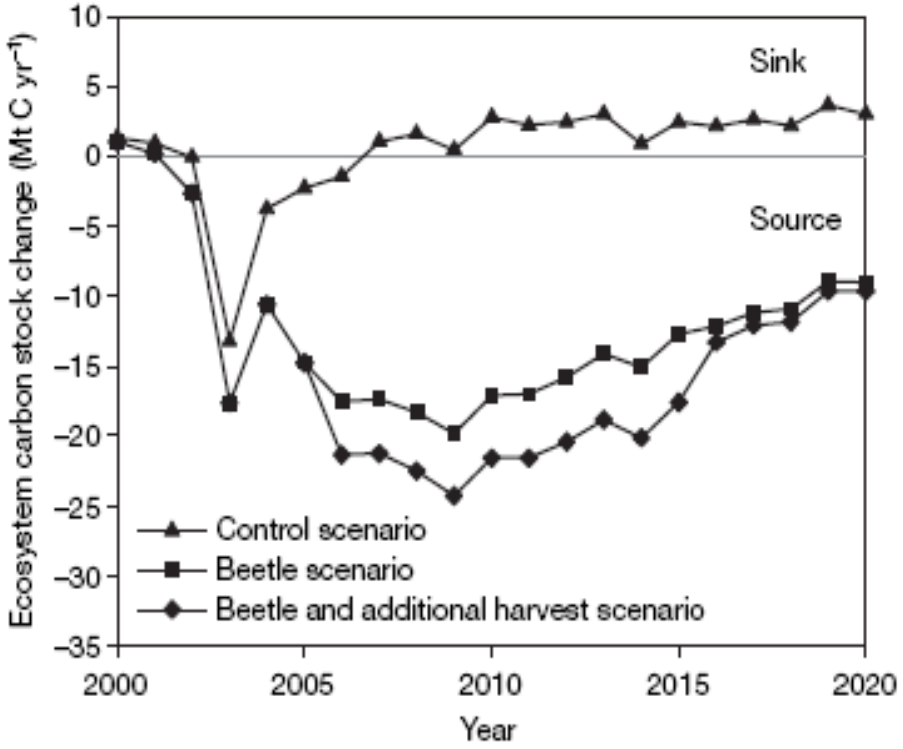


(3) Will the damage of pests induce the increase of CO_2 concentration ? What's the proportion?

Dendrolimus punctatus tabulaeformis

Eg. In 2008, it was estimated that the cumulative impact of *Dendroctonus ponderosae* out-break in the affected region during 2000–2020 will be **270 mega-tonnes (Mt) carbon**, which is equal to the amount greenhouse gases absorbed by all the trees in Canada during the last 10 years.





(Kurz. WA *et al.*, 2008)

(4) How much the contribution that the control of pine moths to CO_2 reduction?

Dendrolimus punctatus tabulaeformis

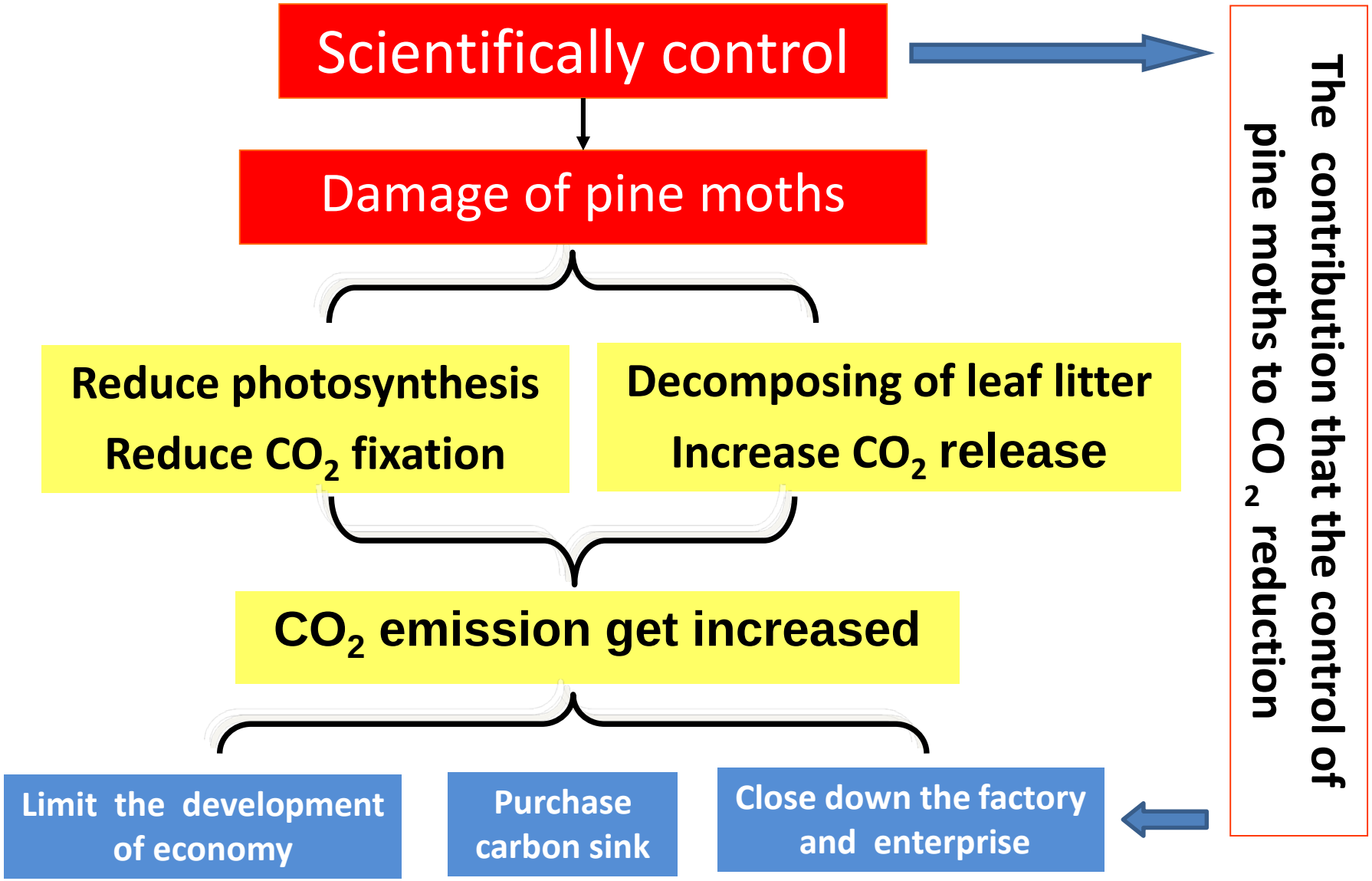
Jianping, Liaoning

Dendrolimus punctatus **Guangxi**

Dendrolimus superans

Inner Mongolia

Dendrolimus houi **Puer, Yunnan**


Scientifically control
Damage of pine moths
Reduce photosynthesis
Reduce CO_2 fixation
Decomposing of leaf litter
Increase CO_2 release
CO_2 emission get increased
Limit the development of economy
Purchase carbon sink
Close down the factory and enterprise
The contribution that the control of pine moths to CO_2 reduction

Acknowledgments

Supervisor: Prof. Shixiang Zong

Thanks to

- Institute of Zoology, Chinese Academy of Sciences, Beijing, China.
- Chinses Academy of Forestry, Beijing, China.
- Coconut Research Institute, Chinese Academy of Tropical Agricultural Sciences, Wenchang, Hainan, China
- Forest pest control station of Jianping, Liaoning, China

Thank you for your time and attention !

Welcome to BJFU!