From Climate Projections to Adaptive Governance: Multi-Dimensional Approach for Rural Risk Management

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Shanghai Jiao Tong University

5th June, 2025

Sino-Bulgarian Joint Lab on Climate Change Adaptative Governance for Rural Ecosystem

- To promote international collaboration in scientific research, technology development and talents training in the field of risk management and adaptive governance of rural ecosystems under climate change.

Rural Revitalization

Rural Climate Change Assessment

Climate Adaptative Governance

Carbon Neutral Village

Sino-Bulgarian Joint Lab on Climate Change Adaptative Governance for Rural Ecosystem

International Platform

Climate Adaptative Research Platform

Data base, work station, UAV, etc.




Construction of Joint Lab Platform

International Science and Technology Cooperation Platform

Research Team

A research team with international influence.







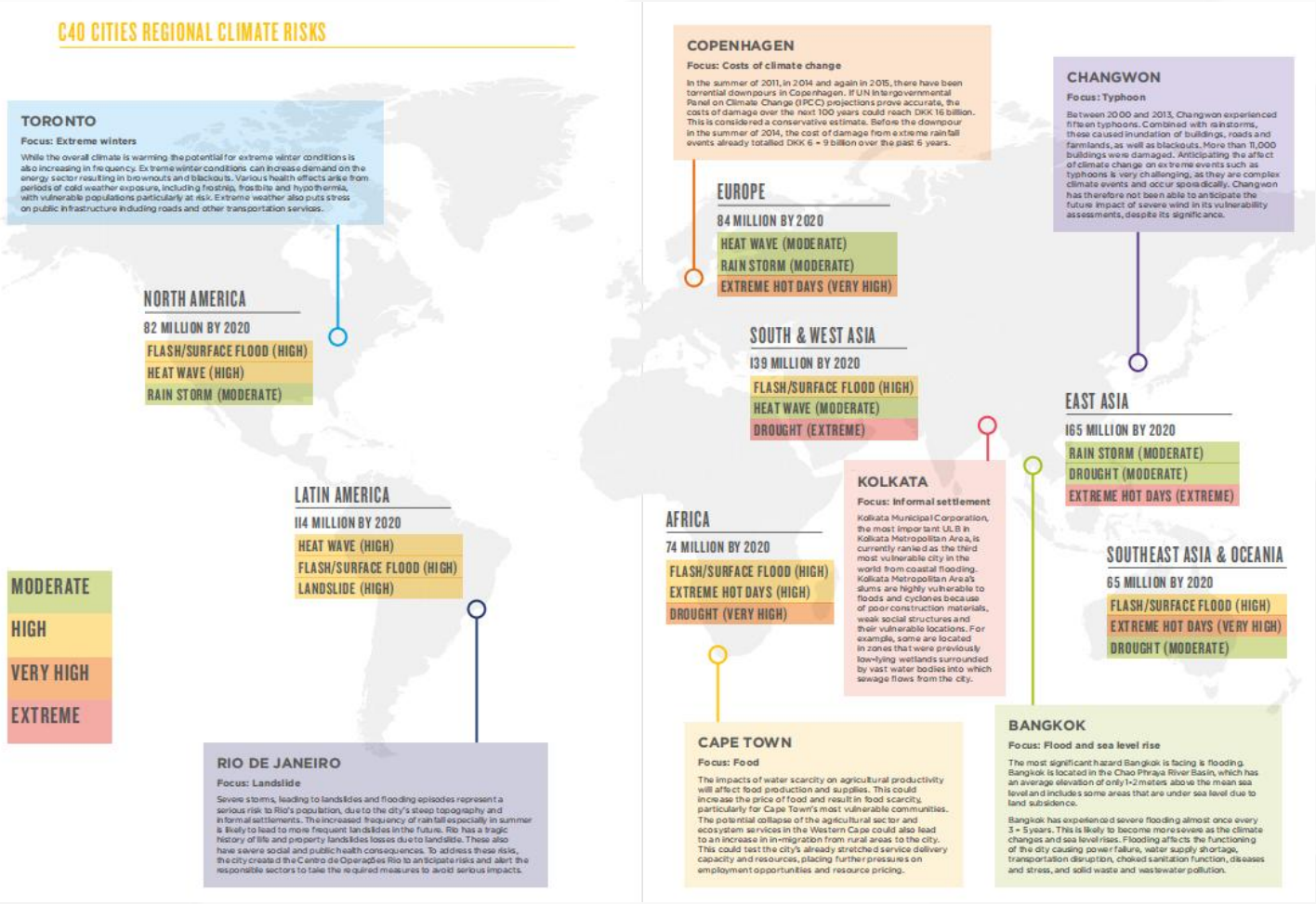


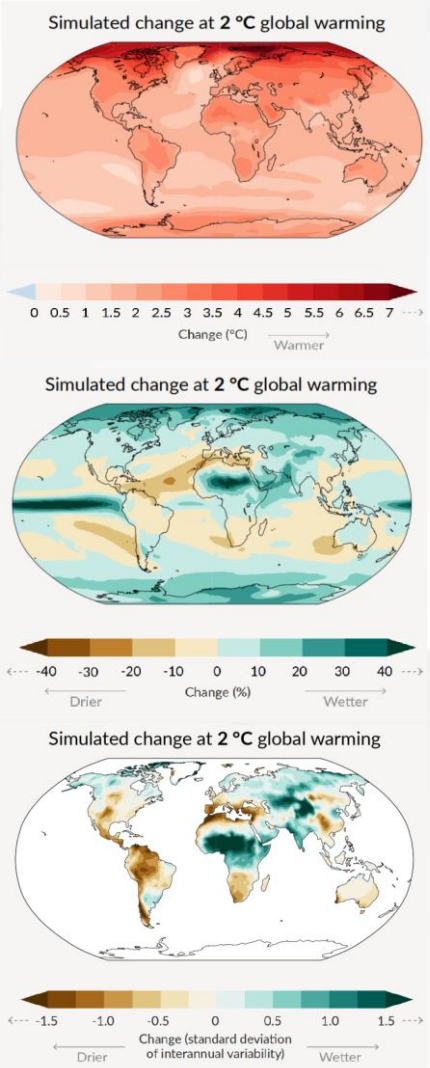

Academic Exchange and Talent Cultivation

- Opening and Sharing of The Joint Lab
- Technical training
- Cultivate Students
- International Forums

Rural Climate Risk

- Rural climate risk poses a significant challenge to global sustainable development and rural areas at large
- Rural areas are often overlooked in discussions of climate impacts and risks, yet they are a key part of the solution





- Flood, heatwave, and heavy rain threat (North American cities).
- Heatwave, flood, and landslide risks (Latin American cities).
- Heatwave, heavy rain, and extreme hot weather risks (European cities).
- Flood, heatwave, and drought risks are (West and South Asian cities).
- Flood, extreme hot weather, and drought risks (African cities).
- Flood, drought, and extreme hot weather risks (East Asian cities).
- Flood, extreme hot weather, and drought risks are (Southeast Asian and Pacific cities).

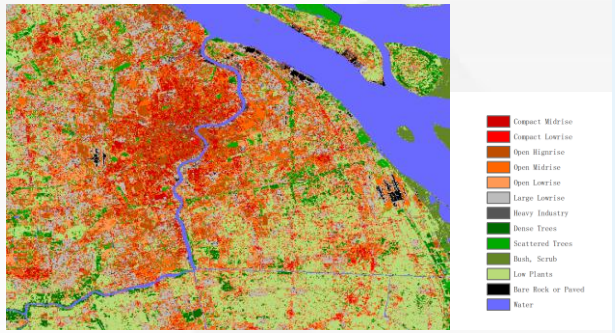
Source: IPCC Climate Change 2021, C40 CITIES Report

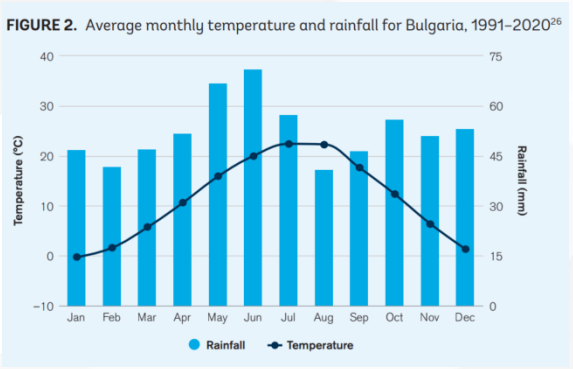
Climate Risk Assessment

Focus on rural living environment and agroforestry complex ecosystem

1 Climate adaptive data base

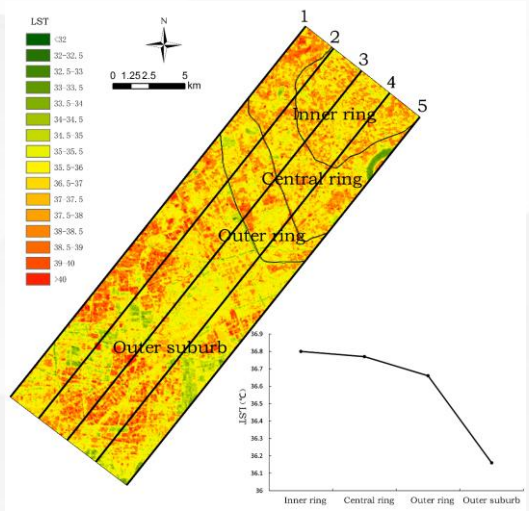
- Historical meteorological and disaster data
- Ecological data
- Environmental data
- Social and economic data

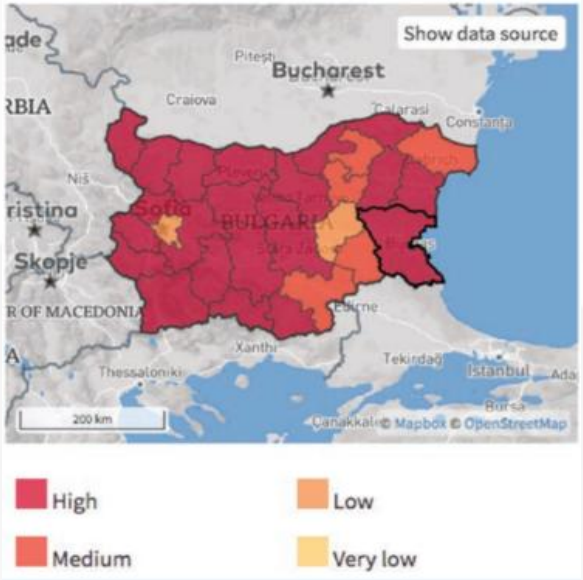




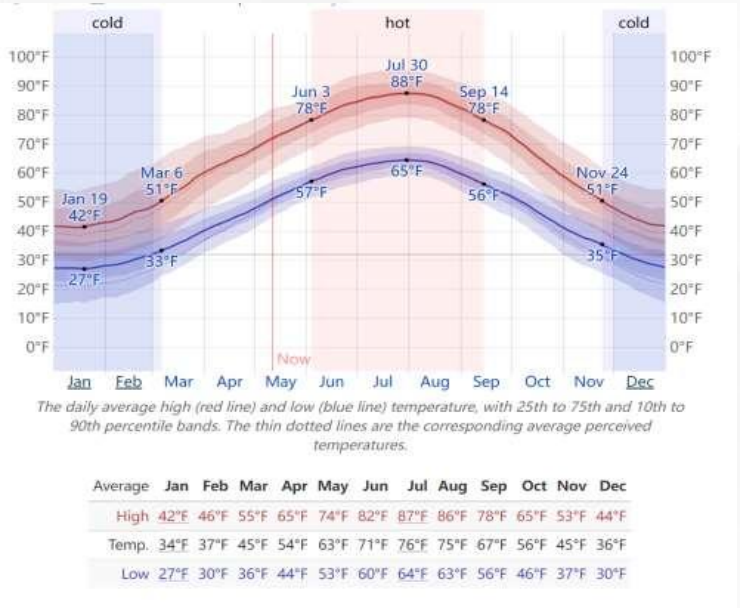
2 Climate change prediction and risk assessment

- Predicting climate change trends in rural area
- Predicting the types of climate disasters
- Screening climate hazards and risk factors
- Establish a climate risk assessment index
- Conducting risk assessment



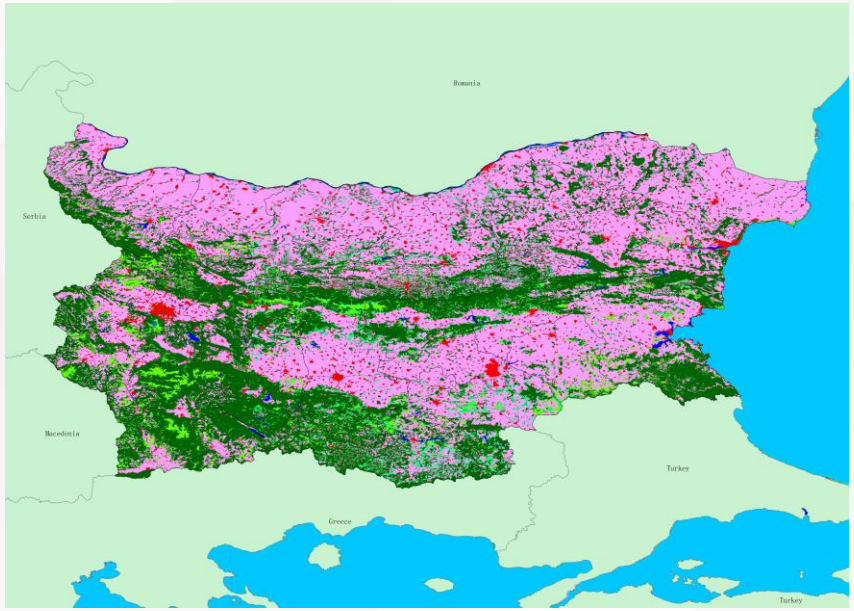


Climate Risk Assessment

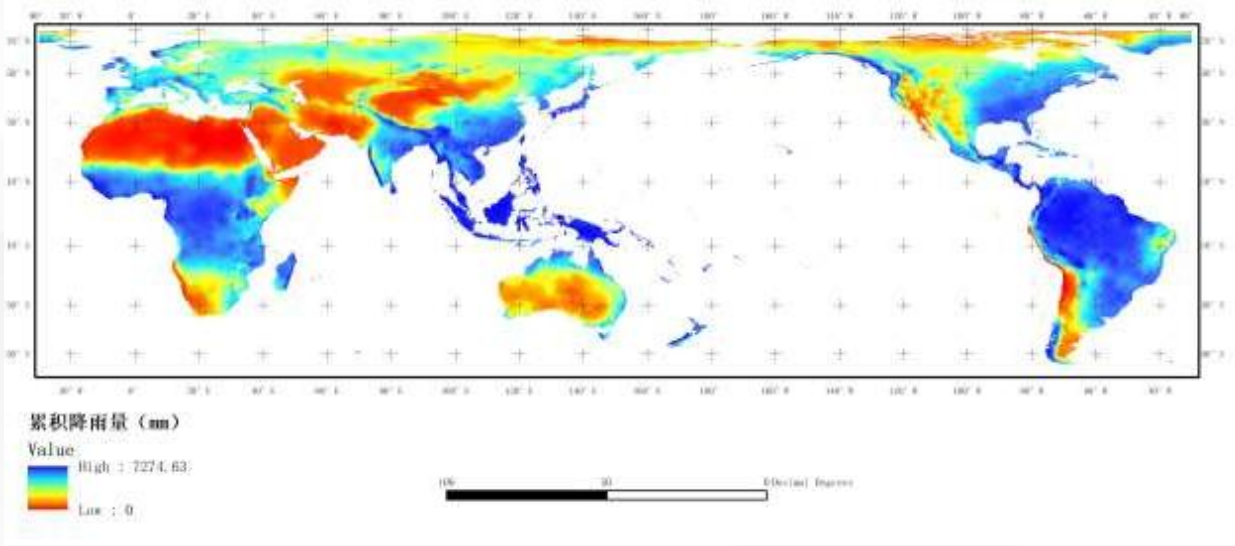


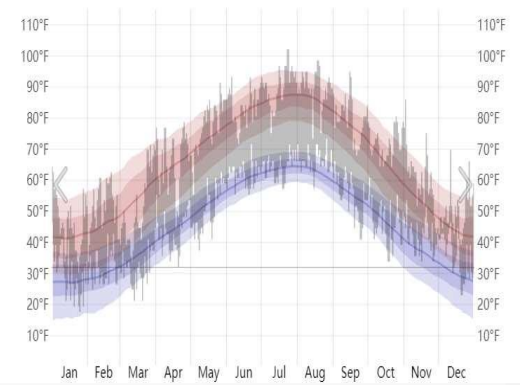
The daily average high (red line) and low (blue line) temperature, with 25th to 75th and 10th to 90th percentile bands. The thin dotted lines are the corresponding average perceived temperatures.

Average	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High	42°F	46°F	55°F	65°F	74°F	82°F	87°F	86°F	78°F	65°F	53°F	44°F
Temp.	34°F	37°F	45°F	54°F	63°F	71°F	76°F	75°F	67°F	56°F	45°F	36°F
Low	27°F	30°F	36°F	44°F	53°F	60°F	64°F	63°F	56°F	46°F	37°F	30°F



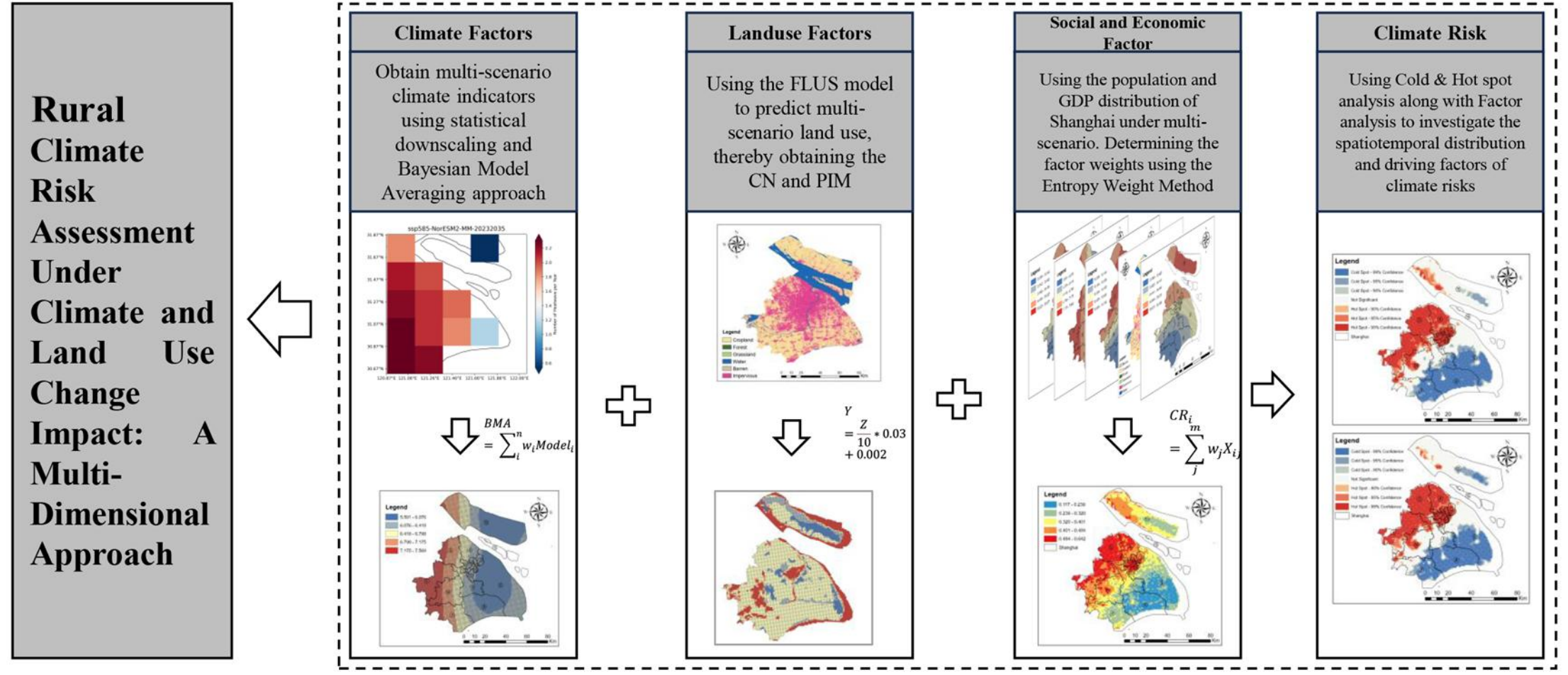
Land use, land cover and local meteorological data of the research sites have been collected and analyzed.





Climate Risk Assessment

- A multidimensional model for climate risk assessment
- FLUS model for land-use prediction and statistical downscaling of CMIP6 Data for climate modeling
- Climate, land use, and socio-economic factors are considered for the assessment
- Urban climate risks are quantified under climate and land-use change scenarios
- Geographical detector is used to analyze main influencing factors of climate risk

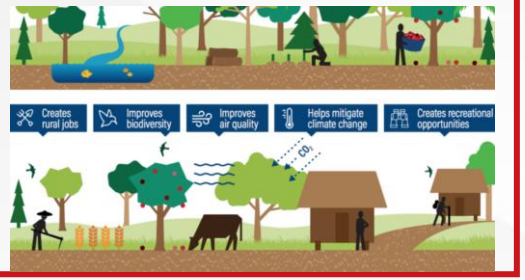


Climate Risk Assessment

3 Vulnerability Assessment and adaptive strategies of rural area

Rural living environment

- Assess the exposure of rural living environment and form risk assessment index.
- Simulate the degree of damage, and evaluate its spatial pattern characteristics.
- Propose adaptive strategies of rural living environment under multiple scenarios.



Rural agroforestry complex ecosystem

- Assess the exposure the system and form risk assessment index.
- Analyze its sensitivity, stability, and resilience. Assess its spatial pattern.
- Propose adaptive strategies under multiple scenarios.

Rural Economic Vulnerability Assessment and Governance Measures

- Assess the direct and indirect losses suffered by agriculture, forestry, infrastructure, residents' property and health;
- Obtain the relationship between economic losses and factors causing climate disasters;
- Propose climate adaptation strategies to enhance the resilience.

Climate Risk Assessment

- **Climate Change Vulnerability Assessment Index System for Rural Areas**

Determine main factors influencing climate change vulnerability in rural areas, and identify potential spatial patterns of climate vulnerability

Main Component	Sub-Component	Indicators	Proxy	HR	Reference	Data source
Exposure	Climate variability	Variability of maximum temperature (STDMX)	standard deviation (SD) of mean monthly maximum temperature in the past 5 years	+	Hahn et al., 2009	Shanghai Meteorology Bureau
		Variability of minimum temperature (STDMN)	SD of mean monthly minimum temperature in the past 5 years	+	Hahn et al., 2009	Shanghai Meteorology Bureau
		Variability of rainfall (STDP)	SD of average monthly precipitation in the past 5 years	+	Hahn et al., 2009	Shanghai Meteorology Bureau
	natural disaster	Exposure to storm surges (EXPSS)	proportion of coastline to area (km/m^2)	+	Hagenlocher et al (2018)	LANDSAT 8 imagery https://earthexplorer.usgs.gov/
Sensitivity	demographic pressure	Female population (FPOP)	Proportion of registered female population	+	(Hagenlocher et al., 2018)	Statistical Yearbooks
		Population density (POPD)	Total population divided by administrative area (people/ha)	+	Xue et al. (2019); Daniel et al., 2017;	Statistical Yearbooks
		Dependency ratio (DR)	Dependency ratio, proportion of people aged <15 years and >65 years divided by total population	+	Hahn et al., 2009	Statistical Yearbooks
		Population growth (PGR)	Number of births - number of deaths divided by average population	+	(Zhou et al., 2014)	Statistical Yearbooks
	Soil-health	Drainage (CEC)	Cation exchange capacity	-	Asare-Kyei et al. (2017) (Nambiar et al., 2001)	Soilgrids at https://soilgrids.org
		Soil Nitrogen (NC)	Nitrogen content in soil 100cm-200cm mean cg/kg	-	Hagenlocher et al (2018); Asare-Kyei et al. (2017) (Nambiar et al., 2001)	Soilgrids at https://soilgrids.org
		Organic carbon stock (SOC)	Soil organic carbon stock 100-200cm mean cg/kg	-	Hagenlocher et al (2018);	Soilgrids at https://soil
					(Nambiar et al., 2001)	
	Agriculture	agricultural production (AP)	Total agricultural production (ten thousand yuan)	-	(Srinivasa Rao et al., 2019)	Statistical Yearbooks
	Food production	cultivated land (ACL)	Area of cultivated land	-	(Hoque et al., 2022)	Data Center for Resources and Environmental Sciences, Chinese Academy of Sciences
	Access to resources	distance to urban center (DCC)	Distance to city center (puxi) measured by centroid (kilometers)	+	(Gu et al., 2018)	LANDSAT 8 imagery https://earthexplorer.usgs.gov/
	Built surfaces	built up area (PBS)	Proportion of built up surface over total land cover	+	(Feng et al., 2020)	LANDSAT 8 imagery https://earthexplorer.usgs.gov/
	Water	Water cover (AW)	Proportion of area covered by water	+	(Hagenlocher et al., 2018)	LANDSAT 8 imagery https://earthexplorer.usgs.gov/
Adaptability	Landscape	landscape diversity (SHDI)	Shannon diversity index	+	(Kwabena Asitwi et al., 2015)	LANDSAT 8 imagery https://earthexplorer.usgs.gov/
		Landscape shape (LSI)	Landscape shape index (mean)	+	(Feng et al., 2020)	LANDSAT 8 imagery https://earthexplorer.usgs.gov/
		Healthy vegetation (NDVI)	NDVI	+	(Asare-Kyei et al., 2017)	LANDSAT 8 imagery https://earthexplorer.usgs.gov/

Climate Change Vulnerability Assessment Index System for Rural Areas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Quantitative study on the relationships between smog and online reviews from the perspective of risk perception

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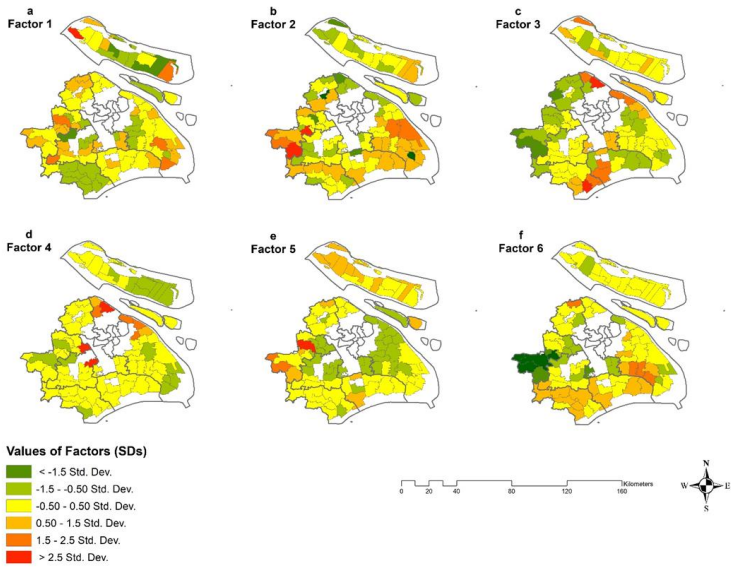
ABSTRACT

At present, online reviews played an important role in the governance of environmental problems. Based on the theory of risk perception, we used online reviews of the smog from 2014 to 2018 as the data source to analyze the spatiotemporal difference between $PM_{2.5}$ concentration and online reviews. We summarize the correlation mechanism between smog and online reviews. The conclusions are as follows: (1) From the perspective of the relationship between smog and online reviews, $PM_{2.5}$ had a growth effect on online reviews, while online reviews had a short-term inhibition effect on $PM_{2.5}$. (2) Online reviews only inhibited the concentration of $PM_{2.5}$ in 2015. Online reviews when are in the peak had raised the environmental awareness of the Chinese public and the government's environmental governance efforts. This also indirectly led to changes in the driving mechanism of $PM_{2.5}$ concentration after 2015. (3) Economic density had negative effect on $PM_{2.5}$ after 2015, which is consistent with theory of Environmental Kuznets Curve. This study provided a theoretical reference for the interaction between online reviews and smog. The government can adjust the environmental protection strategy according to the risk perception through online reviews.



Climate Change Vulnerability Assessment of Rural Areas in Shanghai

- **1 paper published, 1 paper under review**

Qiang Li, Xiaona Guo, Veselin Krustev, Jianming Miao, Heli Lu, Jiangping Qiu, Shengquan Che. Quantitative study on the relationships between smog and online reviews from the perspective of risk perception [J]. Environmental Impact Assessment Review, 2024, 105: 107437.(Published)*

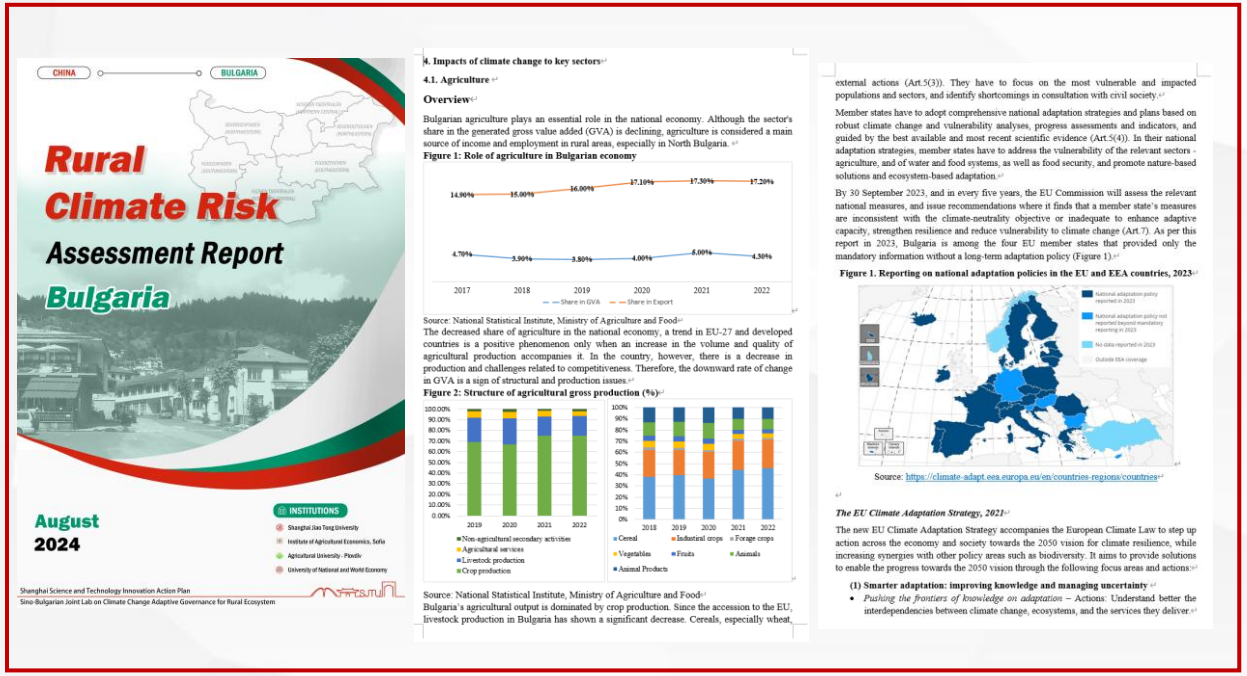
Caihua Yang, Hao Wu, Yifeng Qin, Dobri Dunchev, Shengquan Che. Bulgarian Rural Climate Adaptability: A New Approach to Evaluation Metrics, Ecological Indictors. (Under review)*

- **Development of a Rural Climate Adaptability Assessment and Construction Guideline is in progress**

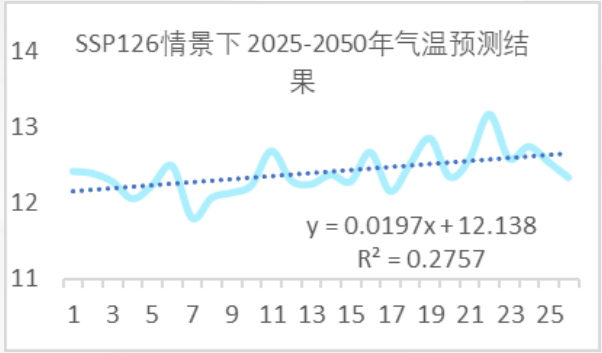
Rural Climate Adaptability Assessment and Construction Guideline

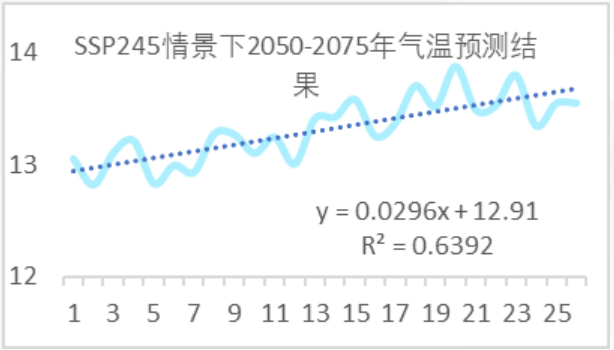
Climate Risk Assessment

- **Rural Climate Risk Report-Bulgaria**
- Future climate simulation of Bulgaria based on CMIP6
- Temperature from 2025 to 2100 is projected to show a fluctuating upward trend, while precipitation is expected to demonstrate a fluctuating downward trend.
- Extreme weather events negatively affect agricultural output and food security
- High-risk of river floods, droughts and wildfires

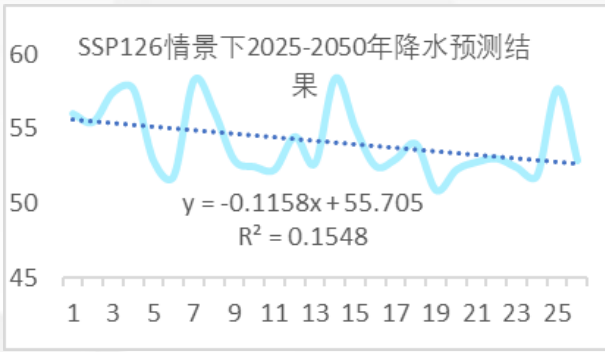


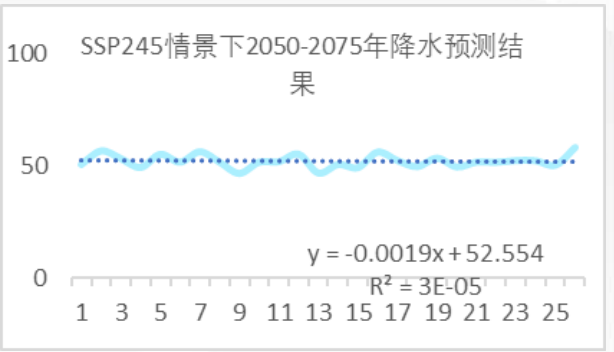
Rural Climate Risk Report-Bulgaria



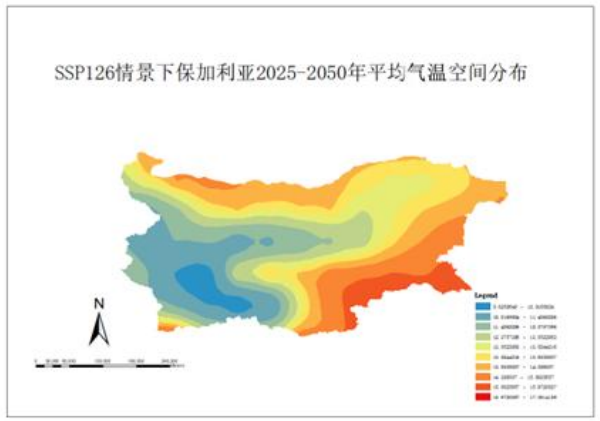


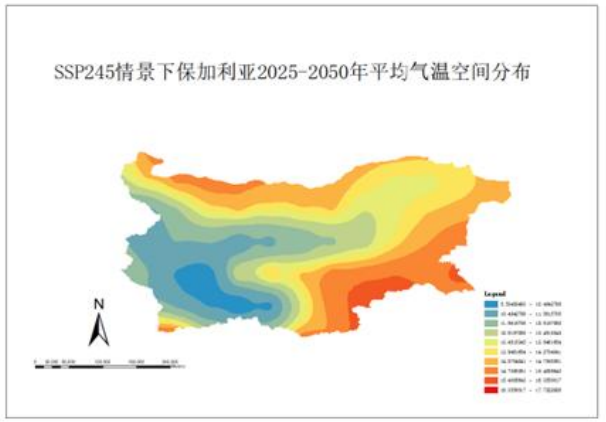
Temperature simulation under different scenario





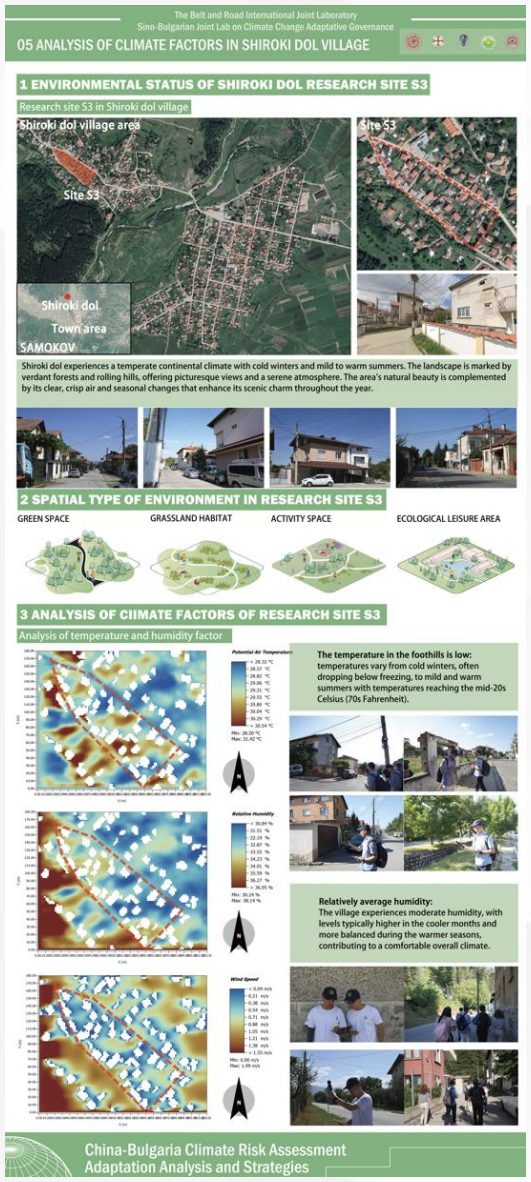
Precipitation simulation under different scenario

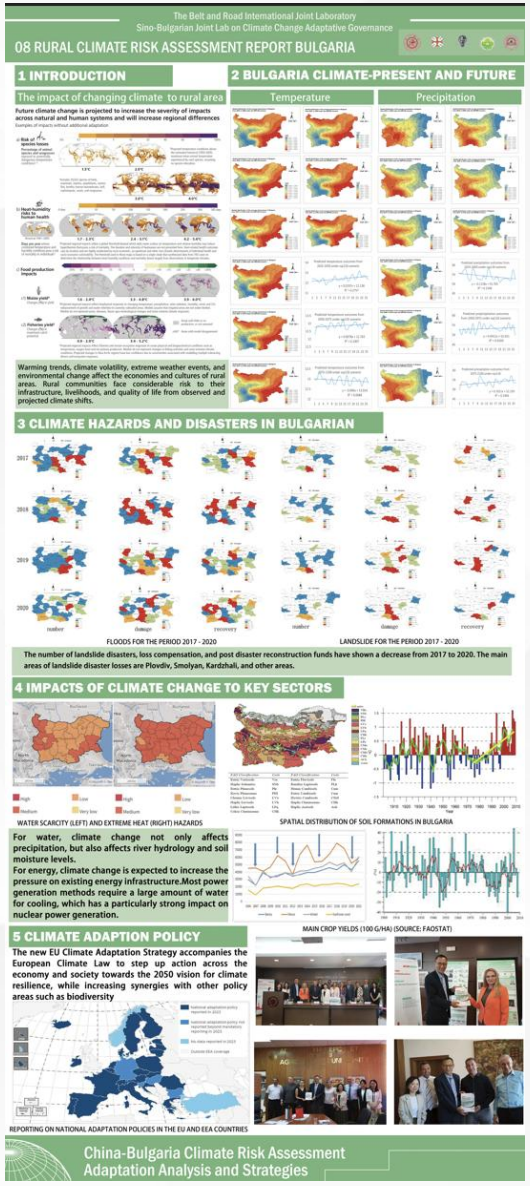


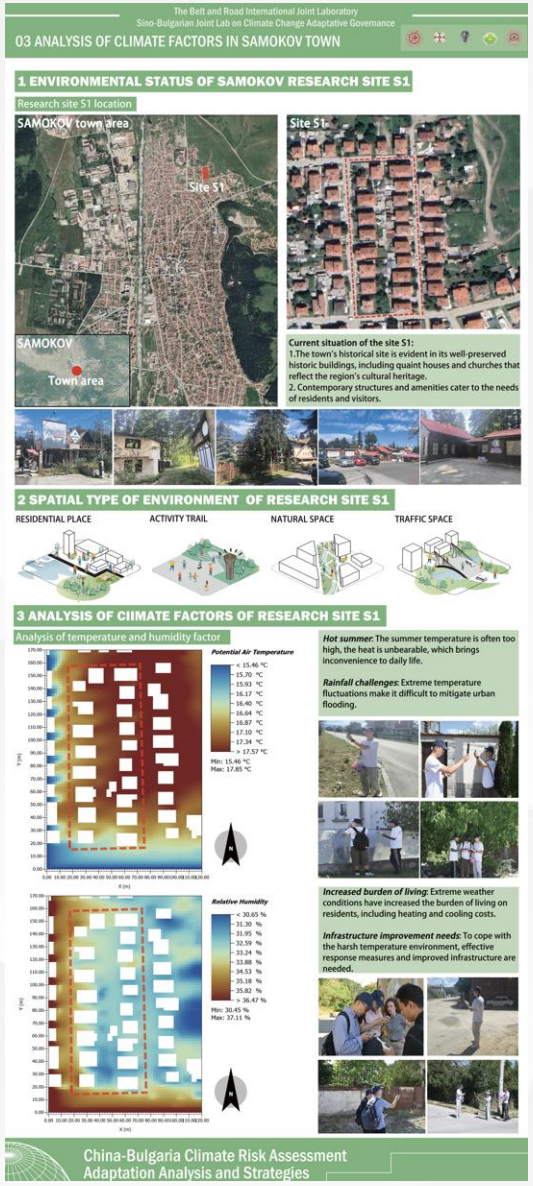


Future average temperature distribution in Bulgaria under different scenario

Climate Risk Assessment——Bulgaria







- A multi-scenario risk assessment was conducted for future climate conditions in rural Bulgaria, evaluating climate change vulnerability and risks for Samokov municipality and six surrounding villages under varying climate impacts.
- In Samokov, thermal risk zones predominantly cluster in peripheral areas of the urban core, while high-risk areas for rainfall-induced flooding are concentrated in northern sectors of the town.
- Adaptation strategies targeting high-risk zones in Samokov include environmental regeneration including green infrastructure expansion and population protection measures informed by localized climate projections.

Climate Risk Assessment——Shanghai

- Vulnerability Drivers & Assessment

Shanghai's rural climate vulnerability index (CVI) integrates IPCC frameworks with 21 indicators, identifying six key factors (67% variance): socio-ecological-built systems, demographic pressures, climate hazards, sponge city capacity, population sensitivity, and landscape fragmentation.

- At-Risk Populations

7% of rural residents (542,377 people), including 8% of children and elders, live in high-CVI zones facing amplified coastal flooding, heat stress, and infrastructure gaps under climate change.

- Resilience Priorities

Strengthen emergency transport/networks, protect farmland via eco-agriculture, expand sponge city features, and prioritize elderly/child-focused adaptation resources (housing, warnings, healthcare).

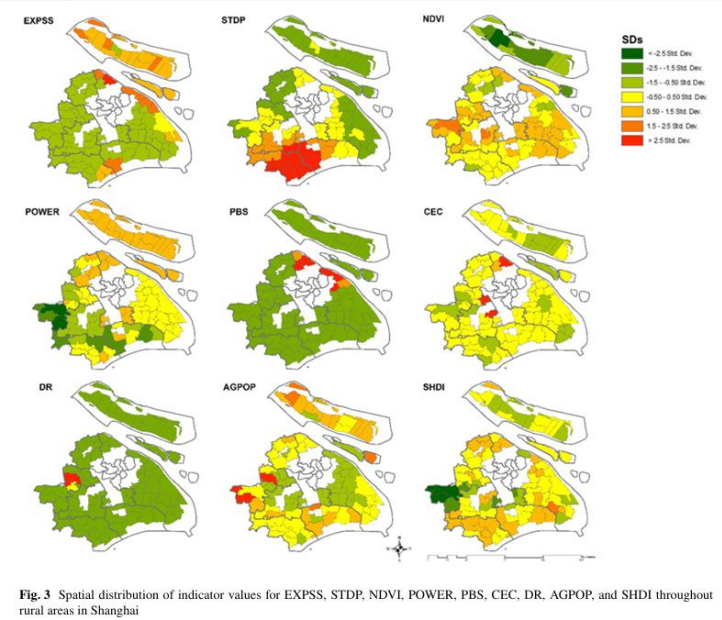


Fig. 3 Spatial distribution of indicator values for EXPSS, STDP, NDVI, POWER, PBS, CEC, DR, AGPOP, and SHDI throughout rural areas in Shanghai

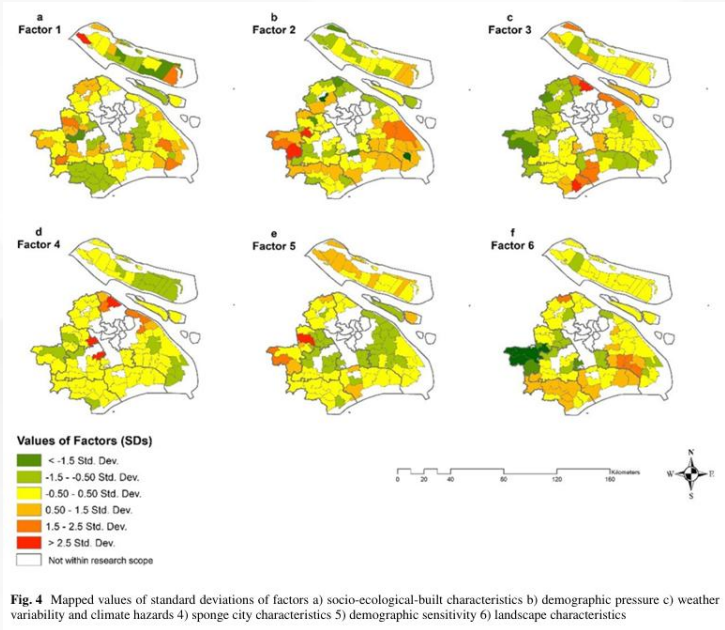


Fig. 4 Mapped values of standard deviations of factors a) socio-ecological-built characteristics b) demographic pressure c) weather variability and climate hazards 4) sponge city characteristics 5) demographic sensitivity 6) landscape characteristics

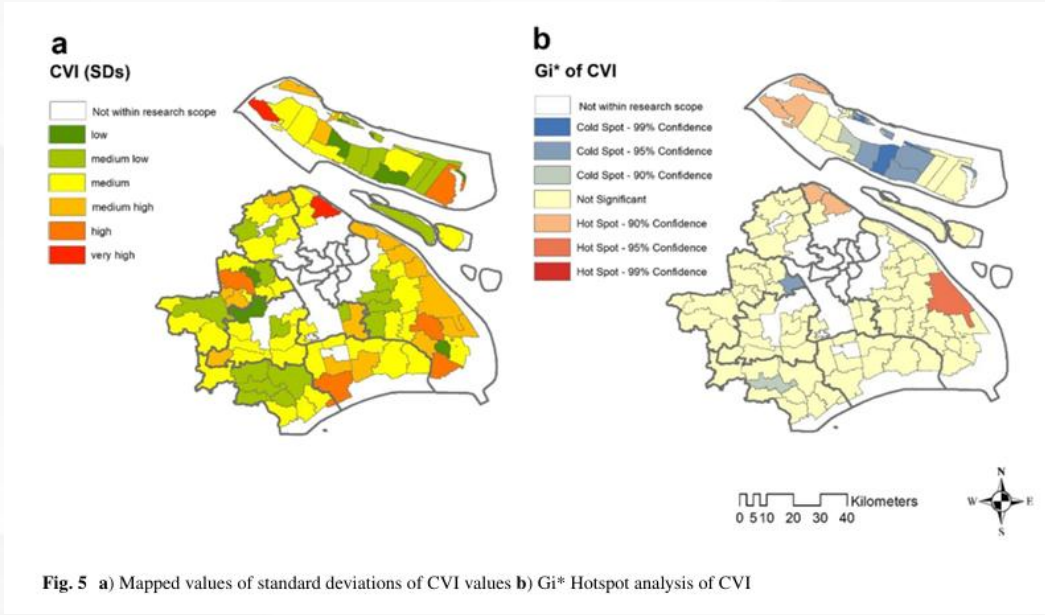


Fig. 5 a) Mapped values of standard deviations of CVI values b) Gi* Hotspot analysis of CVI

Climate Adaptive Strategies

4 Adaptive planning and governance measures

Planning Strategies for Climate Adaptive Rural Ecosystems

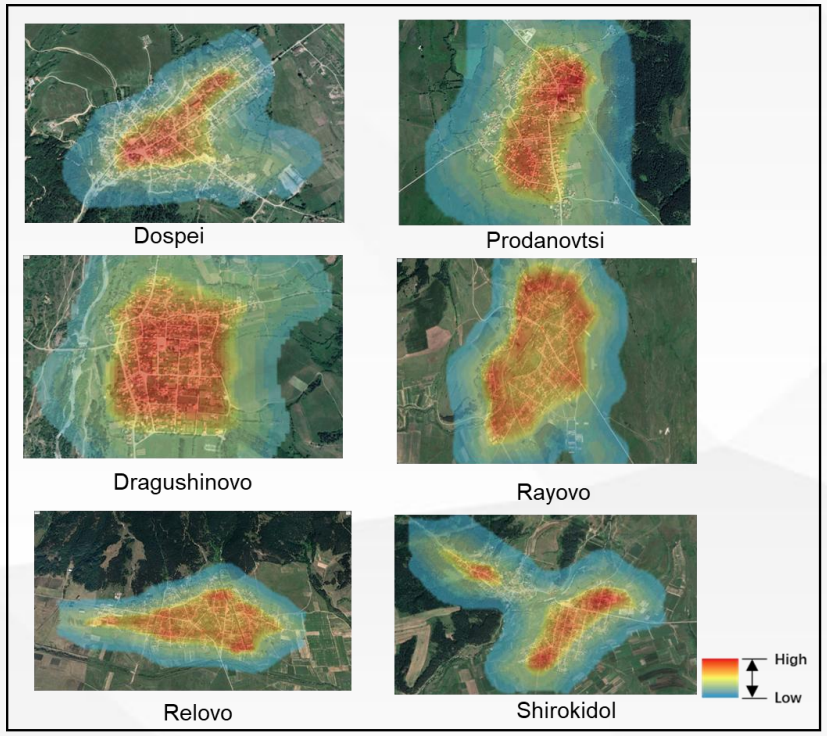
- Consider spatiotemporal pattern changes of risk exposure, sensitivity, adaptability, and vulnerability of rural living environment and agroforestry ecosystems under climate change.
- Propose adaptive planning strategies for rural ecosystems that encompass different scenarios and time periods.

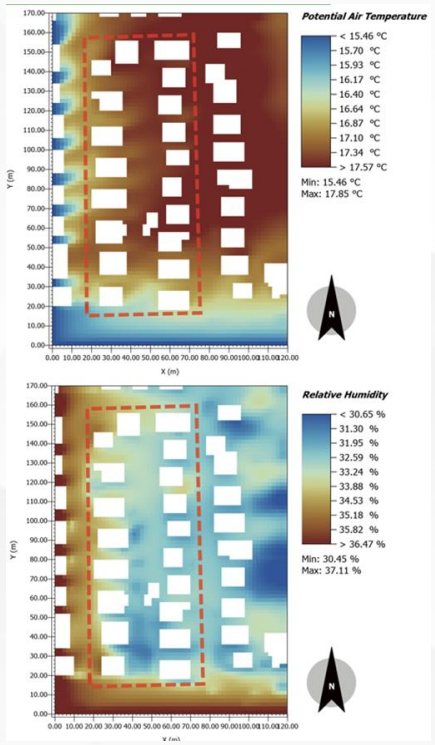
Adaptive Governance and Management Measures

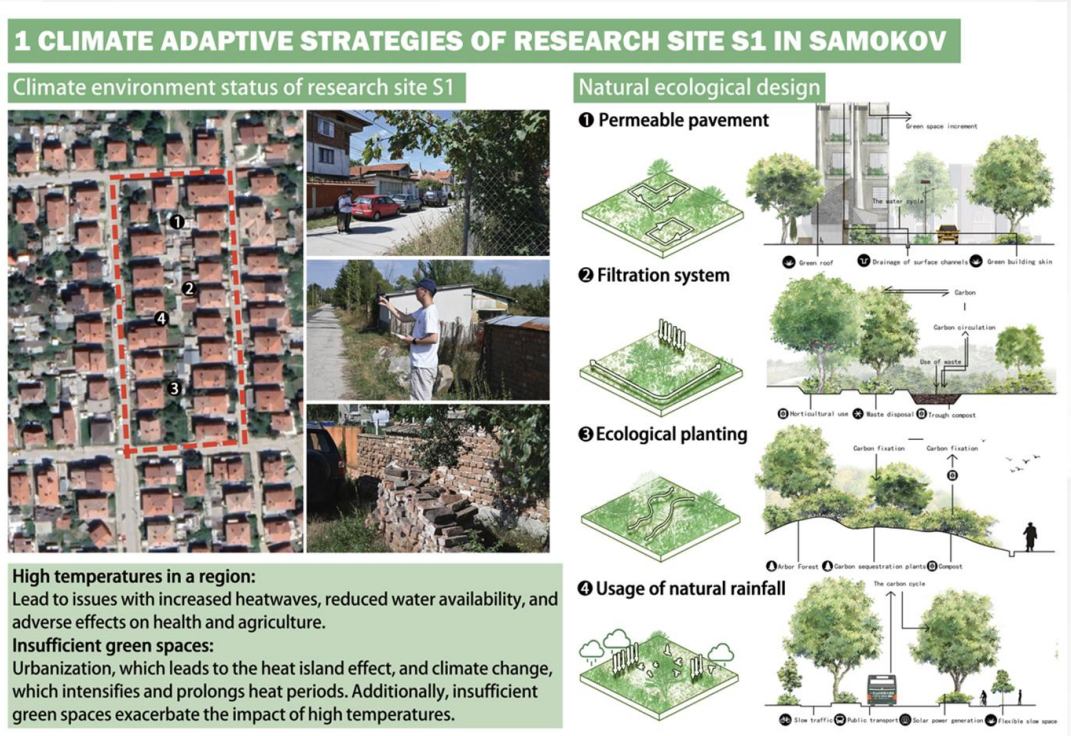
- Develop measures such as climate change trend prediction, risk diagnosis, vulnerability assessment, and adaptive planning under multiple scenarios.
- Develop policies and regulations for climate adaptation governance.

Climate Adaptive Strategies——Bulgaria

- Increasing the number of vegetation patches while reducing inter-patch distances and improving connectivity can effectively enhance the ability of green space vegetation to mitigate urban heat effects.
- Optimize rural rainfall response strategies by integrating natural water retention systems with reinforced drainage infrastructure and community-based early warning mechanisms.

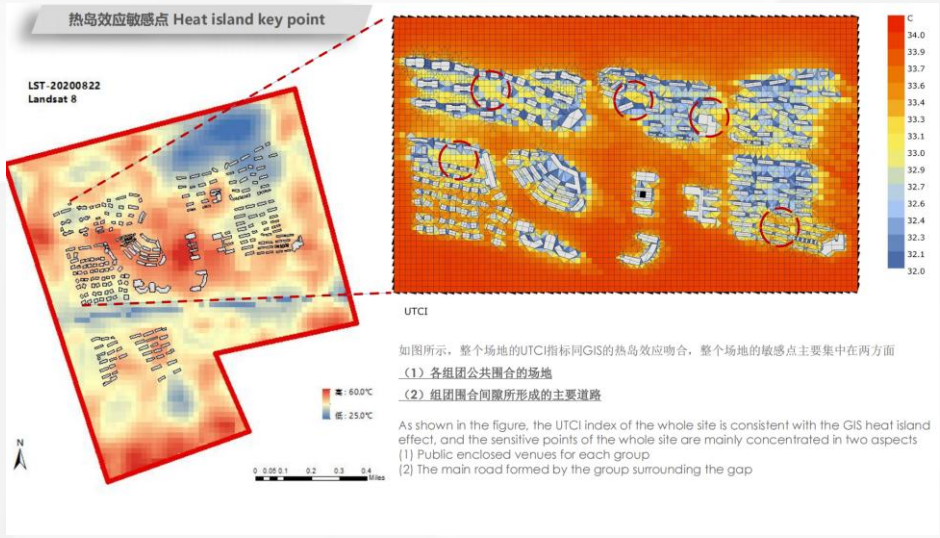


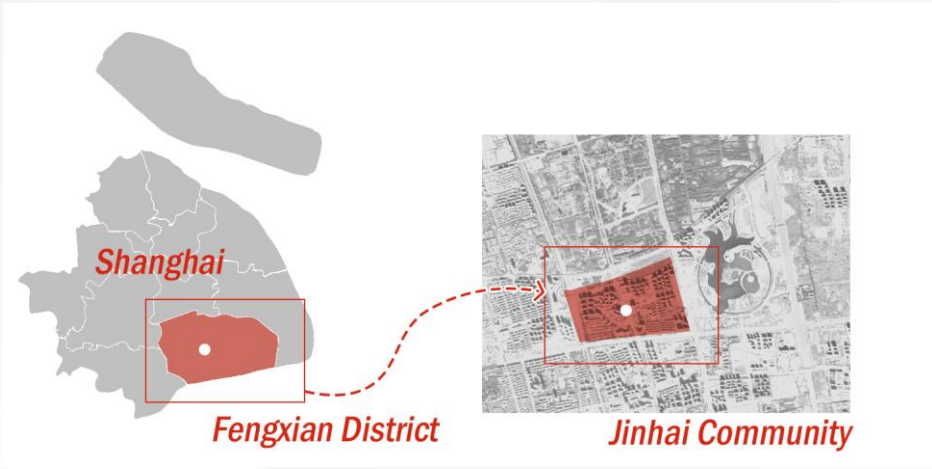




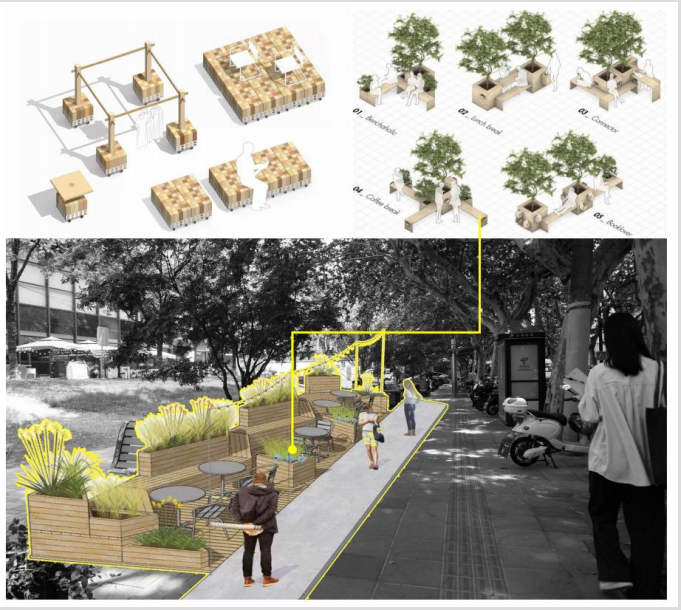
Climate Adaptive Strategies——Shanghai

- Including the optimization modes for road, greenspace layout, and buildings.





Demonstration area in Fengxian, Shanghai

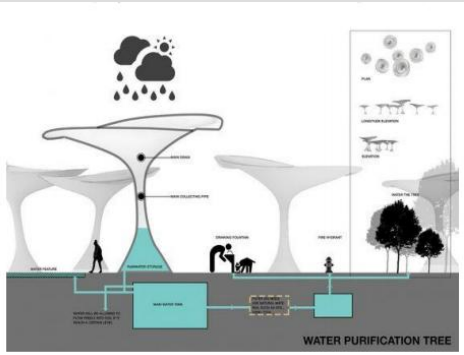


Modular Shade Facilities

- Modular street planting boxes
- Set up green plant landscapes quickly
- Providing shade and transpiration cooling from plants

Public Green Space Optimization

- Rainwater collection system for colling and runoff reduction
- Cooling Spaces with shading, spray or water mist facilities
- Encourage residents to participate in maintenance

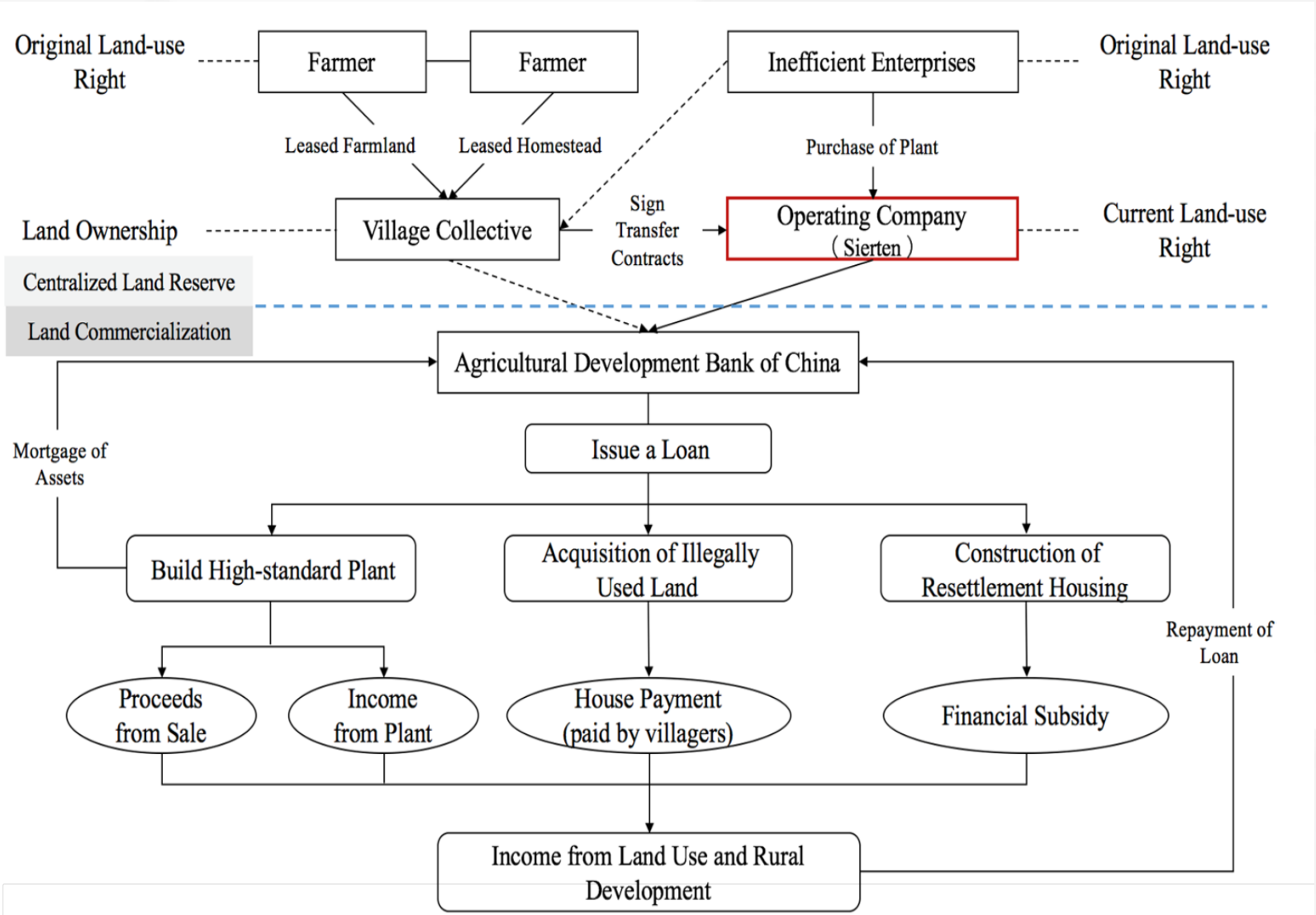


Climate Adaptive Strategies——Governance

To improve the capacity of climate adaptation from the perspective of collective action of stakeholders in LC

Stakeholder		Role	Activities
Government	Shanghai Municipal Government	Strategy and policy makers	Determining reduction target, Funding, Evaluation of the implementation
	District Government	Planners; policy makers	Developing District reduction plan, Funding
	Town Government	Planners; Sponsor	Developing town reduction plan, Develop detailed rules, Financial balance
Village Collective Organization		Land owner; Implementer	Negotiating with enterprise owners, Receive compensation
Farmer		Land use rights holder	Participate , Receive compensation
Enterprise		Land use rights owner	Receive compensation
Planner, Expert		Technical Support	Investigation , Policy evaluation, Participate

Climate Adaptive Strategies ——Governance



Reconstruction of Land Property Rights and Intervention of Social Capital into rural area based on the land consolidation, to improve the tenacity of rural area facing climate change risk.

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谢谢

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