Community Resilience Evaluation and Adaptation Framework in the Context of Climate Change:

3 Pilot Community Cases from China

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I. Introduction

1.1 Background and Significance

Escalating global climate risks threaten community socio-ecological systems, hitting smallholder farmers—frontline food producers—hardest (FAO, 2021, 2024; 2025: smallholders supply 80% of global food). As a major agricultural nation, China has ~200 million farming households (465 million people) with <0.6 hectares/household (NBS, 2025), cultivating 70% of farmland and supplying 80% of national food (Third National Agricultural Census; MARA, 2017, 2023, 2025).

Despite China's robust climate strategies, macro-policy grassroots alignment gaps persist—key for addressing intertwined livelihood, biodiversity, and climate challenges. We adopt a bio-culture nexus approach: local multi-disciplinary collaboration, empowering Indigenous Peoples and Local Communities (IPLC) as core actors in adaptation, ecosystem restoration, and resource management (delivering biodiversity/livelihood/carbon sink co-benefits).

Based on cross-China collaborative action research, this study presents an integrated framework, with three pilot mountain communities (Wangjinzhuang, Stone Villge, Henkouzi) as replicable models. Their bio-cultural richness and socio-ecological sensitivity underscore the urgency of integrated nexus approaches and farmer participation in resilience evaluation and planning—for rural communities in China and beyond.

II. Community Resilience Evaluation and Adaptation Framework

The Framework include 3 Key Parts;

2.1 County-Level Climate Risk Assessment & Analysis

• Evaluate core risk components (via quantitative/qualitative methods): climate hazards (frequency/intensity of climate-related disasters), exposure (at-risk population, assets, key ecosystems), and socio-economic-ecological vulnerability—aligned with a conceptual framework illustrating their interrelationships and aggregate effects.

• Analyze spatiotemporal distribution of county-level climate risks, key natural/human driving factors, and comparative risk characteristics across the regions

and ecosystems, where the three communities located.

2.2. Integrated Community Resilience Evaluation

1) Evaluation Dimensions: Construction of four core dimensions aligned with local contexts—**social resilience** (community cohesion, mutual aid capacity,social network completeness), **ecological resilience** (ecosystem stability, nature resource conservation and utilization efficiency, environmental carrying capacity), **economic resilience** (livelihood diversity, income stability, climate-resilient agriculture, agroforest development), and **institutional resilience** (policy responsiveness, community governance efficiency, coordination mechanisms among stakeholders). **The climate adaptability and resilience diagram** further clarifies the dynamic relationship between original and changed climate states, and how adaptive capacity translates to resilience.

2) **Index System**: Operational indicators under each dimension (e.g., social resilience: participation rate in community public affairs, mutual aid behavior frequency; ecological resilience: vegetation coverage retention rate, water resource utilization efficiency; economic resilience: proportion of non-agricultural income, number of climate-adaptive industries; institutional resilience: speed of disaster response, effectiveness of community regulations). For agricultural biodiversity and local seed security, the radar charts on farming diversity and household security (assessing dimensions like local seed utilization, ecological seed protection, and traditional knowledge inheritance) provide a specialized lens for ecological and cultural resilience.

3) **Assessment Methods**: Combined quantitative (index weighting via AHP-entropy method, comprehensive scoring) and qualitative (case comparison, in-depth interview analysis) approaches; calculation and grading of resilience levels (high/medium/low) for each community.

2.3. Local Adaptation Strategies and Community Action Plan

1) Key Adaptive Strategies & Community Actions

- Ecosystem restoration: Vegetation recovery, soil conservation; enrich ecosystem services/agrobiodiversity; link community to landscape-scale conservation for enhanced service capacity.
- Livelihood optimization: Biodiversity-focused climate-resilient agriculture/

agroforestry; characteristic ecological industries; diversify market linkages/value chains (prioritize biodiversity-driven differentiation over uniformity).

- Infrastructure upgrading: Strengthen traditional irrigation/ancient water-management systems and living facilities via indigenous knowledge; boost functionality with community governance and customized rules.

- Institutional governance optimization: Community-based natural resource management (e.g., seed banks); enhanced self-governance via coordination mechanisms (e.g., women/youth groups) and participatory climate adaptation plans.

2) Case-Specific Adaptive Schemes & Community Actions

Tailored to county-community assessment results, these community-led, farmer-inclusive schemes bridge macro/county climate risk assessment with on-the-ground adaptation. Wangjinzhuang case illustrates core evaluation outcomes and action plans (other 2 cases follow the same framework, see attached).

III. A Case Study of Wangjinzhuang Village, Hebei Province, Northern China

The millet harvest at Wangjinzhuang.

1. Community Background

1.1 Community Profile

Wangjinzhuang Village, located at the eastern foot of the Southern Taihang Mountains (Jingdian Town, Shexiang County, Handan city), is an 800-year-old mountainous community with 1,407 households (4,534 residents, 45% female).

- It features 5,176.69 mu of dryland stone-walled terraces (21,333+ plots) across 12 km², growing millet, corn, beans, and prickly ash. With a semi-humid arid climate (540mm annual rainfall, 12.4 °C average temperature), agriculture relies on rainfall.

- Its terraced system was recognized as a GIAHS by FAO in 2022. Since 2019, Oxfam-supported projects have enhanced smallholders' crop diversity management, but recent spring droughts, erratic rainfall, and temperature fluctuations have disrupted farming and incomes, leaving the community ill-equipped for climate challenges.

1.2 Socio-Economic Development (Past 20 Years)

- Migrant work (initially male, later female) has become the primary income source (80%+), reducing agricultural income to basic subsistence. The remaining agricultural labor force consists of the elderly, women, and children.

- Infrastructure improvements (paved roads, 2016 concrete-lined irrigation canals) and increased forest cover (110,000 cypresses planted in the 1960s-70s, ongoing tree planting) have strengthened disaster resilience.

1.3 Climate Change & Recent Events

- A semi-arid continental monsoon climate brings uneven rainfall (64% in late July-early August) and a history of droughts/floods (150 major disasters in 630 years).

- Recent trends: rising temperatures (shorter, milder winters), erratic rainfall (e.g., 2023 corn reseeded 3x due to drought), and frequent compound disasters (droughts + floods).

- Key events include the 2016 "7.19" floods (400mm+ rainfall), 2019 spring drought (crop failure), 2022 persistent low temperatures (poor bean yields), and 2025 spring/summer droughts + autumn rainfall (low germination/yields).

2. County-Level Climate Risk Assessment (2024)

2.1. Supported by CAAS, the FSN team assessed hazards, exposure, and vulnerability:

- Past 30 Years: The average annual temperature shows a distinct upward trend;

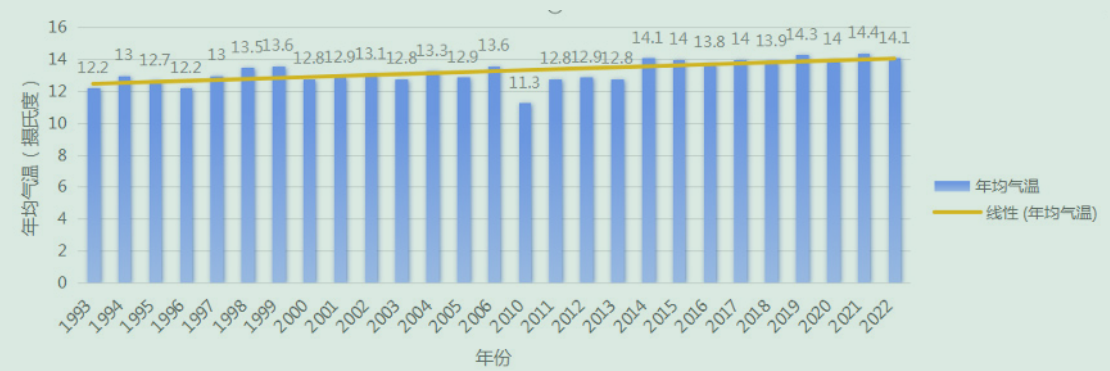


Figure 1: 1993-2022 Annual average temperature in Shexiang County

- Precipitation increased but fluctuated sharply in recent 7 years. Extreme droughts and floods happened in the last 5 years, caused disasters.

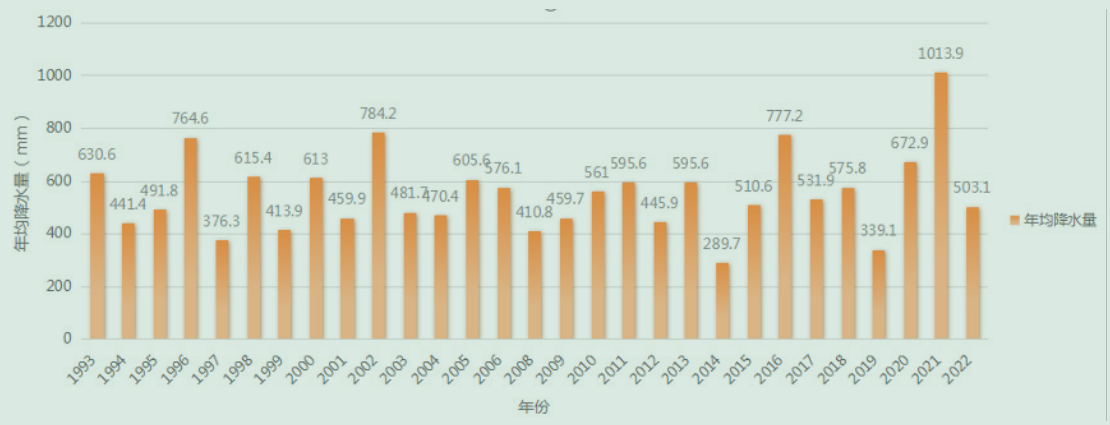


Figure 2: 1993-2022 Annual precipitation in Shexiang county

2.2. Hazard Projection of Future Extreme Climate Events (PRECIS Model):

The future climate change risk assessment conducted in this study adopts climate scenario data simulated by the regional climate model system PRECIS (Providing Regional Climates for Impacts Studies). Based on the climatic characteristics of Shexian County in the study area, three indicators of extreme climate events are selected: number of high-temperature days, number of heavy rainfall days, and number of rainless days.

- Temperature: Significant rise (RCP8.5 scenario most severe).
- Precipitation: More volatile (RCP4.5 shows greater increases).
- Extreme events: More high-temperature days (≥35°C), moderate growth in heavy rain days (max 152mm daily), and compound high-temperature droughts (drought frequency down, intensity unchanged).

In the future, the temperature in She County will show a significant upward trend and the precipitation fluctuations in She County will intensify.

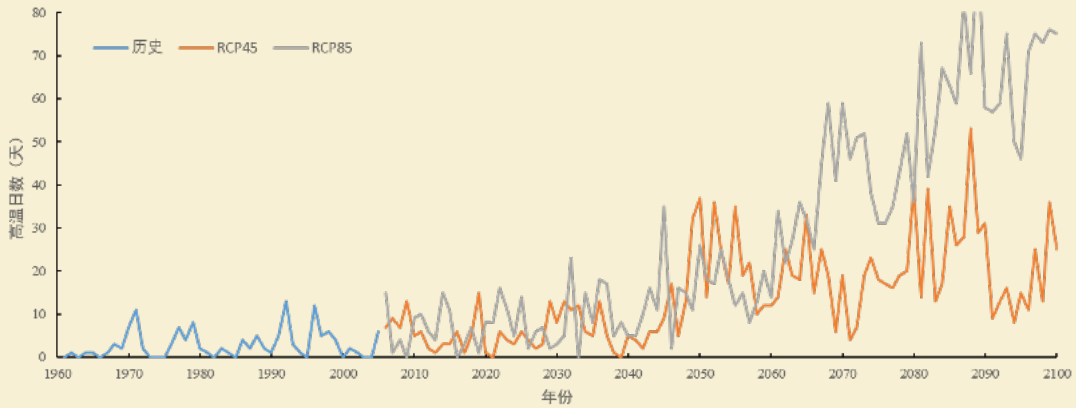


Figure 3: Number of high-temperature days under the future RCP4.5 and RCP8.5 scenarios

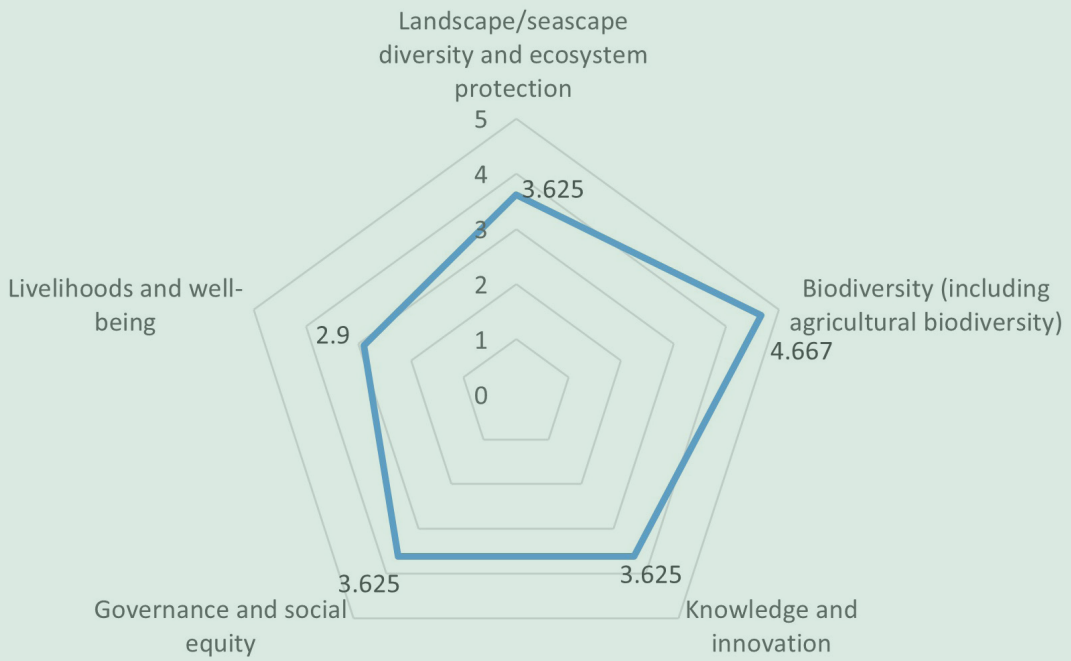
In the future, the number of high-temperature disaster days with temperatures above 35 °C in She County will show a significant increase trend, especially under the RCP8.5 scenario, which will have a significant impact on agriculture, human health and the ecological environment.

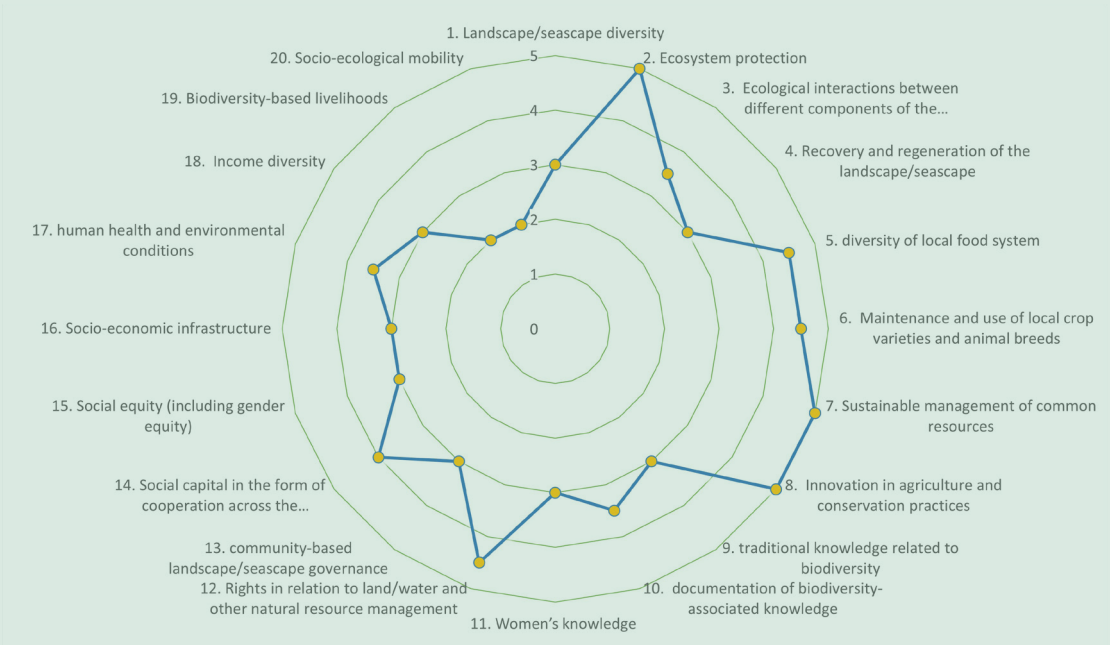
3. Integrated Community Resilience Assessment

The FSN team conducted a community resilience assessment of socio-ecological productive landscapes with community representatives in a participatory manner. A total of 20 questions across 5 aspects were discussed and scored on a 5-point scale, as follows:

- Landscape diversity and ecosystem conservation (3.625 points)
- Biodiversity (including agricultural biodiversity) (4.667 points)
- Knowledge and innovation (3.625 points)
- Governance and social equity (3.625 points)
- Livelihoods and well-being (2.9 points)

The scores are shown in the figure below:





4. Climate Adaptation Strategies and Resilience Actions

Key climate strategies in Wangjinzhuang: integration of traditional agricultural experience into climate adaptation, protection of agricultural biodiversity, as

supported by its historical extreme weather records and climate trend data and community resilience evaluation. The main community based climate actions are:

- Community Seed Bank: Northern China's first, conserving 171 traditional crop varieties, supporting GIAHS recognition and biodiversity conservation.
- PPB and PVS for farmers' selected millet varieties and other preferred crops for agroecology and organic agriculture.
- Value adding and market linkages via farmer markets and on-line shops.
- Terraced Protection Association: 2018 farmer-led organization documenting terrace history and strengthening community-land bonds. Terraced Reclamation: 2023 "I plow for you, you repay with millet" program addressed terrace abandonment.
- Irrigation schemes cannels enhancement for supporting dry land terrace systems.

The water cellar plus drip irrigation system installed in Wangjinzhuang is both water-saving and precise in irrigation, which enhances the utilization efficiency of water cellars.

IV. Conclusions & Recommendations

Key Conclusions

1. A bio-culture nexus approach—backed by multi-disciplinary, multi-stakeholder collaboration at county/community levels—is critical to addressing interconnected socio-ecological, livelihood challenges, and climate risks. It empowers Indigenous Peoples and Local Communities (IPLC) as core actors in adaptation, ecosystem restoration, and sustainable resource management, delivering co-benefits for biodiversity, livelihoods, and carbon sequestration.

2. Living agrobiodiversity and farmer-managed seed systems as root core base of IPLC are crucial for linking nexus approach to comprehensive multiple bio-culture aspects and multiple values including traditional knowledge, spiritual world views, livelihood, ecologic and economic etc.

Researchers guide women farmers in conducting variety selection in the millet experimental field at Wangjinzhuang.

3. County-scale climate risk analysis, future extreme event projections (via PRECIS Model), and community-led integrated resilience assessments (supported by visual tools) create a macro-micro link, enabling targeted local climate action planning.

Recommendations: Policy Piloting for Scaling Up & Out

1. Pilot Core Framework: Roll out the bio-culture nexus-driven, community-led resilience evaluation model (integrating PRECIS climate projections + participatory assessments with visual tools) in target counties and communities. Prioritize multi-disciplinary/multi-stakeholder collaboration and IPLC empowerment as foundational pillars.

2. Pilot Implementation Supports:

- Local governments: Allocate dedicated resources and tailor policies to back pilot execution (e.g., funding for community actions, policy incentives for collaboration).
- Community organizations: support and strengthen community seed banks/laboratories as common space with governance and participatory mechanisms to ensure pilot relevance and ownership.

3. Scaling Pathways: Document pilot best practices to formalize a replicable toolkit—scale horizontally (cross-regional adoption) and vertically (county-to-regional policy integration).

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