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A Guide for Community Climate Change Risk Assessment



PRODUCED BY
YUNNAN SYNETICS PARTNERSHIP FOR
CIVIC ORGANIZATION DEVELOPMENT

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Yunnan Synetics Partnership for Civic Organization Development

In 2014, the Yunnan Synetics Partnership for Civic Organization Development was registered with the Yunnan Provincial Department of Civil Affairs. Adhering to the spirit of public welfare and volunteerism, the Center fosters and nurtures regional public welfare groups, volunteer organizations, civil society actors, and professional volunteers, providing capacity development training, professional consultation, field supervision. The organization's operations include:
Continuing education for social workers and establishing learning and practice-based platforms for social workers within the community; capacity building, incubation services, and assessments for social organizations; including theoretical research on social work and social organization development; advocacy for volunteerism and volunteer training.

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Foreword

Over the past Century, the Earth's climate has been undergoing significant changes caused by global warming. This climate change has increased the frequency, intensity, and scope of extreme weather events, including droughts, floods, and heat waves. These changes have profoundly impacted human societies, disrupted social relationships, societal structures, public safety, livelihoods, and many individuals' physical and mental health.

For this reason, various international levels of government, businesses, and organizations have developed and implemented measures to reduce emissions and curb this ongoing climate crisis. However, since a large amount of greenhouse gases have already accumulated in the atmosphere, achieving an immediate carbon neutrality or net zero emissions will not stop global temperatures from rising. Therefore, adaptation to climate change has become necessary. Determining how to adapt requires climate change risk assessments, which identify the key risks associated with climate change and provide a basis for developing appropriate adaptation measures to address this crisis.

Over the past three decades, a persistent imbalance has existed between climate mitigation and adaptation efforts. In dominant international narratives and discourses, mitigation is sometimes treated as synonymous with addressing climate change, while adaptation is frequently narrowed to disaster prevention and mitigation. This has severely constrained the space for meaningful action on adaptation. According to the Intergovernmental Panel on Climate Change (IPCC), adaptation and mitigation are complementary pillars of climate response, yet adaptation efforts remain uneven and insufficient relative to rapidly increasing climate risks. This imbalance has contributed to multiple systemic challenges, including unequal distribution of adaptation finance and gaps in long-term resilience planning. It is therefore no longer feasible to choose between mitigation and adaptation. Adaptation has undoubtedly become the critical issue for all countries, as it directly determines the capacity of societies to manage both slow-onset climatic changes and more frequent and severe extreme weather events.

Current research on climate change adaptation can be categorized across different spatial scales, including global, regional, sub-national, and community levels. Each scale reflects a different focus of analysis: global adaptation emphasizes international coordination and governance; regional adaptation addresses transboundary climate risks; sub-national adaptation focuses on territorial or administrative planning; and community-based adaptation concentrates on locally specific responses to climate impacts. Among these, communities represent the most fundamental units exposed directly to climate-related hazards, making locally tailored adaptation strategies essential. Such approaches often involve sustainable resource management, ecosystem restoration, and nature-based solutions aimed at enhancing both human well-being and biodiversity co-benefits.

Meanwhile, climate risk is unevenly distributed across both space and social groups. Urban areas, with their high population density and concentrated infrastructure, tend to face greater exposure to extreme weather events and may incur significant economic losses. Consequently, a substantial share of current adaptation funding is directed toward cities to strengthen urban resilience. By contrast, rural areas generally exhibit higher levels of social vulnerability, driven by greater dependence on natural resources, more limited access to public services, and population aging. When adaptation funding is disproportionately allocated to urban rather than rural areas, the vulnerability gap between rural and urban populations may widen, thereby exacerbating existing social inequalities.

In response to these challenges, this guide has been developed to support practitioners, community organizations and researchers in conducting community climate change risk assessments. It provides a practical methodology for identifying climate risks, understanding local vulnerabilities and adaptive capacities, and translating assessment findings into locally appropriate adaptation actions. By emphasizing participatory approaches, the guide aims to help communities better understand their climate risks and strengthen their capacity to adapt to a changing climate.

This guide is organized into nine chapters and four annexes that take readers through the complete process of a climate change risk assessment. Chapter 1 introduces the fundamental concepts of climate change, climate change risk assessment, and participatory rural appraisal (PRA). Chapters 2–7 present the assessment methodology, covering the overall assessment process, desktop research, objective setting, indicator system design, data collection, meteorological analysis, and field research. Chapter 8 explains how to synthesize and analyze assessment results using the Hazard–Exposure–Vulnerability framework, Impact Chain Analysis, and the Pressure–State–Response (PSR) framework. Chapter 9 focuses on translating assessment findings into practical adaptation actions. The annexes provide additional technical guidance on key assessment frameworks, participatory assessment methods, and a suggested outline for preparing a climate change risk assessment report. Although the chapters are presented in a sequential order, readers may refer directly to specific chapters or annexes according to their assessment needs and level of experience.

Chapter I.

Knowledge Preparation



1.1 Climate Change Basics

Climate change refers to the long-term alteration of weather patterns on Earth, typically occurring over 30 years or more. Various factors, including human activities and natural processes, cause it. Climate change has far-reaching effects on the Earth's environment, ecosystems, and human society. [1]

First, climate change is mainly caused by the emission of greenhouse gases. Greenhouse gases, such as carbon dioxide, methane, and nitrogen oxides, prevent part of the energy from the Sun that reaches the Earth from escaping into space, thus causing the Earth's surface temperature to rise. Human activities, such as the burning of fossil fuels, deforestation, and industrial processes, release large quantities of greenhouse gases, thereby accelerating global warming.

Secondly, climate change destabilizes the global climate system. For example, rising temperatures are melting glaciers and raising sea levels, which threaten coastal populations and ecosystems. Extreme weather events, such as droughts, floods, hurricanes, and heavy rainfall, are becoming more frequent and intense. This increase poses challenges to agriculture, water resources, and human health.

In response to climate change, the international community has taken a series of measures, primarily categorized into mitigation and adaptation strategies. A key focus has been on reducing greenhouse gas emissions. Countries have formulated policies aimed at lowering emissions, enhancing energy efficiency, and promoting renewable energy sources and clean technologies. At the same time, adaptation to climate change is also important. This includes improving agricultural practices and water management, building disaster-resilient infrastructure, and strengthening community education and awareness programs.

1.2 Climate Change Risk Assessment

A climate change risk assessment is a structured analytical process used to evaluate the potential risks posed by climate variability and long-term climate change. It is a methodological framework that integrates data, indicators, and participatory assessment to systematically assess climate-related risks. In practice, it typically involves the collection of climatic, environmental, social, and economic indicators, which are then used to identify, quantify, and compare levels of risk across different sectors or geographic areas. The outputs of a climate risk assessment often include risk classifications, vulnerability profiles, spatial risk maps, and recommendations for adaptation planning.

A climate change risk assessment can achieve several objectives, including identifying and prioritizing risks, determining entry points for climate change adaptation interventions, tracking changes in those risks, and monitoring and evaluating adaptation measures. These objectives can be tailored to the specific needs of each organization and project.

The climate change risk assessment has evolved to create several conceptual frameworks that guide the evaluation of climate change risks, particularly in designing the indicator system. These frameworks target different audiences and regions, but they all ultimately focus on the risks associated with climate change. There is no hierarchy among these frameworks. Due to the significant regional variability in climate change risks, the conceptual framework primarily serves as a reference for the project's preliminary design. The specific work will be adjusted and enhanced under this framework according to the regional context and the available indicators for collection.

The following section introduces the Hazard-Exposure-Vulnerability framework proposed by the Intergovernmental Panel on Climate Change (IPCC) and the Adaptation-Institutions-Livelihoods (AIL) framework, which is grounded in sustainability principles. The primary focus will be on the Hazard-Exposure-Vulnerability framework.

1.2.1 The Hazard-Exposure-Vulnerability Framework

Climate change risk assessment is a key step in climate change adaptation. According to the IPCC Fourth Assessment Report,[2] climate change risk is mainly comprised of three components: hazard, exposure, and vulnerability (Figure 1.1). An assessment indicator system is built upon these factors, and the climate change risk assessment is carried out accordingly.

Hazard

refers to the probability and severity of an extreme weather event at a specific location. The assessment of hazard usually relies on analyzing historical patterns of extreme weather events and trends in climate change, including indicators of probability, intensity, duration, and impact.

Exposure

refers to the number of people, their livelihoods, environmental services, and resources (e.g., cash crops) in a location that is likely to be adversely affected. When assessing a community as an entity vulnerable to disasters, the most considered indicators include the number of people and the condition of buildings or facilities. These exposure indicators can vary from one extreme weather event to another, as different events affect various exposed elements, such as populations, infrastructure, agricultural land and ecosystems.

Vulnerability

refers to the physical, social, economic, environmental, cultural, and institutional factors that determine the extent to which the object of assessment is prone to adverse impacts. Vulnerability comprises sensitivity and adaptive capacity. Sensitivity refers to the degree to which the object of assessment is affected by climate change, depending on economic, social, and environmental conditions. Relevant indicators may include socio-economic characteristics, physical environmental conditions, demographic composition, and other related factors. Adaptive capacity refers to the ability of the object of assessment to adapt to and recover from climate hazards. It includes factors such as the capacity for human intervention, policy and planning, basic response measures, education, and public awareness.

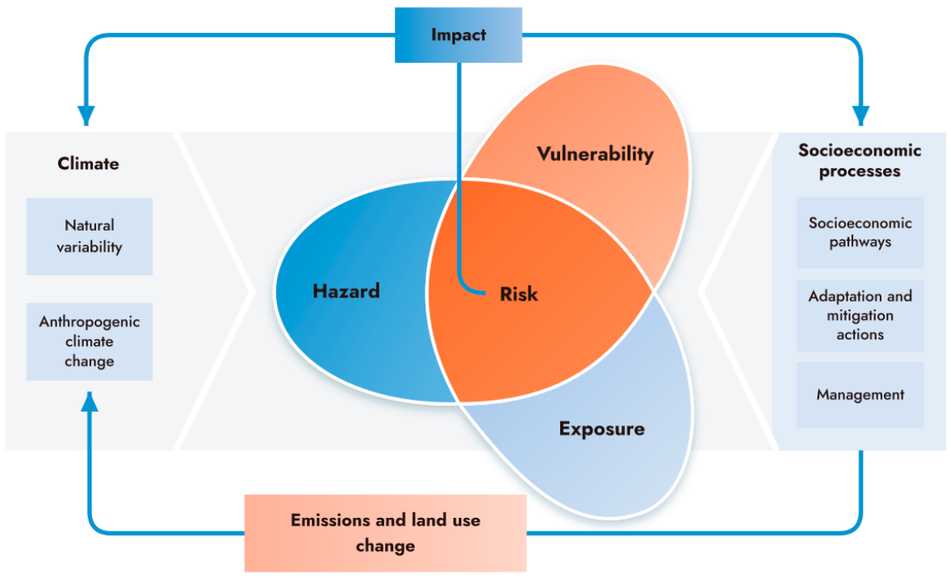


Figure 1.1 Schematic diagram of the IPCC WGII AR4 core concept [2]

Specific indicators are provided in Table 1.1, and further details can be found in the Hazard–Exposure–Vulnerability Framework in Annex 1.

Table 1.1 The Hazard-Exposure-Vulnerability framework indicator reference

Risk Component	Indicators
Hazard	Disaster types and occurrence frequency
	Characteristics of the spatial and temporal distribution of disasters
	Scale of disasters and scope of impact
	Potential joint disasters and cumulative effects
	Possible new types of disasters
	Disaster trends and projections
	Trends in climate change
	Impact of climate change on ecosystems
	Impact of climate change on natural resources
	Impact of climate change on agriculture and other economic sectors
	Economic and social implications of climate change
	Risk propagation and spillover effects
Exposure	Population density and distribution
	Level of exposure to life and economic activities
	Critical infrastructure exposure
	Natural ecosystem exposure
Vulnerability	Social vulnerability
	Population susceptibility and vulnerable groups
	Infrastructure vulnerability
	Economic structure
	Community-based adaptation measures and project implementation
	Adaptive capacity of community residents
	Disaster response and recovery mechanisms
	Community organizations and social capital
	Disaster early warning and monitoring capacity
	Emergency response mechanisms and rescue capabilities
	Community-based adaptation policy and planning

1.2.2 The Pressure-State-Response Framework

The Pressure–State–Response (PSR) framework evolved from the Stress–Response framework proposed by Canadian statisticians David Rapport and Anthony Friend in 1979 and was later developed and applied by the Organization for Economic Co-operation and Development (OECD) and the United Nations Environment Programme (UNEP) in the 1980s and 1990s as a framework for analyzing environmental issues. The PSR model emphasizes causal relationships: pressures cause state changes, which result in corresponding societal responses. This causal chain helps understand the evolution of environmental problems and provides a conceptual foundation for developing effective environmental protection and adaptation strategies. In climate change risk assessment, the PSR model is widely used to analyze the impacts of climate change on ecosystems and socio-economic systems.

In the PSR framework (Figure 1.2), pressure refers to the impact of human activities on the environment. Examples include resource consumption, greenhouse gas emissions, and changes in land use. These pressures are the direct causes of environmental status changes and contribute to climate change. State refers to the current status or development of the object and its surrounding environment, such as the production of red pears, water quality, and air quality. State-related indicators reflect environmental health and the availability of resources. Response refers to the actions taken by society to address environmental pressures and improve environmental conditions. This includes policy, technological, institutional, and other forms of intervention. Response aims to reduce environmental pressures or promote restoration. Climate change risk assessment under the PSR model generally includes adaptation behaviors targeting the assessed system, and mitigation behaviors that reduce carbon dioxide emissions.

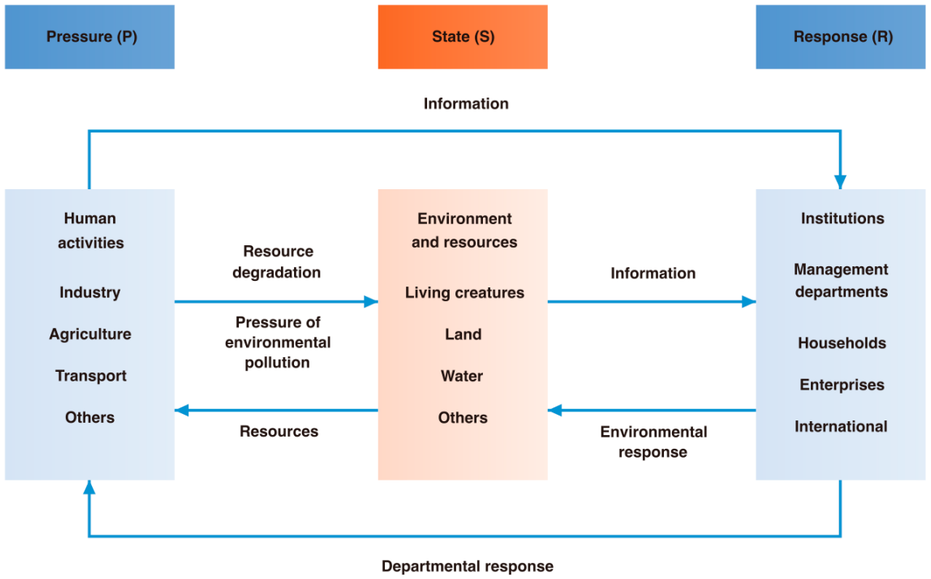


Figure 1.2 Schematic diagram of the “Pressure-State-Response” framework.

The PSR framework emphasizes the causal relationship among pressure, state, and response: pressure leads to changes in state, and these state changes, in turn, prompt society to adopt corresponding response measures, while actions further influence the changes in pressure and state. The dynamics among pressure, state, and response reflect how the system evolves, making the model applicable to various types of environmental and social systems. Currently, the PSR framework has given rise to several related frameworks, including the DPSIR model (Driving Force-Pressure-State-Impact-Response), and the DPSEEA model (Driving Force-Pressure-State-Exposure-Effect-Action). Despite their differences, these frameworks share the same core principle: understanding the causal relationships among human activities, environmental change, and societal responses, which is valuable for conducting in-depth research on specific topics and exploring adaptation options for climate change. Additional information about the PSR framework can be found in Annex 2 “The Pressure-State-Response Framework”.

1.2.3 The Adaptation-Institutions-Livelihoods Framework

Agrawal and Perrin (2009) proposed the Adaptation-Institutions-Livelihoods (AIL) framework for climate change adaptation in rural communities, with reference to the sustainable livelihoods framework [3]. It focuses on how climate change impacts the livelihoods of local people, considering their perceptions of climate fluctuations, the influence of policies and institutions, market accessibility, and household livelihood capital, to inform the development of adaptation programs. The model categorizes household livelihood capital into five types: human, material, financial, natural, and social capital. Referring to Wang et al. (2016) [4] and Shan Shui Conservation Center (2019) [5]. The following visual diagram illustrates this framework (Figure 1.3).

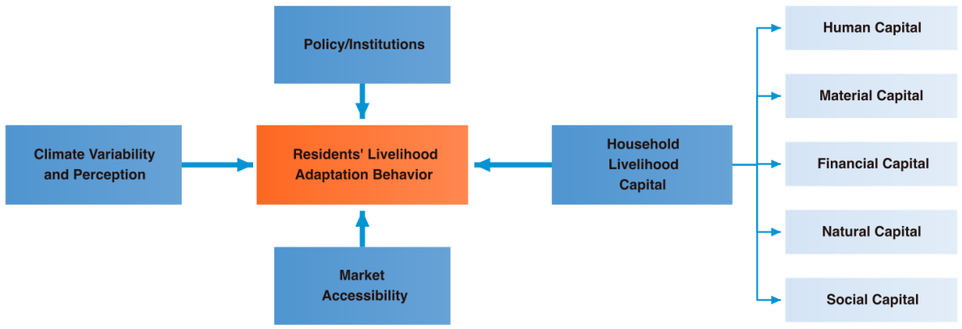


Figure 1.3 Analytical framework for adaptive behavior of residents' livelihoods [4,5]

Furthermore, the framework categorizes residents' livelihood adaptation into five types: mobility (spatial adaptation), storage (temporal adaptation), livelihood diversification (adaptation to means of production), community mutual aid (adaptation among residents), and market exchange (external linkage), which also inform the formulation and selection of adaptation measures.

1.3 Participatory Rural Appraisal

Participatory Rural Appraisal (PRA) is a participatory assessment approach that aims to facilitate community engagement and collaboration in the collection, analysis, and interpretation of information. As a people-centered approach, PRA is widely used in community development practices. It seeks to understand resident perceptions, needs, and priorities regarding specific issues. Through this approach, community members actively contribute their knowledge, experiences, and perspectives while collaborating with researchers and practitioners to develop a shared understanding of topics and issues. PRA employs a variety of participatory tools and techniques, which can generally be categorized into six groups: spatial, temporal, communicative, sequencing, analytical, and interview-based methods. Specific examples include group discussions, focus group discussions, ranking exercises, participatory mapping, and timelines. These tools enable residents to articulate their views, share local knowledge, and facilitate collective decision-making and consensus building.

PRA emphasizes the participation of community residents, leveraging local knowledge and experiences. It serves not only as an assessment method but also supports community development and sustainability. These characteristics make PRA particularly suitable for climate change risk assessments in rural communities. In assessing climate risks in rural communities, it is crucial to understand the residents' knowledge and perceptions of climate change. This helps identify situations and the main risk types, as well as understanding their experiences and adaptation measures in response to previous hazard events. Furthermore, participatory processes provide opportunities to communicate scientific knowledge on climate change based on community needs, enhance residents’ awareness and willingness to adapt, and facilitate consensus building among stakeholders through collective engagement.

Common PRA tools include spatial mapping methods (e.g., community maps, resource maps, transect diagrams), temporal analysis methods (e.g., village history, historical event records, seasonal calendars, daily activity schedules, and trend diagrams), analytical tools (e.g., institutional Venn diagrams, cause-and-effect diagrams, problem trees, SWOT analysis), ranking and classification tools (ranking and scoring, wealth ranking), and interview and discussion methods (e.g., semi-structured interviews, focus group discussions, community meetings). The guide introduces the PRA community maps as an example (Figure 1.4). Other PRA tools are described in Annex 3: Participatory Assessment.

A PRA community map is a visual tool used in PRA to understand the overall structure of a community. By drawing a plan map together, participants can identify the distribution of settlements, community institutions, and various ecological resources, including forests, rivers, and farmland. It also helps identify areas, facilities and other features that may be vulnerable to climate change. A PRA community map is typically developed under the guidance of facilitators with active participation from community members. Through this process, communication and connections between facilitators and community members are strengthened.

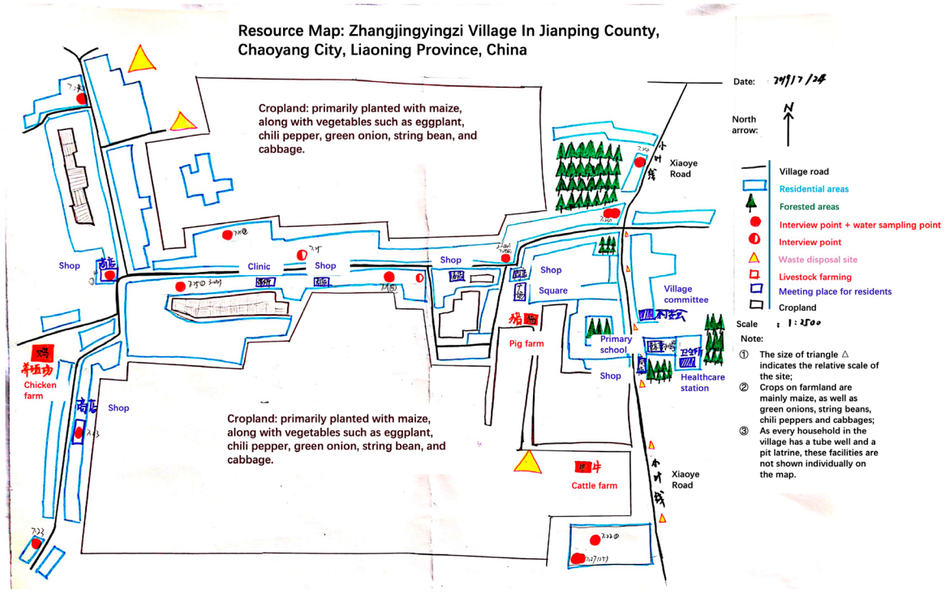


Figure 1.4 Example of a PRA map

Chapter II.

Assessment Process



This chapter's main purpose is to guide practitioners in gaining a comprehensive understanding of the steps and methods in climate change risk assessment. Experienced practitioners can refer directly to this chapter for research and assessment purposes. Below are the operational steps for conducting a community climate change risk assessment, based on various project studies and practices.

2.1 Understanding Context through Desktop Research and Pre-surveys

Every risk assessment has a unique context that shapes its scope, objectives, and expected outcomes. Practitioners should familiarize themselves with the region's basic information and the primary types of climate risks it faces through desktop research or preliminary field studies.

The desktop research seeks to understand the local geography, climate, and other basic information at a macro level, as well as to understand the community's basic situation through the Internet. The information collected covers local geography and administrative divisions, climatic and hydrological characteristics, topography, population composition, socio-economic conditions, and ethnic cultures. Potential data sources include, but are not limited to, regional statistical yearbooks, industry reports and bulletins, local government portals, official websites of statistical bureaus, official websites of relevant sectoral authorities, and online encyclopedias.

In pre-surveys, it is necessary to engage with residents who are knowledgeable about the major types of meteorological disasters in recent years (e.g., floods, waterlogging, drought, high temperatures), as well as to gather information about local industries and identify the most vulnerable local entities (e.g., a particular cash crop, industry, and health conditions of certain demographic groups). These pre-surveys also aim to understand the key influencing factors on harvest production. For example, the cultivation of red pears is mainly affected by temperature, precipitation, pests, and diseases.

2.2 Clarifying Research Objectives and Research Boundaries

Given that climate change impacts vary greatly from one region or sector to another, it is important to identify the target and define the boundaries of a risk assessment before proceeding with the research. This approach allows for a tailored climate change

risk assessment, providing scientific support for developing appropriate adaptation programs and measures.

The evaluation objects and boundaries should be determined based on the information collected from desktop research and pre-surveys, while also considering available resources and the needs of stakeholders. Important factors to consider include the objectives of the risk assessment (e.g., the drought risk affecting red pear cultivation in Yanta Village, Kunming, Yunnan Province), the main target objects and regional boundaries (see Table 2.1 for an example), information gaps that need to be addressed (e.g., the impact of drought on red pear yield in the study area, and the frequency and severity of drought events), the methods to be used (e.g., interviews, questionnaires and surveys, PRA maps), and illustration tools for conclusions (e.g., maps with risk hotspots, a ranking of risk factors, and narrative analysis of the risks and their associated factors).

Table 2.1 Boundaries defined by various spatial scales and fields

Field	Spatial scale	Object	climate change risks
Agriculture	Heilongjiang Province	Maize, rice	Drought, flood
Forestry	Northeastern China	Coniferous, mixed forests	High-temperature, pest and disease
Coastal zone	Southeast coast	Aquaculture, ports	Typhoon, storm surge
Human health	First-tier city	Urban residents	High-temperature, cold wave
.....	.....	.....	.....

2.3 Identifying Indicators

The indicators are based on the information gaps to be filled.

Indicators are parameters that provide information about a specific state or condition.

When a state or a condition cannot be measured directly, proxy indicators can be used (e.g., the incidence of a particular pest as a proxy for crop damage).

Indicator values can be aggregated in quantitative, semi-quantitative, or qualitative ways according to risk components (hazard, exposure, vulnerability), which can subsequently be integrated into a comprehensive risk assessment indicator system.

Below are some examples of assessment indicators (Table 2.2).

Table 2.2 Examples of assessment indicators

Risk component	Risk factors	Indicators
Hazard	Temperature	Number of days with night-time minimum temperature above **25°C** or higher
	Precipitation (meteorology)	Number of days of heavy rainfall
Exposure	Smallholder agriculture exposed to risk	Percentage of peasant population Percentage of total area under cultivation by smallholders
	Infrastructure location	Distribution of transportation infrastructure in flood-prone areas
	Ecosystem exposed to risk	Location of habitats in areas affected by sea level rise
Vulnerability	Vulnerable groups	Percentage of vulnerable population (e.g., the elderly)
	Economic capacity	funding for **investment in adaptation actions**
	Organizational capacity	Strength of local community-based organizations

2.4 Collecting and Organizing Basic and Meteorological Information

During the desktop research process, basic information about the local area is collected through online sources. After establishing the assessment indicator system, the collected information should be organized and reviewed according to the requirements of each indicator. This process helps identify which indicators are already supported by available data and which require further verification through field surveys.

At the same time, relevant meteorological data for the study area should be collected. Multi-year, multi-variable climate data (e.g., temperature, precipitation, wind speed, and other variables from 1990 to 2018) can be obtained through platforms such as the WheatA Meteorological Big Data Platform or the China Meteorological Data Service Centre, https://data.cma.cn/). The collected meteorological data should then be preliminarily analyzed according to the requirements of the assessment indicators.

2.5 Conducting Field Research

Based on the baseline information collected and the established assessment indicator system, the additional information required for completing the assessment should be identified. Field survey questionnaires or interview guides can then be developed accordingly (Table 2.3). Field investigations should subsequently be conducted using methods such as questionnaires and interviews, with a focus on collecting, organizing, and analyzing information related to the climate risks faced by the assessed system. After conducting preliminary analysis of the collected data, the results are used to identify the major climate change-related threats faced by the local area, examine historical trends in climate hazards, and determine the key climate risks that the community may face over the next 10 to 30 years.

Table 2.3 Field research questionnaire design

Questionnaire Design	Content
Overall village information	Village background information: permanent residents, age structure, education, industrial sectors; Climate basic characteristics: climate types, meteorological hazards, climate trends.
Individual interviews with community residents	Basic information such as age and occupation, household livelihood capital, climate change perception and awareness, climate change impacts and adaptation behaviors, and willingness to participate in adaptation.
Adaptation program planning	Governments: current status of risk management, climate adaptation programs, and budgets under planning; Public welfare organizations or related institutions: current service projects and future plans; Key opinion leaders: willingness to participate and the preferred types of work.

2.6 Conducting Climate Change Risk Assessment

Information collected through desktop research and field investigations can be organized and synthesized based on the established assessment indicator system and used to address the objectives of the climate change risk assessment. The analysis can be conducted under the Hazard–Exposure–Vulnerability framework, while the Pressure-State-Response (PSR) framework can be incorporated to further examine causal pathways and develop impact chain analyses.

The Hazard–Exposure–Vulnerability framework provides a comprehensive assessment across multiple dimensions and can effectively identify and prioritize community-level climate change risks, providing a basis for the subsequent development of adaptation action plans. In contrast, PSR analysis provides a more in-depth examination of specific issues by identifying the key factors influencing climate change impacts on the assessed system and supporting the design of targeted response measures.

A suggested structure for the assessment report is provided in Annex 4, “Outline of a Climate Change Risk Assessment Report.” Below are some methods for reference (Table 2.4).

Table 2.4 Qualitative assessment of climate change risk

Assessment steps	Methods
Climate change risk	Identify the main climate threats to the study area in recent years
Exposure and vulnerability assessment	Evaluate the situation of the assessed objects in the research area in terms of exposure and vulnerability
Climate change impact chain analysis	Construct impact chain diagrams through causal relationships under the Pressure-State-Response model
Risk identification	Identify the key risk factors by conducting a comprehensive evaluation of hazards, exposure, and vulnerabilities

Further quantitative assessment of types, scales, frequency, and potential adverse impacts of future climate hazards can rely on professional tools such as climate scenario data simulation and analysis, as well as climate vulnerability and risk assessment. However, employing these highly specialized tools usually requires collaboration with expert teams in climate change. Below are some methods and tools for reference (Table 2.5).

Table 2.5 Methods for climate change vulnerability and risk assessment

Assessment methods	Tools	Note
Analysis of data from climate scenario modeling	Global Climate Model Comparison Program (WCRP-CMIP6) https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6	Climate change risk assessment may require specialized data processing and analysis. It is recommended to collaborate with expert teams in relevant fields.
Analysis of indicators of extreme weather events	Evaluation standards for various weather types in China http://cq.cma.gov.cn/sqxj/ggtz/202305/t20230517_5512379.html	
Vulnerability assessment	Vulnerability assessment tools http://www.ifrc.org/Global/Publications/disasters/vca/vca-toolbox-en.pdf http://www.careclimatechange.org/cvca/CARE_CVCAHandbook.pdf	
Risk identification	Community-based risk identification tools http://www.iisd.org/cristaltool/download.aspx	

Chapter III.

Desktop Research and Preliminary Background Research



This chapter aims to guide practitioners in understanding the background necessary for the preliminary assessment of climate change risks. It introduces the process of conducting desktop research to collect macro-regional information, as well as how to carry out a pre-survey. Desktop research involves gathering macroscopic information online, including local geographic location, climatic and hydrological characteristics, topography, demographic composition, socio-economic status, ethnic culture, etc.; pre-surveys focus on examining economic activities at the community level and identifying the main types of meteorological hazards in the research area through field visits and communication with local residents. By combining desktop research and pre-surveys, practitioners can comprehensively understand the local context, enabling them to prioritize the essential assessment components.

3.1 Conducting Desktop Research to Collect Macro-Regional Information

The recommended search platforms for desktop research include government websites, cnki.net, or related academic literature databases, WeChat search, and AI search tools. Among them, information from government websites is generally more authoritative and accurate, but it may have limited scope. Academic literature provides a deeper understanding of relevant issues but can sometimes be disconnected from community reality. WeChat search is useful for obtaining real-time information about research sites, particularly when those sites run WeChat public accounts. AI search tools (such as https://metaso.cn/) offer a simple and quick way to grasp relevant topics.

Key pieces of information to gather for desktop research include:

3.1.1 Geography and Administrative Divisions

This information provides a basic overview of the local geography, including the geographic location (marked on a provincial or municipal map) and a satellite map of where the survey was conducted. This overview is an essential part of the “Community Profile” section in an assessment report, allowing readers to clearly understand the spatial information of the assessed site. The geographical map can usually be obtained using search engines. For additional details, please refer to the “Administrative Divisions of the People's Republic of China” entry in Baidu Encyclopedia. The satellite map of the target area can be captured using the “91 Weitu Map Assistant” software (recommended for Chinese practitioners). Below is an example of a location map of the research site (Figure 3.1).

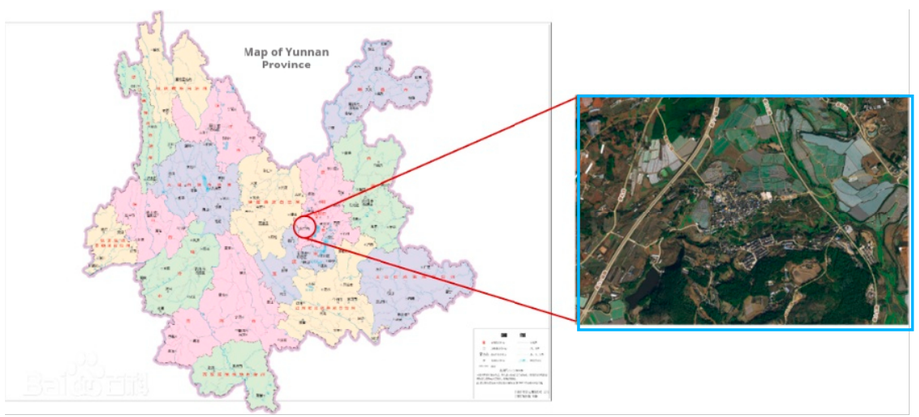


Figure 3.1 A location map of the research site:
(left) administrative divisions of Yunnan Province; (right) satellite image of the research area

3.1.2 Climatic and Hydrological Characteristics

This information helps determine the basic local climatic characteristics and assess the likelihood of climate-related hazards such as floods and droughts. It includes climate types, precipitation patterns and distribution, climate-related disaster types, and river conditions. This information forms an important component of the “Community Profile” section of the assessment report. If the local climate type cannot be identified from available sources, climate classification maps may be used. Information on precipitation characteristics and distribution can be obtained from official meteorological and hydrological sources, such as the China Meteorological Administration (https://www.cma.gov.cn/) and relevant water resources authorities (http://swgl.mwr.gov.cn/). These sources provide data on annual average precipitation, maximum daily precipitation, and seasonal precipitation patterns. Historical records of climate-related disasters can be collected from government publications, disaster management agencies, and relevant academic literature. In regions with disaster mitigation committees or similar organizations (https://www.ndrcc.org.cn/), relevant reports and records may also provide valuable information. River conditions can be obtained from the same sources where available. Below is an example of climate types distribution map in China (Figure 3.2).

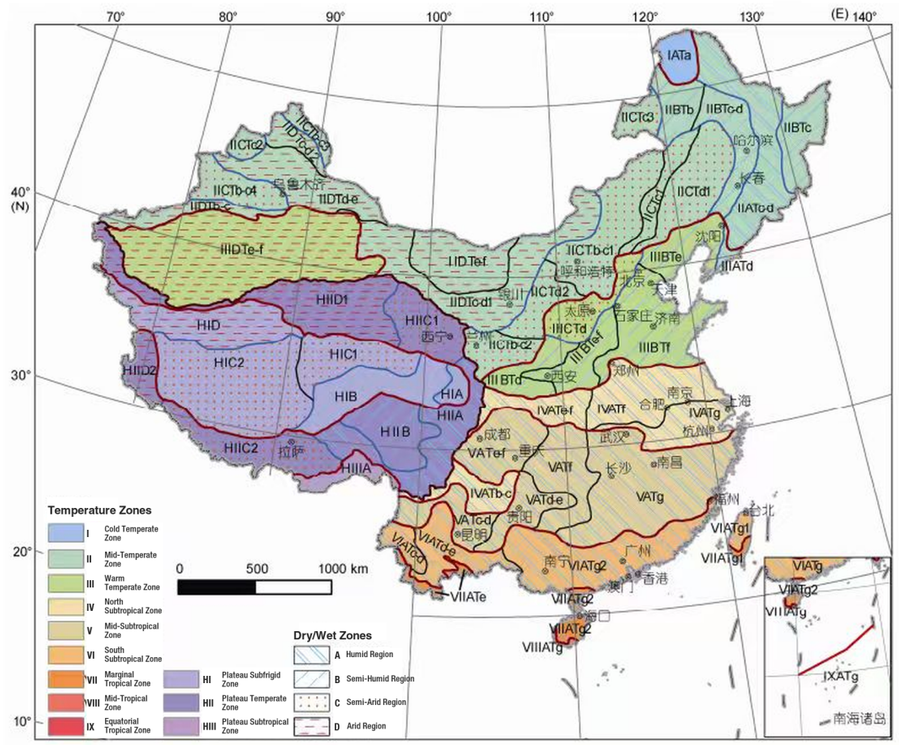


Figure 3.2. Climatic regionalization of China for 1981-2010,
from cold and temperate to subtropical and tropical climates, and from humid to arid areas.[6]
The lower-left legend indicates temperature zones (I–HIII), while the lower-center legend indicates moisture zones (A–D).

3.1.3 Topography and Geomorphology

This information helps characterize the local terrain and land-use conditions, assess the risks of natural hazards such as landslides, and evaluate ecosystem stability. Key factors include altitude, topography, and land-use patterns. This information forms an important component of the “Community Profile” section of the assessment report. Elevation and terrain data can be obtained from official geographic information datasets, government publications, and relevant academic literature. Land-use data (e.g., the proportions of forest, agricultural, and industrial land) can be obtained from official resources provided by natural resource management authorities (https://www.mnr.gov.cn/) and relevant academic studies. For practitioners in China, the latest available data from the “Third National Land Resources Survey”, released in 2021, should also be consulted where applicable.

3.1.4 Population Composition

This information includes demographic size, household numbers, and age structure. Understanding these factors can help identify the number and proportion of people vulnerable to climate change, to properly design adaptation programs, and determine project scales. This information is included in the “exposure” and “vulnerability” sections of an assessment report. Quantitative information is included in the exposure section, while status information, such as age structure, is part of the vulnerability section. The relevant content is usually accessible on Baidu. When information on a rural community is limited, additional information should be requested from higher-level administrative bodies or collected from village committees during field surveys.

3.1.5 Socio-economic Situation

This information includes the local industrial structure, major livelihood strategies, and average annual income. Its main purpose is to understand the local economic capacity to cope with climate change risks and to inform the design of adaptation measures. This information falls under the “Vulnerability” component of an assessment report. Search for relevant data on Baidu, Google, or academic literature sources, and more accurate information could be collected during field surveys.

3.1.6 Development of Major Economic Sectors

The local economy is the primary concern for community residents. This information includes the main economic activities, their history, current output value, and residents' participation. The content is necessary for the “Community Profile” in an assessment report. It can be obtained through Baidu, Google, or academic sources. Field research is a helpful way to gain more accurate information.

3.1.7 Local Culture

This information mainly refers to local ethnic beliefs and cultural practices, particularly in some ethnic minority regions in China. Adaptation programs can be designed based on local cultural contexts, making them more likely to be accepted by community members and facilitating their implementation. This information belongs to the “Community Profile” section of an assessment report.

3.2 Preliminary Field Research

3.2.1 Purpose of Preliminary Field Research

Field pre-surveys are an essential step in the assessment process, providing a foundation for subsequent formal field surveys. They help researchers better understand the assessment object and its surrounding environment, thereby ensuring that the survey objectives are more targeted. In general, pre-surveys for climate change risk assessments aim to identify the assessment object and the main types of local meteorological hazards, as well as determine the key pathways and intermediate factors through which climate change affects the region.

Using Yanta Village in Yunnan as a case for climate change risk assessment, the community's pre-research involves identifying the primary local economic sectors and determining which are vulnerable to climate change. It is also important to understand the main types of local meteorological hazards and how climate change affects the production activities and local livelihoods. Based on this initial survey, an optimal research topic can be selected.

3.2.2 Field Pre-survey Research Methodology

A field pre-survey refers to the basic information conducted from desktop research and analyzed to determine what information is lacking to establish the evaluation objectives. Taking the climate change risk assessment of Yanta Village in Yunnan as an example, the desktop research discovered that red pears are a local specialty, and the village was developing flower businesses. However, the desktop research provided no specific information on the cultivation of red pears nor flowers. Therefore, preliminary research can proceed on these topics to understand the industrial context and to determine whether climate change will impact the cultivation of red pears and flowers.

During the preliminary research process, starting with local acquaintances or administrative personnel, it is generally preferable to obtain initial information. Acquaintances are usually easier to communicate with and can provide more reliable information, while administrators better understand the general situation. For the initial contact with the community, conduct informal street interviews and start with some light conversation to open dialogue. Clarify the purpose of the study to help the interviewee feel more at ease. Identify potential interviewees for further in-depth interviews.

Chapter IV.

Defining Research Objectives and Research Area/ Field Boundaries



4.1 Defining Research Objectives

Research objectives are essential as they provide direction and guidance throughout a project. Clearly defining these objectives is particularly important for the subsequent design of evaluation indicators, conducting fieldwork, and performing evaluation. When setting research objectives, it is necessary to consider the local area's baseline conditions, major economic sectors, community concerns, significant climate change features in the region, and the community's actual needs. This information can be gathered through desktop research and field pre-surveys. Once collected, it can be used to identify two or three candidate issues for further exploration.

For example, a survey conducted in Yanta Village found that drought has been the dominant climate-related hazard affecting the village in recent years. The noticeable temperature rise negatively impacted the cultivation of pears and corn. Even worse, predictions indicated that the frequency and severity of droughts in this area will likely increase due to ongoing climate change. This information can be developed into three potential research topics: "The impact of drought on local pear cultivation", "The impact of drought on local maize cultivation", and "The effect of rising temperature on the health of residents".

Next, select one research topic by evaluating the urgency, importance, and feasibility of these candidate topics, as well as available resources. Further, the selection process can refer to the opinions of the local community through interviews with officials or residents during pre-surveys.

Finally, once research objectives are defined, the geographical scope and field boundaries of the research topic can be clarified. Clear boundaries help make the research more focused and relevant. During the pre-study phase, consider reaching out to surrounding communities to determine whether they are in a similar situation and have the same needs. This can help identify the spatial scope that aligns with program goals.

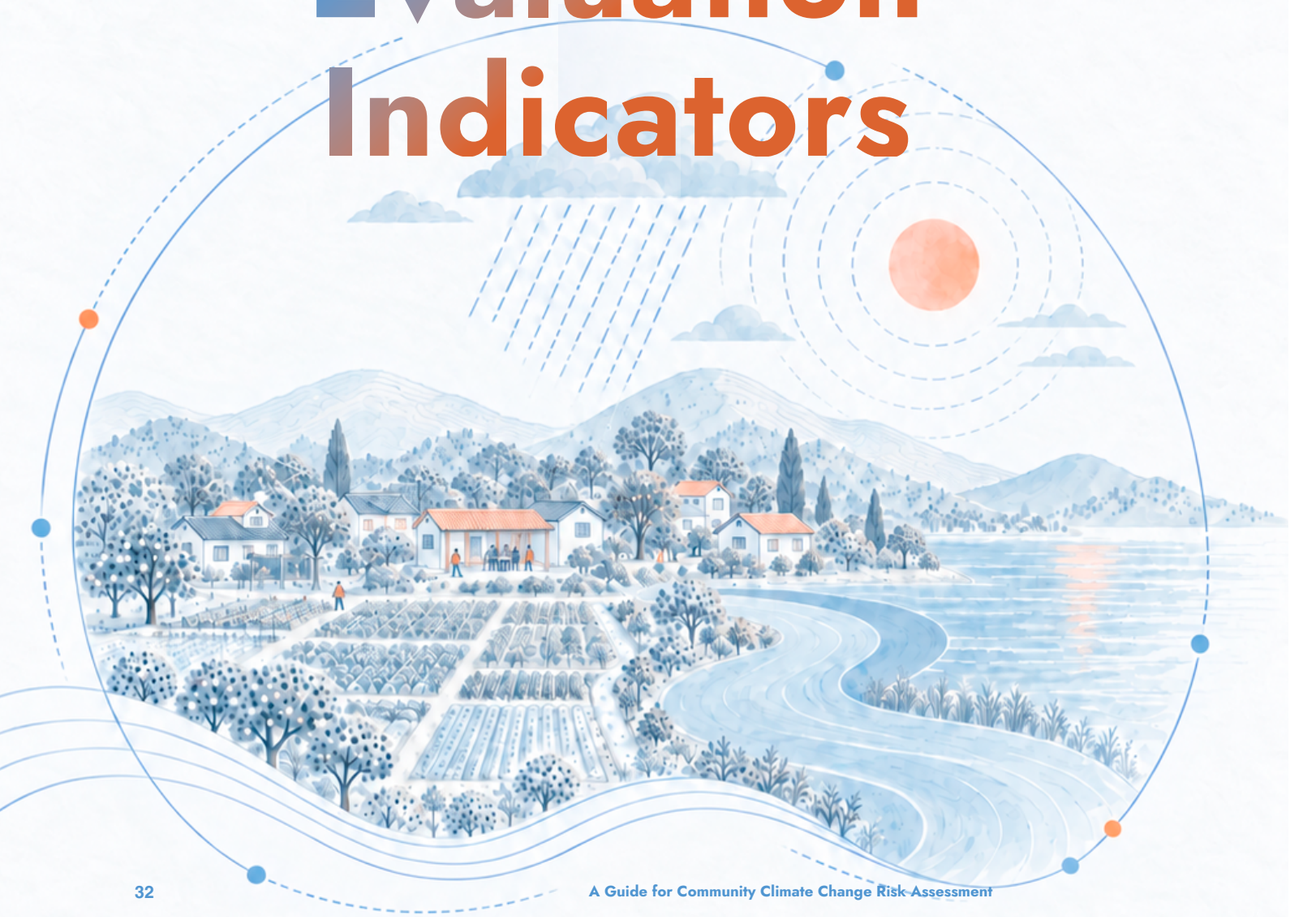
4.2 Dividing the Project into Actionable Tasks

After defining the research objectives and boundaries, it is important to break them into clearer subtopics for implementation. For example, when studying "The impact of drought on red pear cultivation in Yanta Village", it is necessary to examine local meteorological disasters by analyzing the severity and frequency of droughts and their trends in climate change. It is necessary to understand assessed objects by investigating the scope, types, and volume of red pear cultivation, the factors impacting local cultivation, and specifically, the effects of drought on red pear cultivation.

In addition to breaking down the research objectives, it is important to divide the operational process into specific tasks. These tasks may include organizing information, designing assessment indicators and questionnaires, conducting field interviews, and analyzing data. Using project management tools like Gantt charts can assist in establishing an implementation timeline, ensuring a smoother assessment process.

Chapter V.

Designing a System of Evaluation Indicators



5.1 Concepts of Hazard, Exposure, and Vulnerability

Hazard

A hazard is a physical event or trend, natural or human-induced, that may cause casualties, injuries, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, and ecosystems. In climate change risk assessment, hazard generally refers to physical events, trends, or climate-related impacts. Examples of hazards include the number of hot days, warming trends, daily maximum temperatures, night-time temperatures, wind speeds, the frequency of heavy rainfall, and the rise in sea levels.

Exposure

Exposure refers to the quantity and condition of the assessed object exposed to the hazardous environment. It includes the object's quantity and the factors that affect its exposure. The exposure factors can be categorized into three dimensions: time, space, and degree. The dimension of time refers to whether the object is exposed during a hazardous period and specifies when the period occurs. The space dimension assesses whether the object is in a hazardous area. The degree dimension evaluates the presence of shelters or protective measures that may mitigate the risk.

The quantitative information includes population and crop size in *mu* (a Chinese area unit). The temporal aspects examine the overlap between the flowering of pear trees and periods of frost risk. The spatial aspects consider the distance to a mountain prone to landslides. The degree aspects look at whether the crops are grown in a greenhouse or an automated greenhouse and whether they are covered with plastic mulch.

Vulnerability

Vulnerability refers to the likelihood of assessed objects being adversely affected by certain risks. It can be categorized into two indicator types: sensitivity to risk and adaptive capacity. Higher sensitivity to risk leads to increased vulnerability, while a stronger capacity to adapt results in lower vulnerability. For example, sensitivity indicators related to human health include a person's physical condition and any underlying diseases. Adaptive capacity indicators include the awareness of climate change risks, the ability of the household to earn a living, and the community's emergency response capabilities.

In summary, when assessing the risks associated with climate change, hazard emphasizes external meteorological changes (e.g., trends in basic indicators such as weather-related disasters, temperature, and precipitation) and their impact on the assessed object. Exposure focuses on the extent and condition of the assessed object's exposure to these external risks. Vulnerability highlights the internal attributes of the assessed object that determine its ability to adapt to these changes.

5.2 Indicator System Design and Examples

The design of the assessment indicator system is an important yet challenging step in climate change risk assessment. The work demands that practitioners have a strong understanding of the subject matter and the local community, and sufficient experience in conducting assessments. The design of the assessment indicator system is unique; there is no standard template. Below are three examples.



Example 1: Assessment of human health risks associated with high temperatures in A Village.

Risk component	Risk factor		Indicator
Hazard	High temperature		Yearly trend in daily maximum temperature, yearly trend in the number of hot days, yearly trend in summer body temperature, and number of people seeking medical treatment for heat stroke
	Humidity		Yearly trends in summer humidity
Exposure	Population		Number of community residents
	Population distribution		Spatial distribution of community residents
	Exposure of residents to high temperatures		Duration of community members' exposure to outdoor activities in hot weather, sun protection methods used by residents, and capacity of public cooling spaces during summer.
Vulnerability	Sensitivities	Disadvantaged groups	Percentage of the elderly, people with chronic diseases (e.g., cardiovascular diseases)
	Adaptability	Climate change awareness	Interviewees' knowledge of climate change
		Early warning measures	Monitoring the likelihood of high temperatures and methods for notification
		Means for cooling	Number of households with air conditioners, fans, and other means of cooling their homes
		Medical facility	Available facilities for timely medical care for heat stroke, and proximity to residential areas
		Economic capacity	Available community fund for heat stroke prevention and treatment, residents' livelihoods, and incomes
		Organizational capacity	Mobilization strength and cohesion of communities

Example 2: Assessing the risk of drought to the red pear plantation in B Village

Risk component	Risk factor		Indicator
Hazard	High temperature		Trends in annual average temperature, yearly maximum temperature, and number of days higher than 20°C
	Precipitation		Trends in start time of the rainy season, trends in average annual precipitation, and trends in number of days of rainfall
	Humidity		Number of days with less than 40% humidity
	Drought		Number of days and extent of agricultural droughts, volume changes in river flows due to drought
Exposure	Number of red pears		Area size of red pears planted in communities
	Red pear distribution		Location distribution of red pear cultivation
	Red pears exposed to drought		Irrigation and water retention in pear trees
Vulnerability	Sensitivities	Drought tolerance of red pears	Drought tolerance of different red pear varieties in communities
		Probability of drought-induced pests and diseases	Potential impact of drought-induced pests and diseases on red pears
	Adaptability	Early warning measures	Monitoring drought likelihood and notification channels
		Emergency response	Community response to drought, e.g., water tankers, diverting freshwater from other water sources
		Organizational capacity	Mobilization strength and cohesion of communities
		Economic capacity	Resident income levels and community funding for drought response

Example 3: Assessing flood risk to housing

Risk component	Risk factor		Indicator
Hazard	Precipitation		Yearly trend of maximum hourly rainfall, maximum daily rainfall, total annual rainfall, and heavy rainfall days
	Flood and inundation		Damage to houses caused by flooding
Exposure	Number of houses		Number of houses and households in the community
	Housing distribution		Distribution of house locations (density and elevation)
	Exposure of homes to flooding		Distance of houses to the river
Vulnerability	Sensitivities	housing age	Date of construction and condition of houses
		Building materials	Vulnerability of construction materials (e.g., stone, concrete) to washout
	Adaptive capacity	Early warning measures	Monitoring likelihood of heavy rainfall, flooding, landslides; notification channels
		Organizational capacity	Mobilization strength and cohesion of communities
		Economic capacity	Resident income levels and community funding for flood response

Note that the system of assessment indicators varies according to different regions and issues. For example, in some areas, the issue of high temperature is mainly related to the maximum daily temperature, while in others, both temperature and humidity are key factors. Additionally, some areas experience relatively higher night temperatures. Hence, practitioners should design an assessment indicator system based on the specific conditions of their local area.

5.3 Converting Assessment Indicators into a Structured Outline

The system of assessment indicators is straightforward and concise. It is important to convert these assessment indicators into more precise terms to clarify the specific information required for the research. This will involve creating a detailed assessment outline. For example, the mobilization strength and cohesion of local community organizations is a vulnerability indicator for assessment. This can be broken down as the “frequency of survey visits to local residents” and the “level of community cooperation indicated by the presence of organizations such as cooperatives”. Refer to Annex 4 for the sample outlines mentioned above.

Chapter VI.

Collecting and Organizing Basic Information and Meteorological Data



6.1 Organizing Basic Information

Through pre-surveys, clarification of assessment objectives, and the development of an indicator system, the key information required for the assessment can be identified and then be reorganized according to the Hazard–Exposure–Vulnerability assessment framework. It is recommended that this information be compiled into a document, which can later serve as a component of the final assessment report.

6.2 Collecting Meteorological Information

Meteorological information refers to data on past, present, and future climate conditions. This data helps to understand the risks posed by climate change at the local level. It provides insights into basic meteorological characteristics and trends, such as regional temperature and precipitation patterns. Additionally, it indicates the key risks and impacts on the social-ecological systems and human health, as well as projections for future climate changes in the area. This information is categorized under the “Hazard” section of an assessment report.

6.2.1 Characteristics of Historical Regional Climate and Trends

Historical data can be obtained from search engines such as Baidu and Google, official sources (particularly provincial meteorological bureau bulletins), and academic literature, including peer-reviewed studies, research reports, and relevant theses or dissertations. This information helps understand basic climatic characteristics and trends in a specific region, covering temperature and precipitation trends. More specifically, the data can include changes in average, maximum, and minimum temperatures, the number of days with high temperatures >35 °C, average and maximum precipitation levels, and the number of days recording heavy rainfall. If the available information is not current and conclusive, meteorological data could also be obtained from nearby weather stations or latitude/longitude grid points through the National Weather Science Data Center website or the WheatA platform.

In addition, it is important to understand the main types of extreme weather in the region (e.g., heat waves, typhoons, forest fires, thunderstorms, gales, heavy rains, floods, and droughts) as well as their trends in frequency and intensity. For coastal areas, it is also crucial to consider changes in sea level. At the same time, impact analyses based on these weather characteristics and trends, such as their effects on ecosystems, society and economy, and human health, can be gathered through relevant academic or industrial reports.

6.2.2 Regional Climate Projections (optional)

Future climate changes under different climate scenarios in the study region can be investigated through a review of relevant scientific literature and climate projection studies. The assessment should focus on projected changes in key climate variables, including temperature and precipitation, as well as changes in the frequency and intensity of major extreme weather events in the region. Relevant literature can be identified using keywords such as the name of the study region and "climate change." Priority should be given to studies on future climate projections, review articles, and postgraduate theses or dissertations. For guidance on the types of information to collect, refer to the section on "Historical Characteristics and Changing Trends of Regional Climate." Because climate projections are generally available only at regional or larger spatial scales and cannot provide reliable projections at the community level, community-level climate change risk assessments may refer to future climate projection information from the broader region in which the community is located. For China, regional climate information may be organized according to the country's eight geographical regions: North China, Northeast China, East China, Central China, South China, Southwest China, Northwest China, and the Hong Kong–Macao–Taiwan region.

6.3 Analyzing Meteorological Information

Once the basic meteorological data is ready, it is essential to conduct a deeper analysis to identify the specific indicators required for assessment.

This analysis typically involves using time series, which are sets of observations obtained over equally spaced time intervals y_1, y_2, ..., y_N, such as average monthly temperatures and sunspot counts. Time series analysis aims to identify patterns and trends in data collected over time, using these insights to forecast future developments.

Time series data commonly have seasonality, trend, and autocorrelation characteristics. Seasonality refers to patterns that occur over a specific period, such as monthly precipitation data collected over the years, which show similarities during summer. Trend refers to the change in a series over time, such as a gradual increase or decrease in temperature values. Autocorrelation measures how much each point in a series correlates with its previous values; for example, today's precipitation is likely to be correlated with yesterday's volume.

6.3.1 Moving Average

The Moving Average is a simple and widely used technique in the time series analysis for smoothing short-term fluctuations and identifying longer-term trends. It forecasts future values by calculating the average of observations within a fixed-size moving window.

This method involves selecting a window size (e.g., 3,5, or 7 observations) based on the data's characteristics and the objectives of the analysis. The average of the observations within each window is taken as the forecast value, and the window is then shifted forward, typically by one observation, to generate the next forecast. The optimal window size can be determined by comparing the mean squared error (MSE) between the forecast values and the actual observations for different window sizes.

For example, with a window size of 3, the forecast at time t, denoted by $\hat{y}_t$, is calculated as the average of the three preceding observations. The formula is:

$\hat{\mathbf{y}}_\mathbf{t} = (y_{t-3} + y_{t-2} + y_{t-1}) / 3$, where y_t is the observed value at time t.

To apply the moving average method in Excel, arrange the time series data in chronological order and use the AVERAGE function to calculate the average of the observations within each moving window. Repeat the calculation for different window sizes and compute the corresponding MSE values by comparing the forecasts with the actual observations. The window size that produces the lowest MSE is generally selected.

6.3.2 Linear Regression

The Linear Regression is a method used to fit a linear trend to time series data. It enables the calculation of the slope of the line, which represents the trend of change. However, since linear regression assumes a linear relationship between variables, it is less effective for meteorological data, which often exhibits non-linear trends. As a result, linear regression can provide only a rough estimate of the meteorological data trend but is unsuitable for accurate scientific predictions.

Linear regression aims to find the optimal regression coefficients that minimize the difference between the predicted values and actual observations. This is typically evaluated by the "least squares" method.

To perform the analysis, use the smoothed data from the moving average method as input for linear regression to fit a trend line. In Excel, follow these steps:

1. List the time data in one column and the smoothed moving average data (optimal forecast values)in another.
2. Select both columns, go to the "Insert" menu, choose "Chart", and select "Scatter" to generate a time series scatterplot.
3. Right-click on a data point in the scatterplot, select "Add Trendline", and then select the generated trend line.
4. Click the Settings on the right, check "Display Equation on Chart" and "Display R Square Value" to show the regression equation (indicating the rate of change) and the R-squared value (indicating the model's goodness of fit).

In the regression equation, the coefficient of x represents the slope of the linear regression, which indicates the rate of change. The R^2 value measures the model's confidence level, from **0 to 1.** A value closer to 1 indicates a highly reliable model that closely fits the data, while a value closer to 0 suggests a less reliable model with little to no linear trend. Generally, an R^2 value greater than 0.4 indicates that the linear regression model adequately captures the data's trend. Conversely, an R^2 value below 0.4 suggests that the dependent variable y (e.g., meteorological data like rainfall or temperature) does not exhibit a linear relationship with the independent variable x (e.g., time). Annual average temperature often shows a linear trend yearly, whereas annual precipitation tends to fluctuate greatly, typically yielding a lower R^2 value.

6.3.3 The ARIMA Model

The ARIMA model (Autoregressive Integrated Moving Average) is one of the standard approaches used in time series analysis. It has good modelling and forecasting performance but involves relatively complex procedures. It integrates three components: Autoregression (AR), which models the correlation between current and past values; Differencing (I), which stabilizes the series by dealing with the apparent trend or seasonal variation of the data over a long period of time; and Moving Average (MA), which is used to capture random fluctuations in the data.

To perform time series analysis using the ARIMA model in JMP software, follow these steps:

1. Import the time series data into JMP. From the menu bar, select Analyze > Specialized Modeling > Time Series with temperature or other time series data as the Y (dependent) variable and months/years as the X (time) variable.
2. In the time series dialog box, specify the forecast horizon, such as 24 months or 3–5 years. Click OK to generate a time series analysis report.
3. Click the red triangle next to Time Series and choose ARIMA. Use the time series diagnostics to identify suitable ranges for ARIMA parameters. Compare models with different parameter combinations using the AIC (Akaike Information Criterion) to select the model with the lowest AIC for optimal fit.
4. Then apply the selected ARIMA model to predict future values.

Note: The application of ARIMA modeling requires a relatively strong mathematical and statistical background. It is recommended to select and apply this method based on specific assessment needs and objectives.

Chapter VII.

Field Research



Assessment indicators that cannot be obtained through desktop research and analysis of meteorological data generally require field research. This usually involves interviews with local management for macro-community information and with community residents for individual-level information.

7.1 Designing a Questionnaire

The research questionnaire can be structured according to an outline, with two separate questionnaires created for local administration and community residents. Questionnaire design should prioritize simplicity and clarity, avoiding complex or unclear language to ensure respondents can answer questions accurately. It is also important to arrange questions logically, starting with general inquiries and moving to more specific ones. This approach enhances both the accuracy of responses and participant engagement. The questionnaire can be a mix of open-ended and closed-ended questions, with open-ended questions providing richer information and closed-ended questions enabling quantitative analysis.

To ensure the questionnaire design's scientific rigor and validity, it is recommended to conduct a pre-test or pilot test before the formal distribution. This allows for collecting feedback and helps optimize the questionnaire content through small-scale testing. This step helps to identify potential issues and improve the overall design of the questionnaire.

The research questionnaire is designed to cover various aspects of climate change perception and cognition, as well as the impacts of climate change and adaptation behavior. (Refer to Annex 4 for sample questionnaires).

7.1.1 Climate Change Perception and Awareness

The previous section examined regional climate change using meteorological data. However, this regional information serves only as a reference for the research. A questionnaire seeks to better understand local resident perceptions of changes in temperature, precipitation, physical climate, ecology, and other factors in order to capture how climate change is viewed from the local perspective. The findings from this part of the research are crossverified with meteorological data and are included in the “Hazard” section of an assessment report.

At the same time, the questions related to the basic scientific knowledge of climate change can help understand the residents' understanding of the issue. This includes their recognition of climate change as a reality and their awareness of its impacts. Perceptions of climate change can assess how much knowledge respondents have accumulated on the subject, which is part of an assessment report's “Vulnerability” section.

Understanding how community residents perceive and are aware of climate change is important to develop adaptation plans that are acceptable to them. For example, if residents recognize the impacts of climate change but lack relevant knowledge, educational initiatives can be implemented to improve their understanding of the issue.

7.1.2 Climate Change Impacts and Adaptive Behavior

The purpose of this section is to understand the occurrence of local climate hazards and related prevention measures, such as early warning systems, as well as the impacts of climate change on local livelihoods and daily lives. It also aims to assess residents’ capacity to cope with climate change, their willingness to participate in climate adaptation, and their suggestions for adaptation measures.

The impacts of climate change correspond to the “Hazard” section of the assessment report. These questions help identify the pathways and specific aspects through which the assessed system is affected by climate change. In practice, practitioners can establish rapport with interviewees by discussing how climate change has affected local residents.

Residents’ capacity to cope with climate change corresponds to the “Vulnerability” section of the assessment report and mainly refers to the existing coping measures adopted by community members. The willingness to participate in climate adaptation and residents’ suggestions for adaptation measures provide an important foundation for designing future adaptation strategies. These questions are critical for understanding whether residents are willing to engage in climate adaptation efforts and for incorporating their perspectives into adaptation planning.

7.1.3 Community Economic Activities and Income

The “Vulnerability” section of an assessment report contains information about community economic activities and income. The section provides information on a community’s economic situation from the perspectives of local government and residents. The main focus of the research is to conduct interviews with governments to understand the local pillar sectors and the economic income level. It is also important in this section to analyze the impacts of climate change on the pillar industries and the economic adaptive capacity of the local residents. The research also seeks to further explore ways to enhance the climate adaptive capacity of local residents by improving the resilience of economic activities and livelihoods.

7.1.4 Household Livelihood Capital

This section forms part of the “Vulnerability” assessment. Based on the Sustainable Livelihoods Framework, information on local households’ livelihood assets, including human, physical, natural, financial, and social capital, should be collected to assess their adaptive capacity and identify approaches for strengthening livelihood resilience under climate change.

Human capital	refers primarily to labor availability, as well as individuals’ knowledge, skills, and abilities. These factors influence households’ capacity to pursue livelihood strategies and achieve their livelihood goals.
Physical capital	includes infrastructure and productive assets, such as housing, transportation facilities, and production tools. These assets help meet basic needs and support livelihood activities.
Natural capital	refers to natural resources and ecosystem services, including land, water, forests, and biodiversity. These resources provide the foundation for livelihood activities and are essential for sustaining livelihoods.
Financial capital	refers to economic resources available for achieving livelihood goals, including cash income, savings, insurance, and other financial resources. Financial capital plays an important role in supporting economic activities and enabling households to cope with risks.
Social capital	refers to social resources, including networks, relationships, trust, and forms of social support. Social capital strengthens household livelihood capacity by facilitating access to information, assistance, and opportunities for cooperation.

7.1.5 Traditional Culture, Knowledge, and Indigenous Wisdom

Understanding the local traditional culture, especially the traditional wisdom for coping with these severe weather hazards, is an essential aspect of their experiences in adapting to challenges. This component is part of the “Vulnerability” section of an assessment report. Additionally, it is important to learn more about their cultural understanding of the relationship between humans and nature, as well as their traditional knowledge about local agricultural activities based on solar terms. This will boost respondent confidence in the local philosophy of harmony between humans and nature. It will also encourage them to design climate change adaptation programs by integrating traditional culture, knowledge, and local wisdom.

7.1.6 Local Climate Risk Management Systems

The current local climate change adaptation measures and risk management systems, such as early warning systems, constitute a key aspect of the “Vulnerability” section of an assessment report. A research site equipped with an early warning system for climate hazards demonstrates a stronger capability to handle disasters. Interviews with local residents generally reveals their awareness of the risk response systems in place for the community, as well as their historical effectiveness in helping the community, and whether the early warning system requires further optimization.

7.1.7 Willingness to Participate in Adaptation Actions and Recommendations

Understanding the recommendations from local stakeholders regarding climate change adaptation actions, as well as designing adaptation programs based on these recommendations, is a key component of the “Community Participation and Awareness Survey” section of an assessment report. This process involves assessing the engagement and willingness of local governments, NGOs, other organizations, and individuals to participate in climate change risk management and identifying possibilities for collaboration. This information will be particularly valuable for the future design and implementation of adaptation programs.

7.2 Conducting Field Interview

Before conducting field interviews, prepare the necessary materials, including questionnaires, satellite map tools (such as “91 Weitu Assistant,” which can be used to view local satellite imagery, understand the distribution of communities and natural resources, and plan interview routes), GPS tools (for recording the coordinates of interview locations), and blank paper for participatory rural appraisal (PRA) mapping.

Before starting fieldwork, it is recommended to conduct preliminary sampling to select interview participants based on factors such as age groups or spatial distribution.

For age-based sampling, participants can be selected proportionally according to the composition of young, middle-aged, and older residents. For spatial sampling, participants can be selected by drawing concentric circles outward from the village center and identifying residents from different areas. Appropriate sampling methods help ensure that the information collected is more accurate, representative, and reliable.

During field interviews, it is important to establish good communication and trust with participants and to maintain a people-centered approach. When approaching unfamiliar community members, participants may initially be cautious. Researchers should begin conversations with topics related to everyday life, introduce the purpose of the visit, and obtain consent before proceeding with the interview.

Field notes are an important tool for recording field observations and data. They help researchers record environmental changes. When writing field notes on social processes and related events, the following approach should be followed:

1. **Record basic elements:**

   Field notes should include information about the physical environment, such as time and location, as well as the participants' social context information such as behaviors, interactions, and roles. These basic elements help provide a clear context for subsequent analysis.

2. **Use everyday language:**

   When recording, try to use everyday language and avoid subjective inference or interpretation to ensure objectivity of the record. If explanatory material is required, it can be enclosed in brackets to distinguish fact from subjective opinion.

3. **Recording in different levels:**

   Field notes can be divided into two stages: shorthand and detailed notes. Shorthand notes are captured quickly, while detailed notes are collated and supplemented after leaving the scene to ensure the completeness and accuracy of the record.

4. **Combine observation and reflection:**

   While recording observations, workers should maintain the habit of reflection and record personal reflections. This not only helps capture unnoticed phenomena, but also provides richer insights for subsequent analysis.

5. **Timely organization and reflection:**

   Field notes should be organized and reflected upon at the end of each day to ensure that the information is continued and complete. At the same time, researchers should review their notes regularly to identify potential omissions or new research directions.

For questionnaire collection, a self-completion approach can generally be used, allowing greater flexibility during the interaction. If sufficient personnel are available, one person can conduct the interview while another records the responses. With the participant's permission, audio recordings are recommended as a supplementary record to support later review.

When researchers first enter a community, they often need to absorb a large amount of new information. During this initial stage, interviews can be conducted in greater depth and sufficient time should be allocated to gain a comprehensive understanding of local conditions. After approximately 10–20 completed questionnaires, researchers usually develop a preliminary understanding of the community. At this stage, the interview process can be adjusted, with greater attention given to information that differs from previous understanding or initial assumptions. Throughout the fieldwork process, original questionnaires should be carefully retained, and daily field notes should be recorded to document key information obtained from interviews. These records will facilitate future review, analysis, and knowledge sharing.

PRA mapping is generally conducted through focus group discussions, which provide a participatory approach for community members to share their knowledge and experiences on specific topics. Before conducting a focus group discussion, researchers should clearly define the purpose and key themes of the discussion. Participants should then be selected according to the objectives of the assessment, ensuring diversity and representation among different groups, including people of different genders, ages, and occupational backgrounds.

Focus group discussions are usually conducted in an informal setting to encourage participants to express their views openly. During the discussion, the facilitator should guide the conversation, maintain focus on the topic, and avoid joining debates or expressing personal opinions that could influence participants' responses. A designated recorder should document key information during the discussion. The entire focus group discussion should ideally last approximately 30–40 minutes.



7.3 Data Analysis of Field Interviews

7.3.1 Quantitative Analysis

In general, statistical analysis (such as percentages and rankings) can address the basic needs of questionnaire analysis. However, comparative analysis is necessary to compare differences between two samples. Additionally, correlation analysis is required to assess whether a relationship exists between two factors.

7.3.1.1 Comparative Analysis

This analysis is used to determine whether statistically significant differences exist among diverse samples, such as differences in climate change perceptions among residents with various ages and education levels.

The method uses t-tests to compare differences in means between two independent samples, and analysis of variance (ANOVA) can be used to compare differences in means across multiple independent samples.

Before comparing sizes, it is usually necessary to conduct a normality test. This can be done using the one-sample Kolmogorov-Smirnov (K-S) test in SPSS, found under the menu path: "Analyze > Nonparametric Tests > One-Sample K-S". If there is no correlation basis, it can be assumed that the data is normally distributed, allowing for a t-test to assess the results, and a normality test can be performed afterward if needed.

To perform a t-test in Excel, the t.test() function can be used. The syntax is as follows: =T.TEST(array1, array2,tails,type). In this function, "array1" indicates the value range or data range of sample 1, while "array2" represents the data range for sample 2. "Tails" specifies whether a one-tailed or two-tailed test is conducted: a value of 1 indicates a one-tailed test, while a value of 2 indicates a two-tailed test. "Type" is an optional parameter that specifies the type of a t-test: 0 indicates the use of a paired test, 1 indicates the use of a t-test with unequal variances for two samples, and 2 indicates the use of a t-test with equal variances for two samples. A one-tailed test is used when one sample is greater than or equal to (or less than or equal to) the other sample. If this condition is met, the one-tailed test is preferred as it assists to improve the confidence level of the results. Paired testing is used when there is a one-to-one correspondence between two samples. For example, if the same respondents are interviewed before and after a project to assess their changes in perception of climate change. In that case, a paired test is preferred, as it helps to improve the confidence level of the results.

Before conducting an analysis of variance in Excel, the Analysis ToolPak must first be activated. Follow these steps: click on "File > Options > Add-Ins" in the menu, click on "Go", then check the box for "Analysis ToolPak", and click "OK". And then perform an analysis of variance in the menu bar "Data > Data Analysis". After activation, ANOVA can be conducted by navigating to "Data" in the menu bar and selecting "Data Analysis". If the P-value is less than 0.05, a significant difference exists between the samples with a 95% confidence interval.

7.3.1.2 Correlation Analysis

The main purpose of correlation analysis is to analyze the relationship between two variables, such as the correlation between temperature and the prevalence of cardiovascular disease.

To achieve this, use the CORREL() function in Excel by selecting two sample data sets. If the return value is closer to +1 or -1, it indicates a stronger positive or negative correlation between the two data sets. Conversely, the closer the value is to 0, the weaker the correlation. Generally, a correlation coefficient with an absolute value greater than 0.7 indicates a strong correlation.

7.3.2 Qualitative Analysis

7.3.2.1 Respondent Profiles

A respondent profile is developed by integrating information collected from research participants and selecting representative cases, such as young college graduates returning to their hometowns or elderly residents who have spent their entire lives in villages. These profiles describe typical characteristics of the population and provide an illustrative representation of residents' actual and common living conditions. Relevant content may include demographic characteristics, living situation, and other key information pertinent to the questionnaire.

For example, a researcher interviewed a 49-year-old herder, Uncle Xiang, who is currently living in a Chinese township. He previously enjoyed the freedom of a herder's life but later moved to a larger town due to a decline in livestock numbers and the need to provide better educational opportunities for his children. Currently, he makes a living mainly by harvesting and selling cordyceps (a fungus with medical value), earning approximately 6,000 to 7,000 RMB per year. He also owns eight yaks. His annual expenses are close to 10,000 RMB, and he still owes about 5,000 to 6,000 RMB. When asked what he would do if cordyceps resources were to also decline, he simply took off his hat to show his gray hair and replied, "There is nothing I can do; I am an old man now." He has noticed that winters are becoming warmer, with reduced snowfall, and that river flows and the snow on hilltops have decreased. However, he has not observed any significant changes during summer. Despite these environmental changes, he believes that the overall surrounding environment has improved due to improved waste collection and cleanliness, and that grass is growing better. Uncle Xiang is a typical resident who relocated from a village to a township. His income is low and unstable, leaving him with few other options. He has some awareness of climate change, but further interviews are needed to better understand his views.

This section can be presented as an independent chapter to illustrate the broader context of local livelihoods and culture or incorporated into the "hazard–exposure–vulnerability" framework as narrative evidence.

7.3.2.2 Word Cloud Analysis

> The Word cloud analysis is a visualization technique that displays keywords from textual data based on frequency or significance, creating an image where words are the primary elements. Word clouds effectively highlight key terms, themes, and insights within the data.

For operations, Python libraries like Jieba for word segmentation and WordCloud for generating word clouds can be used to segment words, calculate word frequencies, and produce word cloud maps. Alternatively, one can use a Tableau or other data visualization platforms for word cloud creation and analysis.

Chapter VIII.

Integrated Assessment and Analysis



8.1 Integrated Hazard-Exposure-Vulnerability Framework Analysis

This section conducts an integrated assessment based on the Hazard–Exposure–Vulnerability framework. It first analyzes the three components—hazard, exposure, and vulnerability—by describing the relevant indicators for each component. Each component is described in detail, with specific indicators used for assessment. After that, a synthesis of the three components highlights its key information. Since it is difficult to apply a unified quantitative evaluation standard (e.g., standardized indicators or monetary values), a qualitative integrated assessment is often the only feasible approach for drawing comparative conclusions. The section also explains the factors influencing the evaluation outcomes and provides supporting evidence for the assessment results.

The **Hazard** analysis focuses on the impact and evolving nature of climate risks. It identifies the main types of climate risks affecting the local area and assesses their likelihood, intensity, duration, and trends. Additionally, it describes the historical impacts of climate hazards on the region and provides a comprehensive assessment. For an example of a hazard assessment, refer to the table below.

Table 8.1 A hazard assessment

Primary indicators	Secondary indicators				Overall assessment
Hazards	Types of hazards	High Temperature	Drought	...	
	Likelihood				
	Intensity				
	Duration				
	Trends				

The **Exposure** section focuses on the magnitude of the assessed elements potentially affected by climate change. For instance, in assessing climate change risks to human health, key indicators include the total population and the size of vulnerable populations, such as older adults and individuals with pre-existing health conditions. In assessing climate change risks to agriculture, exposure is characterized by the area of agricultural land and the cultivated area of different crop types. Specific indicators vary based on the objectives of the assessment and local context.

Table 8.2 An exposure assessment

Primary indicators	Secondary indicators		Overall assessment
Exposure	Population density	e.g., population and building clusters with high density	
	Productive and economic activities		
	...		

The **Vulnerability** section explores the sensitivity and adaptive capacity of the assessed elements. It examines factors such as the aging local population, economic structure and infrastructure vulnerability, public perception and understanding of climate change, existing adaptation measures, and available resources or capacity.

Table 8.3 A vulnerability assessment

Primary indicators	Secondary indicators			Overall assessment
Vulnerability	Sensitivities	Sensitive and vulnerable groups	e.g., Aging population; large proportion of vulnerable groups	
		Economic vulnerability		
		Infrastructure vulnerability		
	Adaptive capacity	Social organizations and financial resources		
		...		

8.2 Impact Chain Analysis

An impact chain analysis traces the cascading impacts of climate change on a community system, illustrating causal relationships (see Figure 8.1). The approach focuses on the factors that have the greatest influence on the system, identifying critical effects and key areas of concern.

The mapping process starts by identifying key local risk elements and hazard types, analyzing their causes, and outlining potential impacts on community elements (e.g., water supplies and crops). It then assesses the community's vulnerability, considering sensitivity and adaptive capacity, and finally integrates these factors into an overall assessment of local climate risks.

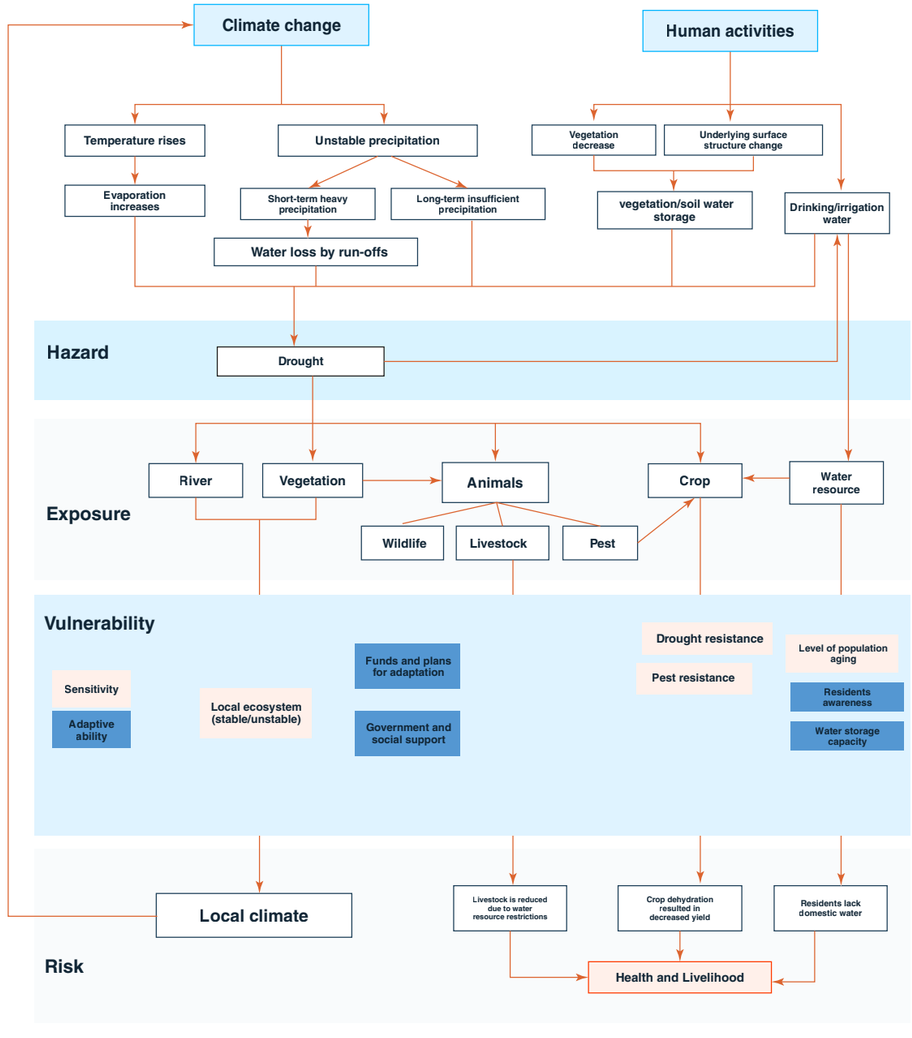


Figure 8.1 Diagram of impact chain analysis

8.3 “Pressure-State-Response” Analysis

Like Impact Chain Analysis, the “Pressure-State-Response (PSR)” framework is also grounded in causal relationships. However, while Impact Chain Analysis provides a comprehensive assessment that incorporates information related to hazards, exposures, and vulnerabilities, PSR analysis focuses on an in-depth examination of a specific issue.

To conduct a PSR analysis, the first step is to define a specific topic, such as the impact of drought on the red pear farming industry in Yanta Village. The next step is to identify and quantify the factors that exert pressure on the environmental or social system, which may originate from human activities, climate change, or other drivers. The current state of the assessed system is then evaluated to understand how it responds to these pressures. In the example shown in Figure 8.2, the state change represents the impacts of drought on the red pear industry. Finally, based on the assessment of pressures and states, appropriate response measures are developed to reduce impacts of pressures, improve system conditions, and enhance adaptive capacity. These response measures are indicated by the blue lines in the figure.

The Pressure-State-Response (PSR) analysis helps practitioners conduct in-depth analyses of specific issues, identify key influencing factors and causal pathways, and explore targeted and feasible response options. It is particularly useful for detailed, issue-specific analysis and for developing climate change adaptation strategies.

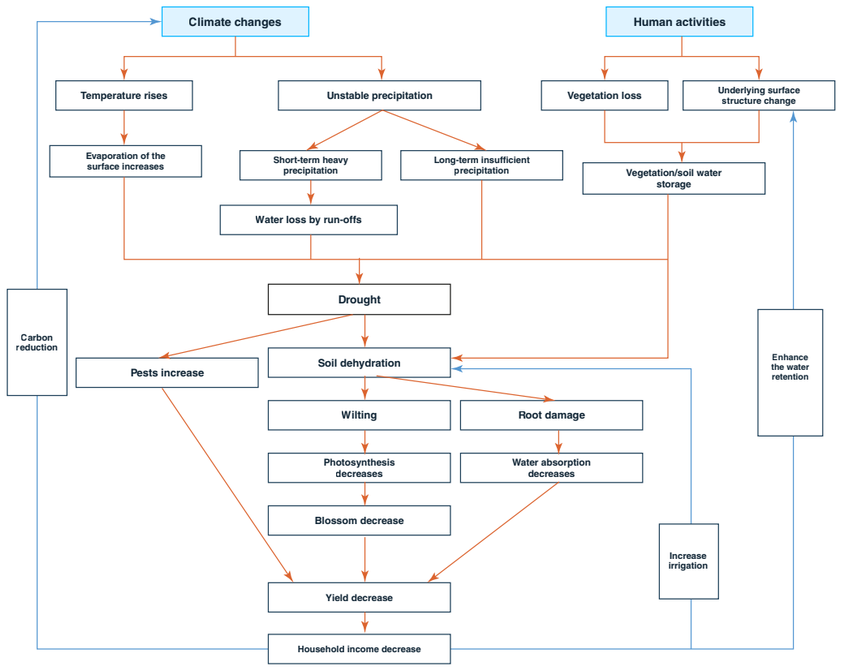


Figure 8.2 Diagram of “Pressure-State-Response” Analysis.

Chapter IX.

Recommendations for Adaptation



9.1 Overview of Adaptation Planning

To enhance resilience against adverse climate impacts, adaptation strategies can be developed for different areas, including water resources, agriculture, building safety, and vulnerable populations. For water management in arid areas, adaptation measures can focus on water conservation, storage, and efficient use, including rainwater storage systems, improving soil quality to enhance water retention, and optimizing irrigation methods. For agriculture, measures can include selecting climate-suitable crops and more resilient varieties. For buildings, enhancing thermal insulation and improving drainage systems can improve safety. For vulnerable communities, adaptation measures can focus on strengthening livelihoods and community-based support networks.

The AIL (Adaptation, institutions, and livelihoods) framework categorizes adaptation strategies for livelihoods into five types: mobility, storage, livelihood diversification, community support, and market exchange. Mobility involves adjusting risk exposure through spatial movement, such as relocation and rotational grazing. Storage focuses on reducing risks over time by maintaining reserves, such as storing food, water, or livestock fodder. Livelihood diversification boosts economic resilience through additional income sources, such as crafting and selling handicrafts or expanding tourism services. Community support enhances collective resilience through cooperation, such as sharing labor and weather information, or joint farming efforts. Market exchange increases disaster resilience through market-based mechanisms, such as land leasing or purchasing additional food or fodder for livestock.

Adaptation approaches can improve resilience to climate shocks by upgrading infrastructure. Meanwhile, educational campaigns can raise resident awareness and foster their proactive attitudes toward climate adaptation. Long-term planning for water resources, agriculture, and livelihoods can also help communities gradually adjust to changing climate conditions.

> This section seeks to inspire ideas for adaptation. Specific plans should be tailored to local contexts, incorporating residents' insights and trusting local wisdom.

9.2 Designing an Adaptation Plan

Adaptation plans are the culmination of climate change risk assessments in rural communities, built on a comprehensive understanding of local situations through data collection and analysis. These plans are developed using various project tools with examples followed, such as logic tree and prioritization matrix. Initially, all possible adaptation options are identified and narrowed down using tools like prioritization matrices to select the most suitable ones. Next, an in-depth analysis is conducted on the selected options, which are ultimately compiled into a comprehensive report or presented through a community forum.

9.2.1 Identifying All Possible Adaptation Options

Identify the key challenges faced by the local community due to climate change, such as, for example, droughts threatening pear orchard yields, the safety of water resources, and increasingly severe weather events such as heavy rainfall. Response measures for these risks are organized in a logic tree, a hierarchical tool that structures broad adaptation strategies into specific actions. The upper levels of the tree outline broad categories of adaptation measures (e.g., raising awareness of prevention), while the lower levels detail specific actions (e.g., workshops on climate change topics).

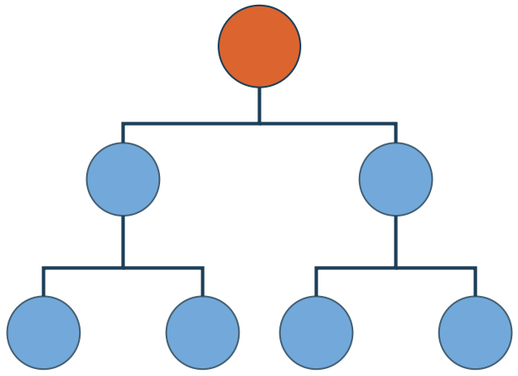


Figure 9.1 Logic tree concept map

Enumeration can leverage impact chain analysis, a systematic approach to identify causal relationships and influence paths within complex problems. Tracing and analyzing correlations between elements help pinpoint root causes, identify main factors, and propose practical solutions. For example, applying impact chain analysis to major local industries, for instance, cash crop production, allows for a comprehensive assessment of climate change impacts across the entire industrial chain- from seed germination and growth to harvesting, transportation, and marketing- enabling the development of feasible adaptation measures.

9.2.2 Prioritizing Solution Options

To prioritize adaptation measures, create a two-dimensional prioritization matrix evaluating feasibility and importance. Each adaptation measure is then plotted in the matrix to identify high-priority actions.

Feasibility

Feasibility should consider local resources, capacities, and alignment with local development plans,

Importance

while importance should reflect the adaptation measure's ability to address key risks and its urgency.

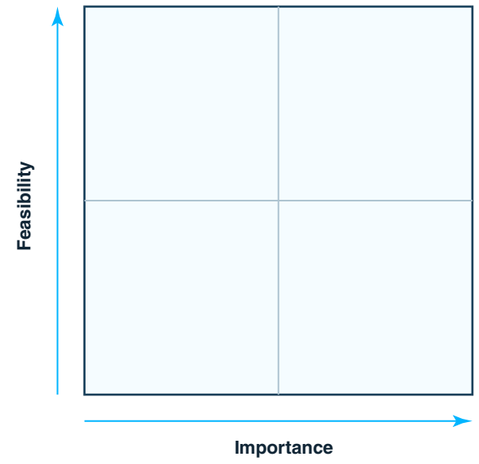


Figure 9.2 Diagram of the Prioritization Matrix

In addition to importance and feasibility, practitioners can tailor the prioritization matrix by incorporating institutional needs or adding dimensions like organizational resources, program requirements, or other relevant factors.

9.2.3 Defining Topics

Select one high-priority adaptation measure for in-depth analysis. Use a problem definition sheet to examine the issue's context, stakeholders, constraints, success factors, and boundaries, clarifying specifics of implementation plans for the selected measure.

<table>
<tr><td colspan="2">Problem definition sheet</td></tr>
<tr><td colspan="2">Define the issue</td></tr>
<tr><td colspan="2">To define this topic, pay attention to following SMART principles (specific, measurable, attainable, relevant, time-bound).</td></tr>
<tr><td>Background</td><td>Decision-maker</td></tr>
<tr><td rowspan="2">Clearly describe the current situations and causes and context.</td><td>The person who decides whether to implement the project.</td></tr>
<tr><td>Stakeholder</td></tr>
<tr><td></td><td>Persons who can affect the project execution.</td></tr>
<tr><td>Successful factors</td><td>Constraints</td></tr>
<tr><td>Factors that measure the success of a project</td><td>Main restrictions faced by the project.</td></tr>
<tr><td colspan="2">Boundaries of the issue</td></tr>
<tr><td colspan="2">What are included and excluded in the project</td></tr>
</table>

Figure 9.3 An example of a problem definition sheet

9.2.4 Focus Group Interviews for Solutions

After identifying priority topics and shortlisting adaptation options, organize focus group interviews with community administrators and residents. Moderators guide discussions on the selected options, taking the community's feedback into account, and formulate final decisions.

9.2.5 Project Presentation

Begin with a clear and compelling headline, followed by a concise introduction of background and key stakeholders to engage the audience in a particular scenario. Conclude the introduction by highlighting the challenges and crisis of that scenario.

Next, delve into the problem's complexities and propose feasible solutions. Start by presenting local needs identified through questionnaires and interviews, followed by the project's core solutions. Clearly articulate the project's value and provide a detailed implementation plan.

Finally, outline the next steps with measurable indicators and summarize the project's significance and anticipated benefits. For a detailed sample report outline, refer to Annex 4 "Outline of a Climate Change Risk Assessment Report".



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This guide was informed and drew upon several previous research reports and community-based studies, including:

1. *Climate Change Vulnerability Assessment and Risk Analysis of Shunde Community in Foshan, Guangdong 2020*, jointly developed by the Harmony Community Foundation and the Chinese Academy of Agricultural Sciences;
2. *Research and Analysis on Climate Change Awareness of Community Residents in the Pearl River Delta (PRD) Region - A Case Study of Guangzhou, Foshan and Shenzhen*, developed by the Harmony Community Foundation with support from the Vanke Foundation;
3. *Research on Drinking Water Quality of Villagers in Jianping County, Chaoyang , Liaoning*, conducted by the "Embrace the Countryside" Practice Team of Dalian University of Technology with support from the MyH2O Information Platform;
4. *Research on Climate Change Vulnerability in the Sanjiangyuan Region: A Case of Tuanjie Village, Qumalai County, Qinghai*, developed by Hangzhou Lyu with support from the Roots and Shoots Changfeng Project;
5. *Climate Change Perception and Adaptation of Herders on the Tibetan Plateau* written by Shan Shui Conservation Center.

We would like to express our sincere appreciation to all organizations and authors whose work contributed valuable insights and experiences to the development of this guide.

Annex 1: The Hazard-Exposure-Vulnerability Framework

1. Contexts

Since the Industrial Revolution, human activities have released vast amounts of greenhouse gases, such as carbon dioxide and methane, accelerating rising global temperatures and driving climate change. Climate change profoundly affects ecosystems, socio-economic development, human health, and sustainability, posing a critical global challenge.

To address this issue, the international community must assess climate change risks to develop effective policies and strategies. The Hazard-Exposure-Vulnerability framework was developed in response to the need for comprehensive climate change risk assessment and sustainable development. The framework emphasizes assessing the risks faced by communities or regions and their vulnerability and adaptive capacity.

Key factors shaping the framework's development include:

Complexity of climate change	Human-induced greenhouse gas emissions since industrialization have triggered rising global temperatures and altered the Earth's climate system. The multifaceted nature of climate change demands an integrated approach to assess its impacts and risks.
Multidimensional risks	Climate change impacts ecosystems, socio-economic development, and public health, creating risks across natural, social, and economic sectors. Therefore, a framework that considers these diverse factors is essential for comprehensive risk assessment.
Sustainable Development Goals (SDGs)	Achieving global SDGs requires integrated approaches to assess the impacts of climate change on the sustainability of communities and nations. This includes assessing risks, vulnerabilities, and adaptive capacity.
Policymaking needs	Policymakers need scientific, systematic, and integrated information to develop appropriate climate policies and response strategies. A framework capable of systemically assessing risks and vulnerability is essential for informed decision-making.

In summary, the Hazard-Exposure-Vulnerability framework addresses the extensive impacts of climate change on society, environment, and economy. It enables a better understanding and assessment of risks, informing policymakers and planners with comprehensive information to develop effective climate policies and response strategies.

2. Introduction to Framework Development

The Hazard-Exposure-Vulnerability framework evolved gradually through efforts to develop integrated approaches for assessing the impacts of climate change.

Its development spans several key stages:

Early Research and Understanding (Early to Mid-20th Century)	During the early to mid-20th Century, scientists began exploring climate change impacts on ecosystems, socio-economics, and human health. Although the Hazard-Exposure-Vulnerability framework did not exist yet, foundational concepts such as natural hazards and social vulnerability emerged in research.
Rising International Attention (Late 20th Century)	The establishment of the United Nations Framework Convention on Climate Change (UNFCCC) and growing global awareness heightened attention to the threats of climate change to society and the environment. The international community began to seek comprehensive approaches to assess these risks and formulate effective policies and strategies.
Emphasis on Vulnerability and Adaptive Capacity (1990s to Present)	As climate change gained global attention in the 1990s, emphasis shifted toward understanding community and national vulnerability and adaptive capacity. Researchers began to integrate the elements of hazard, exposure, and vulnerability into a comprehensive framework for assessing climate change risks.

International Organizations and Policies as Driving Forces (21st Century)	Climate change became a priority on the global agenda in the early 21st Century. International organizations and policymakers increasingly adopted the Hazard-Exposure-Vulnerability framework to evaluate climate change risks and vulnerabilities and formulate appropriate response strategies and policies. The framework was first explicitly articulated in the IPCC's Fourth Assessment Report (2007), where hazard, exposure and vulnerability were established as key concepts in climate change risk assessment. Since then, it has been widely applied and refined across disciplines, becoming more comprehensive and practical.

3. Advantages and Disadvantages

The Hazard-Exposure-Vulnerability framework has the following strengths and weaknesses in assessing climate change risks to communities:

3.1 Advantages

Comprehensiveness

The framework organizes climate change risk assessment around three key elements—hazard, exposure, and vulnerability—enabling multidimensional assessments. This approach deepens understanding of climate change complexity by integrating social, geographical, and economic factors alongside climatic impacts.

Guidance for policymaking

The framework provides policymakers and decision-makers with valuable insights for formulating climate change adaptation and mitigation policies. By assessing hazard, exposure and vulnerability, policymakers can develop tailored policies to reduce risk and vulnerability.

Data-driven assessment

The framework employs scientific data and quantitative analysis, ensuring objective, comparable, and comparable assessment of risks and vulnerabilities across different regions and communities.

Worldwide recognition

Widely recognized by the international community, the framework serves as a commonly used methodology for assessing climate change risks. This consensus facilitates global collaboration among nations and organizations to advance climate policies.

3.2 Disadvantages

Complexity

The framework's comprehensive nature demands extensive data and analysis. This may increase the time and cost of assessments.

Data insufficiency

In some cases, particularly in developing countries or remote areas, limited access to the data necessary to quantify risk, exposure, and vulnerability may be limited or unavailable.

Subjectivity

Certain aspects, such as assessing community vulnerability, may be influenced by subjective judgments and therefore vary among different evaluators.

Flexibility

The framework's standardized approach may require modifying to account for unique local conditions, ensuring accuracy and applicability of the assessment.

Omitted factors

The framework may overlook complex interactions or future uncertainties, resulting in underestimated risks.

Overall, the framework provides a systematic approach to assessing climate change risks. However, its practical application requires careful consideration of its strengths and limitations to ensure valid and reliable outcomes.

4. Future Directions

The Hazard-Exposure-Vulnerability framework presents significant opportunities and challenges for assessing climate change risks to communities:

4.1 Opportunities

Technological advances

Ongoing technology advancements will improve data collection, modeling, and analytical capabilities, resulting in higher accuracy in assessing exposure, sensitivity, and adaptive capacity. New technologies such as remote sensing, artificial intelligence, and big data analytics enable the collection of comprehensive information to support more precise assessments.

Data sharing

Increased international cooperation and data sharing will better address data deficiencies. With more active data sharing, methods, and experiences, countries and organizations can enable broader participation in climate change risk assessment.

Policy integration

Integrating the "Exposure-Sensitivity-Adaptive Capacity" framework with the broader policy landscape, such as the Sustainable Development Goals (SDGs), fosters holistic solutions and ensures multi-dimensional policy development processes.

Stronger public awareness

Increasing global awareness of climate change increases societal focus on climate risks. The trend will bolster support for the application of the framework and the implementation of policy.

4.2 Challenges

Complexity and resource availability

The framework's comprehensive approach may require significant time investment, resources, and expertise. The complexity and high cost of data collection, analysis, and interpretation can pose barriers throughout the assessment process.

Data gaps

In some communities and regions, limited access to reliable data hinders accurate assessment of risks, exposure, and vulnerability. Insufficient data may lead to inaccuracies in assessment results.

Uncertainty

Climate change is a complex system with future uncertainties. The framework may not adequately account for these uncertainties, leading to greater uncertainties in assessment results in the long term.

Applicability

The framework's standardized structure may require adjustments according to local contexts, ensuring relevance and accuracy across diverse communities and regions.

Community engagement

Effective community participation in assessments and decision-making processes faces challenges, including language barriers, information sharing issues, and power imbalances.

Overall, the framework holds substantial potential to guide communities in assessing climate change risks. However, leveraging its opportunities and addressing its challenges are critical to the implementation, ensuring the effectiveness and reliability of assessments.

4.3 Future development

To enhance the Hazard-Exposure-Vulnerability framework for community-based climate change risk assessment, its strengths, weaknesses, opportunities, and challenges suggest the following directions:

a) Improving data collection and analysis

- **Strength:** The framework's reliance on scientific data and quantitative analysis can be further strengthened by adopting more precise and comprehensive data collection and analysis. These improvements would reduce uncertainties in risk assessments.
- **Challenge:** In regions with limited data, modern technologies such as remote sensing, drones, and geographic information systems (GIS) could be leveraged to obtain more quality data.

b) Incorporating uncertainty

- **Challenge:** To better anticipate risks, the framework could integrate uncertainties inherent in climate change and consider possible development pathways and scenarios.

c) Expanding Applicability

- **Strength:** The framework's comprehensiveness allows it to be applied across diverse communities and environments. Further improvements could broaden its applicability across diverse geographic, cultural, and social contexts.

- **Challenge:** Ensuring the applicability of the framework across regions requires customizing methodologies and indicators to account for distinct local conditions.

d) Strengthening community participation

- **Opportunity:** More effective approaches should be explored to promote community participation, including training, information sharing, and participatory decision-making mechanisms.

- **Challenge:** Language barriers, power relations, and information sharing may challenge community participation.

e) Scenario analysis and policy recommendations

- **Opportunity:** In the future, the framework could be applied to scenario analysis to assess the impact of different policies and adaptation strategies on risk management.

- **Challenge:** Ensuring the validity and reliability of scenario analyses and translating assessment results into practical policy recommendations can be challenging.

f) Integration of socio-economic dimensions

- **Opportunity:** As the framework currently focuses on climate and environmental factors, it can integrate socio-economic dimensions more thoroughly, considering factors such as population, economic activity, and social structures.

- **Challenge:** Integration of socio-economic dimensions can increase analytical complexity and require consideration of different factors.

In summary, the Hazard-Exposure-Vulnerability framework can be developed to improve climate change risk assessment by enhancing data quality, reducing uncertainty, encouraging community participation, advancing scenario analysis, refining policy recommendations, and integrating socio-economic dimensions. These developments can provide stronger support to community-based adaptation and mitigation strategies.

5. Application of the framework in rural climate change risk assessment

For examples of applications of the Hazard-Exposure-Vulnerability framework in rural climate change risk assessment, please refer to the survey outline below:

Survey Outline: Climate Change Risk Assessment in Rural Communities

(1) Community Overview

Conduct background research on the community for a preliminary understanding and initial assessment.

1. **Profile**
   - Name and location
   - Size and composition of population (by age, gender, occupation, etc.)
2. **Economic condition**
   - The community's primary sources of income or livelihood (agriculture, industry, service industry, etc.)
   - Primary economic resources within the community
3. **Infrastructure**
   - (school, hospital, transportation, water supply, power grid, etc.)
4. **Ecology**
   - natural environmental features (river system, ecosystem, natural resources, etc.)
5. **Topography**
   - topographic and geomorphic features (elevation, landform, etc.), and land use
6. **Climate types and characteristics**
   - average annual precipitation and precipitation distribution, etc.
7. **Main types of climatic hazards**
   - drought, flood, etc.
8. **Community education and health**
   - educational institutions and healthcare facilities.
9. **Community organizations and governance**
   - village committees, neighborhood or residents' committees, community liaison or outreach workers, volunteer groups, farmers' associations, and other community-based organizations.
10. **Development plans for the community**
    - released plans or draft documents.

(2) Hazard assessment

Identify the major types of hazards facing the community, assess the likelihood and potential severity of each hazard, and assess its impact on the community. Refer to historical data and make scientific projections.

1 Disaster type and frequency

- Identify and describe past disasters: earthquake, flood, storm, fire, etc.
- Analyze historical data for natural and human-caused disasters to determine their frequency and patterns.

2 Spatial and temporal distribution

- Analyze past disaster events' spatial and temporal patterns to pinpoint high-risk zones and peak periods within the community
- Examine how hazard impacts vary across seasons and geographic areas to identify distribution trends

3 Scale and scope

- Assess the scale and scope of past disasters, including casualties, property damage, ecosystem destruction, etc.
- Assess potential changes in disaster scale, considering emerging hazards and their possible consequences

4 Trends and projections

- Analyze trends in past disasters and evaluate how climate change may affect future disaster frequency, and make projections
- Explore the possible future impact of climate change or other related factors

5 Potential compound disasters and cumulative effects

- Investigate risks of compound disasters arising from multiple hazards occurring simultaneously or sequentially
- Analyze the interactions and aggregated impacts of various disasters to determine their combined effects on the community
- Consider the cumulative effects of disasters in the long term

6 Emerging disaster types

- Identify potential new hazards, such as those triggered by climate change or emerging technologies.
- Explore the potential impacts and challenges these new types of hazards may pose to the community in the future

7 Climate Trends

- Analyze climate trends in the community's area, including changes in temperature, precipitation, and sea level rise

8 Local impacts of climate change

- **Ecosystem:** Assess the impacts of climate change on local ecosystems, such as altered vegetation cover or declining biodiversity
- **Natural resources:** Examine the impacts on natural resources within the community, such as water scarcity and land degradation
- **Agriculture and other industries:** Analyze impact on agriculture and major industries, such as declining crop yields or fisheries
- **Economy, financial and social systems:** Analyze broader consequences for the community's economy, financial and social systems, including aspects such as employment, income, and social stability
- **Ecosystem functioning and services:** Investigate impact on ecosystem services such as forest, wetland, and ocean that protect and support the functionality of the community

9 Risk propagation and spillover effects

- Assess how risks in the community may propagate to or impact surrounding areas, creating regional spillover effects
- Analyze the community's role and connectivity within the regional risk management network

(3) Exposure assessment

Analyze the community's population distribution, economic activities, infrastructure, etc., to evaluate the direct impact of disasters.

1 Population density and distribution

- Map the population density and distribution in the community, identifying high-density and less populated areas
- Assess how population distribution affects disaster impacts. Densely populated areas often face greater risks

2 Exposure of livelihoods and economic activities

- Investigate the community's main livelihoods and economic activities, such as agriculture, fishing, livestock, industry, tourism, etc.
- Evaluate the exposure of these activities to disasters and estimate potential economic losses

3 Critical infrastructure exposure

- Identify critical infrastructure within the community, such as roads, bridges, water systems, power grids
- Examine the exposure level of these infrastructures and the potential impact on community functionality

4 Ecosystem exposure

- Understand surrounding ecosystems, such as forest, wetland, and river
- Analyze the role of these ecosystems in buffering and protecting the community from disasters and the direct impacts of disasters on them.

(4) Vulnerability assessment

Evaluate a community's sensitivity and adaptive capacity to climate change, analyze its socio-economic situation, including income level, employment, education level, and examine the condition of infrastructure, such as road, water supply, electricity grid network, etc., as well as the emergency response capacity and rescue mechanisms.

1 Social vulnerability

- Examine the community's social and organizational structure, including ethnic groups, social classes, and cultural characteristics
- Analyze reasons for social vulnerability, such as inequity, poverty or social divisions, etc.

2 Population susceptibility and vulnerable groups

- Investigate the special needs and susceptibilities of different groups in the community (e.g., the elderly, children, people with disabilities)
- Assess the additional risks and challenges these groups face during disasters

3 Infrastructure vulnerability

- Analyze the vulnerability of critical infrastructure within communities (e.g., water supply system, transportation, river embankment and flood-control system) to climate-induced risks

4 Economic structure diversity

- Evaluate the diversity of the community's economic base, noting that an economy with diverse industries is usually more resilient to climate change impacts

5 Community-based adaptation measures and project implementation

- Review existing adaptation measures in areas like agriculture, water management, or nature conservation
- Examine the effectiveness of these measures in mitigating the climate change impact and strengthening community resilience

6 Adaptive capacity of community residents

- Evaluate community resident awareness of disaster risks and knowledge of response measures
- Assess residents' adaptive capacity and willingness to adopt relevant measures

7 Disaster response and recovery

- Assess the community's response and recovery efforts following past disasters, evaluating their effectiveness and sustainability
- Analyze challenges faced by the community in post-disaster reconstruction and emergency response

8 Community organizations and social capital

- Map social capital resources such as social organizations, volunteer networks, and community collaborative mechanisms
- Assess the role of these social capital resources in supporting disaster response

9 Disaster early warning and monitoring

- Assess the community's early warning and monitoring mechanism and facilities, as well as information dissemination system
- Analyze resident responsiveness to disaster warning and their responsiveness to and compliance with disaster warnings, to evaluate the system's practical effectiveness

10 Emergency response and rescue capabilities

- Investigate the community's emergency response mechanism, including rescue teams and warning systems
- Assess the community's rescue capacity and response efficiency, as well as its preparedness for disasters

11 Community adaptation policy and planning

- Review existing climate change policies or planning documents, assessing their effectiveness in implementation

(5) Community engagement and awareness survey

Examine residents' knowledge and awareness of disaster risks and response measures. Assess their willingness and capacity to participate in risk management and adaptation measures.

1 Experience of participating in decision-making and planning

- Investigate whether residents have been involved in the decision-making and planning process related to disaster risk management and adaptation
- Evaluate their level of involvement and whether their views are adequately considered in these processes

2 Participation in risk education and training

- Examine whether community members have participated in disaster-related education and training programs
- Evaluate the effectiveness of these programs in raising their risk awareness and building capacities

3 Resources and capacities

- Investigate the resources, skills, experience of residents, and available materials
- Assess the support and contribution of residents to disaster risk management and adaptation.

4 Mechanisms for participation and communication

- Examine the existence of effective community participation mechanisms and communication channels
- Evaluate the quality of communication and collaboration among residents, government, and other stakeholders

5 Residents' needs and expectations

- Identify residents' needs and expectations for disaster risk management and adaptation measures
- Assess whether these needs and expectations are being adequately addressed

(6) Recommendations for response measures and planning

Based on the risk assessment, develop tailored disaster risk management and adaptation measures that align with the community's needs and circumstances. Analyze the community's views and needs to develop risk planning and response strategies according to the specific context.

1 Community resources and capacity

- Investigate the community's resources and capacity, including human, material, and financial resources
- Identify resources that can be mobilized to support the implementation of response strategies

2 Budget and funding sources

- Explore the community's budget and funding sources, including government grants and donations
- Analyze the community's financial needs and potential strategies to secure funding for disaster risk response

3 Policy and legal framework

- Examine the policy and legal frameworks related to disaster risk management and adaptation
- Assess whether existing policies effectively support response measures and identify gaps or conflicts

4 Technical and scientific support

- Explore the latest scientific and technological developments applicable to disaster risk management and adaptation
- Evaluate the community's ability to access and utilize the latest advances in science and technology

5 Cooperation and partnerships

- Assess existing collaborations and partnerships between the community and external organizations and institutions
- Explore collaboration opportunities with external stakeholders to enhance collective disaster response efforts

(7) Resource requirements and cooperation mechanisms

Identify the resources and support the community may need to implement effective risk management and adaptation measures. Explore cooperative mechanisms between the community, governments, non-governmental organizations (NGOs), and other stakeholders to jointly address disaster risks.

1 Government support and policies

- Review government policies and support measures for disaster risk management and adaptation
- Assess the extent to which the government provides resources, policy guidance, and regulatory support to the community

2 NGO-community cooperation

- Examine community-NGO partnerships and understand the role of NGOs in disaster risk management and adaptation
- Assess the contribution of NGOs in providing resources and technical support

3 Private sector and enterprises' engagement

- Examine the involvement of the private-sector organizations and businesses in disaster risk management and adaptation
- Explore opportunities for collaboration between the community and the private or public companies

4 Transboundary and regional cooperation

- Explore mechanisms for transboundary and regional cooperation among communities, regions or countries
- Analyze the importance and impact of such cooperation on effective disaster risk management and adaptation

5 Fundraising and support mechanisms

- Investigating financial needs and potential fundraising channels
- Explore sustainable financial support mechanisms and partnerships

6 Community participation and mobilization

- Develop strategies to mobilize community residents to participate in the development and implementation of disaster risk management and adaptation measures
- Identify barriers and facilitators of effective community participation



Annex 2: The Pressure-State-Response Framework

I. Background and Development of the Pressure-State-Response Framework

In the 1970s, as environmental issues became increasingly prominent, there was a growing need for a systematic framework to assess environmental conditions and their relationship with human activities. In 1976, Canadian statisticians David J. Rapport and Anthony Marcus Friend introduced the Pressure-State-Response (PSR) framework. The framework aims to clarify the causal relationships between human activities and environmental changes, providing a scientific basis for environmental management and policy-making.

The framework was originally developed for environmental quality assessment and ecosystem health evaluation. During the 1980s and 1990s, it underwent further development and refinement by the Organization for Economic Co-operation and Development (OECD) and the United Nations Environment Programme (UNEP), and it was applied to studies on environmental reporting.

In the 21st Century, the PSR framework has been widely applied in various fields such as infrastructure resilience evaluation, ecological risk assessment, and disaster risk assessment. During its development, the PSR framework has inspired several variants, including the Driving Force-Pressure-State-Impact-Response (DPSIR) model. This model adds the components of “driving force” and “impact” to the PSR framework, providing a more comprehensive understanding of the interactions between human activities and environmental systems. Additionally, the Driving Force-Pressure-State-Exposure-Impact-Response (DPSEIR) model was created by incorporating an “exposure” component into the DPSIR model. This addition highlights how environmental changes expose humans and ecosystems to various risks. These derivative models have further expanded the application scope of the PSR framework.

II. Basic Concepts

The PSR framework consists of three core dimensions

1 Pressure

- This dimension refers to the negative impacts of human activities, climate change, or other stressors on the environment. Examples include pollutant emissions and the overexploitation of natural resources.

2 State

- This dimension refers to the changes in environmental systems under the influence of the pressure applied. For instance, it includes issues such as deteriorating air quality and water scarcity.

3 Response

- This dimension encompasses the actions taken by society to improve environmental conditions. Examples include the enactment of environmental regulations and the promotion of clean energy.

III. Advantages and Disadvantages

1 Advantages

Simple structure and clear logic

- The PSR framework is simple and easy to understand, clearly illustrating the causal relationship between human activities and environmental changes.

Wide applicability

- The PSR framework can be applied to the assessment of various environmental issues, such as climate change, biodiversity loss, and water resource management.

Supports decision-making

- The PSR framework provides a scientific basis for environmental management and policy-making, assisting decision-makers in identifying key issues and formulating effective response measures.

2 Disadvantages

Linear thinking

- The PSR framework treats environmental systems as linear, overlooking the complex interactions and feedback mechanisms within these systems.

Data dependency

- The construction and application of the PSR model require a substantial amount of data, which can lead to high costs for data acquisition and processing.

Subjectivity

- The selection of indicators and the determination of their weights involve a certain degree of subjectivity, which may affect the objectivity of the assessment results.

IV. Practical Applications

The PSR framework has been widely utilized in various environmental assessment and management practices. For example:

Ecological and Environmental Assessment

- The PSR framework is widely used to assess the ecological and environmental health of various regions, such as in an ecological safety assessment conducted in Shanghai from 1999 to 2005.

Infrastructure Resilience Assessment

- The PSR framework is used to assess the resilience levels of urban infrastructure under different stress conditions. It has been applied in studies on infrastructure resilience in metropolitan cities like Beijing, Shanghai, Chongqing, and Tianjin.

Sustainable Development Research

- The PSR framework helps analyze key factors in sustainable development, such as resource utilization, environmental protection, and socio-economic coordination.

International Projects

- The PSR framework has been applied in numerous projects by the United Nations Commission on Sustainable Development (UNCSD) to support the development of measurement models that align with specific objectives.

V. Summary

The Pressure-State-Response (PSR) model, a well-established framework for environmental assessment, highlights the interactive relationship between human activities and the environment. It also serves as a powerful tool for addressing issues related to sustainable development. Despite some limitations, the PSR framework remains highly applicable across various fields, thanks to ongoing improvements and expansions.

Annex 3: Participatory Assessment

1. Introduction to Participatory Development Theory

Participatory development encompasses theoretical, research, and practice frameworks. It covers theoretical perspectives, research methods, and practical tools used in the planning, implementation, and evaluation of programs.

1.1 Emergence and development

The origins of the participatory development theory can be traced back to the 1950s. It gained prominence in the late 1970s and early 1980s. During this period, concerns about the inequalities and unsustainable outcomes associated with traditional development models prompted scholars and practitioners to explore more participatory, inclusive, and sustainable development paths.

The emergence of participatory development as a concept has been a gradual historical process, spanning multiple domains of the social sciences, development economics, and development practice. This approach emphasizes the right of community residents to participate, values local knowledge, promotes social justice, and highlights the importance of sustainable development. This philosophy of participatory development has been validated in practice and has profoundly impacted the development field. Below are several key factors which have shaped the concept of participatory development.

- **Inequality and unsustainability of development:** In the mid-Twentieth Century, traditional development models led to unequal economic growth, contributing to persistent poverty and environmental degradation in certain regions. This reality triggered a reevaluation of the paradigms of that time and prompted a search for more inclusive and sustainable development models.

CASE 1 **The Green Revolution and Agricultural Inequality**

The Green Revolution was a major transformation in agriculture during the mid-twentieth century, aimed at increasing agricultural production and addressing food shortages due to the rising global population through new farming technologies. This movement began mainly in Mexico and later spread to several Asian countries, including India, the Philippines, China and Pakistan, as well as other developing countries worldwide. The Green Revolution introduced several key elements:

- **New high-yielding varieties**

The Green Revolution saw the introduction of new varieties of high-yielding crops through improved breeds of wheat, rice, and maize. These varieties were bred for greater resistance and adaptive capacity to pests and diseases, significantly increasing yield.

- **Widespread use of fertilizers and pesticides**

The Green Revolution promoted the use of fertilizers and pesticides to enhance crop growth and protection against pests and diseases, thereby increasing overall crop yields.

- **Irrigation and water management**

Significant improvements in irrigation systems ensured that farmland received adequate water supplies. Proper water management is essential for achieving high yields in agriculture.

- **Scientific agricultural practices**

Emphasis on scientific farming practices, including timely planting, fertilization, and pesticide use, helped maintain crop health and production.

- **Agricultural mechanization**

The Green Revolution fostered agricultural mechanization to improve the efficiency and productivity of farming operations.

- **Government support and external assistance**

The movement was driven by extensive support from governments and international organizations. This included funding, training, technical support, and financial and technical aid from external entities to promote the Green Revolution.

However, the Green Revolution also brought numerous problems and challenges, including land degradation, overexploitation of water resources, adverse effects from chemical pesticides, and social impacts on farmers. While the movement did, to some extent, increase food production, help alleviate hunger, and introduce modern agricultural practices, its benefits were unevenly distributed. The primary beneficiaries were large-scale agricultural producers. Unfortunately, rural poverty persisted as smallholder farmers and vulnerable rural groups gained much less from the Green Revolution, exacerbating existing inequalities in rural areas.

- **Critical Development Theory:** This theory challenged the dominant view of the traditional development paradigm by highlighting the marginalization of disadvantaged groups in the development process. It provided the basis for the subsequent conceptualization of participatory development.

CASE 2 **Challenges with traditional development approaches**

Traditional development models often prioritize economic growth as the only or primary indicator of progress, focusing on replicating the strategies of developed countries. This economic-centric strategy promotes a "top-down" approach that overlooks local geographic, cultural, and socio-economic contexts. In this model, experts and leaders dominate decision-making while the voices and needs of community residents are largely ignored. As a result, projects often lack alignment with local realities.

- **Social mobilization and social movements:** Emerging social movements such as human rights and environmental movements emphasize the right of community members to participate in decision-making. These movements foster greater social engagement and democratic development.
- **Indigenous knowledge and cultural values:** Development practice increasingly recognizes the value of indigenous knowledge and cultural values held by community members. Integrating local knowledge into projects supports a more inclusive development model.

CASE 3 **Challenges with development aid**

Historically, development aid has often treated target countries or regions as instruments to advance the agendas of developed countries rather than as active agents of their own progress. This approach has restricted the mobilization of local people, who frequently lack the authority to shape the direction and agenda of development initiatives. Consequently, aid projects often suffer from poor sustainability, failing to adequately address local needs and community aspirations.

- **Rural Development Practice:** Some rural development practices leverage the close relationships between rural communities and natural resources to promote direct community involvement. This approach ensures that development initiatives are better adapted to local needs.
- **United Nations advocacy:** In 1990, the United Nations Development Programme (UNDP) formally introduced the concept of Human Development in its first Human Development Report. The report defined development as a process of expanding people's choices and capabilities, shifting the focus of development from economic growth alone to human well-being. This human-centered approach further encouraged greater emphasis on community participation and the empowerment of local people.
- **Practical experiences and case studies:** A growing number of practical global examples demonstrated that community participation and resident ownership are critical to the success and sustainability of development initiatives. These successful cases have significantly shaped the concept of participatory development.

Participatory development has become a mainstream model in development studies. Especially in recent decades, reflections on traditional development models, along with a shifting focus on social inclusiveness and sustainability, have driven the widespread adoption of participatory development concepts and methodologies in the international community.

1.2 Core principles of participatory development

- **Community Participation:** Community residents are central to development. Their active involvement in project planning, implementation, and monitoring ensures alignment with their needs and aspirations.
- **Democratic decision-making:** Decentralizing decision-making at the community level encourages residents to participate in the decision-making process, enhances a project's feasibility, and promotes success.
- **Local knowledge:** Respecting and incorporating the local knowledge and community experience into development projects facilitates more practical solutions.
- **Equitable participation:** Equal participatory opportunities for all groups, including diverse classes and genders, prevent marginalization and promote project inclusivity.
- **Sustainability:** Ensuring that development projects are viable in the short and long terms.
- **Capacity building:** Capacity building refers to strengthening the capabilities of community members, organizations, and other stakeholders through training, education, and skills development so that they can participate more effectively in and contribute to the development process. Its objective is to enable participants to better understand, plan, implement, and monitor projects, programs, or policies, thereby promoting more sustainable, impactful, and adaptive development.
- **Transparency and accountability:** Build trust by providing precise and accessible information to community members on program progress and resource utilization, supported by a robust accountability mechanism.

Participatory development aims to promote social justice, reduce poverty and enhance community well-being, with full respect for local culture, values and needs. This bottom-up approach fosters close collaboration with community residents to drive sustainable and inclusive development.

1.3 Introduction to the development of participatory development theory in China

The introduction of the participatory development theory in China began in the late 1980s and early 1990s. During this period, China started adopting external development concepts and approaches, including participatory development approaches, in response to address domestic development needs and challenges.

Key milestones and influencing factors include:

- **Late 1980s:** China's reform and opening-up policy created opportunities for domestic development experiments. External participatory approaches were introduced to explore development paths suited to China's conditions.
- **Early 1990s:** Community-based participatory development projects emerged in rural China, focusing on agriculture, poverty alleviation, and other rural development areas. International development organizations and public welfare organizations initiated pilot projects, promoting the concept of participatory development.
- **Mid-1990s:** In some regions, the Chinese government began incorporating participatory methods, such as Participatory Rural Appraisal (PRA), into rural development policies and projects.
- **2000s and Beyond:** Participatory development expanded to urban and rural settings. Government and social organizations launched numerous community-driven projects to improve the effectiveness and sustainability of development projects.

Though introduced relatively late, participatory development approaches have been widely applied and promoted in China over the past few decades. Governments at all levels increasingly recognize the importance of community participation and are actively adapting these approaches to foster more inclusive and sustainable development adapted to China's circumstances.

2. Introduction to Participatory Rural Appraisal

The Participatory Rural Appraisal (PRA) is a practical application of participatory development theory in rural settings. It is designed to promote community participation and cooperation in collecting, analyzing, and interpreting information. Rooted in humanism, the PRA applies to both rural and development contexts to understand community perceptions, needs, and priorities. It empowers residents to share their knowledge, experiences, and opinions while working closely with researchers and practitioners in development to advance deeper insights into specific issues.

The PRA employs various participatory tools and techniques to encourage expression, facilitate collective decision-making, and build consensus. These tools generally include spatial, temporal, communicative, ranking, analytical, and interview-based methods. By applying these tools, community stakeholders jointly gather and analyze data, leading to a more comprehensive and inclusive understanding that informs more targeted and adaptive development planning and projects.

Beyond its role as an assessment methodology, the PRA emphasizes local knowledge, experience, and community participation to promote sustainable development.

2.1 Introduction to Participatory Tools

2.1.1 Principles of PRA tool use

Participatory Rural Appraisal (PRA) tools are guided by two core principles:

- **Intuitiveness and openness:** The primary purpose of PRA surveys is to serve the community, so the tools should be intuitive, easy to understand and use. This intuitiveness fosters effective information exchange by reducing barriers between facilitators and participants. Openness ensures the incorporation of diverse experiences and perspectives, leading to a comprehensive and diverse understanding of community issues.
- **Focus on the process:** In PRA, the participatory process is as important as the outcome. The PRA tools facilitate shared learning, reflection, and collaborative problem identification and solving. This process fosters a better understanding of problems and challenges and encourages collaboration in finding solutions. By engaging participants throughout the process, the PRA tools facilitate data collection and prompt reflection, communication, and co-creation.

2.1.2 Common Tools

- **Spatial structure tools:** These include community maps, resource maps, and profile maps. Focusing on a community's natural landscape planning, these tools help analyze natural resources and track changes in socio-economic spatial dynamics.

Community Map	
Materials	White papers and colored pencils, tape, etc.
Process	Invite 5-10 participants of diverse ages and both genders. Start with a selected reference point (e.g., a landmark public place, or a farmer's house) and then expand to cover the surrounding area. Use various markers to represent different objects.

Content	• Administrative boundaries of village groups; • Key features, e.g., households, roads, houses, village councils, schools, factories, cultural symbols, etc. • Economic status (e.g., wealth distribution among households)
Notes	The map should represent the living environment most familiar to participants. After the facilitator explains the mapping objectives, participants collaborate to create the map together. One person may lead the drawing, while others discuss and suggest revisions. Once complete, another participant can verify the map for accuracy. Encourage positive engagement to foster a collaborative environment. Avoid criticism about the community map and actively appreciate all participant contributions.

Resource Map

Process	Invite participants to share their understanding of resources and then draw their spatial distribution. Next, explain their use and quantities in greater detail.
Content	• Resource type • Resource distribution • Resource management and ownership • Resource plan
Notes	• Use symbols or other visual elements in resource mapping to make it more understandable and to facilitate discussion • Determine the spatial direction based on individual preferences. Create a map and then use it as a reference. The map does not need to follow conventional geographical orientation (e.g., north at the top and south at the bottom).

Transect Diagram

Procedure	Select a representative transect across the village and conduct a joint field walk with community participants. After the walk, draw the transect profile, and indicate the basic ground conditions observed along the route (e.g., land use, land classification). Discuss the opportunities and constraints associated with each land type.

Contents	• A transect diagram is a cross-sectional representation of the community landscape that illustrates ecological changes, land-use patterns, and resource distribution, particularly in areas where forests constitute the dominant ecosystem. Its purpose is to present clearly features that are not easily visible in a plan view, such as slope, drainage system, vegetation, and land types. • Topographic information — elevation, slope, vegetation, and land types (including locally recognized and culturally defined land classifications), water supply, and drainage systems. • Vegetation cover — Food crops (e.g., rice, wheat), cash crops (e.g., pear orchards), forests, shrubs, grasslands, and wetland vegetation. • Land use types — forest land, agricultural land, grazing land, barren land, grassy hills, industrial and mining land, residential land, and other land use types, particularly those of cultural significance (e.g. sacred mountains, scenic forests, Longshan (a type of sacred natural site in southwestern China) • Resource management — ownership and management arrangements for natural resources within different ecoregions. • Simple analysis — analyze existing issues related to natural resource management and land use, and discuss potential solutions
Notes	• Select a transect that captures the full range of landscape variation, ideally extending from higher to lower elevations and encompassing different ecological zones and land use types. • Use locally recognized land use and soil classification systems whenever possible to ensure that participants can easily understand, validate and contribute to the discussion. • It is possible to prepare two or three transect diagrams to compare resource changes over time.

- **Temporal changes:** analyze trends of local living over time such as village history, significant events, seasonal calendars, diary charts, and trend charts, identify problems and causes.

Historical Timeline

Process	Enlist community members, particularly elders with more profound village knowledge, then clarify requirements with examples and produce a timeline to guide participants in recalling past events within a specific timeframe.

Notes	• Write down all ideas shared during discussions • Highlight major events that significantly impacted community life or livelihoods • Encourage in-depth discussion about key events, prompting participants to reflect on lessons learnt, experiences gained, or pride derived from their history

Daily Activity Log

Process	Create a timeline (e.g., 24-hour period) and guide participants to list their activities during each time range. Ask them to describe the effort and difficulty level of each activity.
Notes	• Participants may perform multiple activities simultaneously • Discuss who performs each activity, how long it takes, and what constraints exist (e.g. women's cooking responsibilities) • Chart daily activity schedules for different groups and analyze differences

- **Communication analysis tools:** culture circles mapping, diagrams of material, financial, and information flows. Analyze the scope, volume, and impact factors of these elements.

Material flow charts

Process	• Start by discussing the types and quantities of major local supplies • Discuss the mediums and destinations of main material flows, mapping each flow in different colors and line styles • Discuss the types and quantities of materials from external sources (e.g., exchanges, purchases, or gifts from relatives) • Discuss the mediums and sources of the material inflows, mapping each flow with different colors and line styles.
Notes	• Material flows may vary by time or season • During the discussion, encourage participants to thoroughly discuss the reasons for flows, challenges, and related issues • Recognize diverse stakeholders. Foster positive collaboration and avoid negative feedback.

- **Analytical tools:** institutional linkage diagrams, cause and effect diagrams, problem trees, strengths-weaknesses-opportunities-risks analysis (SWOT analysis), etc. Choose proper tools to identify and analyze the underlying causes of these phenomena.

Strengths-Weaknesses-Opportunities-Risks Analysis (SWOT Analysis)

Process	• Identify the problems for analysis • Fill a four-column matrix with four elements — strengths, weaknesses, opportunities, and risks • Work with participants to understand strengths, weaknesses, opportunities, and risks • Collect all ideas for analysis • Conduct a comparative analysis of strengths, weaknesses, and opportunities versus risks. Discuss potential benefits, possibilities for growth, and limitations.
Notes	• Analyze the common questions of participants • Use a logical analytical structure to guide discussions and foster a shared understanding among participants • Conclude the analysis with a group review of its completeness and address any gaps or omissions

Problem Tree Analysis

Process	• Identify the problems for analysis • Ensure a common understanding of these problems • Discuss and map the outcomes and causes • In-depth analysis of causes. Be specific.
Notes	• Ensure problems are specific, measurable, and solvable • Analyze the correlation between causes and effects • Conduct a review on the overall logic of the analysis and check for possible omissions prior to the mapping process

- **Classification and sorting tools:** sorting and scoring, wealth level classification, item stratification, decision analysis, etc.

Sorting

Process	• Invite participants based on the sorting objective • Have participants list, ideally, 10 or fewer items; collaboratively refine the list if it exceeds 10 items • Document all listed items and rank, score, or vote on each • Compile and summarize the results • Compare, discuss, and analyze the outcomes
Notes	• Ensure uninterrupted input during content collection, allowing all participants to express their views fully • Encourage independent voting to avoid groupthink to prevent bias.

Wealth Level Classification

Process	• Define categorical indicators, e.g., good, medium, poor; or high, medium, low, based on main economic sources • List the heads of the household; • Engage participants in a collaborative discussion to categorize each household • Calculate the number of households in each category • Discuss the characteristics of each category to identify patterns
Notes	• Ensure indicators are quantifiable • Limit participants to around five individuals who are knowledgeable about the community's conditions

- **(c) Interviews, seminars, and meetings:** semi-structured interviews, group discussions, general assembly.

Interviews

Interview Process	• Key informant interviews — A "key informant" should have sufficient knowledge and influence in specific community issues • Farmer interviews — after key figure interviews, engage diverse groups within the village to capture broader perspectives. These interviews will be conducted in farmers' homes only after obtaining their consent. • Group interviews — Arrange group discussions by inviting a small number of community residents who participate voluntarily; schedule appointments with them in advance
Notes	• Allow sufficient time for discussion. Schedule follow-up appointments if topics cannot be fully covered in one session. There is no need to analyze all the topics thoroughly in one short period. If possible, spread discussions over multiple sessions in later days, as participants may continue conversations independently after each group discussion. This may enrich subsequent sessions. • Cross-check information provided by different interviewees, as knowledge and opinions vary. When inconsistencies arise, explore the reasons behind the differences. • Pose questions one at a time to avoid overwhelming participants • Evaluate responses — assess the verifiability of answers; consider how the questions' phrasing and delivery influence responses; observe body language and note any evasive behavior to judge the interviewee's mindset • Avoid leading questions — A "leading question" suggests predetermined answers and hinders key information and deeper inquiry. While challenging to eliminate leading questions, try to be more aware and minimize their use during interviews

3. Advantages and Disadvantages of Participatory Development Theories and Methods

3.1 Advantages

Participatory development offers numerous benefits and has gained popularity. Key advantages include:

Enhanced sustainability

Involving community residents in the project's planning and the decision-making process ensures its alignment with local culture, values, and needs, fostering long-term viability and impact.

Adaptability and flexibility

This approach allows projects to adjust to local conditions and needs, making them more flexible and responsive in addressing local challenges.

Leveraging local knowledge and experience

Combining community knowledge with expertise results in more effective development strategies and solutions.

Increased sense of belonging and willingness to participate

Community resident involvement in the decision-making process encourages them to invest more time, energy, and resources in the project, which boosts project success.

Reduced conflict and resistance

Inclusive decision-making and implementation minimize resistance as participants feel respected and valued.

Increased Efficiency

Community input in the decision-making process provides more accurate information, reducing errors and resource waste and improving efficiency.

Promotes democracy and equity

Participatory development emphasizes democratic decision-making and equitable opportunities for community residents, reducing social inequalities.

Enhanced community autonomy

Encouraging local initiative enhances the sense of autonomy among community members and improves their self-management ability.

Greater transparency

A transparent and open decision-making process builds a project's credibility.

Enriches experiences and skills

Participation equips community members with new skills and experiences, supporting personal and collective growth.

Overall, participatory development drives better program outcomes, community satisfaction, sustainability, and social equity by empowering residents to become more actively involved in realizing their needs and aspirations.

3.2 Disadvantages

Despite its numerous benefits, participatory development has notable limitations and challenges. Below are some disadvantages of participatory development approaches:

High time and resource demands

Participatory development requires significant time, financial resources, and human resources. Training community residents, organizing meetings, and facilitating discussions can increase project costs and duration.

Representation issues

Community participation may not reflect all interests equally. Dominant voices can overshadow minority opinions, resulting in unequal representation.

Power imbalance

Internal community power relations can undermine fair decision-making, potentially marginalizing vulnerable groups.

Limited expertise

Community residents may lack specialized knowledge and skills, leading to technical and managerial barriers during project planning and implementation.

Complex decision-making

The participatory process involves multiple stakeholders, which can lead to disagreements and make the decision-making process complex and difficult.

Sustainability concerns

Communities may lack sufficient resources and expertise to effectively manage and maintain their projects in the long term.

Dependency issues

Over-reliance on external support and resources can hinder a community's ability to develop independently.

Consistency issue

Participatory approaches may result in fragmented, small-scale projects that lack coordination and consistent actions, reducing overall development effectiveness.

Knowledge gap

Community members may lack sufficient information to make comprehensive and wise decisions.

While participatory development offers significant advantages, addressing these challenges and limitations through careful project design and management is critical to achieving its intended outcomes.

4. Opportunities, Challenges, and Future Directions for Participatory Theory and Methods

By evaluating both the strengths and weaknesses of participatory development theories, key opportunities and challenges can be identified for its future application:

4.1 Opportunities

Technological innovations

Advancements in digital technology, the development of the Internet, and the expansion of social media enable broader community participation, facilitating resident engagement in decision-making and implementation of development projects.

Emphasis on sustainability

Participatory development emphasizes community resident involvement and initiative. This approach promotes the alignment of projects with sustainable development goals across social, economic, and environmental sectors.

Social innovation and entrepreneurship

Participatory development stimulates innovation and entrepreneurial capacity among community residents. It fosters the development of more effective adaptive solutions tailored to local needs and resources.

Stronger community cohesion

Involving community residents in the development process enhances collective action and social ties to achieve their common interests.

Credibility and legitimacy

The transparency of participatory development approaches boosts project credibility and legitimacy, reducing conflicts and resistance.

4.2 Challenges

Resource constraints

Participatory development requires significant time investment of time, personnel, and funding, posing challenges in areas especially those with limited resources.

Representation issues

Ensuring equitable participation remains a persistent challenge, particularly for vulnerable groups.

Decision-making complexity

The involvement of community residents can complicate decision-making and often hinder consensus and delay project progress.

Technological and digital gap

While technology enhances participation opportunities, unequal access to digital applications may exclude certain groups from joining projects.

Knowledge and skill insufficiency

Community residents may lack the expertise for effective decision-making and project implementation.

The opportunities and challenges for participatory development will inevitably coexist in the future. Acknowledging them and addressing them strategically will promote success in practice.

4.3 Future Directions

Considering the strengths, weaknesses, opportunities, and challenges of participatory development, the following strategies provide a path forward:

Meaningful community participation

Ensure community involvement is substantive, not superficial. Express sincere respect for community members' contributions and genuinely integrate their opinions to influence decision-making and project implementation.

Blending scientific and local knowledge

Combining scientific knowledge with local experience can promote more feasible and adaptive development strategies. Participatory development fosters mutual learning and interdisciplinary cooperation.

Cross-level coordination and policy support

Participatory development calls for policy support from governments and public interest organizations to encourage community engagement. Through multi-level collaboration, local efforts can align with broader sustainable development goals.

Technical and digital support

Use modern technology and digital tools to enhance participation for broader coverage and greater depth. Digital platforms and social media can facilitate the collection and exchange of information and ideas, enabling more inclusive engagement in the development process.

Monitoring and feedback systems

Implement transparent and appropriate monitoring and feedback mechanisms to protect participant rights and interests. These mechanisms can take the forms of regular community meetings and evaluation reports.

Continuous Learning and Adaptation

Promote ongoing improvement by adapting strategies based on practical experience and staying responsive to emerging trends, ensuring participatory development approaches remain forward-looking and practical.

5. Application of participatory approaches in rural climate change risk assessment

Participatory methodologies are particularly suitable for climate change risk assessment, as climate impacts are often complex and diverse at the community level, requiring the integration of multi-level knowledge for assessment and planning.

During surveys on rural communities, it is important to evaluate the condition and main types of climate hazards based on resident understanding and perception of climate change. Exploring local experiences and adaptation measures from previous disasters can provide valuable insights for future risk assessment.

Participatory Rural Appraisal (PRA) incorporates the knowledge and experience of local residents and equips them with climate science. The process enhances resident awareness of self-adaptation and understanding of climate impacts, enabling them to develop adaptation measures tailored to local needs.

In addition, the PRA research process facilitates consensus among stakeholders through collective participation. Involving community residents, government agencies, public interest organizations, and other stakeholders in discussions and decision-making ensures the inclusiveness and credibility of conclusions. The participatory process also enhances the feasibility and sustainability of adaptation measures.

5.1 Strengths of PRA's application in climate change risk assessment

Incorporation of local knowledge and experience

Community residents often have profound knowledge of local climate change impacts and risks, including past observations, hazard history, and existing adaptation measures. This information complements scientific data for the research.

Comprehensiveness and diversity

Participatory assessments involve diverse groups of people, regions, and industries. Integrating multiple perspectives and the demands of all stakeholders ensures comprehensive results.

Raising awareness

Participatory approaches can raise community resident awareness of climate change risks, encourage participation, and enhance their capacity to participate and mobilize other members to jointly implement adaptation measures.

Feasibility and sustainability

Adaptation measures developed by residents are context-specific and therefore more sustainable in the long term.

Democracy

The democratic participation process respects community knowledge and residents' opinions. The approach is important for building trust and promoting cooperation between residents and decision-makers.

Applying PRA methods for climate change risk assessment requires ensuring the process is transparent, inclusive, and participatory. Different stakeholders should be encouraged to actively participate and incorporate their views and recommendations into risk assessment and the planning of adaptation measures. This improves the feasibility of risk management and adaptation strategies, thereby enhancing the community's resilience and sustainability.

5.2 Designing a PRA plan for climate change risk assessment in rural communities

A PRA outline for climate change risk assessment for rural communities could include the following contents:

(1) Community profile and background

- Basic information such as community name, geographic location, population size, and composition
- Background information on the community's history, characteristics, and main economic activities

(2) Research purpose and objectives

- Explain the aims of climate change risk assessment; identify the objectives and expected outcomes

(3) The assessment framework

- Introduce basic principles and methodology of Participatory Rural Appraisal (PRA) and explain considerations of the selection of this model

(4) Community participation strategies and plans

- Describe the form of participation and roles of various stakeholders such as community residents, government, and public interest organizations
- Develop a community engagement program including meetings, discussions, workshops, or other activities

(5) Hazard assessment

- Identify historical natural and human-induced hazards that have occurred in the community, and analyze hazard types, frequency, intensity, and impacts.
- Predict new types of disasters that may result from climate change

(6) Exposure assessment

- Investigate the community's geographic location, topographic conditions, and its distances and correlation to potential hazards
- Analyze the community's population distribution, economic activity, infrastructure, etc. to identify direct impacts of climate events

(7) Vulnerability assessment

- Investigate the community's socio-economic conditions, including income levels, employment situations, educational levels, and other relevant factors
- Understand the community's infrastructure conditions, including roads, water supply, electricity, and related emergency response measures

(8) Integrated risk assessment

- Conduct an integrated analysis of hazards, exposure, and vulnerability to assess the community's overall disaster risk
- Identify primary disaster risks and vulnerability issues

(9) Community participation and awareness survey

- Investigate community residents' knowledge and awareness of climate change risks
- Analyze the willingness and capacity of community residents to participate in risk management and adaptation measures.

(10) Response measures and planning recommendations

- Suggest disaster risk management and adaptation measures according to the community's specific needs, based on the results of the assessment
- Analyze the opinions and needs of community residents; develop risk planning and response strategies that align with the community's actual condition

(11) Resource requirements and cooperative mechanisms

- Identify resources and support that communities may need to implement effective risk management and adaptation measures
- Explore mechanisms for cooperation among communities, government, social organizations, and other stakeholders to jointly address disaster risks

(12) Conclusions and recommendations

- Summarize the results of the assessment and propose recommendations and action plans to address climate change risks in the future

(13) References

- Cite studies, data, and reports that support the reliability of the assessment process and results

(14) Appendix:

- Additional information such as questionnaires, meeting minutes, participant lists

This outline serves as a starting point for tailoring it to specific community situations and goals. The primary focus should be on ensuring the participation of community residents and other stakeholders while incorporating their knowledge and experience into the assessment process. This approach promotes the development of context-specific, effective risk management and adaptation measures.

Annex 4: Outline of a Climate Change Risk Assessment Report

I. Introduction

Briefly describe the purpose and scope of the assessment, and basic information about the assessment subject.

Explain why the climate change risk assessment was undertaken and what to expect from the results.

II. Methodology

Describe the Hazard-Exposure-Vulnerability assessment framework and the indicator system for the report.

Introduce the data sources, methods, and models.

Describe the temporal scale and geographic scope of the assessment.

III. Risk assessment

Provide an overview of analyzed climate hazards, including potential climate events and projected changes.

Present key results of hazard assessment, such as frequency, intensity, and spatiotemporal distribution of extreme climate-related events.

IV. Exposure assessment

Assess exposure to a specific area or system.

Analyze key factors such as geographic location, climatic conditions, population density, and infrastructure.

Provide key findings from the exposure assessment.

V. Vulnerability assessment

Analyze vulnerability, including sensitivity and adaptive capacity at the social, economic, environmental, and institutional levels.

Analyze factors such as population, social structure, infrastructure resilience, climate change awareness, perception and understanding, and existing adaptation measures.

Provide a detailed assessment of vulnerability.

VI. Comprehensive risk assessment

Integrate the results of hazard, exposure, and vulnerability assessment for a comprehensive climate risk assessment

Describe the assessment's uncertainty and sensitivity.

Provide a comprehensive conclusion on the primary risk factors.

VII. Adaptation and mitigation recommendations (on which applications for small grant projects are based)

Recommend adaptation and mitigation measures based on the results of the assessment.

Include recommendations concerning strategy, policy, technology, and social innovation.

Emphasize the importance and feasibility of implementation and indicate the associated risks.

VIII. Risk communication and dissemination

Propose a risk communication and dissemination strategy to ensure efficiency.

Consider the diverse needs and expectations of various stakeholders.

IX. Conclusion (on which the applications for small grant projects are based)

Summarize the key findings and recommendations.

Highlight suggestions for key protocols.