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Designing for Cultural Sustainability: A Cultural Ecology Approach to Environmental Design in Chuxiong's Rural Areas

Rui Li[1*] and Pisit Puntien[2]
[1*,2]Faculty of Fine and Applied Arts, Suan Sunandha Rajabhat University, Thailand
[1*]Corresponding E-mail: s64584948071@ssru.ac.th, ORCID ID: https://orcid.org/0009-0009-0527-6093
[2]E-mail: pisit.pu@ssru.ac.th, ORCID ID: https://orcid.org/0000-0002-4495-9147

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Abstract

Background and Aim: Cultural sustainability is crucial for rural development, especially where modernization threatens traditional lifestyles, architectural heritage, and ecological balance. This study develops a culturally responsive environmental design framework for Chuxiong's rural areas, integrating vernacular identity with sustainable modernization strategies.

Materials and Methods: This study employed literature review, field observations, case study analysis, and surveys to examine cultural and environmental dynamics in rural settlements. These methods provided a comprehensive understanding of how environmental planning can align with local traditions and community needs.

Results: Findings demonstrate that integrating traditional courtyard layouts and locally sourced materials enhances community acceptance of new developments and strengthens ecological resilience. The proposed strategies for Nanhua Xincun reintroduce vernacular spatial organization, promote sustainable material use, and incorporate landscape elements that reinforce cultural continuity.

Conclusion: The proposed strategies serve as a replicable framework for culturally responsive rural planning, offering valuable insights for governmental policymakers, rural development planners, and environmental designers seeking to balance heritage conservation with modernization.

Keywords: Cultural Sustainability; Environmental Design; Cultural Ecology; China Rural Revitalization; Vernacular Architecture

Introduction

China's rapid urbanization is reshaping rural landscapes, often at the cost of traditional cultural heritage, vernacular architecture, and community identity. Chuxiong, a region known for its diverse ethnic heritage and ecological richness, is experiencing increasing pressure from modernization, which threatens its indigenous spatial practices and traditional settlement patterns. Without strategic intervention, unregulated development and standardized architectural models risk erasing centuries-old cultural landscapes, weakening community cohesion, and diminishing the region's heritage-driven rural economy (Lang, Chen, & Li,2016).

Despite the growing body of research on rural development and environmental planning, existing studies predominantly focus on economic growth and infrastructure expansion while often neglecting the cultural and ecological dimensions of rural transformation. Although vernacular architecture studies emphasize historical preservation, few propose adaptive environmental design frameworks that integrate cultural sustainability with contemporary development needs (Nassauer, 1997). This study addresses this gap by applying cultural ecology principles to rural environmental planning, offering a replicable model for harmonizing modernization with cultural preservation.

Cultural ecology provides a theoretical foundation for understanding the dynamic interactions between cultural identity, environmental adaptation, and rural development. By examining diverse rural settlements in Chuxiong, this research develops environmental design strategies rooted in cultural ecology principles, ensuring that modernization efforts remain culturally and ecologically responsive (Sutton & Anderson, 2020). Through a case study approach, this study evaluates the effectiveness of these strategies in balancing rural revitalization with cultural heritage conservation.

This research makes contributions at three levels: (1) Theoretical Contribution – Extends cultural ecology theory to rural environmental design, providing a framework for integrating built environment and cultural heritage; (2) Practical Implications – Offers design strategies for culturally responsive rural

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revitalization, applicable to policymakers, architects, and planners; and (3) Policy Relevance – Provides insights for rural development policies that seek to balance economic growth with heritage conservation in China's ethnic minority regions.

The remainder of this paper is structured as follows: Section 2 presents a literature review on cultural sustainability, cultural ecology, and vernacular architecture. Section 3 outlines the research methodology, including field studies and case analysis. Section 4 discusses findings on Chuxiong's rural transformations and proposes design strategies. Section 5 offers conclusions and recommendations for culturally sustainable rural planning.

Objectives

To design environmental strategies based on cultural ecology for Chuxiong's rural areas to foster cultural sustainability and rural development.

Literature Review

The concept of cultural sustainability has gained increasing attention in rural development, particularly as modernization and urbanization threaten traditional lifestyles, architectural heritage, and ecological balance. Existing studies highlight the essential role of cultural identity in maintaining the social and environmental continuity of rural communities (Rapoport, 1982; Wang, 2019). In this context, cultural ecology provides a theoretical framework that examines the dynamic relationship between people, their built environments, and the natural landscape, informing culturally and environmentally responsive planning strategies (Oliver, 2003).

1. Cultural Ecology and Rural Development

Cultural sustainability in rural development requires a balance between modernization and the preservation of cultural identity. Cultural ecology offers a holistic perspective, emphasizing that built environments, cultural practices, and ecological systems are deeply interconnected (Wu & Yang, 2020). Studies argue that rural development should be adapted to local cultural and environmental contexts rather than imposing uniform models (Oliver, 2003; Wu & Yang, 2020). However, implementing context-sensitive strategies remains challenging due to policy-driven standardization and limited frameworks for translating theory into practice. This gap underscores the need for applied research on how to operationalize cultural sustainability principles in specific regional contexts.

2. Vernacular Architecture and Spatial Organization

Vernacular architecture plays a critical role in cultural sustainability by embodying local traditions, climate-adaptive techniques, and social organization. Traditional Chinese rural settlements, including those in Chuxiong, feature courtyard-centered layouts, locally sourced materials (wood, earth), and spatial designs fostering communal interaction (Fang, 2020). Studies show that these traditional elements enhance environmental performance and strengthen cultural identity (Liu & He, 2021). However, rapid modernization has led to the decline of vernacular features, as prefabricated materials and standardized housing replace traditional forms (Zhang, 2019). Research also highlights practical challenges, such as residents' preference for modern materials due to perceived durability and policymakers' tendency to prioritize quick, standardized development over labor-intensive vernacular techniques (Chen et al., 2022). Addressing these issues requires community engagement and economic incentives to preserve vernacular architecture while meeting contemporary needs.

3. Traditional Social Structures and Cultural Practices

Beyond architecture, traditional social structures and cultural practices shape rural spatial organization and environmental adaptation. In China, clan networks historically influenced village layout, land use, and governance (Xu & Xia, 2023). Though weakened by urban migration, clan structures still play a role in collective decision-making, suggesting potential for leveraging lineage associations in sustainable rural design. Similarly, traditional agricultural practices impact land-use patterns, irrigation, and environmental adaptation. Many Yi communities in Chuxiong historically employed semi-agricultural,

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semi-pastoral models, with homesteads incorporating courtyards for drying crops, communal threshing grounds, and livestock areas. However, modern planning often disrupts these patterns, overlooking indigenous ecological knowledge that contributes to sustainability.

Ethnic minority traditions also shape rural environments. The Yi community's spiritual practices, such as Bimo rituals and fire worship, influence courtyard layouts, communal fire pits, and ceremonial spaces. These cultural elements reinforce social cohesion and identity, yet are often ignored in contemporary rural planning. Incorporating clan-related sites, sacred landscapes, and communal gathering spaces into design frameworks could enhance cultural sustainability and community acceptance.

4. Sustainable Environmental Design and Cultural Sustainability

Sustainable rural design must integrate ecological conservation with cultural identity, ensuring that modernization complements rather than replaces traditional landscapes. Research highlights that green spaces, water conservation systems, and locally sourced materials contribute to both cultural and ecological resilience (Zhang & Liu, 2021). Additionally, passive design techniques—such as natural ventilation, rainwater harvesting, and low-impact construction—are increasingly recognized in rural revitalization projects (Wu & Yang, 2021). However, many of these technical interventions overlook the role of cultural traditions, vernacular architecture, and social structures, which are essential to community engagement and long-term sustainability. To address this gap, this study applies cultural ecology principles to develop an environmental design strategy that reinforces both cultural continuity and ecological resilience.

5. Challenges and Opportunities in Rural Modernization

Rural modernization presents both opportunities and challenges for culturally sustainable development. While infrastructure and housing investments improve living conditions, poorly managed modernization can lead to cultural homogenization and the loss of vernacular landscapes (Wang, 2019; Zhang, 2019). A key critique is that top-down policies prioritize economic growth over cultural values, resulting in standardized rural construction that erodes village identity. Scholars emphasize that successful rural revitalization must integrate cultural preservation with economic development, promoting participatory planning, local craftsmanship, and heritage-based tourism (Zhang & Liu, 2021).

Successful case studies demonstrate that mapping cultural assets (e.g., temples, courtyards, historical trees) and engaging local artisans in public space design strengthen cultural identity while supporting economic sustainability. However, policy coordination across sectors (culture, tourism, construction, agriculture) remains a challenge, and heritage conservation often competes with development incentives. The literature calls for structured policy frameworks that balance modernization with cultural conservation, ensuring that development efforts are both culturally meaningful and economically viable.

6. Research Gap and Relevance to Present Study

Existing studies emphasize the importance of culturally responsive environmental design, but few provide a practical framework that integrates architectural heritage, social structures, agricultural practices, and ethnic traditions into a cohesive rural development strategy. This gap is particularly evident in Chuxiong, where strong clan networks, Yi cultural traditions, and unique landscape practices are often overlooked in modern planning.

Much of the current research remains theoretical, offering limited guidance for planners and policymakers on how to apply cultural sustainability principles in real-world projects. This study addresses this gap by developing a cultural ecology-based design framework tailored to Chuxiong. It incorporates clan-based governance (to strengthen community ties), traditional land use (to support rural livelihoods), and Yi cultural elements (to maintain local identity in new developments).

By translating these insights into practical design strategies, this research ensures that modernization respects cultural heritage while enhancing ecological and social sustainability. It offers a replicable model for rural revitalization, bridging the gap between development and cultural preservation to support more resilient and culturally rich rural communities.

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Methodology

1. Research methodology

This study employs a mixed-method approach, integrating qualitative and quantitative methods to analyze cultural sustainability and environmental strategies in Chuxiong's rural areas. The methodology consists of five key methods:

1.1 Literature Review Method

A comprehensive literature review was conducted to establish the theoretical foundation of this study, drawing from Google Scholar, Web of Science, Scopus, and CNKI. The search focused on cultural sustainability, cultural ecology, vernacular architecture, and ethnic minority spatial planning in China, with inclusion criteria emphasizing peer-reviewed journal articles, policy reports. Studies lacking direct relevance to environmental design and cultural sustainability were excluded. This review provided critical insights into the relationship between cultural identity and environmental planning, forming the basis for the study's methodological framework.

1.2 Field Observation Method

Field observations were conducted in multiple villages in Chuxiong, selected based on their ethnic diversity, level of modernization, and preservation of vernacular architecture. The study encompassed traditional settlements with high cultural retention, villages undergoing modernization, and hybrid settlements integrating both traditional and contemporary elements. Observations focused on spatial organization, including courtyard layouts, street networks, and communal spaces, as well as vernacular architecture, examining building materials, construction techniques, and aesthetic elements. Additionally, environmental design elements, such as sustainability measures and land-use adaptations, were analyzed alongside community interactions in public spaces, festivals, and daily routines. To ensure systematic documentation, photographs and sketches were used to capture spatial patterns and cultural markers.

1.3 Survey Research Method

To ensure a comprehensive understanding of public perceptions, cultural influences, and the feasibility of proposed environmental strategies, this study employed a structured questionnaire and semi-structured interviews targeting key stakeholder groups. The survey was designed to provide both qualitative and quantitative data, ensuring the findings align with local needs and inform culturally responsive design strategies.

Survey participants were selected using random sampling techniques to ensure broad representation across different population groups. The study focused on New Village, which has a total population of 1,568, including 1,501 agricultural residents. The sample size was determined using Cochran's formula to achieve a 95% confidence level with a 5% margin of error, resulting in a final sample of ≈310 respondents. The distribution among key groups was as follows:

1) Local Residents (150 participants): Stratified by age, occupation, and involvement in community activities to ensure diverse perspectives on rural living conditions and cultural sustainability.

2) Outsiders (150 participants): Balanced across tourists, temporary residents, and entrepreneurs, capturing external viewpoints on rural identity and development.

3) Experts and Scholars (5 participants): Selected for their expertise in environmental sustainability, cultural heritage, and rural development, providing academic and professional insights.

4) Government Officials (5 participants): Representatives from rural development departments contributed policy perspectives on cultural preservation and environmental planning.

This sampling method ensures that the voices of both community insiders and external stakeholders are incorporated, enhancing the validity and generalizability of findings.

The structured questionnaire focused on key aspects of rural development and cultural sustainability, assessing perceptions of vernacular architecture, community engagement, environmental awareness, and the feasibility of proposed design interventions. It examined attitudes toward traditional building preservation, the role of courtyards and public spaces in social interaction, and preferences for

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sustainable land use and agro-tourism strategies. A pilot survey with 30 participants was conducted to refine the questionnaire.

1.4 Data Analysis Method

This study employed descriptive statistics to summarize survey data and correlation analysis to explore relationships between cultural factors and environmental design preferences. Thematic analysis was applied to interview responses, identifying key themes related to cultural sustainability. Additionally, content analysis of literature and policy reports provided insights into existing environmental strategies.

1.5 Conceptual Design Method

Building upon the findings from case studies, field observations, and survey results, this study developed a culturally responsive environmental design framework for Nanhua Xincun, a site selected for its rich Yi minority cultural heritage, ongoing rural revitalization efforts, and a distinct contrast between traditional and modern design approaches.

The conceptual design process involved identifying key spatial conflicts, such as the loss of communal spaces and the disconnection between old and new structures, and extracting vernacular architectural principles, including courtyard layouts and adaptive building forms. Community feedback was incorporated to align design elements with local needs, while SketchUp and AutoCAD were used to develop initial conceptual models, which were refined through expert consultations and cultural ecology principles. The final design integrates traditional spatial patterns to preserve community cohesion, vernacular materials for environmental and cultural sustainability, multi-functional public spaces to support local activities and tourism, and ecological resilience measures to enhance environmental adaptation. This framework ensures that modernization efforts respect and reinforce the cultural identity of Nanhua Xincun.

2. Research tools

2.1 Digital Imaging Tools: Cameras captured architectural details and landscapes. SketchUp (SU) and Lumion visualized conceptual designs, while Photoshop enhanced and analyzed spatial elements.

2.2 Survey and Interview Tools: An online survey platform collected questionnaire responses, and semi-structured interviews were recorded and transcribed digitally, providing quantitative and qualitative data.

2.3 Literature Management Tools: Zotero and Mendeley organize scholarly articles, policy documents, and historical records, ensuring efficient citation management.

2.4 Data Analysis Tools: SPSS and Excel were used to apply descriptive statistics for survey data and correlation analysis to examine relationships in environmental design preferences. Thematic and content analysis identified key insights from interviews and literature.

Results

1. Cultural Ecology and Environmental Design in Chuxiong's Rural Areas

Cultural sustainability is crucial in shaping rural environments, ensuring modernization does not erase traditional identity. Chuxiong, known for its ethnic diversity and rich heritage, faces challenges in integrating cultural elements into contemporary environmental planning (Wu & Yang, 2020; Zhang, 2019). Rapoport (1982) emphasized that cultural sustainability in environmental design requires preserving traditions, adapting architecture, and maintaining spatial organization. However, rapid urbanization has disrupted traditional settlement patterns, making it essential to balance modernization with heritage preservation.

A comparative analysis of multiple villages in Chuxiong highlights significant differences in spatial layout, material use, and community engagement (Li & Sun, 2020; Fang, 2020). Table 1 summarizes these distinctions. Traditional villages typically feature clustered courtyard homes with wooden structures and earthen walls, while modernized rural areas are dominated by scattered concrete houses, resulting in the loss of vernacular elements. Our field observations confirmed this contrast—older hamlets retain tightly-knit clusters around temples or marketplaces, whereas newer developments lack communal spaces, affecting how residents interact with their environment.

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Table 1 Key Characteristics of Rural Settlements in Chuxiong

No.	Aspects	Traditional Rural Settlements	Modernized Rural Spaces
1	Architectural Style	Vernacular houses with wooden structures, sloped roofs, and courtyards	Concrete houses with standardized designs, loss of traditional elements
2	Spatial Organization	Clustered layouts around communal spaces	Scattered housing, fewer community-oriented spaces
3	Public Space Use	Central courtyards, temples, and markets as gathering points	Reduced public space, more individualized housing
4	Cultural Elements	Decorative motifs, locally sourced materials, and symbolic spatial planning	Minimal integration of cultural identity

Industrialized construction has largely replaced traditional materials and craftsmanship in Chuxiong's rural areas. A survey of 60 households across three villages revealed that over 90% of homes built after 2010 were made of concrete and brick, with no use of local timber or clay. As a result, younger generations no longer recognize traditional wood carving or rammed-earth techniques. A village mason lamented, "Few people build with wood and earth now. The old skills are disappearing." Additionally, the loss of communal spaces has weakened social cohesion. Field observations showed that three out of five villages surveyed no longer have an active central square, and in Nanhua Xincun, a once-bustling public courtyard is now used for parking and storage, limiting cultural events. An elder resident noted, "We hardly celebrate the New Year together now because there's no open space large enough for the whole village." Furthermore, new housing developments lack cultural integration. A spatial analysis of a recently built housing cluster near Nanhua Xincun found identical two-story houses arranged in a grid, with no decorative motifs reflecting Yi or Bai architectural styles. Survey results showed that 68% of respondents felt their new buildings lacked cultural character, with one resident commenting, "The new houses are practical, but they could be anywhere – they don't feel like our village."

Despite these challenges, there is strong community support for culturally responsive modernization. 73% of survey respondents expressed a desire to preserve or restore traditional architectural elements, and a majority supported revitalizing communal spaces if given the resources. These findings suggest that modernization, if guided by local cultural and ecological knowledge, can align with community identity and contribute to long-term sustainability. The following sections present a case study of Nanhua Xincun, illustrating these issues in detail, followed by a conceptual design framework addressing these challenges.

2. Case Study: Nanhua Xincun as a Model for Culturally Responsive Environmental Design

Nanhua Xincun was selected as a representative case study to assess the feasibility of cultural ecology-based design strategies in rapidly evolving rural environments. Located in Nanhua County, Chuxiong Prefecture, the village consists of approximately 200 households, predominantly of the Yi ethnic group, with influences from neighboring Bai culture. While the community retains strong cultural characteristics in language, festivals, and collective memory, its built environment has undergone significant transformations over the past two decades.

According to village records and testimonies from elderly residents, more than half of the traditional houses in Nanhua Xincun have been demolished or extensively renovated since 2000. The introduction of modern concrete housing and the expansion of infrastructure have led to the loss of traditional architectural features and the reduction of communal spaces. For example, the village once had three public courtyards and two ancestral temples, but today, only one courtyard remains intact, and one small temple is still in use—the others were either demolished or abandoned during development projects between 2010 and 2015. These changes reflect broader trends in China's rural modernization, where traditional villages face

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increasing pressures from urban expansion, economic transitions, and top-down development policies (Liu & He, 2021).

Our field observations and spatial analysis provide an in-depth understanding of spatial disruptions and cultural losses in Nanhua Xincun. Figure 1 highlights the village layout, with traditional residential areas concentrated in the center, while Figure 2 illustrates the outward expansion of new housing developments, particularly toward the north and east, as indicated by shaded areas. This unregulated expansion has disrupted the overall layout, with some peripheral houses now located 500–600 meters from the old village center, making access to public facilities more difficult.

Field measurements show that after 2010, the average walking distance from residences to the nearest public gathering space increased from approximately 100 meters to 350 meters, reducing pedestrian accessibility and overall connectivity within the village.

Villagers reported that several historically significant footpaths, which had connected the village to nearby farms and water sources for generations, have now been blocked by the walled courtyards of newly built homes. This has forced residents to take longer detours, reducing spontaneous social interactions along these routes and weakening the village's sense of community and cultural connectivity.

Figure 1 Satellite Map of Nanhua Xincun
Source: http://www.wxno.com/

Figure 2 Current Conditions of Nanhua Xincun
Source: http://www.dashangu.com/postimg_21958724_8.html

3. Conceptual Design Proposal for Nanhua Xincun

3.1 Design Principles and Strategy Development

Based on the analysis, a culturally responsive environmental design framework was developed for Nanhua Xincun, integrating principles of cultural preservation, ecological sustainability, and functional spatial planning. The proposal restores traditional spatial patterns by reintegrating courtyard-based community spaces, enhancing cultural identity through the use of locally sourced materials and vernacular construction techniques, and promoting sustainability by incorporating cultural and ecological elements into the landscape design (Wu & Yang, 2021).

Additionally, multi-functional public spaces are introduced to support cultural activities and local economic development, ensuring a balance between tradition and modernization. The framework follows place-based design strategies, ensuring that modernization aligns with local heritage and ecological context, which is critical for rural sustainability (Li & Sun, 2020).

Table 2 summarizes the four primary facets of the proposal and their linked strategies, which are further detailed below:

1) Spatial Organization: Reintroduce clustered layouts – The plan consolidates homes into small clusters around shared courtyards, counteracting the scattered housing pattern we observed. This strategy addresses the loss of traditional settlement structure by enhancing community interaction and ensuring each cluster has an accessible gathering space.

2) Architectural Features: Adapt vernacular designs for new buildings – We propose modernized versions of vernacular architecture, utilizing local materials (timber, rammed earth) and traditional forms

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(courtyard houses with pitched roofs). This approach aims to revitalize the village's architectural heritage, replacing the "urban box" houses with designs that reflect Yi and Bai cultural aesthetics.

3) Public Space Enhancement: Create multi-functional communal spaces – The design introduces or restores public plazas, courtyards, and markets as hubs for cultural and social activities. By doing so, it strengthens community engagement and provides dedicated areas for festivals, markets, and daily interaction.

4) Ecological Integration: Incorporate sustainable landscaping and farmland preservation – We integrate the surrounding rice paddies, gardens, and forested hills into the village plan through green buffers, irrigation systems, and agroforestry. This ensures ecological balance and livelihood support, preserving the agricultural heritage while protecting the environment.

Table 2 Key Features of the Conceptual Design Proposal

No.	Design Aspect	Proposed Strategy
1	Spatial Organization	Reintroducing the traditional clustered layout to enhance community interaction
2	Architectural Features	Revitalizing vernacular architecture through modern adaptations of traditional designs
3	Public Space Enhancement	Creating flexible-use spaces for cultural and social activities
4	Ecological Integration	Sustainable landscaping with native plant species

3.2 Conceptual Master Plan for Nanhua Xincun

The proposed master plan for Nanhua Xincun integrates architecture, public spaces, and agricultural landscapes to restore cultural continuity while addressing modern rural needs. The strategy focuses on revitalizing vernacular architecture, reintroducing communal courtyards and markets to enhance social cohesion, and preserving rice paddies and mountain landscapes through sustainable land management. By reinforcing spatial continuity and aligning built forms with ecological systems, the plan creates a cohesive, culturally responsive rural environment.

The conceptual master plan for Nanhua Xincun integrates spatial reorganization, functional zoning, transportation planning, and landscape design to enhance community interaction, cultural preservation, and ecological sustainability. It addresses the fragmentation of settlement patterns and loss of communal spaces while supporting rural development.

The proposed village master plan restores courtyard-based residential clusters, integrating modern infrastructure while maintaining traditional spatial organization (Figure 3). The functional zoning strategy defines six key areas: a comprehensive service zone for administration and commerce, a public activity zone for markets and festivals, a residential community, a mountainous landscape zone for biodiversity preservation, an agricultural cultivation area, and an education and school zone, ensuring a balanced integration of social, cultural, and ecological functions (Figure 4).

The transportation plan prioritizes pedestrian-friendly routes and reinstates traditional footpaths to enhance accessibility and social connectivity (Figure 5). The spatial and landscape framework establishes a primary spatial axis, a landscape axis, and key landscape nodes to reinforce structural coherence and visual continuity (Figure 6). The spatial axis links major functional areas, while the landscape axis incorporates green buffers and scenic corridors to blend built and natural environments. Key landscape nodes, such as plazas, courtyards, and cultural landmarks, serve as focal points that enhance community interaction and spatial identity.

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Figure 3 Master Plan Diagram
Source: By Researcher

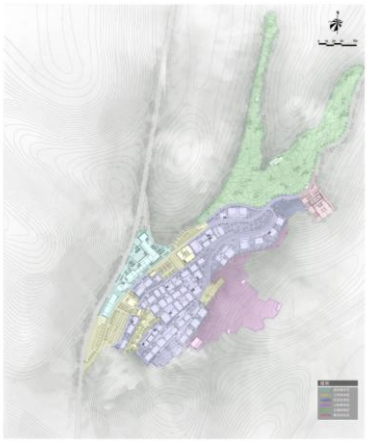

Figure 4 Functional Zoning Plan
Source: By Researcher

Figure 4 Traffic Analysis Plan
Source: By Researcher

Figure 5 Landscape Analysis Plan
Source: By Researcher

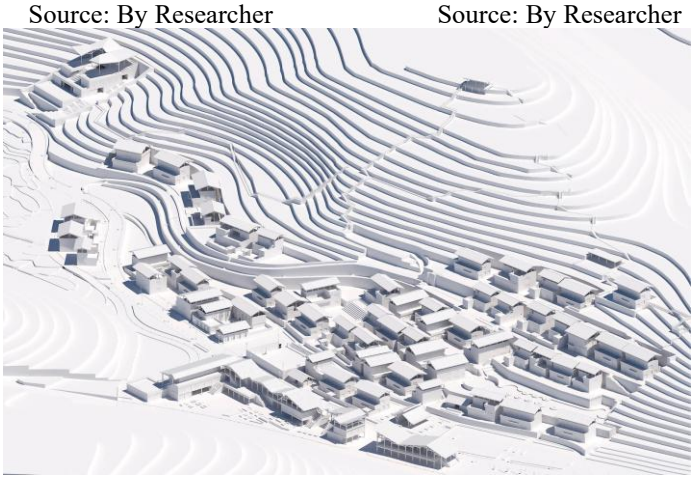

Figure 7 Planning Aerial View
Source: By Researcher

4. Visual Representation of the Design Proposal

To effectively illustrate the conceptual design strategy, a series of 3D-rendered images, diagrams, and spatial analyses was developed using SketchUp and Lumion. These visualizations comprehensively present how traditional architectural forms, public spaces, and agricultural landscapes can be reintegrated into Nanhua Xincun, ensuring that modernization efforts align with cultural sustainability and rural revitalization goals.

4.1 Architectural Design: Integrating Vernacular Forms with Contemporary Needs

The architectural design integrates traditional vernacular forms with modern functionality, drawing from Chuxiong's courtyard houses and mountain dwellings while preserving cultural identity. Inspired by local rammed-earth homes and community preferences, the new residential design reintroduces courtyard-centered layouts, ensuring social interaction, cultural continuity, and natural ventilation. Modern adaptations include locally sourced materials, contemporary amenities, and terrain-sensitive construction, maintaining a human-scale height (4–6 meters) to blend with the village skyline.

Architectural Elevation Drawing presents an elevation drawing, showcasing timber-framed roofs with extended eaves and grey clay tiles, characteristic of Yi and Bai dwellings, providing shade and rain protection. Walls of rammed earth and locally fired brick offer sustainability and thermal efficiency, as demonstrated in field tests, where traditional materials kept interiors 3–5°C cooler than concrete houses.

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The elevation also highlights terrain-adaptive construction, with some homes built on raised stone foundations, reducing land reshaping and preserving the natural landscape (Figure 8).

Figure 8: Architectural Elevation Drawing
Source: By Researcher

To implement this vision, key architectural interventions include:

1) Courtyard-Centered Layouts: Homes are arranged around 50–80 m² courtyards, ensuring ventilation, daylighting, and private outdoor space. It's an inward-facing layout, with a veranda and family shrine, preserving local traditions while integrating modern functions (Figure 9).

2) The use of local materials and craftsmanship incorporates native timber, rammed earth, and mud bricks, reviving traditional construction methods while supporting local employment. Collaboration with local artisans ensures the integration of decorative timber joints, preserving craftsmanship and reinforcing cultural authenticity.

3) Cultural Aesthetics with Modern Amenities: Homes follow a "traditional exterior, modern interior" approach, incorporating kitchens, bathrooms, insulation, and discreet solar panels (Figure 10).

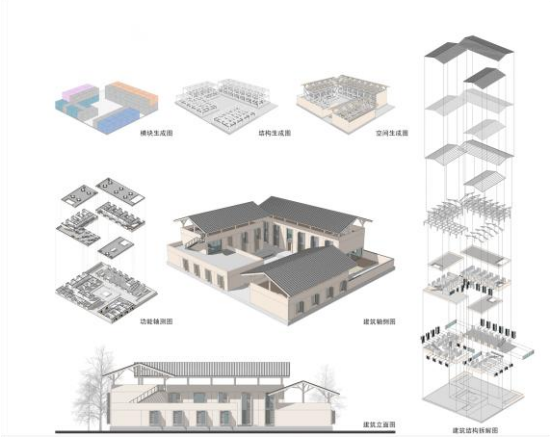

Figure 9 Rural Residential Architecture Plan
Source: By Researcher

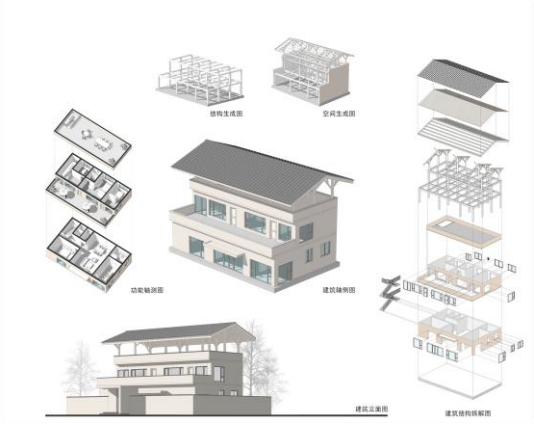

Figure 10 Rural Residential Architecture Plan
Source: By Researcher

4.2 Public Space Enhancement: Strengthening Community Engagement

To counter the decline of communal spaces in Nanhua Xincun, this proposal revitalizes key public areas, ensuring accessibility and restoring traditional gathering spaces. The entrance plaza, historically central to festivals and social life, will be expanded and redesigned as a multifunctional square. It will accommodate daily activities, seasonal festivals, and markets, incorporating seating, landscaping, and cultural elements that reflect Yi heritage (Figure 11).

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Additionally, a small leisure park will be introduced within newly expanded residential clusters, strategically positioned along pedestrian routes to encourage spontaneous social interactions. Designed around an existing gathering spot, this space will feature seating, water wells, and shaded areas, ensuring that every neighborhood has a shared public space within walking distance (Figure 12).

A key intervention is the revitalization of the village market and artisan quarter, transforming the east–west street into a pedestrian-friendly market zone. On designated days, vendors will set up stalls along the widened, stone-paved street, fostering local trade and cultural exchange. Adjacent vacant buildings will be repurposed into workshops for traditional crafts such as woodworking and weaving, creating an economic and cultural hub (Figure 13).

To unify these spaces, a network of pedestrian-friendly pathways will reconnect the plaza, leisure park, market street, and school. These paths, designed based on observed natural desire lines, will use locally sourced stone or compressed earth to maintain the village's aesthetic. Wayfinding elements, such as wooden posts with ethnic motifs, will enhance navigation while reinforcing cultural identity (Figure 14).

Together, these interventions aim to revitalize communal life, support the local economy, and restore cultural continuity. The enhanced public realm is expected to significantly increase community events, strengthen social ties, and preserve traditions for future generations.

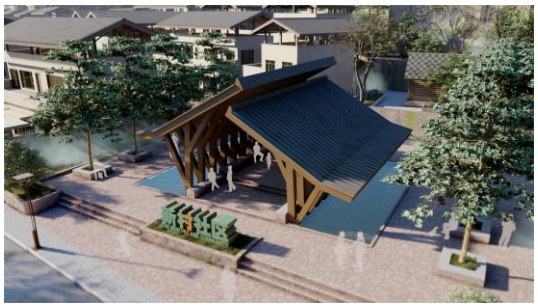

Figure 11 Entrance Plaza Rendering
Source: By Researcher

Figure 12 Leisure Park Rendering
Source: By Researcher

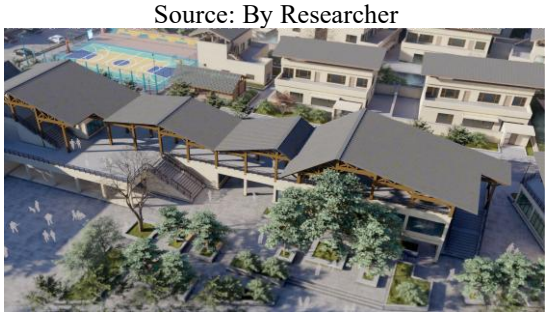

Figure 13 Comprehensive Building
Source: By Researcher

Figure 14 Block Plan Rendering
Source: By Researcher

4.3 Agricultural Landscape and Farmland Integration

The proposal integrates agriculture and ecological conservation to preserve Nanhua Xincun's agrarian heritage and ensure sustainable land use. Farming and natural ecosystems are central to local culture, but modernization pressures have led to farmland reduction and declining interest in agriculture. The design revitalizes rice paddies, orchards, and forests, reinforcing their role in both economic livelihoods and cultural practices.

The rice paddies are preserved as active farmland, maintaining the village's traditional agrarian landscape while supporting experience-based agriculture. A network of footpaths weaves through the fields, allowing for agro-tourism activities such as rice planting experiences and harvest festivals, reinforcing the connection between farming, culture, and rural development (Figure 15).

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The mountain forest landscape is managed as a productive and ecological zone, incorporating native fruit trees, herbal gardens, and biodiversity conservation efforts. Community orchards support local livelihoods, while medicinal plant gardens sustain traditional foraging knowledge. Pavilions and scenic trails enhance recreational and cultural engagement, ensuring the land remains socially and ecologically valuable (Figure 16).

By integrating sustainable agriculture, conservation, and cultural tourism, the plan ensures that Nanhua Xincun's landscapes remain productive, culturally meaningful, and environmentally resilient.

Figure 15 Pastoral Landscape Rendering
Source: By Researcher

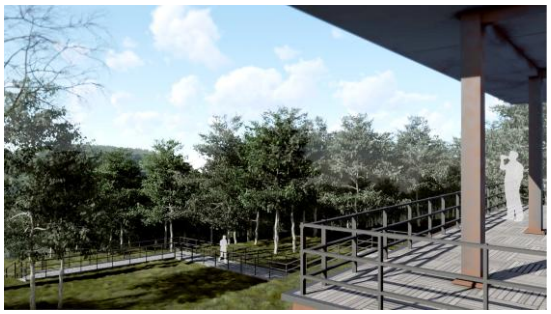

Figure 16 Mountain Forest Landscape Rendering
Source: By Researcher

5. Linking Findings to Design Strategies and Outcomes

The environmental design strategy for Nanhua Xincun applies cultural ecology principles, integrating architecture, community space, and landscape to address identified needs. Each design component directly corresponds to research findings: the reintegration of vernacular architecture (courtyard layouts, local materials) addresses the loss of traditional houses and craftsmanship; public space revitalization and market areas respond to declining social cohesion; and ecological interventions in farmland and forests mitigate environmental neglect while supporting rural livelihoods.

This approach ensures culturally rooted, environmentally sustainable, and socially inclusive rural development. Moreover, it provides a replicable framework for other rural settlements facing similar challenges, demonstrating how tradition and modernity can coexist in rural revitalization.

Village leaders and elders responded positively, remarking that the proposed design revitalizes traditional village aesthetics while integrating modern elements, indicating strong community support—critical for successful implementation.

Discussion

This study highlights the critical role of cultural identity in sustainable rural development, as demonstrated in the case of Nanhua Xincun. Integrating cultural ecology principles into environmental design has reinforced communal bonds, heritage preservation, and ecological balance. The reintroduction of traditional courtyard layouts has strengthened social cohesion, aligning with research that warns against the disruptive effects of neglecting local traditions. The case illustrates how vernacular architecture and spatial organization enhance community resilience, supporting the view that rural culture is fundamental to social identity and harmony with nature.

Findings confirm that culturally aligned development strategies create villages that are both socially cohesive and ecologically sustainable, extending theories of vernacular sustainability with new empirical insights. Consistent with Oliver's (2003) framework, the case demonstrates how adaptive design (rammed earth, timber, courtyards) accommodates modern needs without eroding cultural meaning. It also challenges one-size-fits-all development models, which have contributed to cultural identity loss in rapidly modernizing rural areas. Unlike Zhang's (2019) warning about unchecked urban expansion diluting rural identity, this study presents a counterexample, proving that integrating indigenous architecture and practices mitigates cultural erosion. The findings also align with research from Chuxiong and Southwest China, showing that the integration of ecological and cultural factors enhances rural sustainability.

Despite its contributions, the study has several limitations. First, as a single-case study, its generalizability is limited; rural communities vary, and contextual adaptations may be required elsewhere. Second, while qualitative data (field observations, interviews, surveys) provided valuable insights, the lack

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of extensive quantitative or longitudinal data makes impact measurement suggestive rather than definitive. For instance, while community feedback strongly supports the courtyard-centric plan, without pre- and post-implementation surveys, precise effects on social interaction or ecological sustainability remain unquantified. Third, the conceptual design framework, though outlined, lacks detailed spatial metrics and architectural visualizations, which could enhance its practical applicability.

These limitations suggest clear directions for future research. Further studies should test this framework across multiple villages, monitor long-term impacts, and integrate quantitative surveys on resident satisfaction and ecological indicators. Developing detailed master plans and 3D models would improve usability for practitioners. Acknowledging these constraints ensures transparency and lays the groundwork for refining the intersection of cultural sustainability and environmental design.

Conclusion

This study demonstrates that cultural ecology principles can effectively balance modernization and cultural sustainability in rural development. The Nanhua Xincun case illustrates how courtyard-based layouts, vernacular architecture (rammed earth, timber structures), and local landscape preservation can meet contemporary needs while retaining community identity. The study reinforces the interdependence of cultural heritage and sustainable planning, offering a practical framework for integrating cultural ecology into design strategies.

Beyond theory, the findings have policy and practical significance. Policymakers can apply this evidence-based framework to shape rural revitalization policies, ensuring that development permits and funding include cultural preservation criteria. Planners can draft zoning laws that sensitively integrate new infrastructure into traditional landscapes, while architects and designers can use this study as a practical guide for community-driven, culturally grounded design.

As rural communities face modernization pressures, this study highlights the need for development approaches that respect heritage while ensuring long-term sustainability. Cultural sustainability is essential for social resilience, identity, and ecological balance. By prioritizing local heritage and environmental sustainability, rural communities can adapt without losing their cultural foundations. This study provides a roadmap for culturally sustainable rural development in Chuxiong. By embracing the principles of cultural ecology and prioritizing the preservation of local heritage, we can create rural communities that are both vibrant and resilient for generations to come.

Recommendations

To effectively implement cultural ecology-based environmental strategies in Chuxiong's rural areas, the following prioritized recommendations are proposed to ensure practical and actionable outcomes.

1. Prioritize the Preservation and Revival of Vernacular Architecture

Preserving and reinforcing vernacular architecture is essential for maintaining cultural identity and traditional craftsmanship. Design guidelines should mandate the integration of traditional materials (rammed earth, timber), architectural features (extended eaves, grey clay tiles), and spatial layouts (courtyard-centered homes) into new developments. To support this, financial incentives such as government grants and tax reductions should encourage homeowners and developers to incorporate vernacular elements. Local craftsmanship should be strengthened through apprenticeship programs, skill-sharing workshops, and material subsidies, ensuring that traditional construction knowledge is preserved and passed down. A certification program for artisans specializing in vernacular techniques can further support their employment in restoration and conservation projects.

2. Integrate Traditional Spatial Planning with Sustainable Infrastructure

Revitalizing courtyard-based layouts in both new and renovated developments is crucial for preserving social cohesion and cultural continuity. Restoring communal gathering spaces and integrating cluster housing models that reflect historic settlement patterns can reinforce local traditions. Modern infrastructure projects, including roads, water systems, and public buildings, should be planned in alignment with traditional village layouts to minimize disruption to the cultural and environmental landscape. Sustainable solutions such as solar-integrated tiled roofs, compressed earth brick pathways, and rainwater collection systems should be prioritized, ensuring that modernization enhances rather than replaces the traditional built environment. Furthermore, hybrid public spaces that combine modern amenities (sanitation, electricity, and digital access) with culturally significant communal areas (markets, gathering spaces, and ancestral halls) will help balance modernization with heritage conservation.

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3. Strengthen Cultural Policy and Community Participation

Establishing cultural zoning laws to protect heritage sites, historic village cores, and traditional public spaces will ensure that new development aligns with local identity. A community-led environmental and cultural council should be introduced, allowing local stakeholders to participate actively in planning, construction, and heritage preservation decisions. Additionally, heritage education initiatives in schools and training centers can raise awareness and equip younger generations with knowledge in vernacular architecture and ecological planning. Public-private partnerships with tourism and cultural heritage organizations can generate economic incentives for conservation, including heritage tourism programs, local material markets, and eco-homestay initiatives that encourage sustainable rural development.

By implementing these targeted strategies, Chuxiong's rural development can achieve a sustainable balance between modernization and cultural preservation. These recommendations provide a replicable model for rural areas facing similar challenges, ensuring that local heritage, community resilience, and ecological sustainability are safeguarded while adapting to contemporary needs.

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