Planning for Resilience:
A Proposed Landscape Evaluation for Redevelopment Planning
In the *Linpan* Landscape

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Abstract

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China's countryside is rapidly changing under the New Socialist Countryside policy aimed at village and town modernization. Planning solutions often prescribe a standard concentration approach, where many believe that a dense settlement pattern is more efficient at providing social services and public amenities while attaining the necessary economies of scale for modernized living, agricultural productivity, and stability. This can be a drastic change to traditional settlement patterns. The *linpan* landscape of the Chengdu Plain is a useful case study, given its unusually dispersed pattern, which nevertheless supports a high population density at a large scale with interdependent social-ecological systems over a long period of time. Local planners have experimented with varying degrees of concentration to meet both national redevelopment goals as well as local planning ideals that value preservation of the landscape's traditional characteristics. This highlights conflicts between short-term planning goals focused on efficient land use and long-term goals that support adaptability and continued ecological function. This thesis illustrates the use of a resilience framework to evaluate redevelopment alternatives and focuses specifically on

landscape structure (pattern) as a variable in agroecosystem resilience. A set of indicators and measures in three main categories were proposed: landscape heterogeneity, appropriate scale, and biodiversity. Three administrative villages in Pi County were tested to develop a baseline of the existing typology and compare alternatives. Results found that village sites have similarities in many indicators and measures that help form a baseline of the existing *linpan* landscape typology. In comparing alternative development models against this baseline, the eco-village model in Anlong best meets indicators of traditional landscape structure that support resilience. The extreme concentrated alternative model in Zhanqi deviated the most from the traditional landscape structure.

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CHAPTER 1: INTRODUCTION

1.1 Problem Statement

Planning for Resilient Cultural Landscapes During Rural Redevelopment in China

China's rapid urban transformation fueled by the economic boom of the past thirty years has captivated world attention. In this short time, urbanization and economic development have transformed what was for a long time an agrarian society into an urbanized one. As of 2011, 51.3 percent of China's population (690 million) now live in urban areas (Chan 2012). The urban population is expected to reach 1 billion by 2030 (McKinsey Global Institute 2009).

What is less known is the drastic change sweeping across the countryside. Economic growth since Deng Xiaoping's reform and opening policy began in 1979 has disproportionately benefited urban areas, leading to increased urban-rural inequality. To address this imbalance, the national government launched the New Socialist Countryside (NSC) campaign in 2006 to modernize infrastructure, improve livelihoods, and increase agricultural efficiency in rural areas. NSC policy has been swiftly implemented in many rural areas around the nation since that time. Yet the effects of such rapid and widespread change on China's roughly 600 million rural residents are slowly coming to surface and have recently begun to appear on front page international headlines.[1]

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[1] The New York Times published a series of articles on the subject called 'Leaving the Land.' The first of these articles was published in the summer of 2013. See bibliography for articles.

[2] According to Lei Guang, Justin Yifu Lin is credited with coining the term 'new socialist countryside,' which was adopted by the government as the slogan for new rural development policies (Guang 2010).

[3] Planning documents were provided courtesy of the Chengdu Planning Bureau during a visit in August 2012. These refer to the following documents: (Rural Planning Manaul 2010, Planning and Construction Technical Guidebook

At the local level, municipal planning departments carry out rural redevelopment policy for their surrounding regions, including rural counties, towns and villages under their administration. In western China, rural planners in Chengdu administer redevelopment planning for peripheral agricultural areas outside of the city core, a landscape known locally as *linpan* (林盘), meaning forest basin. Locals value *linpan* for its cultural and ecological significance, a socio-ecological system that has persisted for hundreds, if not thousands of years. The *linpan* landscape is characterized by a dense-but-dispersed settlement pattern and the interplay of essential land use elements including fields, irrigation channels, and homes within wooded or forested patches.

The continuation of *linpan's* historical landscape structure and function is threatened not only by larger urbanization pressures at play, but also by a redevelopment policy preference for concentrated settlement forms. China's assumption that concentrated, dense form is good is also held by the planning profession in the developed, urbanized West. Such planning movements as New Urbanism and Smart Growth advocate for compact form to achieve other goals for walkable, less car dependent, mixed-use neighborhoods. These movements believe that a dense settlement form "supports wider transportation choices, and provides cost savings for localities…In addition, local governments find that, on a per-unit basis, it is cheaper to provide and maintain services like water, sewer, electricity, phone service and other utilities in more-compact neighborhoods than in dispersed communities" (Smart Growth Online 2013).

National redevelopment policy in China promotes the concentration of land, people (settlements), and industry due to a belief that this kind of land use development is more efficient. Concentrated housing would increase agricultural plot sizes and increase efficiency of social services, achieving the necessary economies of scale for modernized living, agricultural productivity and stability that are national goals. At the local level, Chengdu planners are also concerned with protecting the environment and aim to make the Chengdu region a 'world modern garden city' (*shijie xiandai tianyuan chengshi)* (ABC Planning Handbook; Ye and LeGates 2013). With many conflicting goals to meet, planners have been experimenting with different redevelopment spatial models to fit local context and achieve both local and national goals.

There are many aspects and challenges to rural redevelopment that relate to the work of this thesis but are not specifically addressed. From the anthropological perspective, current research examines the effects of rural development and redevelopment policy on local livelihoods. Matthew Hale conducted a comparative ethnographic account of four rural villages experimenting with redevelopment beyond official policy (Hale 2013). Anna Lora-Wainwright looks at the controversies and contentions from the perspective of local villagers during the urbanization of their rural village in western China (Lora-Wainwright 2012).

From a planning perspective, Ye Yumin and Richard LeGates consider Chengdu's rural-urban integration policy as an example of successful policy designed to meet modernization goals (Ye and LeGates 2013) that other cities can learn from. Yet their study does not consider the impacts of such policy on traditional landscape structure, nor what benefits such traditional landscape structure might support. I was interested in a land use perspective of how national and local redevelopment policy may affect a traditional landscape structure or pattern that is an example not only for China, but globally, of a sustainable, resilient agricultural landscape. The challenge of how to best plan for and manage resilient agroecosystems to support a growing human population in the face of increasing uncertainty, including climate change, is a globally important one. I focus on the role of landscape structure in supporting socio-ecological resilience because of the relationship between form and function. This has been a topic of research for decades in the field of landscape ecology. According to one perspective on this relationship, Richard Forman argues, "landscape structure is a key indicator of how the land works for people and for nature" (Leitao et al. 2006). While the relationship between landscape form and ecological function are complex, some forms seem more adaptable to changing conditions yet continue to function in a predictable way.

Through the *linpan* case study, I wanted to study the characteristics of the traditional landscape pattern through a resilience framework and identify resilience indicators and measures for landscape structure to compare current redevelopment alternatives to better inform the planning process and decision-making in a context specific site. From qualitative fieldwork conducted in the summers of 2012 and 2013, I noticed several problems related to two key steps in the Chinese planning process: setting goals and planning implementation. First, contradictions exist among planning goals to both increase commercial and industrial productivity and also protect the environment and preserve the traditional landscape. Local planning goals and documents published by the rural planning department of the Chengdu Planning Bureau expressed the need to preserve *linpan*, yet direct observation of many redevelopment models showed a lack of consideration for its unique landscape spatial patterns, focusing more on architectural and landscaping aesthetics as opposed to a deeper understanding of form and function. In interviews, local planners also expressed that the dispersed landscape model was wasteful of land, and that consolidation of settlements would lead to more efficient economies of scale. Second, planning implementation happens at a rapid pace. In one village site, reconstruction was scheduled to be completed within a year. Rapid implementation not only can have negative effects within the planning process, but also undermines the slow change that shaped the landscape over a long period of time.

To address these issues, I argue that redevelopment planning should include resilience as a planning goal to plan for potential disturbances (natural and man-made) that may occur in the future. Second, I use planning evaluation methods using resilience indicators to evaluate landscape structure as one factor that supports resilience in a socio-ecological landscape. I then illustrate the use of these indicators by comparing several alternative redevelopment models that I observed during fieldwork. The spatial analysis illustrates a method to quantify potential baseline characteristics of the traditional *linpan* landscape typology and also shows how alternatives compare against this baseline. This method may help local planners in China bridge gaps between policy and practice.

Planning for Resilience

This thesis first argues for the inclusion of resilience as a planning goal of rural redevelopment. In resilience, the goal is for a system to absorb shock and change while still maintaining its intended function (providing goods and services) over the long term. New Socialist Countryside policy goals aim to improve rural livelihoods and increase agricultural productivity through solutions that focus on short-term efficiency. Yet such a short-term focus may compromise long-term ability of the landscape to continue to produce food and provide ecosystem services.

Resilience is therefore a fitting goal to address China's larger national goals to continue and increase agricultural productivity in rural areas under increasing uncertainty over the continued ecological capacity of agricultural landscapes to function and produce food in the face of threats such as climate change, urbanization and environmental degradation. This thesis looks at the literature on resilience theory in agroecosystems, particularly the role of landscape structure in supporting three main resilience principles to buffer disturbances, promote self-organization, and support adaptive capacity. It analyzes the *linpan* landscape as an example of a resilient agroecosystem given its long history as an agriculturally productive region. This is discussed in Chapter 3.

Need for Evaluation in Resilience Planning

To help planners evaluate the range of choices for redevelopment of the *linpan* landscape and to address contradictions between local planning goals, I argue for the use of evaluation methods to compare alternatives. There is currently little in the local planning process that evaluates the alternatives, nor measures the traditional landscape characteristics. Given some assumptions about the resilience of the time-tested spatial structure of *linpan*, what can we learn about the features of that structure, so that some of them might be incorporated into the future environment? This thesis explores the use of a resilience framework to understand what kind of spatial patterns promote productive, adaptive and resilient socio-ecological systems over the long term. It then looks at how those characteristics are manifested in the *linpan* landscape and how such characteristics might be evaluated and measured using landscape metrics from landscape ecology. This thesis helps to quantify how much the landscape changes under different redevelopment alternatives.

1.2 Research Questions

This thesis addresses the following research questions:

- What are the goals of planning policy and practice in the *linpan* landscape of the Chengdu Plain?
- How can evaluation in planning resolve contradictions among policy goals?
- How does landscape structure support resilience?
- Using a resilience framework, what indicators for spatial patterns of land use and landscape structure should be considered for redevelopment planning in the *linpan* landscape?
- What do these indicators reveal about characteristics of the traditional landscape spatial pattern? How do alternative redevelopment models compare using these indicators?

1.3 Scope and Limitations

In the summers of 2012 and 2013 I conducted fieldwork in three administrative villages in Pi County (*Pi Xian*), each implementing a different redevelopment model. Field sites included Anlong Village, Jiang'an Village and Zhanqi Village. In summer of 2012, qualitative field research was conducted to understand the local perception of *linpan* as well as planning and preservation policy for the *linpan* landscape through interviews with local government officials, local rural planners, residents, scholars, and NGO workers. Interviewees were asked to give their thoughts and opinions on the definition of *linpan*, current planning policies, and future planning policies. Field research was conducted in the summer of 2013 to gather spatial data on selected sample areas in each of the three villages to compare and analyze land use characteristics. Please see subsequent chapters (Chapter 4 and Chapter 5) for a more detailed methodology.

Due to time and resource limitations, this thesis does not provide a detailed ethnographic, historic account of landscape change in the *linpan* landscape. It does not look at how each village developed historically or provides detailed information about the political, social or economic conditions of each place. Field research sketches a rough picture of these existing conditions with the purpose of supporting the main focus of the work- to illustrate characteristics of landscape structure in each of the village field sites and compare these characteristics as a way to evaluate outcomes and provide guidance for future redevelopment planning and implementation.

1.4 Outline of Thesis

Chapter 2 provides background and context for planning in the *linpan* landscape. It describes national and local rural redevelopment policy in China, known as the New Socialist Countryside policy (NSC). It then provides a brief overview of the *linpan* landscape in the Chengdu Plain and further describes how Chengdu planners interpret national rural redevelopment policy through their own goals, policies and practice.

Chapter 3 first discusses the use of a resilience framework in planning to explain why it should be included as a planning goal. It explains the concept of resilience and how it has been applied to agroecosystems, which the *linpan* landscape is an example of. It then discusses the role of landscape structure (spatial patterns, land use and scale) in maintaining socio-ecological resilience in an agroecosystem to suggest potential indicators that could be applied to the case study. Second, it discusses how evaluation is used in the planning process, what evaluation methods have been implemented in China in relation to NSC policy, as well as other evaluation methods that have been attempted for more participatory evaluation and planning.

Chapter 4 returns to the case study and describes the application and analysis of the proposed evaluation method to the *linpan* landscape. It describes the village sites chosen for study; defines the scales of study; identifies potential indicators and measures through the resilience framework and landscape ecology; and illustrates how these indicators manifest themselves in the context of the *linpan* landscape.

Chapter 5 describes the results of the evaluation method in the three village sites. It illustrates how the evaluation method can form a baseline of traditional *linpan* landscape characteristics and how the alternatives compare against this baseline.

Chapter 6 offers reflections on the use of this evaluation method as well as possible future steps for continued research on resilience planning for traditional socio-ecological agroecosystems facing redevelopment, modernization and urbanization pressures.

CHAPTER 2: BACKGROUND AND CONTEXT

2.1 National policy: New Socialist Countryside Policy

Policy Origins

The rapid pace of China's economic development since the 1980s distributed gains unevenly between rural and urban society, with urban residents and cities benefitting much more than their rural counterparts. Increasing income inequality has led to a widening rural-urban gap both inter-regionally between the western and eastern parts of the country and intra-regionally between rich urban centers and poor peripheral villages (Whyte 2010). The severity of the situation in rural China was famously summarized in early 2000. Li Changping wrote to then Premier Zhu Rongji in an open letter. "Peasants are really poor, rural life is exceedingly hard, and agriculture is in deep crisis" (Whyte 2010; Day 2008). This statement became known as the "three-rural crisis," or *sannong wenti*. It raised public and government concern about the plight of the countryside. The threat of an unequal society and millions of unhappy rural residents also has the potential to undermine the political regime. The national government is well aware of the importance of creating a more 'harmonious society' to maintain social and political stability.

In intellectual efforts to address rural problems, Wen Tiejun, a prominent intellectual and agricultural economist, emerged at the forefront of the New Rural Reconstruction Movement (NRRM) (*xin nongcun jianshe),* a socialist line of thought that produced a coalescence of research, experiments and activities in a new rural social and cooperative movement (Day 2008). Wen and proponents of NRRM viewed *sannong* not only as an economic problem in agricultural production, but also as a social and cultural crisis in the countryside, where links to China's place in a globalized market were a factor in the marginalization of the peasantry. Additionally, Wen argued that weak social institutions and organization in the countryside were a main factor in rural problems (Looney 2012). Researcher Lei Guang agreed with this opinion (Guang 2010 311-334). The movement gave rise to experiments in new cooperative farms in the mid-2000s as a way of protecting peasants and farmers from the increasing marketization and globalization of village life (Day 2008).

Using a more capitalist approach, Justin Yifu Lin, a prominent Chinese economist, advocated the use of market forces and globalization to address declining peasant income which he saw as the main problem in rural China. His plan proposed that the state invest more in rural infrastructure to help generate rural demand for urban goods (Guang 2010, 319). Ironically, the state ascribed to Lin's more capitalistic recommendations (Guang 2010, 312; Day 2008) to address the rural crisis through increasing rural income and consumption. The National People's Congress approved the government policy of "build a new socialist countryside" (*shehuizhuyi xin nongcun jianshe*) in March of 2006.[2]

Policy Objectives

Largely modeled after The Republic of Korea's New Village Movement of the 1970s (Looney 2011), the policy aims to improve rural livelihoods and living conditions through increased agricultural efficiency, urbanization, and increased infrastructure and social service provisions (Ahlers and Schubert 2009). Since 2006, it has served as a national policy framework with rough guidelines to induce local governments to promote comprehensive rural development,

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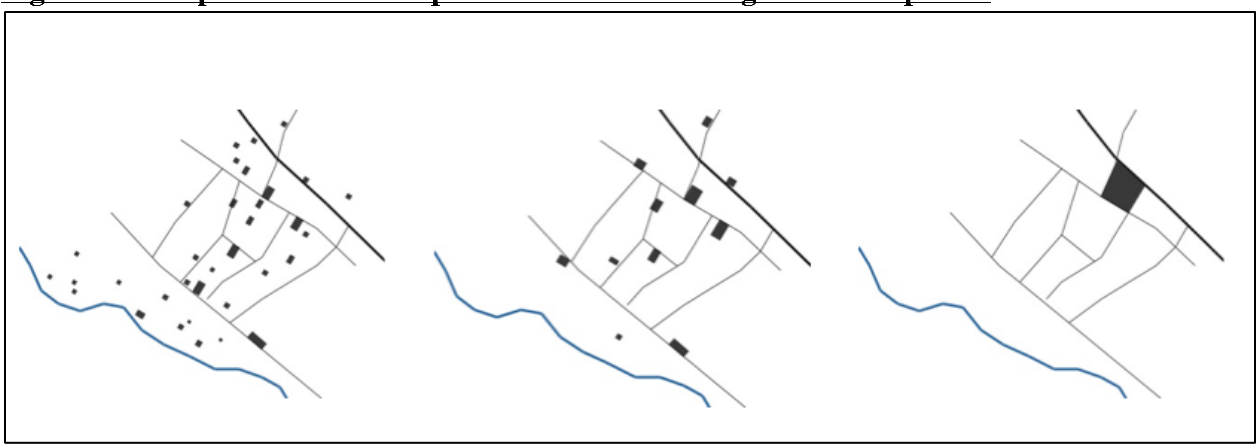
[2] According to Lei Guang, Justin Yifu Lin is credited with coining the term 'new socialist countryside,' which was adopted by the government as the slogan for new rural development policies (Guang 2010).

“which is primarily understood as infrastructure and agriculture modernization linked to ecological sustainability, and the provision of public goods such as social welfare and basic education” (Ahlers and Schubert 2009). At a meeting with provincial leaders in February 2006, Hu Jintao explained that the New Socialist Countryside was important for several reasons, including reducing urban-rural disparities, solving China’s food security problem, increasing domestic demand for consumer goods, and securing the Party’s popular legitimacy. Notably, food security has been a key national policy that long predates the *sannong wenti* concern mentioned above. With urbanization pressures on peripheral rural regions, China has had a strict arable land quota in place since 1999 to control the conversion of arable land to other uses (Ye and LeGates 2013). Hu emphasized, moreover, that programs to “develop production” should be the top priority of local NSC initiatives (Looney 2012). This focus on the rural economy (instead of social welfare, village governance, etc.) stems from the perception, held by many in China, that the urban-rural income gap and declining food production constitute two of the country’s most urgent problems.

One major course of action to meet policy goals is to modernize villages through re-construction. According to Looney, policy focus on housing construction and village redevelopment began in 2008, citing a concern to build safe housing. Perhaps non-coincidentally, this was the same year that a powerful earthquake struck Wenchuan, causing devastating destruction in western Sichuan. Since that time, implementation of this policy objective has led to rapid redevelopment of villages across the nation. Top-down policy prescribes concentrating settlements to meet other policy objectives, yet it often creates generic, standard outcomes, often not suited to local conditions. While concentrated settlement patterns are thought of as effective solutions to meet policy goals—they often open up new farmland and make it easier to bring in modern service provisions (such as necessary water, power, and road infrastructure, social amenities like schools and health care facilities), they come at the expense of destroying traditional settlement patterns, ignoring local context and the traditional knowledge often inherent in anthropogenic landscapes (Ellis 2000). At the local level, municipal rural planning departments are tasked with the challenge of meeting national goals while also working to adapt policy to local conditions. This tension in implementing top-down policy to fit local context can be seen in the case of Chengdu Municipality's rural planning policy for its surrounding regions and the *linpan* landscape.

Fig. 2.1. Example of Different Spatial Patterns of Village Redevelopment



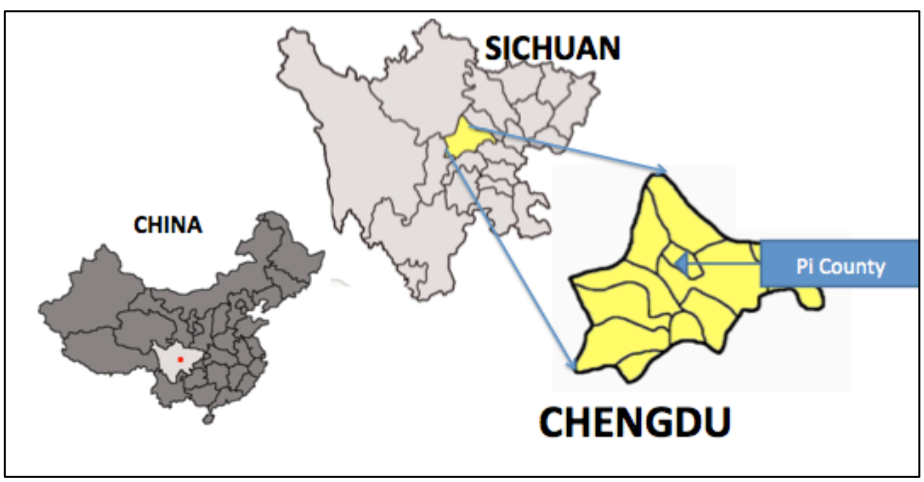
Left: traditional dispersed spatial pattern of *linpan* landscape. Middle: semi-concentration pattern. Right: extreme concentration pattern. Source: Created by Wang Yue, Sichuan University third year undergraduate student, 2013.

2.2 Chengdu Plain Context and History

About the Chengdu Region

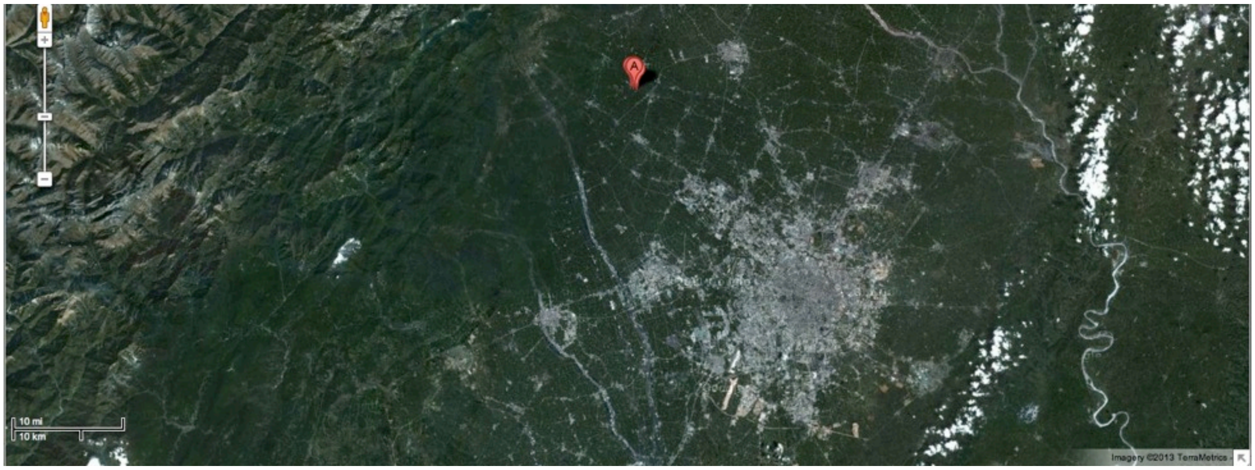
The Chengdu Plain in the western parts of Sichuan is considered one of the most productive agricultural landscapes in the world. The region attained much higher agricultural productivity with the construction of the Dujiangyan Irrigation System in 256 B.C. A simple yet effective piece of engineering, the Dujiangyan Irrigation System works with the natural topography to irrigate the region. The Chengdu Plain slopes with a gentle gradient of about 0.4 per cent from Dujiangyan (730 meters above sea level) to Chengdu (500 meters) and beyond (Willmott 1989). Chengdu is the capital of Sichuan Province. According to the 2010 Chengdu Municipal Rural Planning Manual, Chengdu has a total population of 14 million people with 2.6 million floating population (2010 Handbook). Chengdu has 9 districts (*qu*), 4 county-level cities (*shi*) and 6 counties (*xian*) under its administration. It has an area of 1,232 square kilometers. Major land types include 36.3% plains, 30.4% hills, and 33.2% mountains. Such geographic elements, rich water resources from the irrigation system created at Dujiangyan, mild weather, and long history of ancient civilization and commercial development, have sustained civilization in the area for more than 2,000 years, earning it the nickname as the "Land of Abundance" (Chen and Gao 2011). According to Steven Sage, Dujiangyan was the basis for grain surpluses that gave the Qin army a huge advantage over their adversaries (Sage 1992).

Fig. 2.2. Context map of Chengdu and Pi County



Source: Modified by author from Wikipedia 2013, "Pi County."

Fig. 2.3. Satellite Image of Chengdu and Region



Note the spread of urban development along roads and infrastructure. Marker is for Zhanqi Village, Pi County. Source: Google Maps 2013.

Linpan Landscape History

> "There are few regions in China that, if equal areas are compared, can rival with the plain of Ching-tu-fu [Chengdu Fu], as regards wealth and prosperity, density of population and productive power, fertility of climate and perfection of natural irrigation."
>
> "The plain is dotted with small groups of houses, in which the country-people live. Each one of them is nestled under a grove of bamboo, ornamental and fruit trees, which give the country the appearance of being wooded."
>
> - Ferdinand von Richthofen, "Baron Richthofen's Letters, 1870-1872" 1872.

> "This portion is densely populated and carefully cultivated, this cultivation not being confined to agriculture alone, but extending to the planting of useful and

> ornamental trees such as the bamboo, tung, mulberry, cypress, varnish, was, and a variety of fruit-trees. The most important part of the Red Basin is the Chengtu plain, which has been described as the most densely [cultivated?] area of the earth's surface. The vegetation is in most parts of the basin of almost tropical luxuriance owing to the extreme dampness of the climate, which permits, in the Chengtu plain, an admirable system of irrigation. Seen from a height, the plain looks like a forest, for every farm has its grove of bamboo, cypress, palms, and fruit orchards while tung and varnish trees abound. The country along the Min between Kiating and Chungking is also rich in trees, which are described as "of living green, free from insects, and without blight or deformity" thus rendering this part of Szechwan an object lesson to regions farther east."
>
> -Norman Shaw, *China's Forest, Trees, and Timber Supply*, 1914.

While it is not certain exactly how long the *linpan* landscape has persisted, the above historical descriptions provide clues to the continuance of its form and function since the time Baron Ferdinand von Richtofen wrote his letter describing the region in 1870. During fieldwork in the region in summer of 2012, these descriptions match closely with direct observations of the landscape, providing evidence that the physical characteristics of the landscape have remained largely unchanged for over 140 years, and almost certainly for much longer. Li Deying's account of land subletting in the Chengdu Plain during the Republican period implies that the spatial structure of the landscape has remained historically continuous while accommodating major changes in population density and in sources of livelihood, including investment in land (Li 2007).

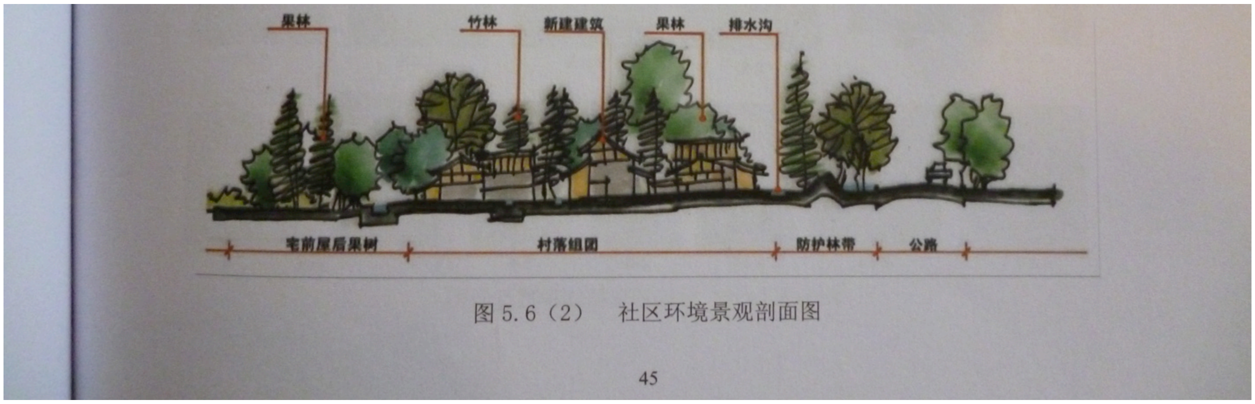
Linpan, which means forest basin in Chinese, is almost unique among rural landscapes not only within the Chengdu Basin and Sichuan, but also among many rural landscapes throughout China.

While most villages in China exhibit a concentration of dwellings surrounded by agricultural fields and resource lands, the *linpan* landscape is characterized by a dense-but-dispersed settlement and spatial pattern (see Fig. 2.4 and 2.5). Stephen Endicott wrote in his 1992 description of Magaoqiao village that "a feeling of physical dispersal pervades" (Endicott 1992).

<u>Fig. 2.4. Comparative Views of Rural Landscapes in China.</u>

Left: Aerial image of village settlement pattern in Guangzhou province, 2008. Middle: Rural settlement near Yangzi River delta, 2006. Right: *Linpan* settlement, 2010. All photos are from the same height (and same scale) in Google Earth. All are also in flat, delta regions. Source: Google Earth.

<u>Fig. 2.5. Views of *Linpan* Landscape</u>



Top: *Linpan* from the ground in Jiang'an illustrates traditional housing typology. Source: Photo by author. Bottom: Sectional diagram of *linpan* environment. Source: Chengdu Rural Planning and Construction Technical Guidebook 2011.

It was not just Western explorers and social scientists that found *linpan* to be a remarkable landscape. Local scholars also write of the region's rich culture and heritage with descriptive language that speaks to desires to protect and preserve the landscape:

> "In these native lands, rice fields meet sky, rivers and streams weave across the landscape, footpaths meander between fields, and houses of gray tiles and wooden walls stand beneath the forest canopy. This is *linpan*… Western Sichuan's *linpan* landscape is often viewed as a special rural settlement pattern in the western Sichuan Plain, preserving a true connection and continuity between human settlement and the natural environment. The characteristics of the local culture and architecture express the integrity of both its spirit and substance…making the *linpan* landscape a distinctive cultural expression of the Chengdu Plain. It is a precious cultural heritage."
>
> (Le 2011)

Such descriptions reveal not only emotional and aesthetic ideals about people and nature in harmony with one another, but also provide evidence of the interdependence of its social and ecological components. Landscape elements including bamboo groves, cultivated fields, an intricate irrigation system, vegetated riparian areas, along with human management and maintenance created a self-sustaining, close-knit socio-ecological system. Local planning guidebooks (perhaps ironically) also highlight the interconnectedness of the *linpan*'*s* physical elements. "According to history, Chengdu's plain is covered with a web of rivers, fields, mountains, *linpans* and rivers are the foundation of good ecology" (Rural Planning Manual 2010). Such elements, established through slow changes over the years, built a stable, sustained agroecosystem and the spatial pattern that is a hallmark of *linpan*. Such physical characteristics also sustain ecosystem services and natural regeneration without need for outside resources or artificial inputs. Tian Jun, founder of the Chengdu-based NGO Chengdu Urban Rivers Association (CURA), said that the most important feature of *linpan* is the stability and recyclability of the system as a whole. "The whole system can support itself without any sources from the outside. There is also a balance between agriculture and aquaculture. Waste from humans and animals become fertilizers for soils to grow both vegetables and trees like bamboo. In a word, *linpan* can operate very well without any outside economic influence" (interview with Tian Jun, August 2012).

2.3 Chengdu Policy Objectives

Urban-rural integration through World Modern Garden City Model

The Chengdu Municipality Planning Bureau and its rural planning department oversee redevelopment planning and policy of the *linpan* landscape. Interviews with local planners, local planning documents[3] and the work of other researchers indicate that Chengdu's implementation of New Socialist Countryside began in 2003. It has evolved since that time in stressing different themes to achieve rural-urban integration (*cheng xiang yiti hua),* or "coordinated urban-rural development" (*cheng xiang tongchou fazhan*). More recently, the emphasis has shifted to create a "world modern garden city" (*shijie xiandai tianyuan chengshi*) model to achieve coordinated urban-rural development and New Socialist Countryside goals.

Chengdu is in many ways a leader in experimenting with urban-rural integration. According to Ye and LeGates, Chengdu's coordinated urban-rural development has gone through different phases since 2003 based on a study of policy content (Ye and LeGates 2013). Urban-rural development reforms promoted pilot programs and experiments that emphasize the three concentrations – concentrating industry into strategic function zones, concentrating land into large-scaled farms, and concentrating farmers into denser new rural communities, and six integrations – integrated urban and rural planning, industrial development, markets, infrastructure, public services and management (Ye and LeGates 2013). Chengdu soon gained national designation from China's State Council in 2007 as one of the nation's first "experimental zones" in urban-rural integration (Ye and LeGates 2013; Abramson and Yu 2011). Details of this goal to 'break the urban-rural dual structure' as well as a push to preserve and increase agricultural land meant that the entire municipality's land use master plan "sought to consolidate more than 970 square kilometers of rural collective built land area—the vast majority of which was individual scattered housing, small yards or natural villages—into 570 square

[3] Planning documents were provided courtesy of the Chengdu Planning Bureau during a visit in August 2012. These refer to the following documents: (Rural Planning Manaul 2010, Planning and Construction Technical Guidebook 2011, ABC Planning Handbook)

kilometers of more centralized, planned housing estates and town centers, and thus gain 400 square kilometers of new land for agriculture or urban development." (Ye and LeGates 2013). Such a plan meant the complete replacement of *linpan* to attain the new land. Thus, at this time *linpan* preservation was in direct conflict with goals of efficiency and could be viewed as a rather backward landscape form that should be redeveloped into more efficient land use patterns.

Chengdu Rural Planning Timeline (from ABC Planning Handbook):

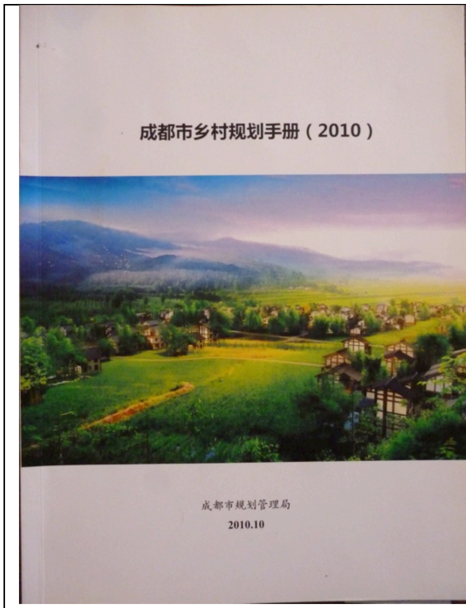
- 2003: Our planning began to break the urban-rural dual structure involved in rural planning.
- 2005: Integrated planning of townships and villages throughout the municipality.
- 2009: Post-disaster rural housing reconstruction (2008 Wenchuan earthquake) brought our planning to every household.
- 2010: World Modern Garden City long term goals proposed, allowing Chengdu planning to enter a new stage. Planning for a world modern garden city includes not only planning a modern metropolis, but also includes molding a bright, modern, civilized countryside.

Ecological Planning, Linpan Preservation

In recent years, Chengdu rural planning and redevelopment documents from 2010 and after have changed course from this large-scale concentration scheme and began to see value in preserving the orginal *linpan* landscape pattern (Abramson and Yu 2011). In 2009, Chengdu began to emphasize its goal to become a global modern garden city. Policy documents from 2010 and after stress the importance of ecological planning as a main planning principle. The Chengdu

Municipality Rural Planning Manual 2010 discusses the history of ecological planning, citing the work of Scottish planner Patrick Geddes, landscape architect Ian McHarg who pioneered the concept of ecological planning, and the emergence of landscape ecology's application to urban and regional planning. The handbook highlights landscape ecology's emphasis on maintaining specific landscape structure (*ge ju* 格局) to protect the continuation of ecology processes. It also covers the concepts of ecological corridors and landscape patchiness to protect biodiversity and species habitat.

The planning documents also stressed the need to fit local context and protect the *linpan* landscape heritage, now seen as important in maintaining ecological function. Chengdu planners have made efforts to address environmental and *linpan* preservation goals by outlining design guidelines for planners to follow (Guidebook 2011). This includes guidelines and suggestions for the construction of homes, rural environments public amenities and infrastructure. However, the guidebook does not offer any suggestions about a 'do nothing' approach to maintain the traditional settlement pattern as it currently is. This seems to contradict with the goal to continue and maintain the landscape texture, or at the very least, places the two objectives in conflict. It raises the question; can new redevelopment patterns that concentrate settlements still maintain the traditional landscape texture? The following examples illustrate this change in emphasis within recent planning documents.



Chengdu Municipality Rural Planning Manual 2010
This manual outlines the 11 main planning principles for rural villages in Chengdu Municipality.

Village Planning's Core Idea: our urban-rural planning should follow ecology as a priority, with people as the foundation, respect history and culture as three core ideas.

(1) Ecology Priority

Deep understanding of ecology firstly should build life earth and people with natural harmony joined as a living earth system concept

Chengdu Municipality Rural Planning Goals
1. Support industry, sustainable development
2. Intensive development, multi-function
3. Environmentally friendly, harmoniously integrating
4. Natural ecosystem, garden landscape
5. History protection, culture inheriting
6. Safe & comfortable, people-oriented space
7. Economical practical, moderately advance
8. Balanced service, treatment in accordance with local conditions
9. Emphasizing characteristics, diverse style & features
10. Green & low-carbon, energy saving & environment protection
11. Organic renovating, sustainable development

Chengdu Rural Planning Principle #4: Natural Ecosystem, Garden Landscape

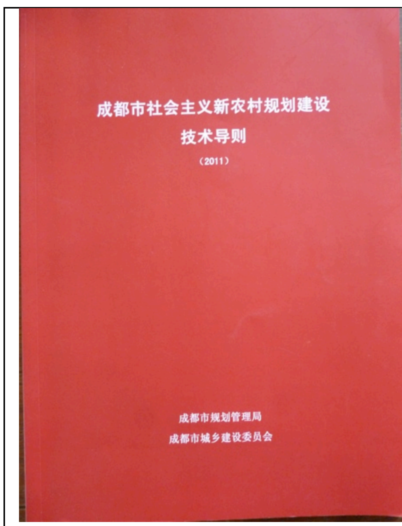
To maximize full use of the natural environment for urban-rural construction, advocate for landscape 'gardenization' and the comprehensive role of agricultural economy, society and environmental benefits

1. Natural Ecosystem
Planning and construction that make use of natural environment more than constructing an artificial/man-made environment; Protect the continuity of ecological processes, don't use too much man-made construction.

2. Garden Landscape
Fully protect rural area garden texture. Thousand-year-old mountains, **water, fields, trees/forest** are the inheritance/heritage/ that built Chengdu's local ecology.

***Linpan*'s** special garden texture is the garden city's most directly observed expression. **We should cherish and protect this unique resource** during modern construction.

Make full use of essential landscape elements in rural areas. **Planning and design reflect local characteristics**, avoid directly copying/applying city planning and architectural design techniques to agricultural regions.



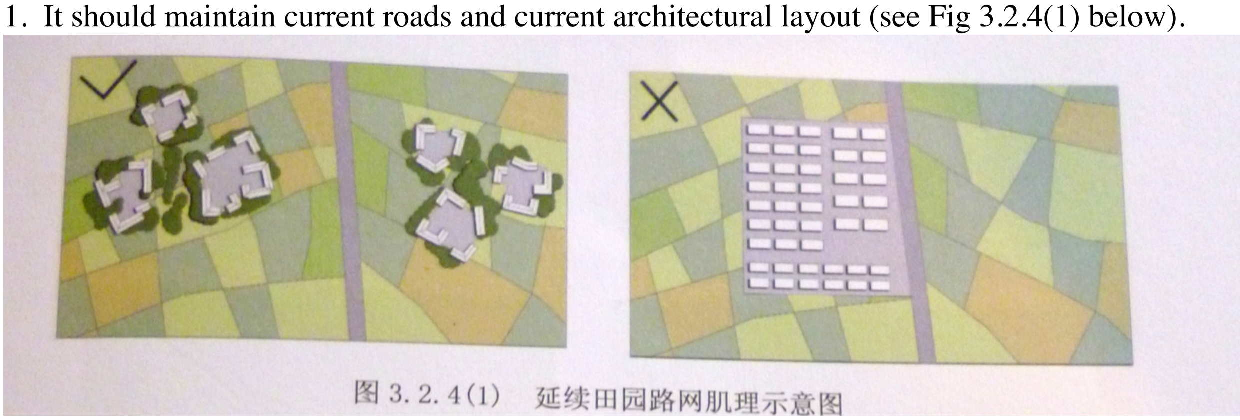
Design Guidelines: Planning and Construction Technical Guidebook 2011

The Chengdu Planning Bureau published a guidebook to aid planners in more technical aspects of planning. It also provides more detail as to how they envision redevelopment to meet planning goals and objectives. The guidebook offers advice on the following topics that relate to landscape structure. Chapter 3 discusses technique for overall composition (*zongti buju*).

3.2.4 Continue/Maintain the Landscape Texture

Chengdu Plain villages should sufficiently consider the Western Sichuan 'garden landscape.' It should protect the integrity of the layout.

1. It should maintain current roads and current architectural layout (see Fig 3.2.4(1) below).



2. It should also keep the current water and irrigation system; it is best not to change the paths of irrigation channels (see Fig. 3.2.4(2) below).

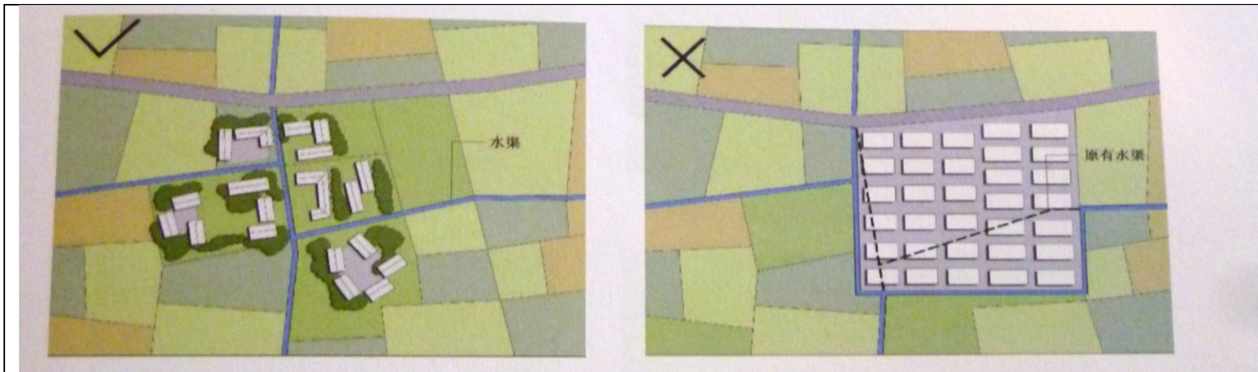


图 3. 2. 4(2)　保护原有渠系示意图

3. Maintain existing woods and forest (*linshu*) and use them as part of the composition and organic form of settlement clusters (see Fig 3.2.4(3) below).

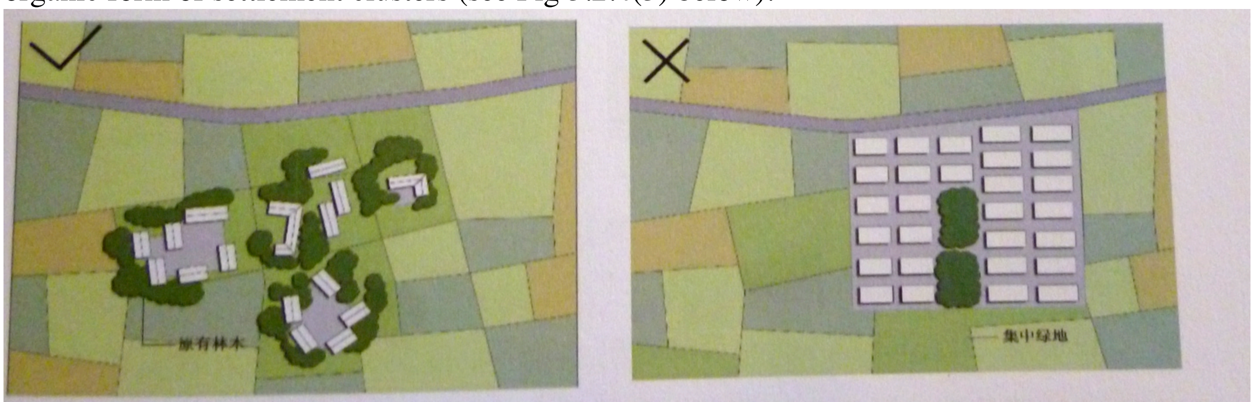
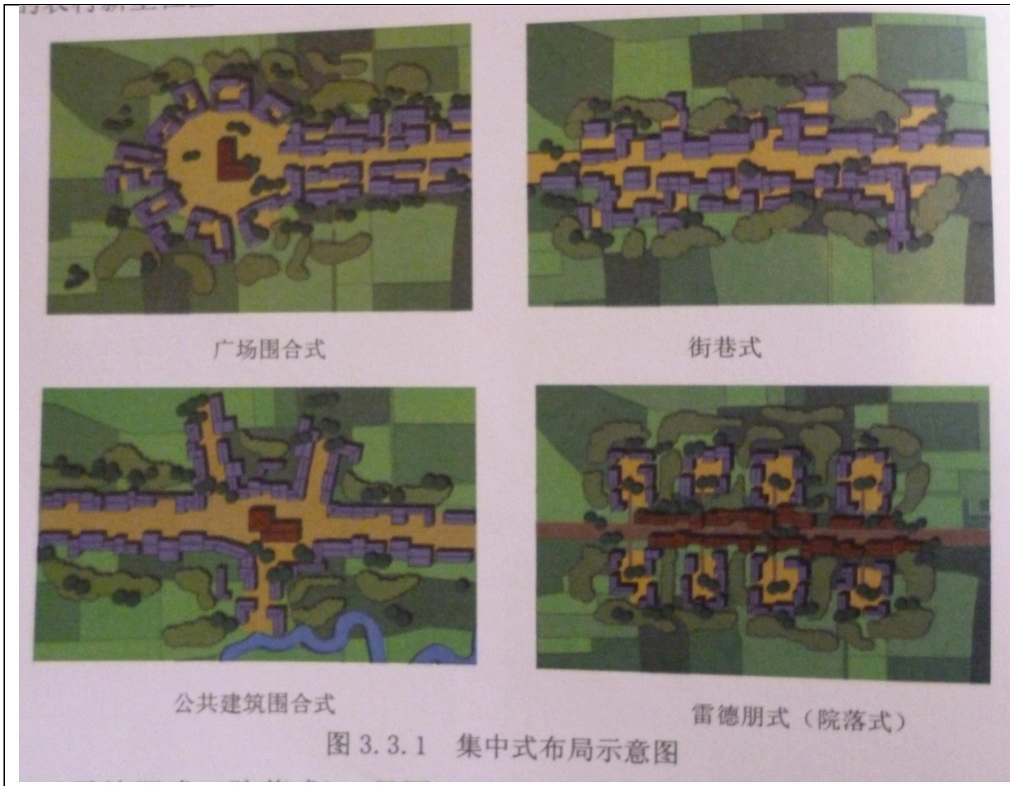


图 3. 2. 4(3)　利用原有林木示意图

3. 3 Settlement Form (p.11)
This section covers guidelines for both concentrated (*jizhongshi*) and clustered (*zutuanshi*) new village settlements and offer written and graphic examples of different styles that meet these two kinds of development patterns. The guidebook does not offer a 'do nothing' approach to redevelopment that would retain the traditional dispersed landscape spatial pattern.



Examples of concentrated settlement patterns

2.4 Policy Outcomes: Redevelopment Leads to Decline of *Linpan*

This contradiction between efficiency and resilience places *linpan* at a crossroads. Is it an inefficient, backward landscape that should be redeveloped, or is it a valued landscape that supports ecological resilience and needs to be preserved? Local researchers in China have noted that *linpan* units in the overall landscape have been rapidly disappearing in recent years due to several socioeconomic factors including urbanization, rural migration and government redevelopment policy (Le 2011, Yang et al. 2011). Broadly, these factors point to drastic changes taking place in rural society that impact the physical landscape. While economic and social forces, including rural migration and urbanization pressures that have contributed to rural de-population, have also had negative impacts on the *linpan* landscape, I will focus on the effects of redevelopment policy on the landscape.

Yang et al. argue that village re-construction from government redevelopment plans causes a decline in *linpan* units and changes the traditional landscape pattern. They found that large-scale residential areas replaced a large number of forest patches (2011). This decreased patchiness in the traditional landscape pattern, especially natural patches. In addition, ecological corridors were cut off by the construction of new communities or withered due to the lack of human management in deserted *linpan* areas (2011).

Yang et al. conducted an analysis of the change to *linpan* landscape, focusing on aesthetic and ecological indicators. Yet the methodology that informed their analysis and conclusions is not clear. Their recommended design strategies to protect *linpan* and the ecology also lack specificity in their research methods. This thesis aims to quantify the changes- by how much might the landscape change according to different redevelopment alternatives?

2.5 Need for Evaluation

Planners have made efforts to address the goals above by outlining rough guidelines for planners to follow. This includes architecture, rural environmental construction, and public amenities. But current planning guidebooks are still general at best and lack specificity in regards to broader landscape structure. More specifically, neither planners nor researchers have quantified elements of the traditional landscape. How then, do planners know when redevelopment models meet traditional landscape characteristics, and when do they not? The use of an evaluation method can offer a way to clarify and balance contradictions among goals. This also fits a Chinese rational-scientific view of planning the professed goal of the government to make decisions "scientifically." "With such a great ecological background, biodiversity and historic cultural resources, plans need to pass the scientific regulations rules with added serious protection and used wisely" (Handbook 2010).

CHAPTER 3: THEORETICAL FRAMEWORK

This chapter describes the theoretical framework used to evaluate alternative redevelopment models in the *linpan* landscape on how well they meet goals for preserving and maintaining original landscape structural features that may be indicators of resilience. It has two major sections. The first describes the application of resilience theory to understand the role of landscape structure (spatial patterns, land use, scale) in supporting sustainable agroecosystems. This thesis analyzes the *linpan* landscape as an agroecosystem, argues that resilience is an important goal in the design or planning of such a system, and that there are measures that can be used to evaluate its resilience. This provides a lens though which to choose indicators in the evaluation for *linpan* redevelopment. The second section describes the role of evaluation in planning and how evaluation can be used in the case study for the *linpan* landscape. This provides context for a proposed evaluation process for *linpan* redevelopment.

3.1 Resilience Framework

Resilience Theory in Agroecosystems

Resilience theory applied to agroecosystems is a useful lens through which to view the *linpan* landscape which has been described as a self-sustaining, productive agricultural settlement pattern with interdependent social-ecological systems that local planners now see as supporting goals for ecological maintenance and function. Resilience in agroecology also offers a way for planners in China to think more dynamically about the long-term function of the landscape. It allows for change and adaptability that more traditional preservation and sustainability frameworks do not consider.

Resilience has become an increasingly popular perspective to analyze coupled socio-ecological systems, particularly for natural resource systems that humans depend on, such as forests and fisheries (Gunderson and Holling 2002). The concept was the idea of ecologist C.S. Holling, who was interested in creating a theory that fit adaptive change for better policy and management of natural resource systems. A simple definition of resilience describes the concept as "the capacity of a system to experience disturbance and still maintain its ongoing functions and controls" (Gunderson and Holling 2002, Walker and Salt 2010). The appeal of resilience lies in its inclusion of the sustainability concept but adds a dimension of dynamism (Van Appeldoorn 2011, Ostrom and Cox 2010).

Resilience has been used to analyze a wider variety of systems beyond natural resources, including economic, social, political and cultural systems (Gunderson and Holling 2002; Plieninger and Bieling 2012). While research on sustainable rural development has been ongoing for decades (Altieri and Hecht 1990), it is only recently that researchers began to apply resilience concepts to agroecosystems, illustrating the spread of resilience theory to systems beyond 'original' natural ecosystems. A search on the *Ecology and Society* website, a "journal for integrative science on resilience and sustainability" (Ecology and Society 2013) for the pairing of resilience with agriculture-related keywords returns articles that discuss the linking of the two beginning in the early 2000s. Agroecosystems can also be viewed as intricate socio-ecological systems "in which humans manage and use communities of plants, animals, their biophysical environment, and their interactions" (Van Appeldoorn 2011). Altieri and Hecht note that agroecology emphasizes "reproduction of the household and regeneration of the agricultural resource base" (Altieri and Hecht 1990). Based on this definition, this thesis analyzes the *linpan* landscape as an example of an agroecosystem.

Maintaining Resilience

Since resilience itself is a neutral value, both desirable and undesirable systems can be termed resilient. Thus it is important to ask, resilient to what? Researchers have posited that a resilient agroecosystem is one that has the capacity to continue to generate goods and services (sensu Holling 1973). Additionally, resilient agroecosystems should continue to generate goods and services in the face of increasing environmental and social uncertainty (i.e. climate change, economic crisis) over the long term. This seems to closely match the goals that Chinese planners and government officials have for rural redevelopment.

To cultivate resilience in agroecosystems it is important to "understand and manage vital ecosystem functions as well as social mechanisms that can respond to feedback signals from the ecosystems in an adaptive way" (Kremen et al. 2012). There are three aspects of resilient systems that are important to agroecology: the capacity to absorb and internalize disturbance and change while maintaining function, the capacity to self-organize following disruptive change, and the capacity for learning (Gunderson and Holling 2002, Resilience Alliance 2001).

1. Buffer disturbances: This principle looks at the ability of a system to absorb shock, stress, disturbances, or unusual events (Scheffer et al. 2002). In agroecosystems, there can be both social and ecological disturbances or shocks to the system. Ecological or environmental disturbances include changes in weather or climate patterns, natural hazards like fire, flood or drought, crop disease or pest outbreak, and change in soil quality, to a name a few. Social disturbances could include economic factors, such as price changes in inputs (labor, transportation, fertilizer) or outputs for producing and selling agricultural products. The mechanisms that buffer disturbance are a combination of social and ecological factors.

2. *Capacity for self-organization*: Self-organization in resilience theory applies to both ecological self-organization and social or human self-organization. Ecological self-organization "establishes the arena for evolutionary change; self-organization of human institutional patterns establishes the arena for future sustainable opportunity" (Gunderson et al. 2002). In agroecosystems, these ideas can be reflected in farmers' ability to create farmer cooperatives and organizations at a grassroots level (Cabell and Oelofse 2012, Kremen et al. 2012). From an ecological perspective, "a self-regulating agroecosystem, as with any ecosystem, relies on the work of regulating ecosystem services: the hydrological cycle, biodiversity, and soil resources upon which terrestrial communities depend" (Cabell and Oelofse 2012). From the social perspective of self-organization, it can be represented by "the degree to which farmers, consumers, and other stakeholders can organize themselves"(Cabell and Oelofse 2012). Cabell and Oelofse further define human self-organization as reliance on individual, small and local organizations. "Individuals, local and regional networks, and smaller institutions of governance can be more responsive and adaptable to changing conditions than can larger groups. Any configuration that they create is more likely to contribute to overall system resilience in the long term because it was created by their own initiative, in response to a real need, and appropriate to

their situation" (Cabell and Oelofse 2012).

3. Capacity for learning and adaptation (Adaptive Capacity): This principle also has ecological and social dimensions. "Adaptive capacity in ecological systems refers to genetic diversity, biological diversity, and the heterogeneity of landscape mosaics" (Resilience Alliance 2013). This applies to ecological components in agroecosystems. In social dimensions, "the existence of institutions and networks that learn and store knowledge and experience, create flexibility in problem solving and balance power among interest groups play an important role in adaptive capacity" (Scheffer et al. 2000, Berkes et al. 2002). Systems with high adaptive capacity are able to re-configure themselves without significant declines in crucial functions in relation to primary productivity, hydrological cycles, social relations and economic prosperity. They also retain opportunity and diverse options. Cabell and Oelofse define this principle for social learning and adaptation as "individuals and institutions learn from past experiences and present experimentation to anticipate change and create desirable futures" (Cabell and Oelofse 2012). Adaptive capacity can also take the form of institutions for knowledge sharing, education and training.

Resilient Landscape Structures

A literature review reveals commonalities about how landscape structures may contribute to resilience principles (Kremen et al. 2012, Van Apeldoorn 2011, Tengo and Belfrage 2004, Berkes et al. 2000, Smith and Wishnie 2000, Cabell and Oelofse 2012, Bergamini et al. 2013). Landscape *structure* or *pattern* comes from landscape ecology and means "simply the spatial arrangement of the elements present, the natural areas and human land uses" (Forman 2008).

There is general agreement that spatial heterogeneity and landscape diversity (patchiness) across temporal and spatial scales, particularly at a small scale, foster resilience in the following ways:

Buffer disturbances: Landscape diversification (patchiness), spatial heterogeneity, intercropping and crop rotation all support ecological diversity and the ability to absorb shock and disturbance. The same disturbance is not likely to harm all patches or all crops in a polyculture landscape equally. Researchers have provided examples of small-scale farms that employ resilient types of land use spatial patterns to absorb natural disturbances. "For example, Holt-Gimenez (2002) showed that after Hurricane Mitch struck Central America in 1998, smallholder farmers that practiced intercropping, the application of compost and animal manure, terracing, and integrated pest management, suffered less damage and recovered more quickly than did farmers who relied more heavily on mechanization and agrochemicals" (Tengo and Belfrage 2004). In the case studies of small-scale farms in Sweden and Tanzania, the researchers found that "small-scale agriculture created a patchy landscape with fields and woodlots interspersed with pastures and tree-rich home gardens. Together with the practice of leaving strips of natural vegetation between fields, this created and enhanced habitat that supported populations of pollinators and natural enemies of pests" (Tengo and Belfrage 2004).

Capacity for self-organization: For ecological self-regulation, diversity of land uses provides habitat for species diversity and continuance at different scales (Cabell and Oelofse 2012). Small-scale farms, use of perennial crops and polyculture, and patchy landscape with spatial proximity provide appropriate scale and key linkages and natural interaction for ecological self-regulation (e.g. pollination). Resilient agroecosystems support and rely upon local self-organization that may be better at changing and adapting to conditions in a local context. For social self-organization, diversity of land uses at the individual farm scale helps farmers retain self-sufficiency, and small-scale farms provide appropriate feedback loops and management at the local level. Kremen et al. provide a case example of agroecology in the Andean highlands. Closely linked social and ecological components have been vital to the system's persistence and sustainability for over 4,000 years: "The ongoing interplay between human management and physical ecology has created a landscape of agroclimatic belts at different altitudes, each characterized by specific field rotation practices, terraces, and irrigation systems, and the selection of specific animals, crops, and crop varieties (Altieri and Toledo 2011). Within these belts, traditional knowledge has helped sustain tremendous genetic diversity, by perpetuating adapted landraces and wild relatives of crops" (Kremen et al. 2012).

Adaptive Capacity: Small-scale farms support "experience with local dynamics that can be accumulated and used to guide farm management" (Tengo and Belfrage 2004). Land use diversification and patchy landscapes at different scales support species and landscape diversity for natural adaptation strategies. Landscape and land use diversification also allow for human learning as a way to experiment with different crops and uses and learn from experience while minimizing risk. The Andean example above provides evidence of the wealth of crop varieties across the terraced landscape that holds abundant genetic diversity, one of nature's ways of adapting to changing circumstances.

<u>Table 3.1. Summary of Landscape Structure Elements in an Agroecosystem That Support Resilience Principles</u>[4]

Resilience Principle	**Scale:** small-scale / appropriate scale	**Spatial Pattern:** spatial diversity and patchiness	**Land Use:** diversity of land uses, biodiversity
1. Buffer Disturbances	Scale needs to be appropriate to ecological functions and signals for feed back and response; small-scale farms tend to be better at this	spatial heterogeneity "buffers against perturbations (insurance) and provides seeds of renewal following disturbance" (Cabell)	different land uses within a defined scale may be better at buffering natural disturbances where the same disturbance won't affect all uses equally
2. Capacity for self-organization	Small-scale provides appropriate proximity or ecological self-regulation, small scales better at adapting social practices and management to ecosystem cues	Patchy landscape and spatial proximity important to create appropriate ecological interaction and synergy for natural ecosystem function and regulation.	Diversity of land uses provides habitat for diversity of species at different scales (Cabell), use perennial and polyculture, providing key linkages and ecosystem services (e.g. . pollination) for ecological self-regulation. Diversity of land uses at individual farm scale helps farmers retain self-sufficiency and have more connections with others using the land differently
3. Capacity for learning (Adaptive Capacity)	Small-scale farms better at supporting local feedback loops from ecosystem cues to management action	Patchy landscapes support **biodiversity**, which in turn supports ecological adaptation.	Polyculture (more uses) in a given patch or scale creates **biodiversity** for ecological adaptation. Polyculture may also help farmers learn and adapt to changing ecological conditions

[4] compiled from analysis of the following articles on agroecosystem resilience: Kremen et al. 2012, Van Apeldoorn et al. 2011, Tengo and Belfrage 2004, Berkes et al. 2000, Smith and Wishnie 2000, Cabell et al. 2012

Summary

This literature review on resilience in agricultural ecosystems suggests indicators to measure and analyze resilience in the landscape as seen in the summary table above. Three key indicators in landscape structure that can be used to analyze resilience include:

- Landscape heterogeneity (diversity of land-use types and ecosystem patches)
- Appropriate scale (small scale)
- Biodiversity, including crop diversity

3.2 Evaluation in Planning

Purposes of Evaluation

The review of literature on resilience in agroecosystems suggests several key indicators within landscape structure that can be used to analyze resilience, providing clues as to what to look for. Evaluation in planning provides a method of how to measure and compare these indicators. Evaluation is a useful tool that can be employed in the planning process, particularly when a project is important, involves a large commitment of time and resources, and has a potentially large opportunity cost. "Evaluation is the analysis of the effectiveness and direction of an activity or research project and involves making a judgment about progress and impact" (Vernooy et al. 2003). According to Miller, evaluation in planning shows reasons and evidence for choosing a particular course of action (Miller 2005). Evaluation is not meant to make decisions, but it is a powerful tool to help inform the decision-making process. Evaluation is also a means of developing, assessing and displaying information, which increases transparency. It is also a way to compare alternatives and shows how well alternatives perform under current conditions versus a ‘do nothing’ approach. In the planning process, evaluation can happen both before and after a planning project is completed. Systematic planning evaluation is also an essential aspect of feedback in systems (adaptive capacity and self-organization) where decision-making and adaptation are not entirely in the hands of the people directly involved in an agroecosystem.

Comparison of Alternative Courses of Action

Evaluation is used often in urban and regional planning to assess alternative courses of action, including plans or projects. Evaluation “links means to ends to enable rational choice” and also shows reasons and evidence for choosing a particular course of action (Alexander 2006). Evaluation methods also provide reasoned justification in making a choice as opposed to making choices based on feelings, personal preferences, or just having them.

Facilitate Informed Decision-making

Evaluation in planning can help to facilitate decision-making in several ways. First, it offers a replicable analysis involving ranking and scaling, making it a reliable assessment of options. It also supports accountability in decision-making, offering full disclosure of how decisions were reached and forming a basis for transparency. Such “reasoned justification” and a “show your work” method provide evidence that supports decisions.

Provide Feedback

Evaluation in planning is also a method of providing feedback on the methods, development, or projects under consideration. Evaluation in planning is similar to feedback loops in the adaptive cycle. It offers the necessary information to make adjustments and improvements to the project or plan that further enhance its ability to meet desired goals and objectives and respond to actual conditions and circumstances within which planning and development is implemented.

Evaluation Methods

There are many different kinds of evaluation methods that have been used to evaluate planning and development projects, including cost-benefit analysis, cost-revenue analysis, multi-criteria evaluation, and participatory evaluation and monitoring (PM&E). This section discusses multi-criteria evaluation and how it has been used in China's National Cadre Evaluation Standards for Building A New Socialist Countryside, where larger policy goals are given indicators and scores to assess if goals are met. Due to institutional barriers to implementing participatory evaluation methods effectively in China as described by Vernooy et al., this thesis utilizes the first few steps of the multi-criteria evaluation method. For a more detailed analysis of PM&E application in China, see Appendix 1.

Multi-criteria Evaluation

Multicriteria evaluation is one type of evaluation method used in planning that is designed to analyze alternatives through measures and indicators for potentially multiple objectives. Such objectives can be given weights to place more importance on some indicators over others.

Steps in Multi-criteria evaluation:

1. Identify alternatives

Alternatives can be plans or policies. ‘Good’ alternatives should be different and represent a range of possibilities or choice. Alternatives should also include ‘do nothing’ or ‘continue with current practice’ as a choice.

2. Identify goals and objectives

Goals and objectives should be established early on to guide the evaluation procedure. The goals of a decision-making process may be broad or more detailed to include sub-objectives that ultimately lead to the goals and objectives of the program. Goals and objectives for evaluation can come from planning documents and policy mandates. Objectives should be relatively comprehensive, independent of other objectives, have a common level of detail and be of a manageable size.

3. Specify indicators and measures

Once goals and objectives have been decided, indicators and measures should be chosen to compare how each alternative meets the objective. Indicators are measurable aspects by which alternatives will be evaluated. There are many ways to develop indicators, and the choice of approach depends on the evaluation problem and the questions that need to be answered (Voogd 1983). Measures are metrics that are used to score expected performance or effectiveness of the alternatives or proposals against the chosen criteria.

Measures can be specified as a range of scores (i.e. 0-10, 0-100%). If a range of scores is allowed or if the numbers used in the table specify different measures then those numbers will have to be normalized or standardized before comparison of alternatives.

4. Create system of weights

Indicators and measures can be prioritized, or ranked, according to importance by using a system of weights. This can be seen in the New Socialist Countryside Evaluation (see Appendix 2), where indicators and measures in the economic development category are allotted more points than indicators in other categories. The distribution of points among indicators reflects which of the indicators may be more highly valued. Weights can greatly affect the final scoring in an evaluation and should be carefully considered when drawing conclusions from evaluations that employ a weighting system.

5. Evaluate the alternatives

The final step is to apply the indicators, measures and weights to the alternatives and to compare the final scores of each. Again, the selection of all three – indicators, measures, and weights, influences the final scoring.

Multicriteria Evaluation in New Socialist Countryside Policy

Evaluation in the planning process in China usually only takes place through the cadre evaluation system which puts pressure on local government officials to meet defined targets. The cadre evaluation system is used to judge cadres for promotion and career advancement.

According to Looney's dissertation that compares rural redevelopment policy in East Asia, the evaluation of NSC goals is done by incorporating national level NSC objectives into the local official cadre evaluation system (Looney 2012). She includes in the appendix a list of indicators created to evaluate achievement of national NSC goals. Looney's Appendix 2 shows how these indicators have been incorporated into the local cadre evaluation system, bridging local implementation with national policy objectives (reproduced in Appendix 2). The cadre evaluation system has been largely based on a target responsibility system (TRS) that has evaluated local officials' performance since the 1980s. TRS is a performance evaluation system that the central government uses to assess local cadres in their ability to carry out priority tasks and targets set by upper and central levels of government (Tsui et al. 2004). In 1979, shortly after the economic reforms of the Third Party Plenum in 1978, the CCP's Central Organization Department felt that there needed to be a new system to evaluate local cadres among China's large bureaucracy (Whiting 2001). By the 1980s a system was put into place that assessed cadres mainly on "concrete achievements" in order to determine rewards, penalties and promotions. By 1988 the CCP Organization Department created the official guidelines for the annual evaluation of county and township level officials (Whiting 2001). When the central government sets national policy, this system helps to ensure local governments carry out these policies.

Looney includes in the appendix a sample of the National Cadre Evaluation Standards for Building a New Socialist Countryside from 2006[5]. The evaluation includes 47 indicators spread across 5 larger categories. The indicators are each given points that total to 100 points. The economic development category is given 30 points, whereas "beautification of the environment" is prioritized second with 20 points. Within the category of economic development, the most heavily weighted indicator is rural income, which is assigned 10 points. Beautification of the environment has indicators for number of paved roads, green space, homes renovated, with none weighted above 2 points. It lists no indicators in regards to preservation, protection or improvement of ecosystem services. See Appendix 2 for a reproduction of the evaluation.

Ahlers and Schubert also provide samples of cadre evaluation indicators from Qingyuan County in Zhejiang province to assess NSC goals and implementation (see Appendix 2). This gives further evidence of how national policy is embedded in local redevelopment evaluation, and perhaps reflects, as Looney argues, that despite an attempt to emphasize 'local context,' the evaluation and implementation of NSC may be driving a move to standardize village landscapes as opposed to fitting redevelopment to local conditions. In Lishui Municipality, which administers Qingyuan County redevelopment, there are no indicators in the evaluation that reflected preserving local landscape characteristics.

[5] Source of data listed as *The Urban-Rural Innovative Development Blue Book for China's Building a New Socialist Countryside*; cited in CSUS 2009: 196-199. CSUS-Chinese Society for Urban Studies and the Ministry of Housing and Urban-Rural Construction, *Zhongguo xiao chengzhen he cunzhuang jianshe fazhan baogao 2008 (China Small Towns and Villages Construction and Development Report 2008),* Beijing, China: Zhongguo chengshi chubanshe, 2009.

Evaluation in NSC through the cadre evaluation system not only shows how indicators from national policy may lead to standardization at the local level, it also reveals limitations on who participates in evaluation processes and who benefits from evaluation results. The large majority of evaluation lies in the hands of the government. But there have been attempts to move evaluation in China in a more participatory direction. Vernooy et al. in their 2006 book on participatory evaluation and monitoring in Yunnan and Guizhou provinces describe the process and outcomes of implementing PM&E into natural resource development projects in these two provinces. Although there have been a number of successes, including educating local villagers about PM&E and improvements in the quality of projects, the authors point out many challenges to widespread adoption of participatory evaluation in China. The biggest challenge is the ability to institutionalize this kind of evaluation without adequate support and a long timeline to continue to educate many actors in the evaluation process. They also point to top-down management and implementation styles as an obstacle to continuing or expanding participatory evaluation (Vernooy et al. 2006).

In Chengdu, an attempt to break from standardizing rural villages can be seen in planning design guidelines to redevelop rural areas in accordance with local conditions, and specifically in the advocacy of preserving the ecological features of the *linpan* landscape. Chengdu planning design handbooks from 2010 and 2011[6] provide design guidelines on a variety of topics from architecture to roads, gardens and landscaping. Yet its ability to offer more specific criteria when it comes to broad landscape structure is limited. The next chapter aims to address this deficiency.

[6] Handbook 2010; Guidebook 2011

CHAPTER 4: DEVELOPMENT OF PROPOSED EVALUATION METHOD FOR *LINPAN* LANDSCAPE

Given the current condition of evaluation in planning and implementation of development projects in China, I am proposing an evaluation of planning outcomes to be used by planners in the planning department as well as local government officials. Planners may be able to play more of an advocacy role in the planning and redevelopment process. Because of the fast pace of redevelopment planning and implementation, as well as recognition that slow, long-term, widespread changes are needed to make participatory evaluation work, this evaluation for *linpan* selects a few key indicators and illustrates their use to help planners create redevelopment plans that meet stated goals to preserve both form and function of the traditional *linpan* landscape as well as implement more ecological, scientific and rational planning. The focus of these indicators is to give planners additional tools to assess conflicts between multiple goals, particularly those between modern development and environmental preservation. This evaluation tool can also help to communicate impacts and changes to local residents to help them understand more clearly the trade-offs that come with redevelopment.

Recommended Evaluation Process for *Linpan* Landscape

This evaluation takes the following steps adapted from both the multi-criteria and PM&E evaluation methods.

4.1 Identify alternatives: Identify the different redevelopment models being employed.

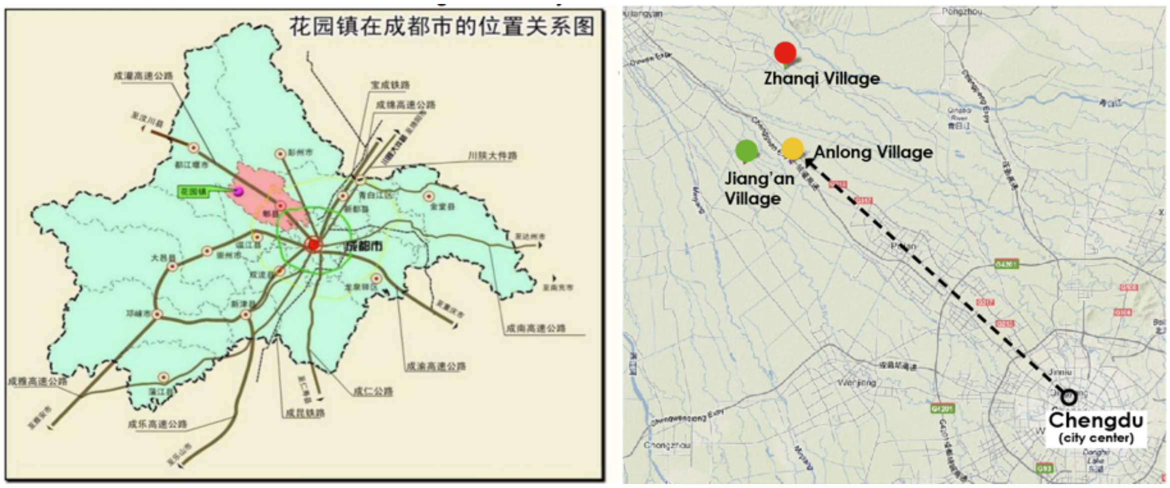
4.2 Identify indicators and measures: Use resilience framework and landscape metrics to identify key characteristics of landscape structure that might be indicators of resilience.

4.3 Evaluate the alternatives: Compare alternatives using these indicators and measures.

4.1 Identify Alternatives

Pi County (*Pi Xian*) lies to the northwest of Chengdu city, a periurban (perhipheral urban) mainly agricultural area. The county is well known for its development of agritourism and is considered the birthplace of the popular *nongjiale*, or farm guesthouse, style of agricultural tourism that has spread across the country. In recent years, many villages in Pi County have undergone or are preparing for re-development. The villages described in the case study have 'village' in the official name, but it should be noted that the term village here describes their administrative function and not a nucleated settlement pattern. These administrative villages have adopted different planning models that are seen as 'pilots' by the Chengdu Planning Bureau as a way to test how different models meet planning objectives. The alternatives studied during field research in the summers of 2012 and 2013 include four models in three administrative villages (two models are in Anlong).

Fig. 4.1. Map of Field Site Locations



Left: Map showing Huayuan Town (purple dot) in Pi County (pink region). Chengdu city center is marked by red dot. The green area is the entire region under Chengdu Municipality governance. Source: Huayuan Town Planning Document (2011). Right: Map showing locations of three village field sites in relation to Chengdu. Source: Google Maps 2013.

Jiang'an Village: Traditional Dispersed Model

Jiang'an Village (*Jiang'an Cun* 江安村) is located in Huayuan Town (*Huayuan Zhen* 花园镇) in Pi County. I visited Jiang'an in summer 2012 after reading the article by Chinese researcher Yin Le who described Huayuan as a good example of a *linpan* landscape still intact (Le 2011). I planned a visit to Huayuan Town with my research assistant Wang Yue. Once we arrived, we decided to stop by the government office. By luck, the town planner was in her office and willing to talk with us. She told us that many villages were already undergoing reconstruction but suggested visiting Jiang'an Village as a traditional *linpan* village since it has not yet undergone redevelopment. She also provided us with several planning documents for Jiang'an. I then visited this village twice in the summer of 2012 to conduct direct observations and short interviews and once in July 2013 to conduct spatial analysis of the sample area.

According to local planning documents that describe Jiang'an's future reconstruction, there are currently 2,697 residents in 838 households within a total land area of 3.12 square kilometers (Sichuan 2011). The economy is still largely based on small-scale family farming. Income is low. The average yearly income for residents in the community was 8,066 yuan in 2010 (Sichuan 2011). Land is still mainly used for agricultural purposes, accounting for more than 80% of the total land area (Sichuan 2011). According to the village land use map, there is no industrial land use in Jiang'an at present.

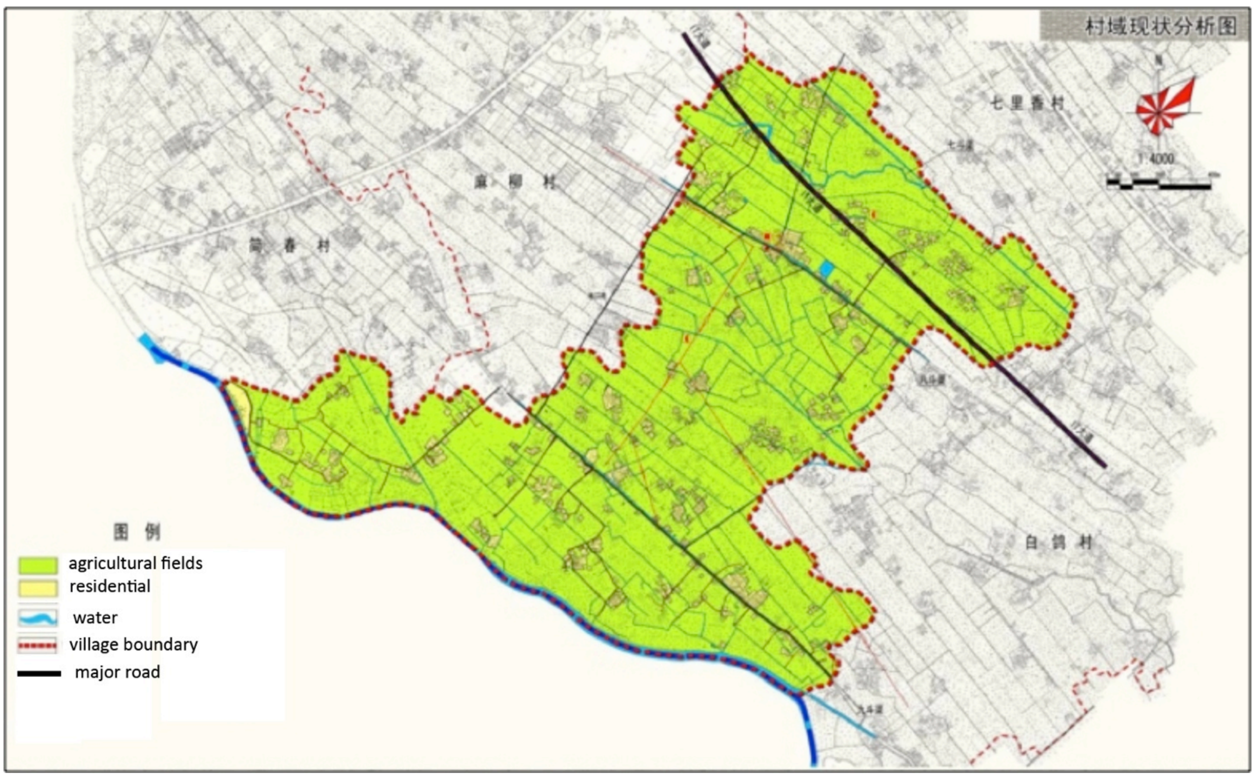
From direct observation in 2012, in general the fields were small in scale and lacked the characteristics of large-scale monoculture agriculture. A local villager said that while many farmers still grow grains (rice) and vegetables for subsistence, they also grow landscape ornamental trees and flowers which command higher returns than food crops (Tippins 2012). One resident said the village did not have much tourism activity, commercial or industrial development. Jiang'an, like many other villages in *linpan* today, now relies on external inputs such as fertilizer and pesticides.[7] Housing in the village consisted of mainly detached houses located near their fields and separated from neighbors.

[7] I witnessed farmers spraying pesticides in the fields during research in August 2012.

Fig. 4.2 Land Use in Jiang’an

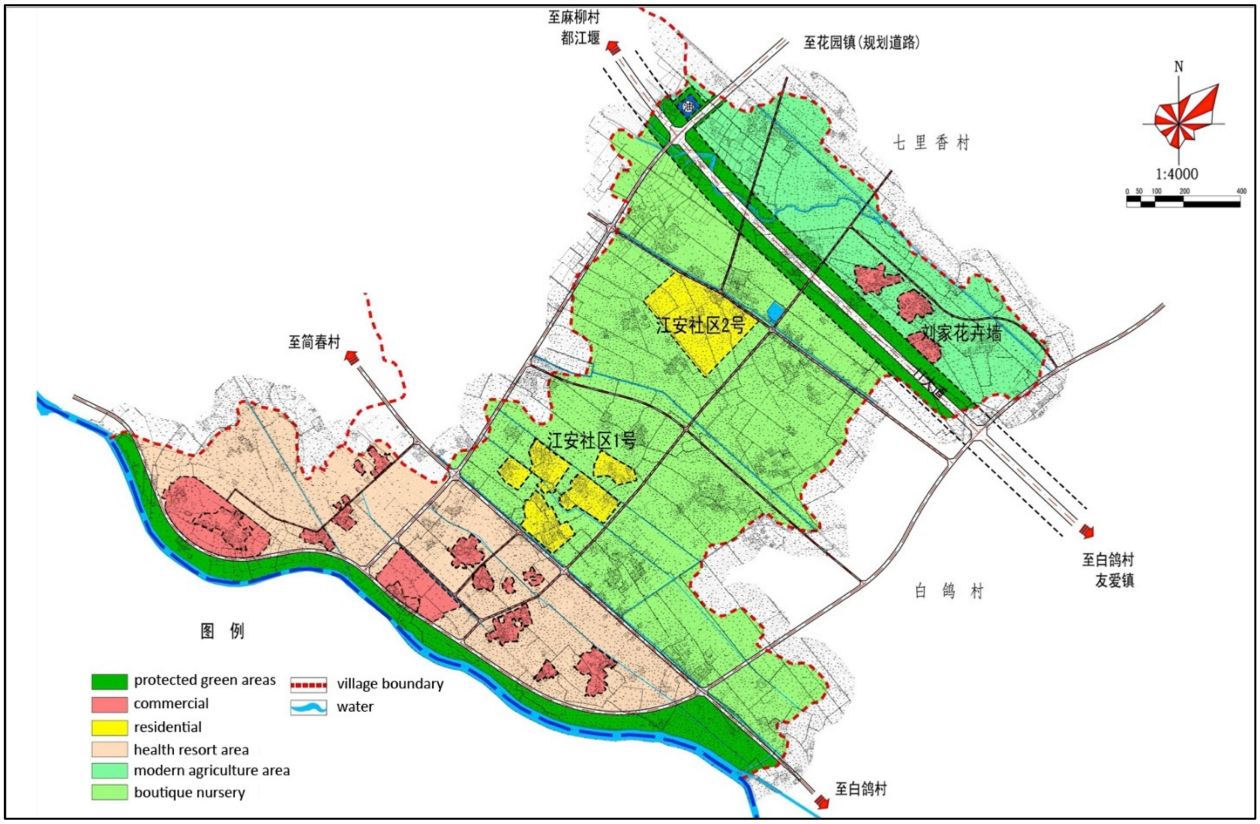
Left: Rice harvesting next to fields with ornamental landscape tree. Middle: Tree groves line water channels. Right: *Linpan* unit in Jiang’an: house with rice field and tree grove. Source: Photos by author, August 2012.

Fig. 4.3. Land Use Maps of Jiang’an Village, Present



Current spatial pattern, land use and scale of village (2012). Source: Village Planning of Jiang’an Village, Huayuan Town, Pi County (2011-2020), 2011.

Fig. 4.4. Jiang’an Future Land Use Map



Projected changes to village spatial pattern, land use and scale for re-development to begin in 2015.
Source: Village Planning of Jiang’an Village, Huayuan Town, Pi County (2011-2020), 2011.

Zhanqi Village: Extreme Concentration Model

Zhanqi Village (战旗村) is located in Tangchang Township (塘昌镇), Pi County. Local officials at Anlong Village (安龙村) in Ande Township (安德镇) recommended visiting Zhanqi as a model village of the extreme concentration approach. I visited Zhanqi once in summer of 2012 for direct observation and once in 2013 for spatial analysis and interviews. Zhanqi has an area of 1.99 square kilometers and approximately 1,700 residents (Zhanqi Planning Boards 2012; Ye and LeGates 2013). It became a model village of extreme concentration redevelopment pattern when it began reconstruction in 2008. In the early stages of the New Socialist

Countryside, it adopted the “three concentration” policy prevalent at the time. Industry would be concentrated in collective development areas, residents would be concentrated in townships or new communities, and agricultural lands would be concentrated to achieve more efficient economies of scale. All of the village residents moved to one large community area that consisted of 401 townhouse semi-detached units and 171 units in apartment-style units. Villagers became local stakeholders in the village collective, creating a joint-equity agricultural cooperative. Farmers joined the collective by selling their land use rights (720 yuan per mu) in order to attract modern agriculture companies to invest. Farmers received a dividend based on how much land they contributed to the collective. It was mentioned that the village collective was the vision of a strong local leader who made the idea a reality (Tippins 2012).

Through direct observation of the village in summer 2012, there was little in the village that resembled *linpan*’s traditional dispersed, patchy spatial pattern and arrangements of land use. The new village consolidated scattered housing settlements into one main area for residential use. It felt like an American suburban subdivision of semi-detached homes complete with garage and driveway. There were also a few apartment buildings roughly 4 stories in height (see Fig. 4.5).

Traditional land use changes were also visible. While the village still retains agriculture as the majority of its land use, it was no longer spatially arranged in accordance to traditional *linpan* units with small-scale family farming fields. The inclusion of industrial land use is a new land use type not seen in traditional *linpan*. The dedicated lands for commercial and industrial uses in Zhanqi included a tourist area with lavender fields (and Dutch-style windmill), vacation bungalows and a near-complete luxury hotel in hopes of attracting urban tourists and vacationers.

Zhanqi also had a food processing plant that made a local specialty chili bean paste called *doubanjiang*. Social amenities were abundant, with a community library, basketball and playfields, and playgrounds and outdoor exercise equipment within the residential district. I did not notice much bamboo groves or the distinct tree-shaded roads and narrow pathways or the system of waterways that weaved across Jiang'an village. In fact, I could hardly tell I was in the *linpan* landscape at all.

Fig. 4.5. Land use in Zhanqi

Left: Semi-detached townhouse units. Middle: Apartments. Right: Tourism development.
Source: Photos by author, August 2012.

Fig. 4.6. Zhanqi Village Land Use Map

Legend: Yellow is residential, orange is commercial, green is agriculture, blue is water. Source: Photo taken by author of map publicly displayed in Zhanqi Village, 2012.

Anlong Village

Anlong administrative village is under the jurisdiction of Ande Township, Pi County. At first appearance, Anlong seems typical of many other administrative villages in the *linpan* landscape in Pi County. It has approximately 3,399 residents in an area of 3 square kilometers (Anlong Planning Boards 2012). But its difference becomes apparent during a walk through the fields along the Zou Ma River. Large signs posted high above the rice advertise that it is organically grown. Although the village faces similar threats of urbanization, migration, and economic pressure as other neighboring villages in Pi County, Anlong embarked on an alternative rural development path with the involvement of a local NGO and a handful of residents willing to experiment with a more ecological model of development. In 2012, it underwent a second transformation to become a 'model village' for the semi-concentration pattern of redevelopment, advocated as a happy medium between problems with the traditional dispersed and extreme concentration spatial patterns, between efficiency and resilience. It is a useful case study in how the redevelopment process and economic pressures mix with attempts at bottom-up local organization.

Anlong Village: Eco-Village Model

Anlong was heralded first as a 'model eco-village,' a project spearheaded by the Chengdu Urban Rivers Association (CURA). According to CURA's website, their primary mission is to protect the water quality of urban rivers, particularly the Funan River that runs through Chengdu. But the organization began to shift its focus to the pollution that was happening further upstream in rural villages where heavy pesticide and fertilizer use were major factors in degraded water quality before it even entered urban areas (Hale 2009; Tippins 2012). CURA then began a pilot project to help farmers adopt more ecological practices. After studying many different villages, they chose Anlong because of its location along the Zou Ma River that could facilitate comparative measurement of water quality between organic and non-organic fields.

In 2005 CURA worked with about 20 households who expressed interest in implementing organic farming methods. By 2007, 11 households remained in the program and declared themselves the Quan Riverbank Natural Farming Co-op (Eckhardt and Hagerman 2010). While not certified organic, the farmers do not use pesticides or herbicides. CURA also constructed water treatment facilities (urine diverting latrines and constructed wetlands) in participating households and around the village as additional solutions to mitigate water pollution. They also created an educational program and training for farmers to share knowledge and organic techniques.

In a 2012 interview, CURA's founder Tian Jun talked about the goals and visions CURA had for their work in Anlong. She felt the most important goal besides implementing organic farming practices and constructing artificial water-treatment facilities was to preserve the original life of the village. In the last thirty years, modernization across the country has had a profound influence on traditional agriculture practices and local livelihoods. Tian Jun also felt CURA's focus on water quality indirectly protected the *linpan* landscape by advocating for organic farming practices (interview with Tian Jun, August 2012). Professor Li Wei at Sichuan University's Department of Urban Planning agreed. He felt CURA's efforts led local residents to protect *linpan* through their own motivation; something the local government is not adept at (interview with Li Wei, August 2012). Indeed, power dynamics between local government and local residents may create passivity, something that planners in Chengdu's rural planning department see as an issue to implementing government-led redevelopment plans (Tippins 2012).

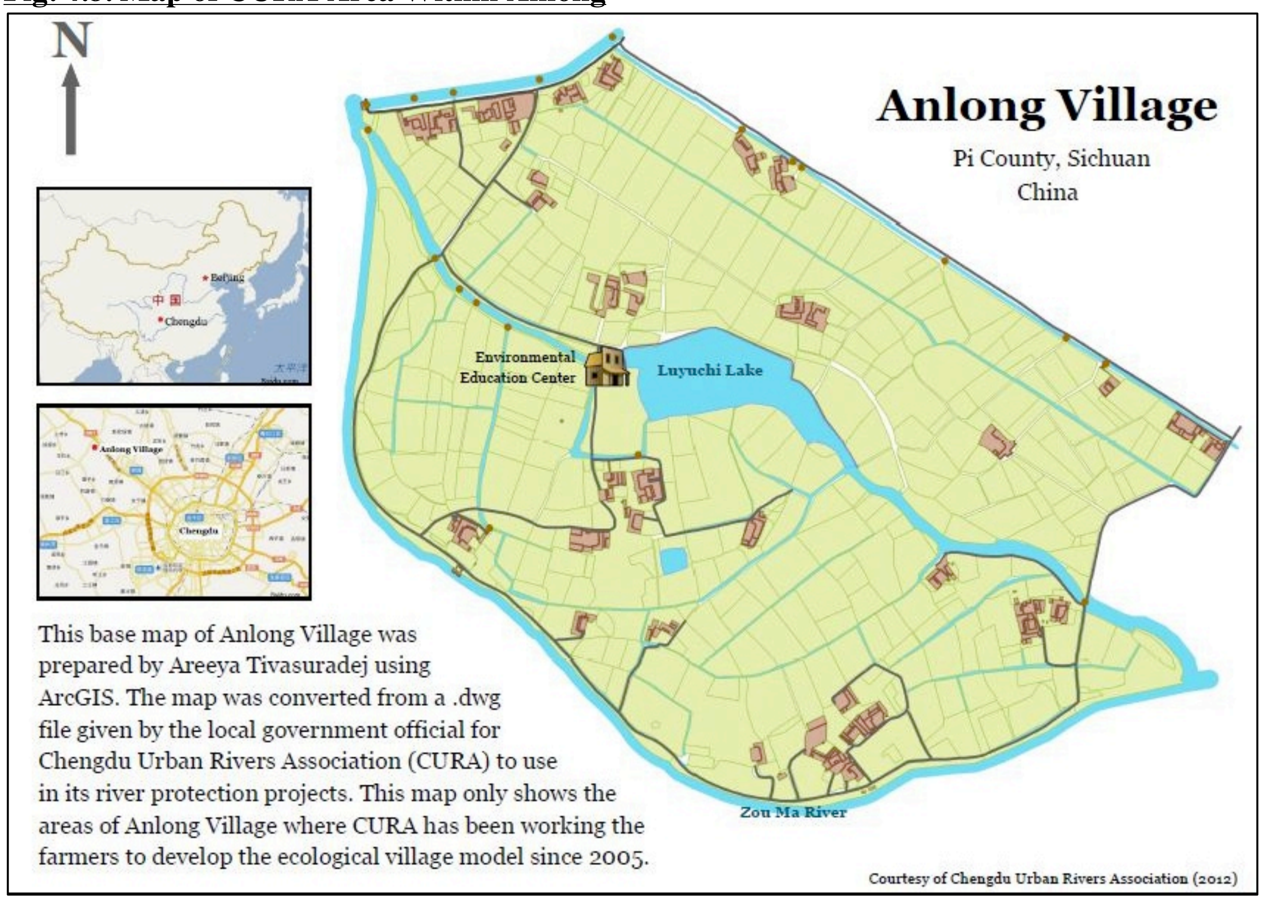
While CURA's involvement educated villagers and demonstrated the use of more sustainable infrastructure mechanisms, it was really in the hands of villagers to adopt these practices and ultimately where tensions between development and environmental protection played out. Despite the good intentions the co-op was founded on (to protect the environment, adopt organic methods, share skills and knowledge), villagers struggled to reconcile the co-op's principles with capitalist economic forces at play. Within the first year, seven families left the co-op and four new ones joined (Hale 2009). The co-op then splintered into three factions due to differences in how they viewed organic farming as practice and philosophy. Members disagreed over how much the business of organic farming should be business, and how much of it was really about an alternative way of life outside of the consumer market and larger global economy (Hale 2013). This is not to say that organic farming was not profitable. According to CURA staff, organic farmers make about 50,000 yuan per year for 4 mu of land (2,664 meters or .65 acres) (Tippins 2012). But the capitalist economy wields a strong influence over the future of rural villages, where non-intensive, small-scale farming does not seem a great fit for capitalistic market structures. From direct observation in the field, housing in this part of Anlong follows the traditional dispersed pattern. Homes are separated from neighbors by surrounding fields, and many homes have personal courtyard areas. For some families, the fields they tend are in very close proximity to their house.[8]

[8] In summer 2013, the grandmother of the Gao family kindly showed me the fields that belonged to the family. Most fields were within close proximity to their house just a few feet away. This is not necessarily true of all house-field relationships in the *linpan* landscape. For example, in Pujiang County under Chengdu municipality that is also

Fig. 4.7. Anlong Eco-village Model

Left: Land use crop diversity in Gao family organic field in Anlong, 2011. Center: CURA artificial wetlands, August 2011. Right: Farmers harvesting rice, September 2012. Photos by author.

Fig. 4.8. Map of CURA Area Within Anlong



Source: CURA 2012.

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considered part of the landscape, a walking tour with villagers in Shalou village revealed that many residents had fields far from their home.

Anlong Village: Semi-Concentration Model

Anlong is undergoing, and near completing, a second round of redevelopment, this time with top-down planning policies and implementation led by the local government. Anlong will become a model village for the semi-concentrated redevelopment approach. This is an experiment to meet regional rural planning goals by incorporating environmental concerns and ecological planning with New Socialist Countryside goals for development, modernization and efficiency (Chengdu Municipality Rural Planning Manual 2010). Dispersed settlements will be concentrated into eight residential areas (Anlong Development Poster, 2012). Local officials said that villagers have a choice in moving to the new homes or staying in their current homes. But in conversations with local residents, the government strongly persuaded residents to move to the new housing. Choice may be an illusion. Redevelopment construction began in Anlong in spring of 2012. Redevelopment of the government buildings was completed, and construction was near complete of the first concentrated settlement area #1 in summer 2013. Housing typologies in the concentrated settlement area consisted of two story semi-detached townhouses with small front and side yards. While the type of housing is similar to that in Zhanqi, the style of housing incorporated more local architectural characteristics.

Fig. 4.9. #1 Settlement Area Housing

New Housing in Settlement Area #1. Source: Photo by Daniel Abramson, July 2013.

Fig. 4.10. Model of Anlong After Redevelopment

This model is located in the Anlong Village Museum. The heavily wooded area close to the river is currently the Anlong CURA area. You can also see the semi-concentration sample area to the left of the Anlong CURA area (brown sign). Source: Photo by Daniel Abramson, July 2013.

Fig. 4.11. Semi-Concentration Development Plans for Anlong Village

Group #	Area (mu)	Area (sq meters)	Number of Households	Total Population
1	21.8	10062.06	55	209
2	3.3	1979.26	11	41
3	7.8	3765.36	20	79
4	29.14	14483.42	88	303
5	53.27	26220.97	160	534
6	37.66	16754.74	103	359
7	42.89	19852.69	128	409
8	36.4	17571.01	106	358
9	14.37	6890.68	44	151
10	24.56	11116.37	71	239

Edited from original photo of planning poster taken by Daniel Abramson in Anlong Village Musuem, July 2013.

4.2 Identify Indicators and Measures

This section outlines indicators and measures for characteristics of resilient landscape structure applicable to the case study in order to develop an understanding of existing characteristics of the *linpan* landscape structure and compare alternatives. The literature review on agroecosystem resilience found that appropriate scale, spatial heterogeneity, and biodiversity are three key aspects of landscape structure that support social and ecological resilience in agricultural landscapes (see Chapter 3 Table 3.1). Before indicators are identified, a brief description of landscape ecology and metrics along with key definitions for landscape ecology and landscape metrics is provided. I then discuss the scales at which potential indicators and measures can be studied. The last section then describes potential indicators and measures applicable to the *linpan* landscape study.

- Landscape Ecology and Metrics
- Determining Scales
- Potential Indicators and Measures

Landscape Ecology and Metrics

Landscape ecology has long sought to understand the relationship between landscape structure and function and has worked to quantify these measures through the use of landscape metrics. I reviewed the literature on landscape ecology and metrics and its application to find appropriate measures. While the literature on landscape ecology is vast, I focused on a few key sources that relate landscape ecology to the field of regional and ecological planning, particularly the work of

Richard T.T. Forman, a Harvard University professor in Landscape Ecology. *Measuring Landscapes: A Planner's Handbook* (Leitao et al. 2006) was also particularly useful in explaining and simplifying landscape metrics for planning practice, and the measures (metrics) come from these works.

"*Landscape ecology* focuses on the relationship between landscape structure and function and the ways landscapes change over time" (Leitao et al. 2006). According to Forman, landscape ecology can be applied to any type of landscape, from urban to natural resource lands. Its advantages include a simple spatial language aimed at easy communication across disciplines and professions as well as focusing on spatial patterns at the human scale (Forman 2008). Forman's land mosaic model (structural pattern model) is underlined by three key elements: patches, corridors, and a background matrix (Forman 1985, Forman 2008), which is also known as the patch-corridor-matrix model. Patches are areas of a defined or categorized land use type. Corridors are strips or connecting lines, and the matrix is the background or scale under study. The analysis employed in the case study, as an illustrative tool, mainly uses patch characteristics of different land use types at a sequence of scales (see section below on Determining Scales).

According to Leitao et al., landscape metrics can be particularly useful for planning in natural and cultural resource areas, or planning for sustainable land use. "*Landscape metrics* help to measure, describe, and understand the significance of these elements (patches, corridors and matrices) or their spatial pattern" (Leitao et al. 2006). Forman defines landscape metrics as "measures (and equations) that quantify spatial attributes of a large area…the beauty of these is that important ecological characteristics are known to correlate with spatial attributes" (Forman 2008).

Landscape ecology methods support the work of evaluation and monitoring, and the following two uses of landscape ecology methods are used to support the work of this evaluation method:

- *Describing patterns (baseline monitoring)*

  Measures in this evaluation help to describe landscape structure of the *linpan* landscape at present in the hopes of quantifying and measuring characteristics of the landscape that planners in Chengdu wish to preserve and maintain.
- *Allowing for comparisons (implementation monitoring, effectiveness monitoring)*

  Measures in this evaluation help to compare the baseline with the alternatives to quantify differences so that planners may have a better understanding of how well alternatives preserve and maintain traditional landscape elements

<u>Landscape Ecology Definitions</u> (Leitao et al. 2006)

The following terms will be used to describe the methods, indicators and measures used in the evaluation of the *linpan* landscape.

Patch: Surface area that differs from its surroundings in nature or appearance; the basic spatial unit or element in a categorically classified landscape. It is a relatively homogenous area that differs from its surroundings, this of course depends on how the landscape is classified.

Patch level: The lowest level comprised of individual patches, which can be aggregated into classes (land use types).

Class level: Is a single land use type or patch type in a categorically classified landscape. It includes all the patches in a given land use/patch type.

Land use type: Different types of land cover and land use in a specified scale or area under study. For example: residential, commercial, industrial.

Scale: Spatial dimension of an object or process

Composition: The variety and abundance of patch types without regard to their spatial character or arrangement.

Configuration: The specific arrangement of spatial elements in a landscape; specifically, the spatial character and arrangement, position, or orientation of patches within a class or landscape.

<u>Landscape Metrics Definitions</u> (Leitao et al. 2006)

The following selected landscape metrics and definitions come from Leitao et al. 2006. These were chosen based on their ease of use and application to planning.

Patch Richness (PR): number of different land uses present at the defined scale

Class Area Proportion (CAP): a percentage of the area of a given land class based on the whole. It is a measure of landscape composition.

Patch Number (PN): the total number of patches in a given land use. This is a measure of landscape configuration. "From an ecological perspective, more patches in a single land class type may assure redundancy within a landscape, thus reducing the risk of loss due to disturbances such as a pest outbreak, hurricane or flood" (Leitao et al. 2006).

Patch Size (AREA): the average size of patches of a particular land use type. "According to McGarigal and Marks (1995), patch area is perhaps the single most important and useful piece of information that can be obtained from a landscape analysis" (Leitao et al. 2006).

Distance to Nth Nearest Neighbor: this is the Euclidean distance between each discrete patch and the Nth nearest neighboring patch of the same patch or class type. A minimum, maximum and average value for distance to the Nth nearest neighbor can be compared (ArcGIS Help 10.1).

Determining Scales for Study

In landscape ecology, scale plays an important role in determining spatial patterns. Four scales were studied in each *linpan* administrative village to evaluate measures of landscape structure that serve as indicators of resilience. *Linpan* at its broadest scale is the entire landscape that covers the Chengdu Plain between Dujiangyan and Chengdu. For the purposes of this thesis, it was not possible to study effects to the landscape at this broad landscape scale. Instead, scale was chosen based on agroecosystem resilience literature discussed previously that identified the plot, field, and landscape scales as important scales in resilient agroecosystems (Kremen et al 2012). For the *linpan* landscape case study, I chose to measure indicators in four different scales. They are described below from smallest to largest.

Field Scale

Field scale here refers to both the field patch level and the field class level. At the field patch level, it looks at the land use types inside a single agricultural field (patch type). At the field patch level, I looked at the major crop type and identifiable crop(s) grown within each individual agricultural field inside the sample area to understand individual patch composition. It also refers to the field class level, which includes all the individual field patches inside the sample area boundaries (see below for specifics on sample area). At the field class level, I studied the arrangement or configuration of field patches. For example, are all grain fields grown in the same area, or are they dispersed among fields with different crop types?

Fields in the *linpan* landscape are delineated by irrigation ditches that surround the field. Field borders were determined based on remote sensing techniques using satellite imagery from Google Earth and ArcGIS 10 base maps for the most current year available (see Appendix 3 for data sources). Limitations at this scale include a margin of error in accurately representing each field and its borders. Therefore, precision and accuracy pertaining to the size of fields and content of the fields is based on my own determination of borders through remote sensing techniques. Field crop type accuracy is based on my direct observations supplemented periodically with confirmation about land use types from short conversations with villagers and research assistants during field research, as well as identification of crops from photographs.

Sample Area Scale (400m x 300m area)

Sample areas were chosen to gain a better understanding and representation of land use, particularly the spatial relationship between agricultural fields and other land use types. This scale offers a proxy for the spatial pattern (composition and configuration) of the landscape at larger scales. See section 4.2 for further details on the methodology for choosing sample areas in each village.

Intermediate Scale

For indicators of settlement pattern and measures such as nearest neighbor distance between houses, a scale between the sample area and village scale was chosen. For the *linpan* landscape, this is based on the size of the CURA eco-village model area (see Fig. 4.8)

Village Scale

The village scale is defined by the administrative boundaries of the village. This scale is used to observe broader land use composition and configuration. See section 4.1 for village site maps that depict their administrative boundaries and section 4.3 for how village maps were obtained.

Potential Indicators and Measures

Methods used to understand how the traditional *linpan* landscape manifests resilient characteristics in its landscape structure come from qualitative fieldwork conducted in the summer of 2012 where various stakeholders (academics, local planners, government officials, NGO workers, local residents) were interviewed on their views and opinions of *linpan*. A literature review of research by Chinese scholars on the *linpan* landscape was also conducted (Duan and Liu 2004; Yang et al 2011; Yin Le 2011).

First, each key characteristic that is an indicator of resilience is briefly described and is followed by a description of how it is reflected in the *linpan* landscape. Again, these key characteristics come from a review of the literature on resilience in agriculture (see Table 3.1 in Chapter 3). It then describes possible measures for these indicators using landscape metrics. A summary chart of all indicators and measures is provided at the end of this section.

A brief outline is provided for each characteristic of resilient landscape structure:

1. Appropriate Scale (Size and distance)
    - Description
    - *Linpan* application
        - Indicator: Field size
        - Indicator: *Linpan* unit size
        - Indicator: Settlement dispersal (settlement pattern scale)
        - Indicator: *Linpan* unit distance

        - Indicator: Density (village scale pop density)

2. Landscape heterogeneity (diversity of land uses, spatial patchiness)
    - Description
    - *Linpan* application
        - Indicator: Traditional land use types and patterns (Patch number, Patch Size, Class Area Proportion)

3. Biodiversity (Agricultural Productivity?)
    - Description
    - *Linpan* application
        - Indicator: *Linpan* unit
        - Indicator: Agrobiodiversity in crop types in field patch and class

<u>1. Appropriate Scale</u>

Description

Scale here refers to both the spatial dimensions (size) and distance between landscape elements. In landscape ecology, the size and shape of patches have a large correlation to their ecological and functional characteristics (Leitao et al. 2006). It has also been a general conclusion in the field of landscape ecology that "large patches of native ecosystems are more likely to possess a greater variety of habitats than small patches, and therefore are more likely to support greater biodiversity" (Leitao et al. 2006). Forman summarizes this as "large patches, large benefits, and small patches, small supplemental benefits" (Forman 1985). Ecosystem services, such as moderating fluctuations in surface water levels, mineral and nutrient cycling, and the removal of toxins from circulation in the environment, also depend on patch size. They are more likely to be achieved as the size of [native ecosystem] patches is increased (Leitao et al. 2006).

Distance between elements also has implications for function, and is referred to as landscape connectivity. "The size, number, and distribution of habitat patches influence the physical connectedness of habitat across the landscape, and may be the primary determinant of connectivity for some species" (Leitao et al. 2006).

Such landscape ecology findings can also be applied to agricultural landscapes. Although native and natural ecosystem patches may be far fewer in a landscape that is largely shaped for human needs, spatial dimensions of landscape elements in agroecosystems are nonetheless important. This is particularly true for two scales (spatial and distance dimensions) in agroecosystems: the field and the farm. For agricultural fields, Forman mentions "in agriculture an optimum field size has both ecologic and economic implications" (Forman 1985). While Forman and Leitao et al. relate larger patches as better for natural systems, this may be the opposite in agricultural landscapes, particularly when looking at the field land use type. The literature on agroecosystem resilience discusses the appropriate the size of a farm. This relates to both the size and distance aspects of scale. Many researchers seem to agree that small-scale farms promote both ecological and social feedback loops important to maintaining resilience. But what is considered 'small-scale' is relative. For example, Tengo and Belfrage consider a farm in Sweden with an average farm size of 30 hectares and a farm in Tanzania with an average size of 2 hectares both small-scale farms (2004). Kremen et al. define small-scale farms as 2 hectares or less (2012). However, it should be remembered that it is the spatial scale of farms coupled with management practice and knowledge that ensure that feedback signals from the natural ecosystem are perceived easily enough, and that a farmer's experience with local dynamics, typically at a small scale, influences how management practices adapt to these signals (Tengo and Belfrage 2004). Thus, an appropriate scale for a farm could be defined as one in which feedback signals are easily observed and farmer's knowledge can cope with local dynamics. This would also account for variance in different contexts. Management practices and ecological services at the small-scale also have effects at higher scales. For example, Van Apeldoorn explains how small-scale farms have been used historically to build critical soil matter. "High soil organic matter content at the field level is the cumulative result of historical management actions. As such, history is reflected in the small-scale landscape... In contrast, conventional grassland management calls for large-scale homogenized fields, causing a loss of accumulated capital of soil organic matter and possibly regional identity" (2011).

Linpan application

For the spatial (size) dimension of appropriate scale, the size of two particular land use types/ patch classes is important. First, the size of agricultural fields in the *linpan* landscape should be quantified to understand both its baseline characteristic and how it may have changed in redevelopment plans. Second, the size of the *linpan* unit should also be measured.

Here, a *linpan* unit is defined as the residential footprint(s) and surrounding forested/tree covered land areas. It does not include vegetated corridors or riparian area. I chose *linpan* unit as a measure because its patch shape is relatively easy to distinguish through remote sensing techniques. Traditionally, agricultural fields surrounded a linpan unit, indicating a very clear edge between changes in land use types.

For the distance dimension of scale, *linpan*'s unique settlement dispersion is a useful indicator. *Linpan*'s dense-but-dispersed population spatial pattern is different from other rural landscapes in China. Most traditional rural villages in China exhibit a concentrated or nucleated settlement form surrounded by cultivated fields in the periphery. According to von Richtofen's rough calculations, he estimated a population density in the Chengdu Plain of 800 per square mile in 1870 (von Richtofen 1872). Today, the population of Pi County is 480,000 over 437.5 square kilometers (Wikipedia 2013), or 1,097 persons per square kilometer, or 2,841 persons per square mile. But this number includes the urban areas of the county as well as the rural. A dispersed spatial pattern helps explain why the villages described in the case study are villages in name only, and the term village merely identifies its administrative functions.

For this indicator, I chose several measures to understand how dispersed or concentrated the settlement pattern is. This includes patch size and patch number for the residential land use type at the intermediate scale. Another potential measurement is distance to Nth nearest neighbor looking at dwelling unit (house or building) point data. It is important to look at the data to understand a significant measurement for measuring the distance to a particular neighbor.

Table 4.1. Potential Indicators and Measures for Appropriate Scale

Scale	Indicator	Measure
Field	N/A	N/A
Sample Area	Appropriate Scale: Size	Patch Size (Area range, mean) for land use types, particularly for fields and *linpan* unit land use types
	Appropriate Scale: Distance between *linpan* units	Nearest Neighbor Second Nearest Neighbor
Intermediate Scale	Appropriate Scale: Distance between settlements	Residential land use type: Patch Size, Patch Area (Min-Max, Mean)
		Dwelling Units within Patch Size (Min-Max, Mean)
		Distance to Nth Nearest Neighbor
Village	Appropriate Scale: Distance	Population Density

2. Heterogeneity in Landscape Structure (diversity of land use types)

Description:

Landscape structure refers to the arrangement of land uses within a defined scale including both composition and configuration. *Land use* is the type of activity and nature of use within a defined scale, such as a plot, field, farm, village or landscape scale. It has both spatial and temporal dimensions. "Land use at the farm scale also has a temporal aspect, where crop rotation and land use changes throughout the seasons or over years" (Cabell and Oelofse 2012). For the purposes of this study, only the spatial dimension is considered given research limitations. At the field scale, land use types refer to different crop and non-crop varieties grown in the field. At larger scales, land use refers to characteristics such as agricultural, residential, commercial, or industrial purposes that define the overall use of the land. *Composition* refers to the number and occurrence of different types of landscape elements and uses. C*onfiguration* describes the physical distribution or spatial arrangement of elements or land use types within a landscape (McGarigal et al. 1994). Put another way, configuration is the specific arrangement of spatial elements in a landscape; the spatial character and arrangement, position, or orientation of patches within a class or landscape (Leitao et al. 2006).

Landscape structure has important implications for agroecosystem resilience. Researchers find that land use diversity across spatial and temporal scales is more resilient than a homogenous pattern of land use and crop varieties (Cabell and Oelofse 2012, Kremen et al. 2012). "Spatial considerations are important, since different components of the system must be in sufficient proximity, at each relevant scale, to create needed interactions and synergies. For example, the utility of intercropping for reducing belowground soil disease depends on spacing the different crops such that their root systems interact" (Kremen et al. 2012). In agroecosystems, Kremen et al. highlight three geographical scales that should each contain biodiversity and a mix of uses. This includes plot (sub-areas within a field), field (land for agricultural purposes), and landscape (Kremen et al. 2012).

Fig 4.12. Spatial Heterogeneity Across Scales

- **Plot**-" include multiple genetic varieties of a given crop and/or multiple crops grown together as polycultures, and may stimulate biodiversity within the soil through addition of compost or manure."

- **Field**- "include polycultures, non-crop plantings such as [intersecting] strips, integration of livestock or fish with crops (mixed cropping systems), and/or rotation of crops or livestock over time, including cover cropping and rotational grazing. Around the field, DFS may incorporate non-crop plantings on field borders such as living fences and hedgerows."

- **Landscape**- "include natural or semi-natural communities of plants and animals within the cropped landscape/region, such as fallow fields, riparian buffers, pastures, meadows, woodlots, ponds, marshes, streams, rivers, and lakes, or combinations thereof (see also Kremen and Miles 2012)."

Source: Kremen et al. 2012

Linpan application:

According to researcher Yin Le at Sichuan Agriculture University, there are several essential land use types within each *linpan* at different scales. The definition of *linpan* can take on two meanings based on scale. *Linpan* can refer to the settlement system on the semi-natural, semi-artificial wetland in the range of the Dujiangyan Irrigation System on the Chengdu Plain. It is also used to describe a courtyard-style house surrounded by bamboo and fields distributed on the Chengdu Plain. In this sense, *linpan* refers to both the entire pattern of settlement as well as the individual house-woods-field units (Duan and Liu 2004).[9] The spatial arrangement of land uses served important interdependent functions and connections that sustained overall system function (Le 2011). These land use elements are also indicated in local planning documents (Rural Planning Manual 2010, Guidebook 2011).

[9] Note that my definition of *linpan* unit for spatial analysis purposes differs from this meaning of *linpan* unit as house-woods-field. As I explain the methodology for spatial analysis in the next section, I use *linpan* unit in the spatial analysis sense to mean residential structures (or building footprints) contained within a wooded area, defined by edge contrast with surrounding fields that can be observed through remote sensing techniques of satellite imagery. It was not possible at this time of research to match individual households (their building structure location) with the fields that they manage. Additionally, because of land redistribution policy and land subletting, many farmers lease some (or all) of their land, further complicating the house-field relationship.

Fig. 4.13. Land Use Types of Traditional *Linpan* Landscape

From Left: water, agricultural fields, bamboo groves, houses. Source: Photos by author, August 2012 (Left: Jiang'an Village; Left middle: Anlong Village; Right middle: Anlong Village; Right: Jiang'an Village).

Traditional Land Use Patterns

Fields: Linpan has been a traditionally wet-rice growing region. Most farms produce one crop of rice and another of either wheat or rapeseed oil each year (Willmott 1989). Individual farmers also grew a variety of vegetable crops such as corn, beans, eggplant, Sichuan peppers, etc. (Skinner 1949).

Water: Water is another main feature of *linpan*, and its abundance and use for agricultural production has been vital to the *linpan* landscape's long history of sustained human habitat. The Dujiangyan Irrigation System, an engineering marvel constructed in 256 BC and still in use today, provides the water for wet rice cultivation in the flat, fertile plain where *linpan* is found.

Wooded Areas (Orchards, Bamboo Groves, Forests): In many interviews with local residents in *linpan* villages, there is almost a unanimous answer when asked to describe *linpan*. Trees and bamboo are defining features of *linpan*. When settlers first came to the Chengdu Plain and chose a site to build their house, they planted bamboo around the home to protect it from the sun and wind. This helped make the home cool in summer and warm in winter (interview with Li Wei, August 2012). The bamboo was also used for heating in the winter and as fuel for cooking, and this is evident even today. Bamboo was grown as an agricultural product and used as a versatile material for many different uses, from a construction material for homes, to making baskets, farm tools, farm clothing (traditional bamboo raincoats), and also as an export item sold and traded at larger markets and cities. Bamboo also represents the interdependence between human management and ecosystem. If bamboo is not cut after three years, new bamboo cannot grow. Thus, it is dependent upon human use for its renewal and growth (interview with Tian Jun; interview with Li Wei; interviews with local residents August 2012). Bamboo groves also provide ecosystem services to clean and filter the water. Therefore, bamboo and its production are valuable for local residents and the ecosystem. Anthropologist William Skinner also noted the abundance of orchard trees and fruits grown in the region during his fieldwork in 1949 (Skinner 1949).

Houses: Houses were also a key element in the traditional *linpan* landscape and were most often found in the dense-but-dispersed settlement pattern described earlier in the discussion on appropriate scale. Traditionally, a single family (immediate and often extended) occupied a house where bamboo was planted around the home as mentioned above, and beyond which were the fields that the family managed. The house-bamboo-field land use pattern together created a basic unit of the *linpan* landscape. Houses traditionally were found scattered across the landscape. While some *linpan* units contain more than one house, often due to growing family lineages, there is not the sense that *linpan* is characterized by a very dense clustering of houses.

From direct observations in the field, it is unlikely to find more than four or five homes clustered together in a single area.

Table 4.2. Potential Indicators and Measures for Landscape Heterogeneity

Scale	Indicator	Measure
Field	Landscape heterogeneity (diversity of crop types): composition	Patch Richness Class Area Proportion
	Landscape heterogeneity (diversity of crop types): configuration	Patch Number Patch Size (Area Range, Mean)
Sample Area	Diversity of land use: composition	Patch Richness (number of land use types) Class Area Proportion
	Diversity of land use: configuration	Patch Number Patch Size (Area Range, Mean)
Village	Diversity of land use: composition	Patch Richness Class Area Proportion
	Diversity of land use: configuration	Patch Number Patch Size (Area Range, Mean)

3. Biodiversity

As noted in Chapter 3, biodiversity is an important component of agroecosystem resilience, where a wide range of species diversity may be better able to adapt to disturbance than those with less biodiversity. The landscape is one scale among many that can help to protect biodiversity (Leitao et al. 2006). According to Leitao's review of the literature on landscape ecology, the following are principles of how the landscape can support biodiversity (Leitao et al. 2006):

1. Large patches of vegetation are preferred that provide habitat for animal populations. "As a general rule, the larger the patch, the better it is for wildlife conservation"

2. Maintain wide riparian corridors

3. Maintain connectivity between important resource patches to allow for key processes to flow freely

4. Maintain bits of nature throughout human-developed areas.

Linpan Application:

'Linpan units': For the *linpan* landscape, biodiversity (crop diversity and non-crop species diversity) could be measured by indicators of landscape structure, particularly through observations of '*linpan* unit' or of the forest class type. *Linpan* unit is here defined as a distinct land use type containing forest cover with small settlements inside. Endicott termed this a *yuanzi* or "scattered clusters of farmhouses that are shaded by bamboo groves or stands of eucalyptus. Typically four to six families live in one of these clusters" (Endicott 1992). It is distinctive when viewing satellite imagery of the village field sites and differs from forested area because they contain settlements and have relatively distinct patch edges. *Linpan* units can be thought of as "bits of nature" in an agricultural landscape, or as Endicott described them, "small islands in a mirage of turquoise or light greens [referring to the fields] depending on the season" (Endicott 1992).

Crop Use: Another indicator could be the diversity of crops grown in the agricultural field patch level and class level. This could be measured by the number of fields with polyculture (more than one crop) as well as the composition of patches in the field class only. Field sites with higher degrees of patchiness (variety of crop types) would indicate a higher degree of biodiversity.

Table 4.3. Potential Indicators and Measures for Biodiversity

Scale	Indicator	Measure
Field	Polyculture within field patch	Patch Richness: Number of different major crop use types
Sample	*Linpan* unit	Patch Number Patch Size

Table 4.4. Summary of Potential Indicators and Measures

Scale (Appropriate Scale)	Resilience indicators	Measures
Field (patch and class level)	Landscape heterogeneity: diversity of crop types	Composition: • Patch Richness • Class Area Proportion for dominant crop type classes (e.g.: ornamental, grain, vegetable) Configuration: • Patch Number: dominant land use type
	(Agro)Biodiversity	Patch Number of polyculture fields (growing more than 1 crop in a given field)
Sample Area (400m x 300m)	Landscape heterogeneity Appropriate Scale	Composition: • Patch Richness • Class Area Proportion for land use types Configuration: • Patch Number: dominant land use type • Patch Size: (Area Range and Mean)
	Landscape heterogeneity: ecosystem patches (*linpan* clusters)	Patch Number for *linpan* units Patch Size for *linpan* units
	Biodiversity	Patch Size for '*linpan* unit' and wooded area land use type Class Area Proportion for *linpan* unit and forested area land use types
Intermediate Scale	Appropriate Scale: Settlement Pattern	Patch Number residential land use (*linpan* unit for Jiang'an and Anlong CURA) Patch Size for residential land use (*linpan* unit for Jiang'an and Anlong CURA) Number of dwelling units in intermediate scale Average Number of dwelling units in residential land use patch Distance to Nth Nearest Neighbor
Village Area	Landscape heterogeneity	Composition: Patch Richness Class Area Proportion Configuration Patch Size (Area Mean)
	Appropriate Scale: Settlement Pattern	Population Density

CHAPTER 5: EVALUATING THE ALTERNATIVES

5.1 Spatial Analysis Methodology

Using the indicators and measures outlined in the previous chapter (Table 4.4), I conducted a spatial analysis in the three field sites (four alternatives and sample areas) using GIS data collected during fieldwork in July 2013 in combination with remote sensing techniques. The first major challenge to conducting spatial analysis in China is the inaccessibility of GIS data. Because of the sensitive nature of geospatial information, I was unable to obtain any official GIS data sets from the planning department. Therefore, for the sample area scale I created GIS shapefiles using satellite imagery and collected field data for fields and roads to aid in georeferencing. This section will discuss the methodology in each scale.

Field scale

To collect data on crop type in individual fields (field patch and class level) that could not be discerned from satellite images, I used a handheld Juno device and visited each village sample area to collect point information for major crop types grown in each field within the sample area boundaries (sample area method described below). Field attribute tables included both a major crop type as well as individually recognized crops in each field.

Major crop types:

- Ornamental: trees grown for landscaping and aesthetic purposes. These include osmanthus tree (Chinese: *guihua*), gingko trees, crape myrtle (Latin: *Lagerstroemia*

Chinese: *zi wei*) which is a flowering tree with pink blossoms, tea shrubs (Latin: *Camellia sinensis* Chinese: *cha hua*)

- Grain: mainly rice, sometimes corn
- Vegetable: food crops such as varieties of squash, melons, beans, peppers, eggplants, sweet potatoes and taro (which are often used for pig feed)
- Fallow: agricultural fields that have no crops growing in them at present

Sample area scale

Due to time and resource limitations, a sample area was chosen for each village as a representation of the general landscape structure. This was based on reading a methodology by Erle C. Ellis who conducted a spatial analysis of land use change in rural landscapes in China (Ellis 2006).

Sample areas were chosen for Jiang'an, Zhanqi, and two areas in Anlong- one within the CURA eco-village boundaries, and one bordering the area of new semi-concentration development that began in the spring of 2012. Sample areas were determined using remote sensing techniques of Google Earth satellite imagery. A 400 meters by 300 meters area (12 hectares) was determined as the most feasible scale to balance the ability of a researcher to walk the entire sample area to collect field data as well as being large enough to analyze patterns. To develop consistency between villages, each sample area is bordered on one end by a major river or water channel that flows through the village and a main road on one other border. Agricultural fields had to compose the majority of the land cover observed in the satellite imagery for the purpose of drawing conclusions about agroecosystems. Limitations include choosing sample areas of this scale that are representative of the village as a whole. Landscape composition and configuration can change considerably if a different sample area is chosen. Additionally, satellite imagery for Jiang'an was much older than the other villages, perhaps affecting accuracy.

Once sample areas were chosen, satellite imagery from Google Earth as well as ArcGIS 10.1 base maps were used to create shapefiles for each land use type. Specific information about the data source for each village can be found in Appendix 4. Shapefiles were created in ArcGIS 10.1 using the GCS China Geodetic Coordinate System 2000, 17N projected coordinate system to calculate geometry of shapefiles.

<u>Sample Area Scale Land use types</u>:

- *Field:* agricultural fields.
- *Residential:* includes footprint of building and courtyard, what can be discerned of as man-made structures. This is supplemented by point data collected in the field when I passed homes in the village. For all but Zhanqi village, man-made structures in the sample areas were all residential use.
- *Wooded:* wooded (tree cover) land areas, distinctive vegetated corridors and riparian areas.
- *Water:* water bodies and major rivers (does not include irrigation channels)
- *Linpan* unit: residential footprint and surrounding forested land areas. Does not include vegetated corridors or riparian area.

- *Tourism:* crop types that are grown for touristic value. This includes plantings of lavender, *ma bian cao* (Herba Verbenae).
- *Commercial:* business activities and purposes without residential function.

Intermediate Scale

To calculate measures for settlement pattern dispersion, I used a mix of point data for houses observed in the field during fieldwork in July 2013 using the handheld Juno device and matching this data to satellite imagery through remote sensing techniques. Raw data points for housing locations collected in the field are given priority as being true and accurate. They are supplemented with created data points through remote sensing for those structures that appear in satellite imagery but for which GIS field data was not collected. As nearest neighbor calculations are sensitive to the overall area, the area for the entire CURA eco-village model site (384,582.54 m^2) is used as a base for all villages (see Fig. 5.1). Thus, the sample area at the intermediate scale used for these measures is about three times larger than the 300 m x 400 m sample area to get a better picture of settlement pattern. For the nearest neighbor measure, the 7^{th} nearest neighbor was used as 7 was the number beyond the high end of the range of housing units found inside a *linpan* unit.

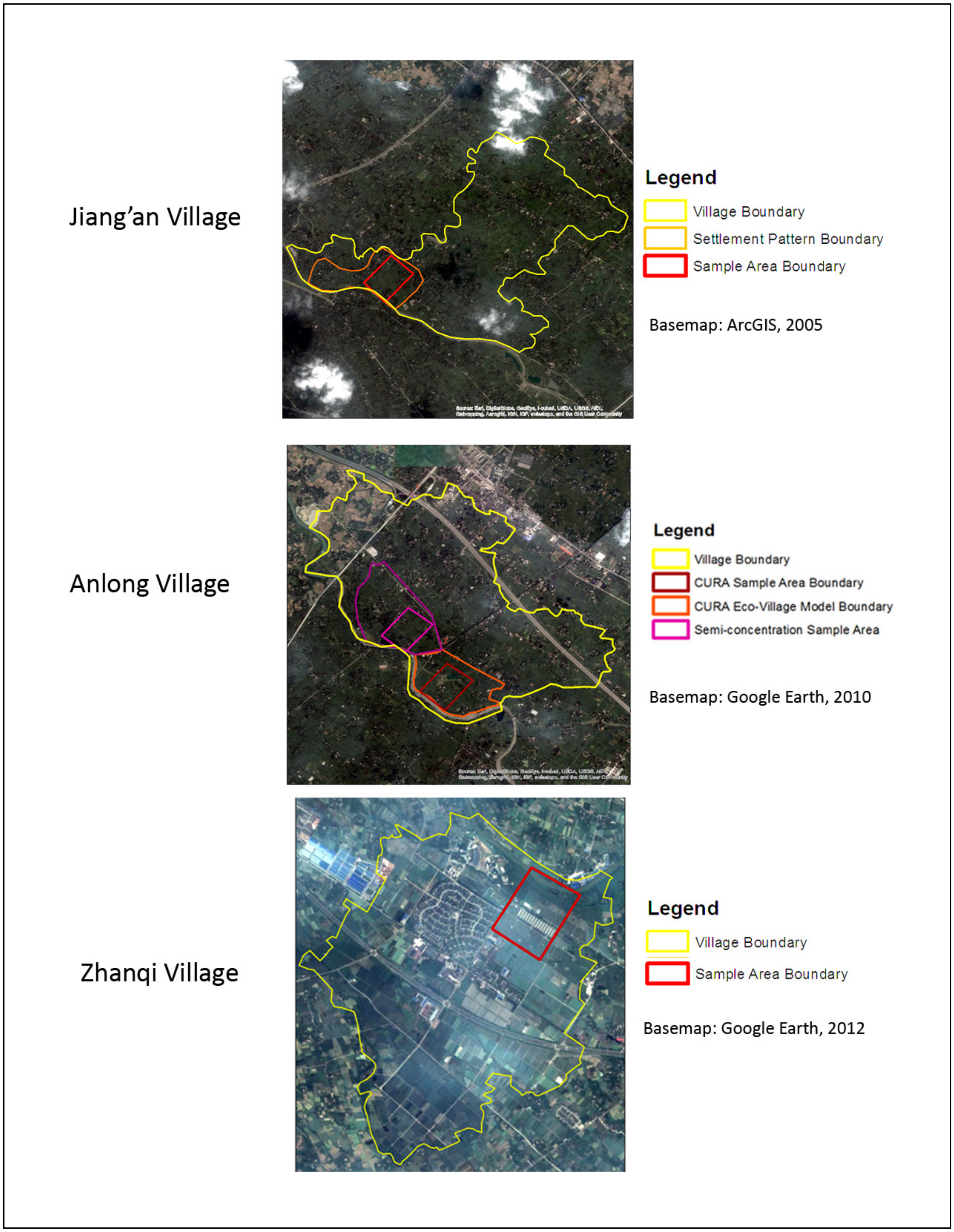
Intermediate Scale Land use type:

Residential: For Anlong semi-concentration area and Zhanqi, the residential land use type is defined by those areas determined for residential use, and this data comes mainly from public posters displayed in the villages that gave both the size of the residential area as well as the number of households and people living in each. It is not based on building footprint. For Jiang'an and Anlong CURA, I use the '*linpan* unit' as a residential land use type. The '*linpan* unit' as defined in the sample area scale is the residential footprint or point and includes surrounding wooded areas. To further discern *linpan* units, I look for those wooded patches with house points (dwelling units) inside and have a distinct edge, giving them the appearance of an island or patch among what can be discerned from satellite imagery as agricultural fields. Therefore, some dwelling unit (housing) points that are more corridor-like in shape were not counted as being part of a residential patch. It is important to recognize the multi-functionality of the *linpan* unit in Jiang'an and Anlong CURA sample areas is distinct from the more purely residential functionality of housing areas in the Anlong semi-concentrated and Zhanqi environments.

Village scale

At the village scale, land use maps collected and observed during fieldwork in 2012 and 2013 provide data. For Jiang'an village, the planning department kindly provided a PowerPoint presentation with AutoCAD images that include statistics on the land use area and class area proportion. For Anlong village, I took photographs of publicly posted land use maps that were displayed outside the local village government offices in the summer of 2011, 2012 and 2013. I also received a few maps for the CURA eco-village area of the village from CURA staff. For Zhanqi village, I took photographs of publicly posted land use maps displayed in the new concentrated settlement public square in summer 2013.

Fig. 5.1. Different Scales Within Each Village



Note: Sample areas are approximately 300 x 400 meters.

5.2 Analysis

This section analyzes the indicators using the measures and methods outlined in the previous two sections. Please also see Appendix 3 for a complete view of the data.

Jiang'an Village: Existing Typology

Field Scale:

At the field class scale, Jiang'an has 134 fields within the sample area using remote sensing satellite imagery from 2005. Sizes range from 185.63 to 1,745.78m^2, with an average size of 765.54 m^2. About 99% of fields sampled in the sample area contain ornamental landscape crops as the major crop type within individual fields (patches). This shows that at the field class level, Jiang'an has little to no food crops, and polyculture across major crop types at this scale is rather scarce. At the field patch scale, many fields exhibited polyculture within its major crop type. Ornamental fields are often planted with a variety of ornamental trees and shrubs underneath, as well as limited food crops (an edge row of squash, corn, etc.) The most common of the ornamental trees include gingko, guihua, and the crape myrtle with its distinguishable pink blossoms.

Fig 5.2. Jiang'an Field Scale Map

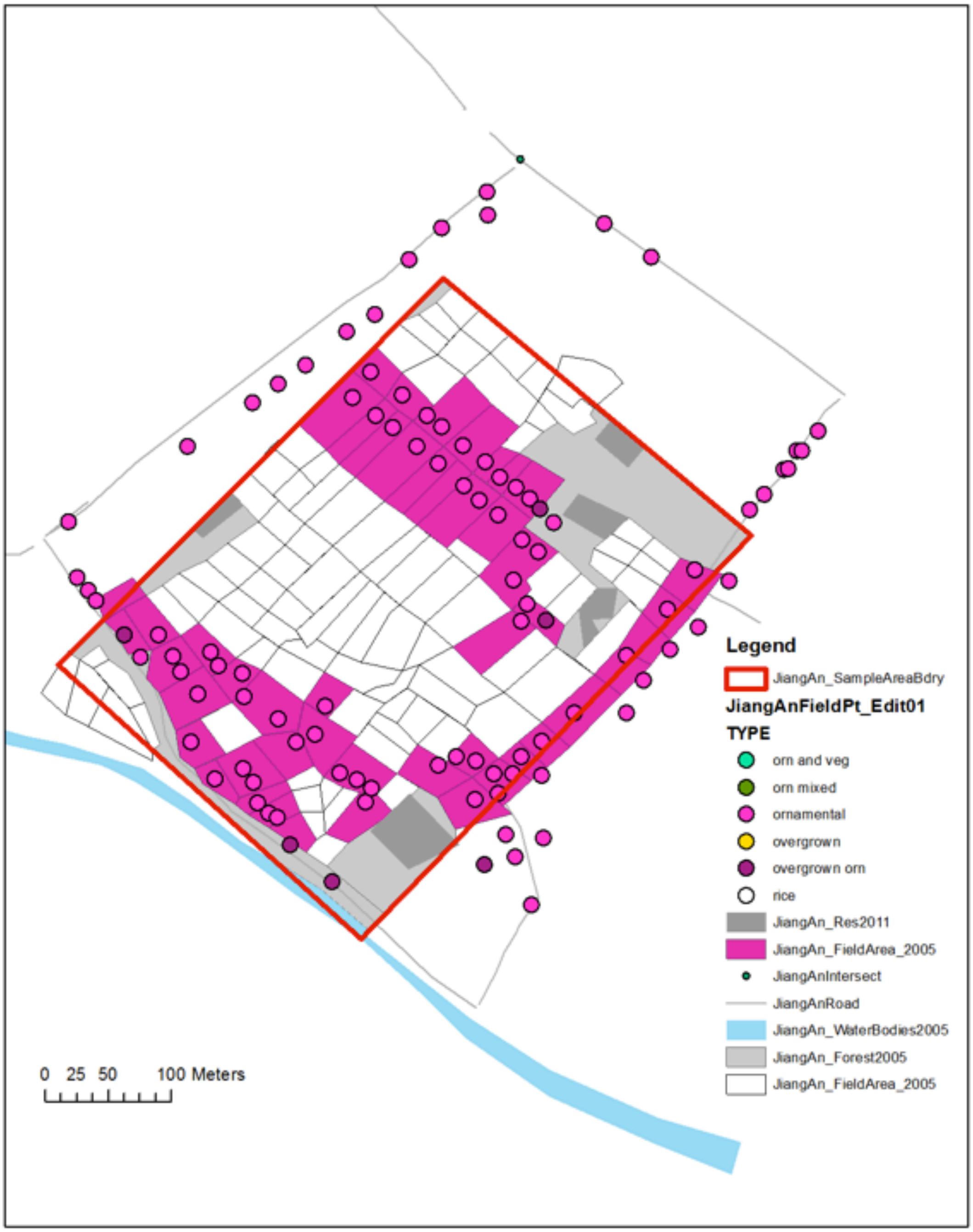
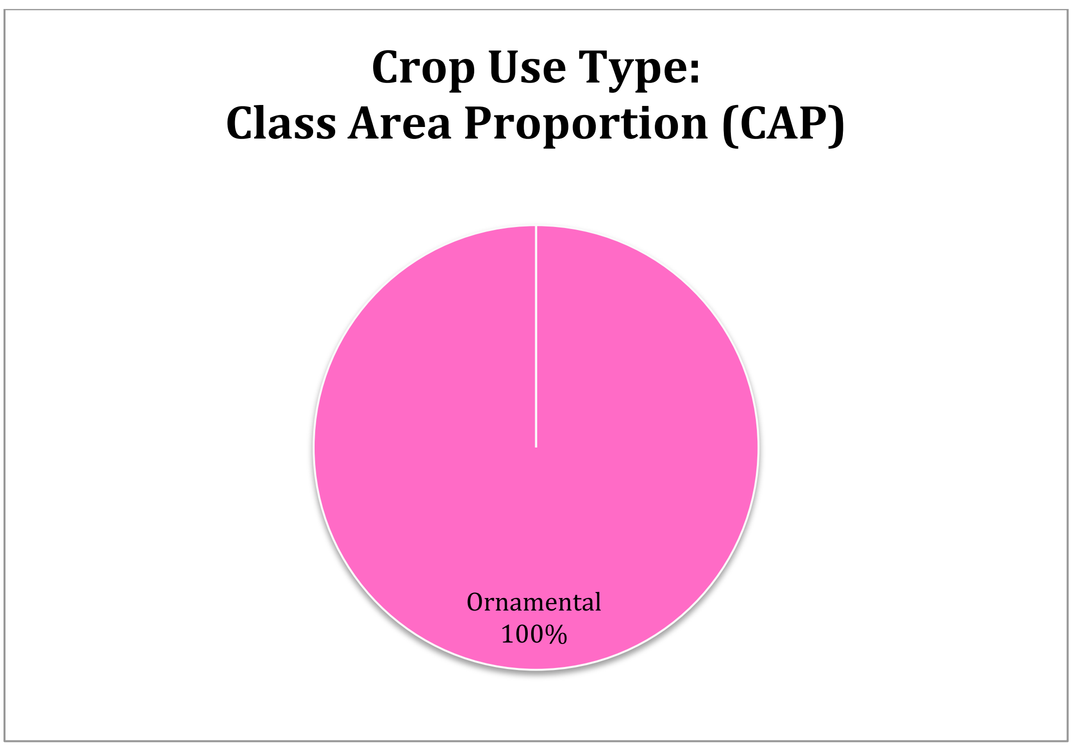


Table 5.1. Jiang'an Field Scale Data

Jiang'an: Field Scale			
Major Crop Use Types	Grain	Ornamental	Fallow
Patch Size: Area Range (min-max) (m^2)	0	320.37-1666.86	0
Patch Size: Average (m^2)	0	896.91	0
Standard Deviation (m^2)	0	372	0
Total Sum (Class Area) (m^2)	0	43948.78	0
Class Area Proportion (CAP) (%)	0	100	0
Patch Number (fields matched to data pts.)	0	49	0
Patch Number (raw data points within sample area)	1	65	

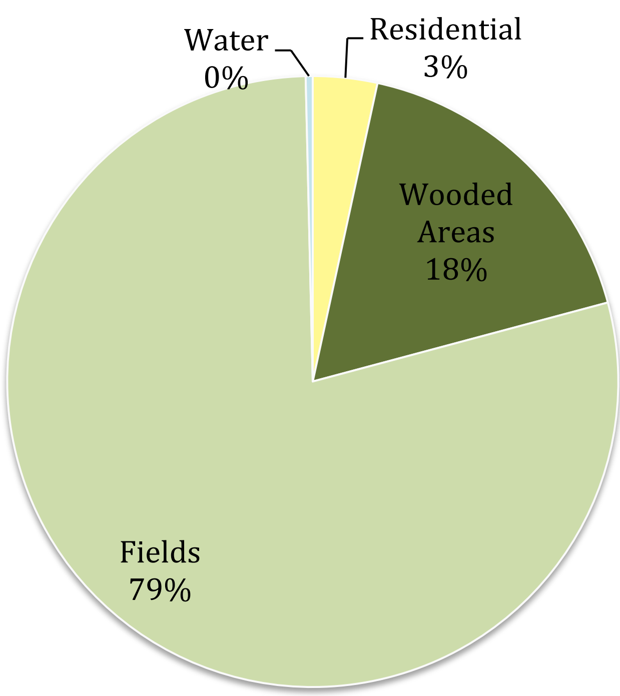
Fig 5.3. Jiang'an Crop Use Type: Class Area Proportion



Sample Area Scale:

At the sample area scale, Jiang'an has four major land use types: fields, wooded areas, residential and water. Fields make up about 78.79% of the land use in the sample area with an average size of 765.54 m^2. 17.43% of the land use is wooded with an average size of 3,819 m^2, and 3.4% is residential. There are approximately 4 *linpan* units that intersect the border of the sample area. Their average area is 8,682.57 m^2.

Fig. 5.4. Jiang'an Land Use Type: Class Area Proportion



<u>Fig 5.5. Jiang'an Sample Area Scale Map</u>

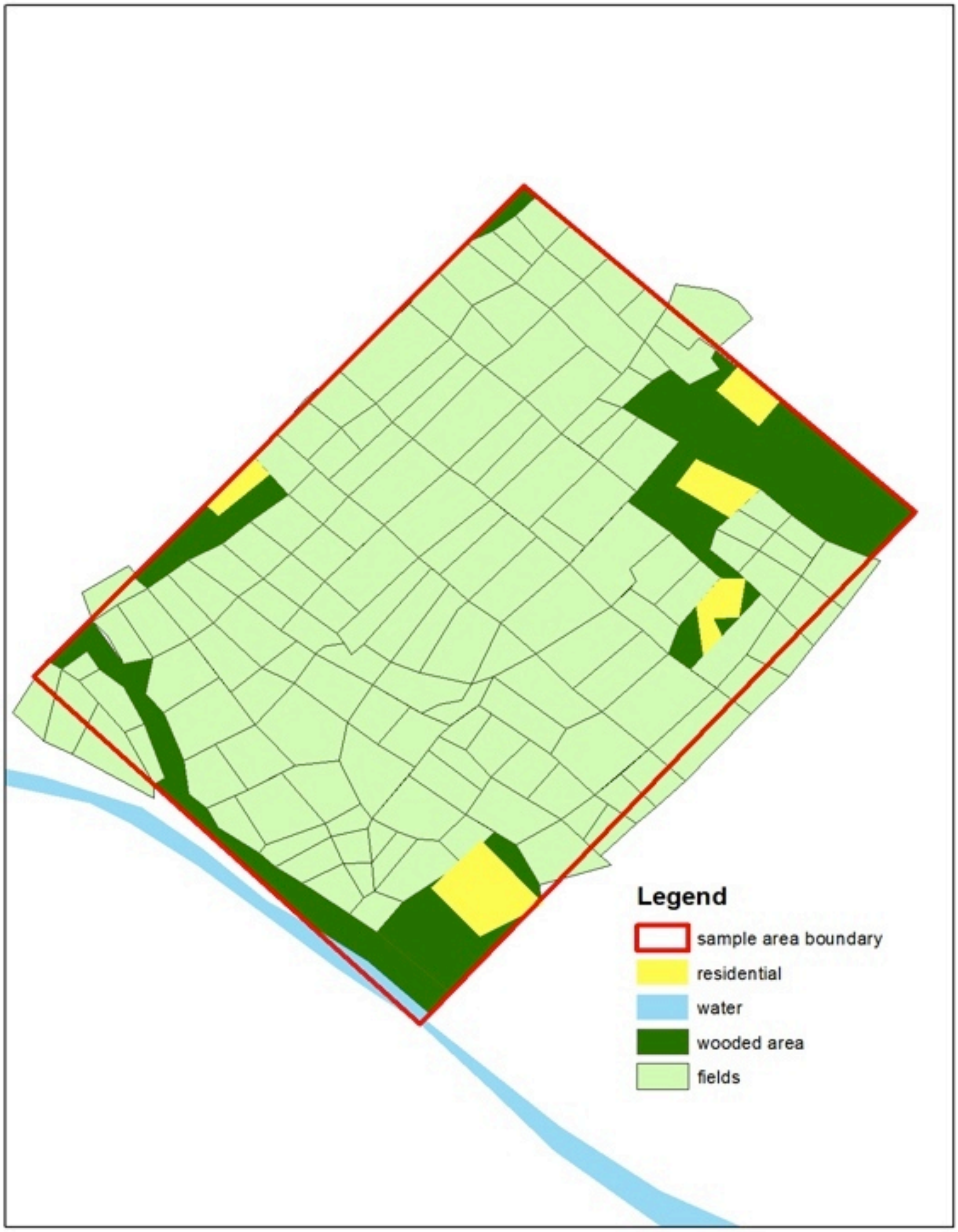


Fig. 5.6. <u>Jiang'an *Linpan* Units That Intersect Sample Area</u>

Table 5.2. Jiang'an Sample Area Scale Data Table

Jiang'an: Sample Area Scale								
Land Use Type	Size of Sample Area (sqm)- Boundary layer:	Commercial Area	Residential (Field Data Pts 2013 within bdry)	Residential Area (Remote Sensing/Maps)	Wooded (all areas in sample area)	Fields (all that intersect sample bdry)	Water	Linpan Unit (contained within/intersect bdry)
Data Source	ArcGIS Basemap 2005: Sample Area Area= 120,134.76sq m		Field Data pts 2013	JiangAn AutoCad Map 2011	ArcGIS Basemap 2005	ArcGIS Basemap 2005	ArcGIS Basemap 2005	ArcGIS BM 2005
Patch Size: Area Range (min-max) sq m				462.49 - 1840.1	319.16 - 11517.44	185.63- 1745.78		1993.48 - 12185.98
Patch Size: Average (sq m)				886.19	4,539.58	765.54		8,682.57
Standard Dev				490.28	3,819.79	366.75		4,034.68
Class Area (Total Area) (sq m)	130,194.39	0		4,430.98	22,697.92	102,582.75	482.74	34,730.29
Class Area Proportion (CAP)				3.40	17.43	78.79	0.37	
Patch Number		0	7	5		134	1	4

Intermediate Scale: Settlement Pattern

59 housing points were approximated (60 from raw data) in an area of 369,633 m^2. *Linpan* unit patch sizes (a residential land use type) had an average patch size of 13,021 m^2. There were 8 *linpan* units in the intermediate scale area, and the average number of houses (dwelling units) in a *linpan* unit was 6, although this number varied widely from 2 to 14. The average distance to the 7th nearest neighbor was 96.3 meters.

Fig 5.7. Jiang'an Intermediate Scale of Settlement Pattern Map

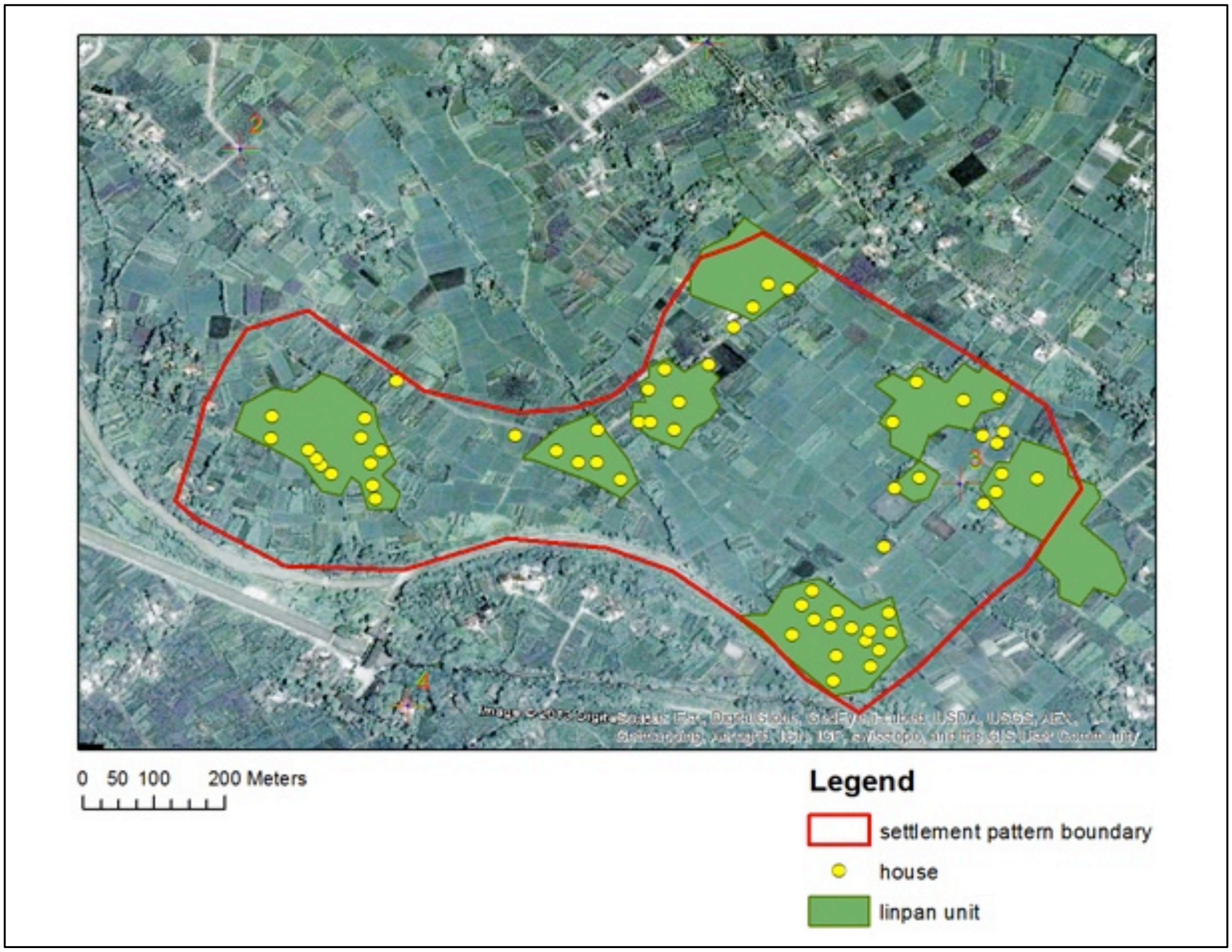


Table 5.3. Jiang'an Settlement Pattern Data

Indicator	Measure
Intermed Area Size (m^2)	369,633
Patch Size: (Min-Max) (m^2)	1,993 - 20,900
Patch Size: (Mean) (m^2)	13,021
Patch number	8
Average distance to 7th nearest neighbor (meters)	96.3
Total # of Dwelling Units (DU) in sample area	59
Total # of DUs in patches	50
Avg # of DUs in patch	6
# DUs range	2 -14

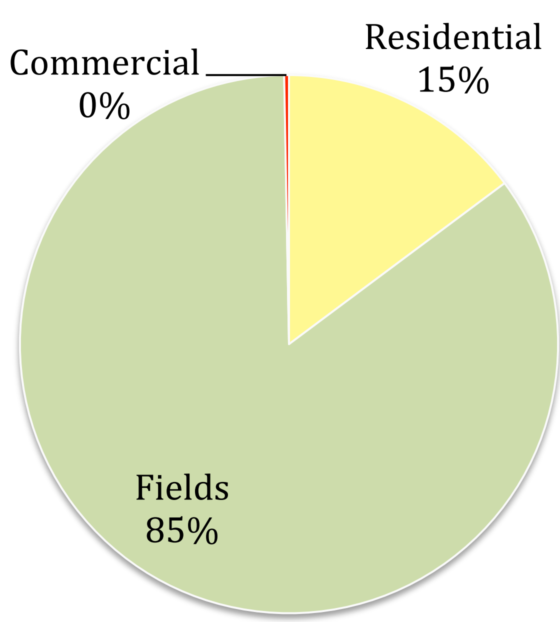
Village Scale:

At the village scale, Jiang'an has a total area of 3.12 square kilometers. The major land use is agricultural use (82.7%) with 2.58 km^2. Man-made areas account for the remaining land use (.53 $km^2$and 17.3% of land use in the village). Residential uses account for .45 sq. km (14.5%). There is no commercial use, and public roads and plazas make up .08 km^2 and 2.8% of land use. The population density at the village scale is approximately 864 persons per square kilometer.

Table 5.4. Jiang'an Village Scale Data

Jiang'an: Administative Village Scale									
Land Use Classes								**Population**	
	Total land area (sq km)	Total Residential Area	Total Agricultural Area	Commercial Area	Green'/ Wooded Area	Public Amenities			Population total persons)
Data Source	Jiang'an (PPT)	Jiang'an (PPT)	Jiang'an (PPT)					Data Source	
Total Area (sq km)	3.12	0.45	2.583	0.0087		0.08		Total Pop (persons)	2697
Class Area Proportion (CAP)	100.05	14.42	82.79	0.28		2.56		Pop Density (persons/sq km)	864.42

Fig. 5.8. Jiang'an Village Scale Land Use type: Class Area Proportion



Summary:

Jiang'an illustrates characteristics of the traditional landscape structure across observed scales, but it lacks patchiness and polyculture at the field scale. In the sample area, little to no fields contained food crops. Jiang'an represents a model of 'do nothing' in terms of changes to traditional landscape structure and form, but it also shows how outside forces beyond redevelopment policy, particularly market forces, have changed the *linpan*'s traditional function as an agricultural landscape. Even though the landscape structure has not changed, some of the landscape functions that provide resilience in an agroecosystem context are gone. Loss of food crops is apparent in the fields within the sample area. However, the change to ornamental landscape trees also shows how the landscape is able to adapt to changing conditions (changes in market preference) yet still retain arable functionality in the sense that the fields are still being cultivated. It may not be difficult to switch back to growing food crops if needed. Additionally, the new crop coverage (ornamental trees) may provide different ecosystem services or environmental benefits (or disadvantages). For example, tree coverage may aid in carbon sequestration, clean polluted soils, etc. From one interview with a long time resident in Jiang'an, they mentioned that some fields planted with ornamental trees, if those crops are not sold, some villagers decide to keep the trees which continue to grow and mature.

2. Anlong Existing Typology

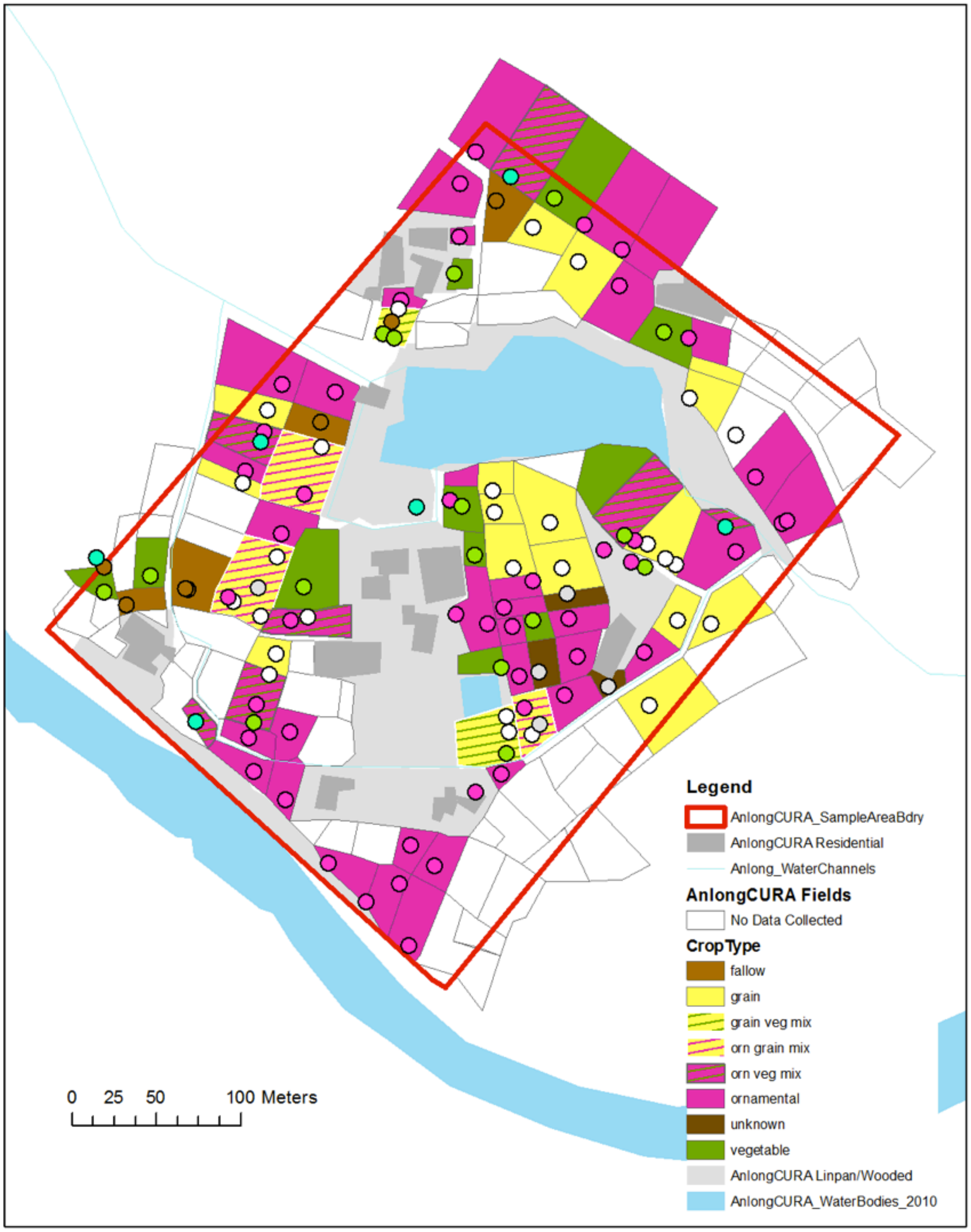
2.a CURA Eco-village Area

Field Scale:

At the field patch scale, 81 fields, just over half of the total number, were sampled during fieldwork. Many fields contained multiple crops within its major crop type (i.e. different kinds of ornamental trees) and some contained a mix of major crop types (i.e. ornamental trees and vegetables). Ornamental fields were often planted with a variety of ornamental trees and shrubs. A third of fields with ornamental trees as the major crop type had vegetables planted in the same field. Vegetable fields usually had several crop varieties growing in the same field. Grains, or rice fields, were exclusively for rice cultivation. The most common crop types in the ornamental use type class were gingko and guihua. The most common food crops were grains (rice) and vegetables (eggplant, beans, squash, peppers). Spatially, ornamental fields were interspersed between grain and vegetable fields, creating a patchy landscape at this scale (see Fig. 5.9).

At the field class scale, Anlong CURA area had approximately 130 fields within the sample area using a GIS base map from 2012 that CURA produced (see Fig. 4.8) adjusted slightly with field data I collected in 2013. Sizes ranged from 99.4- 2247.18 m^2, with an average size of 752.74 m^2. The Anlong CURA sample area showed a mix of major crop types in the field class, including grains, vegetables/fruit, ornamental and fallow. About 41.85% of fields in the sample area contained ornamental landscape crops as the major crop type within an individual field (patch). About 35.65% of fields in the sample area had food crops (grains, vegetables) as the major crop type.

Fig 5.9. Anlong CURA Field Scale Map

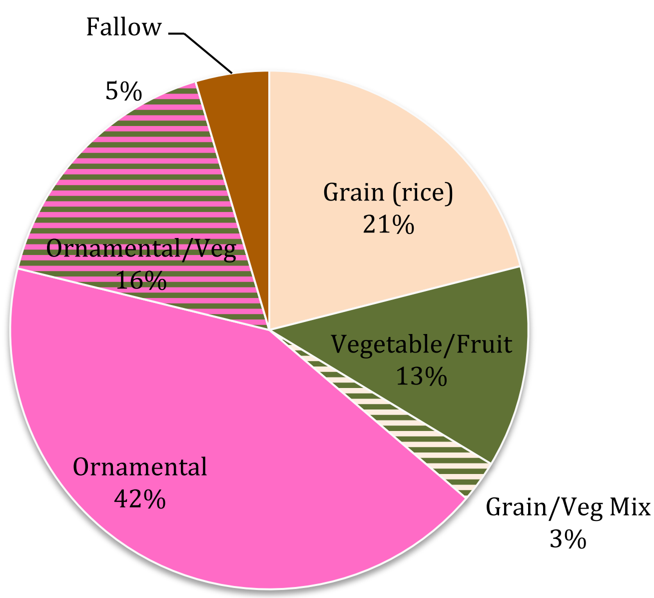


Note: Dots represent raw data points collected in field.

Table 5.5. Anlong CURA Field Scale Data

Anlong CURA: Field Scale								
	Grain	Veg/Fruit	Grain Veg Mix	Predom Food Crops (Grain, Veg, Mix) Total	Ornamental	Orn/Food (Veg or Grain) Mix	Tourism	Fallow
Range (min-max)	274.8-1802.37	238.91-1841.94	472.63-1164.52	238.91-1841.94	150.66-1817.34	185.61-1920.97	0	381.45-1125.56
Average (Mean Patch Area)	823.65	717	818.57	782.85	761.542	1038.346	0	720.08
Standard Dev	419.26	513.22	345.94	455.84	479.95	558.74	0	272.26
Total Sum	13178.52	7887.05	1637.15	22702.72	26653.97	10383.46		2880.35
% of Total (CAP)	20.69	12.39	2.57	35.65	41.85	16.31	0.00	4.52
Total Count (PN) (Fields matched to data points)	16	11	2	29	35	10	0	4

Fig. 5.10. Anlong CURA Field Scale Class Area Proportion



Sample Area Scale:

At the sample area scale, Anlong CURA had four major land use types: fields, wooded areas, residential and water. These are the same land use areas that characterize the traditional *linpan* landscape. Fields comprised about 65.14% of the land use coverage in the sample area with an average size of 765.54 m^2. 23.83% of land use was wooded areas, and 4.16% of land use was residential. There were approximately 5 *linpan* units that intersected the border of the sample area. Their average patch size was 5,912.92 m^2.

Fig 5.11. Anlong CURA Sample Area Land Use

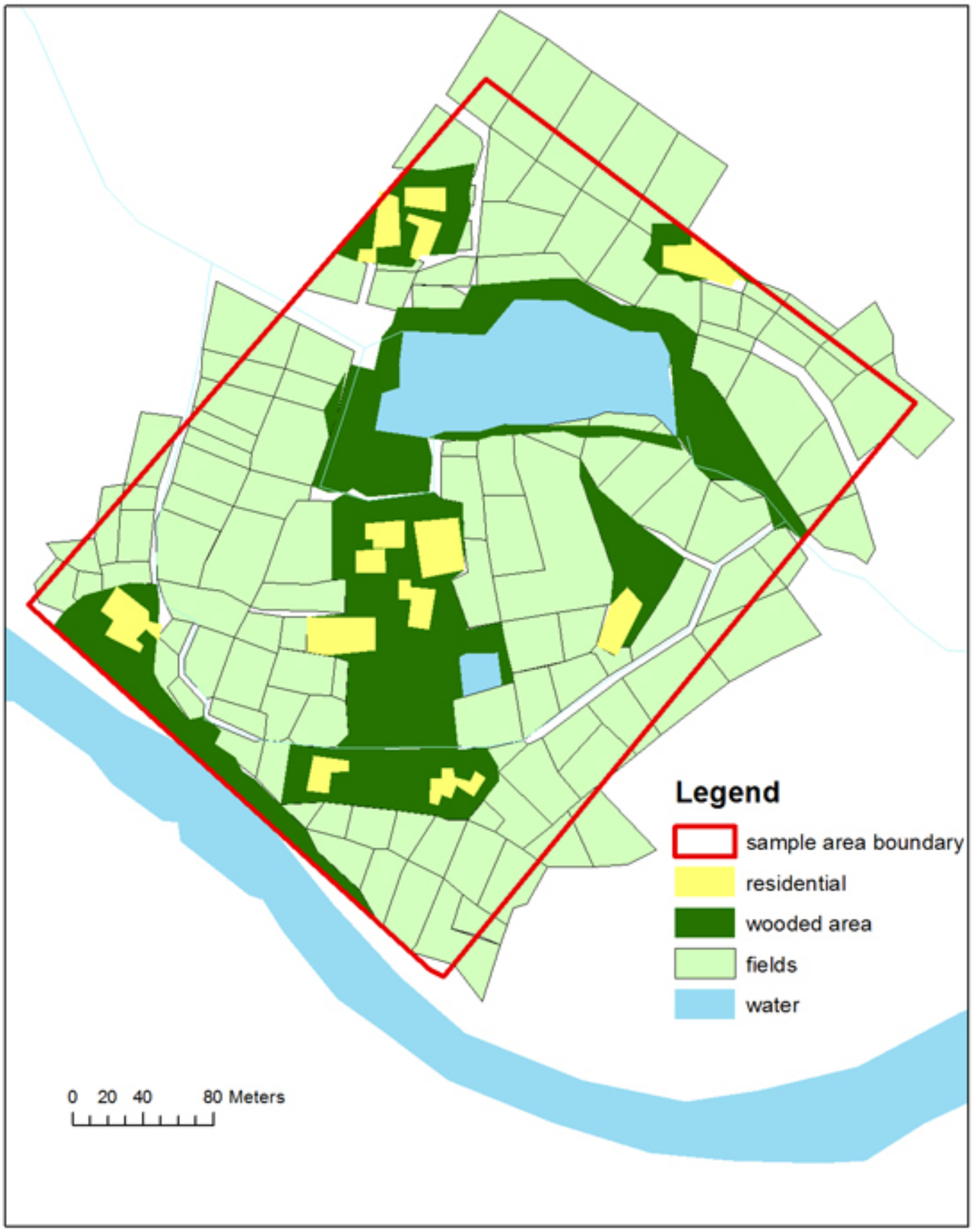


Fig. 5.12. Anlong CURA Land Use Type Class Area Proportion

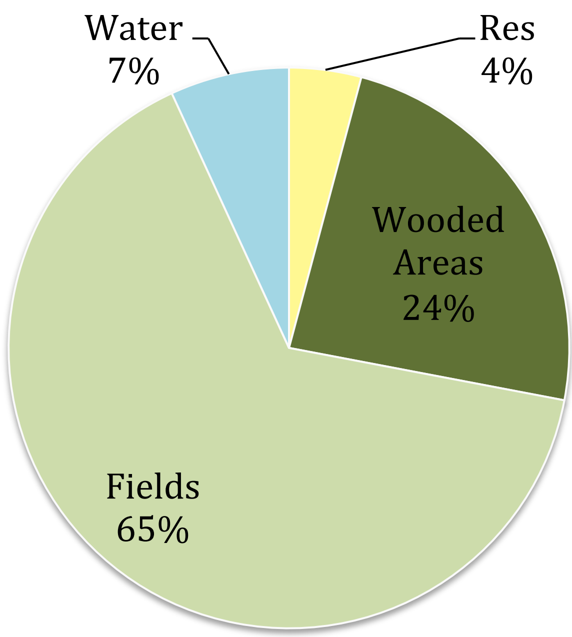


Fig. 5.13. Anlong CURA *Linpan* Units That Intersect Sample Area

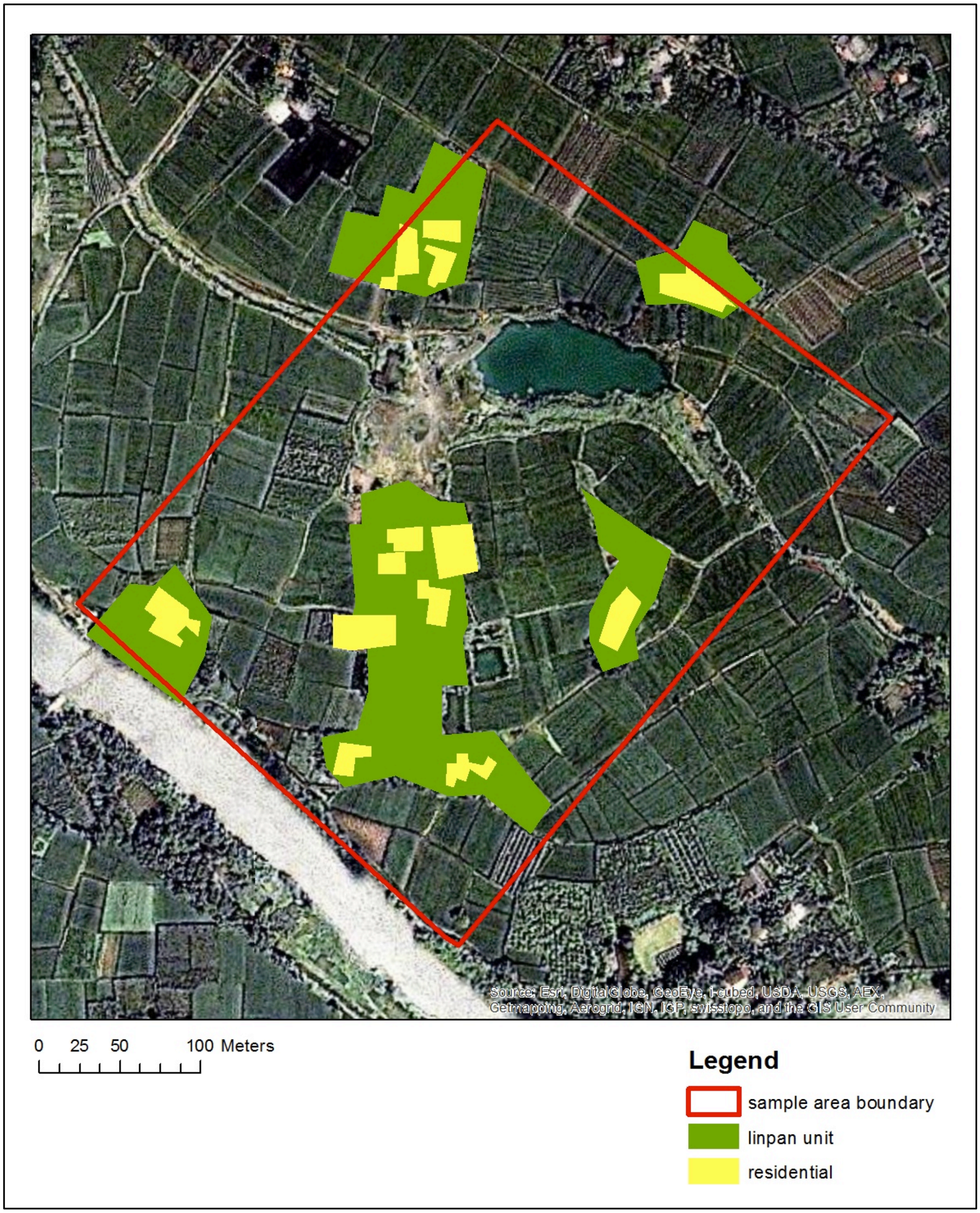


Table 5.6. Anlong CURA Sample Area Data

Anlong CURA: Sample Area Scale								
Land Use	Size of Sample Area (sqm)-Boundary layer	Commercial Area	Residential Area (Remote Sensing/Maps)	Wooded (all areas in sample area)	Fields	Water	Linpan Cluster	Linpan/Wooded (clusters contained within/intersect bdry)
Data Source	127,968.36		CURAMap 2012	CURAMap 2012 with GoogleEarth 2010	CURAMap 2012 adjusted with field data 2013	GoogleEarth 2010, CURA Map 2012	Data Source	ArcGIS Basemap 2005
Range (min-max)			84.58-809.39	161.57-5640.69	99.4- 2247.18		Range (min-max)	2702.45-14414.67
Average (Mean Patch Area)			390.38	2,386.97	752.74		Average (Mean Patch Area)	5,903.19
Standard Dev			223.52	1,627.76	465.35		Standard Dev	4,364.12
Total Sum	150,220.91	0.00	6,246.04	35,804.54	97,856.71	10,313.62	Total Sum	29,515.95
% of Total (CAP)			4.16	23.83	65.14	6.87	% of Total (CAP)	
Total Count (PN)			16	15	130	2	Total Count (PN)	5

Intermediate Scale: Settlement Pattern

45 dwelling units (housing points) were approximated (16 from raw data) in an area of 384,582.54 m^2. *Linpan* unit patch sizes (a residential land use type) had an average patch size of 4,530.9 m^2. This is much smaller than the *linpan* unit average size in the Jiang'an intermediate scale. There were 12 *linpan* units in the intermediate scale area, and the average number of dwelling units (houses or buildings observed through remote sensing) in a *linpan* unit was 3, with a range from 1 to 8 units. This is also lower than those observed in Jiang'an. The average distance to the 7^{th} nearest neighbor was 164.3 meters.

<u>Fig. 5.14. Anlong CURA Intermediate Map Scale</u>

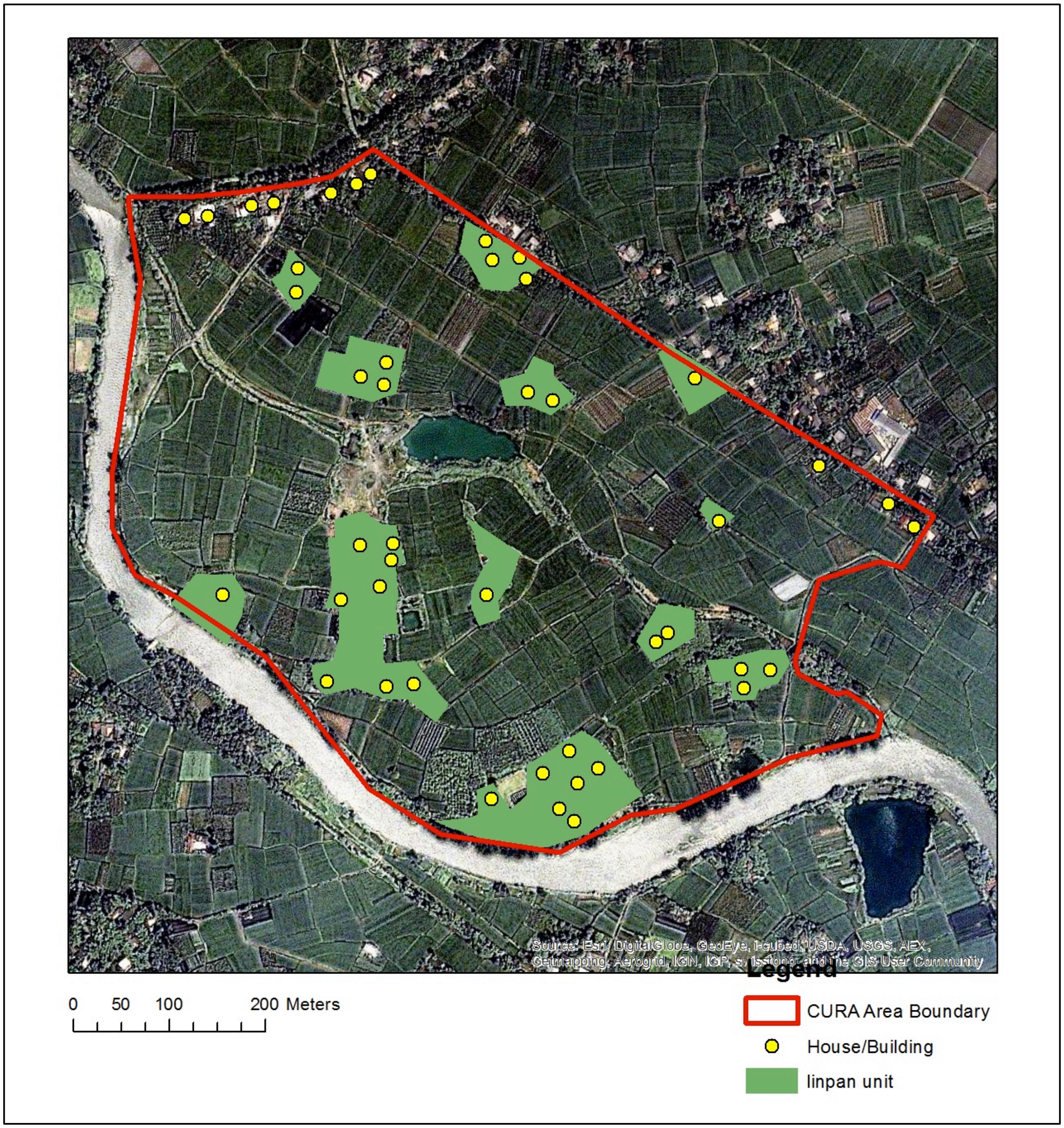


Table 5.7. Anlong CURA Settlement Pattern Data

Indicator	Measure
Intermed Area Size (m^2)	384,582.54
Patch Size: (Min-Max) (m^2)	618 - 14,415
Patch Size: (Mean) (m^2)	4,530.90
Patch number	12
Average distance to 7th nearest neighbor (meters)	164.3
Total # of Dwelling Units (DU) in sample area	45
Total # of DUs in patches	35
Avg # of DUs in patch	3
# DUs range	1 - 8

Summary:

The CURA eco-village model area of Anlong also exhibited many traditional *linpan* landscape characteristics and landscape structure indicators of resilience. At the field scale, Anlong CURA had a patchy configuration and composition among major crop use type with almost an even mix of fields with ornamental and food crops interspersed within the field class level in the sample area. At the sample area scale, it contained all the traditional land use elements- water, fields, *linpan* units, residential and wooded areas. Fields were the dominant land use type, and Anlong CURA sample area had roughly the same number of *linpan* units that intersected the sample area boundaries as the Jiang'an sample area. The Anlong CURA model shows how social variables beyond landscape structure, including involvement of an environmental NGO, growing interest among urbanites in organic produce, as well as the willingness of local villagers to collaborate on their own, may have influenced the landscape's function that may account for such a large presence of fields still growing grains and vegetables. CURA's efforts and focus on reducing water pollution in this part of Anlong may have also helped to increase positive ecosystem services that traditional (and resilient) landscape structure also supports. For example, CURA has promoted organic farming practices and techniques to reduce pesticides that eventually find their way into rivers. As Tian Jun expressed during an interview, CURA's involvement and local villager initiative to support organic, small-scale, self-sustaining farming may have inadvertently helped to protect the traditional landscape structure (interview with Tian Jun, August 2012).

2.b Anlong Semi-concentration Area

Field Scale:

At the field class scale, the semi-concentration area of Anlong had approximately 98 fields within the sample area using an ArcGIS base map from 2005 along with a comparison to Google Earth imagery from 2012. Sizes ranged from 180.87-1989.12 m^2, with an average size of 807.72 m^2. At the field patch scale, 93 raw data points were collected, with 69 matched to field boundaries identified in satellite imagery. Of the 69 fields with identified crop use types, 55 were classified as ornamental, accounting for 77.51% of the fields identified. This sample area of Anlong also shows a mix of major crop types in the field class level, including grains, vegetables/fruit, ornamental and fallow. About 4.34% of fields in the sample area had food crops (grains, vegetables) as the major crop type. The second largest class type was ornamental/vegetable mix accounting for roughly 13.58% of crop coverage in the fields. Grains made up 3.25% of the crop coverage, and fallow made up 4.57%. No fields were predominantly used for vegetables (vegetable crops were found in some fields with mainly ornamental trees and shrubs). Grains, or rice fields, were exclusively for rice cultivation. The most common crop types among ornamental crop class were gingko, guihua, and crape -myrtle.

Fig. 5.15. Anlong Semi-concentration Field Scale Map

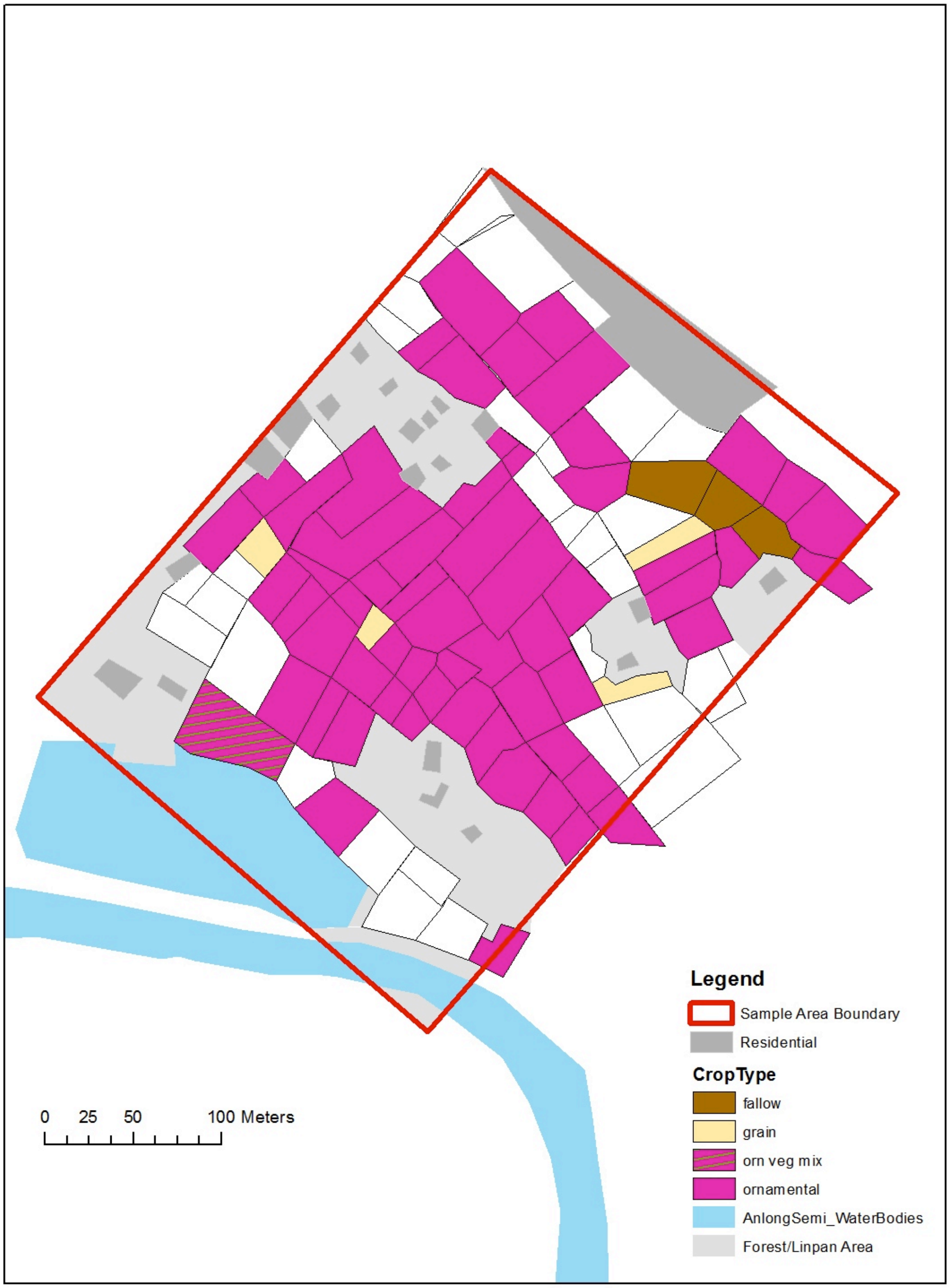
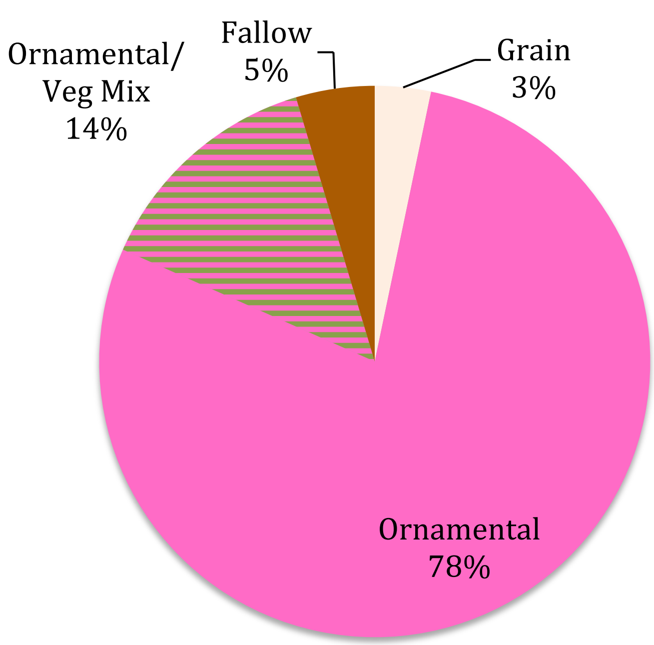


Table 5.8. Anlong Semi-concentration Field Scale Data

Anlong: Semi Concentration Field Scale								
	Size of All Fields Sampled	Grain	Veg/Fruit	Predom Food Crops Total	Ornamental	Orn/Food (Veg or Grain) Mix	Fallow	No Data
Range (min-max)	180.87-1989.12	282.2-552.53	0	282.2-600.54	185.26-1871.26	180.87-1989.12	666.66-1159.3	
Average	798.23	447.05	0	477.75	776.22	1246.82	838.49	
Standard Dev	424.47	101.67	0	109.72	373.96	679.8	227.03	
Total Sum	55077.75	1788.22	0	2388.76	42692.58	7480.93	2515.48	
% of Total	100	3.25	0	4.34	77.51	13.58	4.57	
Total Field Count (Fields matched to data points)	69	4	0	5	55	6	3	29
Total Count (Raw Data points within sample area)	93	6	3	9	68	10	6	

Fig. 5.16. Anlong Semi-concentration Field Scale: Class Area Proportion



Sample Area Scale:

At the sample area scale, Anlong semi-concentration area also had four major land use types: fields, wooded areas, and water and residential use, the same as the traditional *linpan* landscape structure. Fields comprised about 65.88% of the land use coverage in the sample area with an average size of 807.72 m^2. 20.93% of land use was wooded areas, and 6.96% of land use was residential with an average area of 390.38 m^2.[10] There are approximately 5 *linpan* clusters that intersect the border of the sample area. Their average patch size is 5,161.21 m^2.

[10] Note that this mix of land use where residential land use is rather low is partially the result of how the sample area was chosen to include both the river as the southern border, a major road as the western border and to capture a majority of fields outside of the new semi-concentration housing within the sample area boundaries.

Fig. 5.17. Anlong Semi-concentration Sample Area Land Use Map

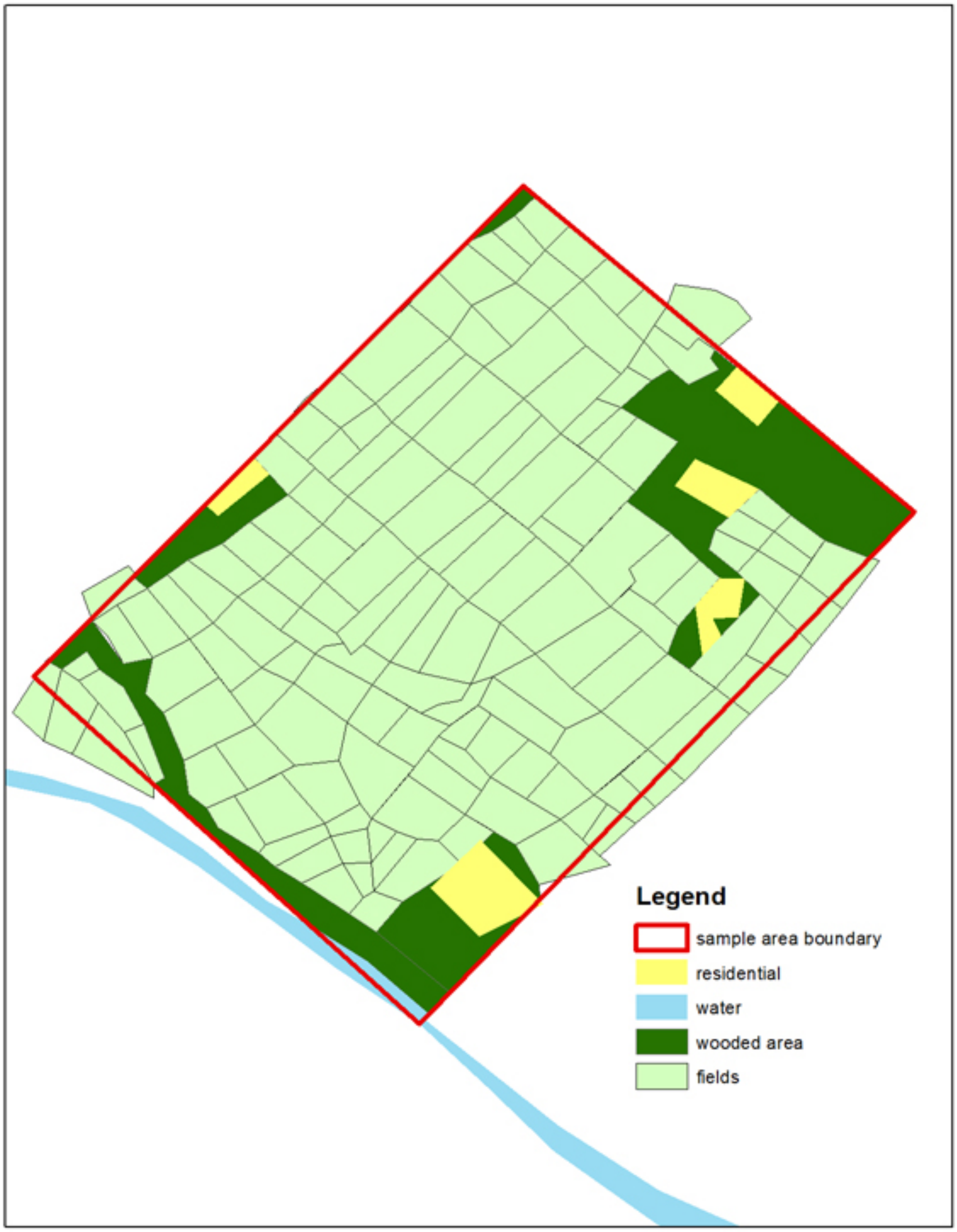


Fig. 5.18. Anlong Semi-concentration Land Use Type Class Area Proportion

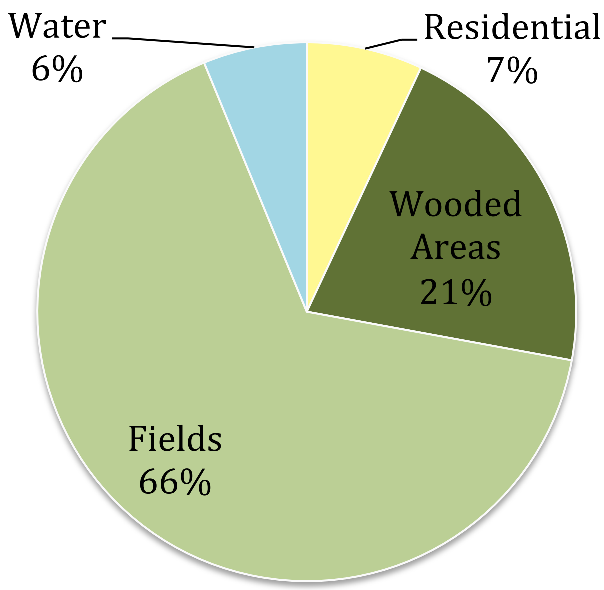


Fig. 5.19. Anlong Semi-concentration Area *Linpan* Units That Intersect Sample Area

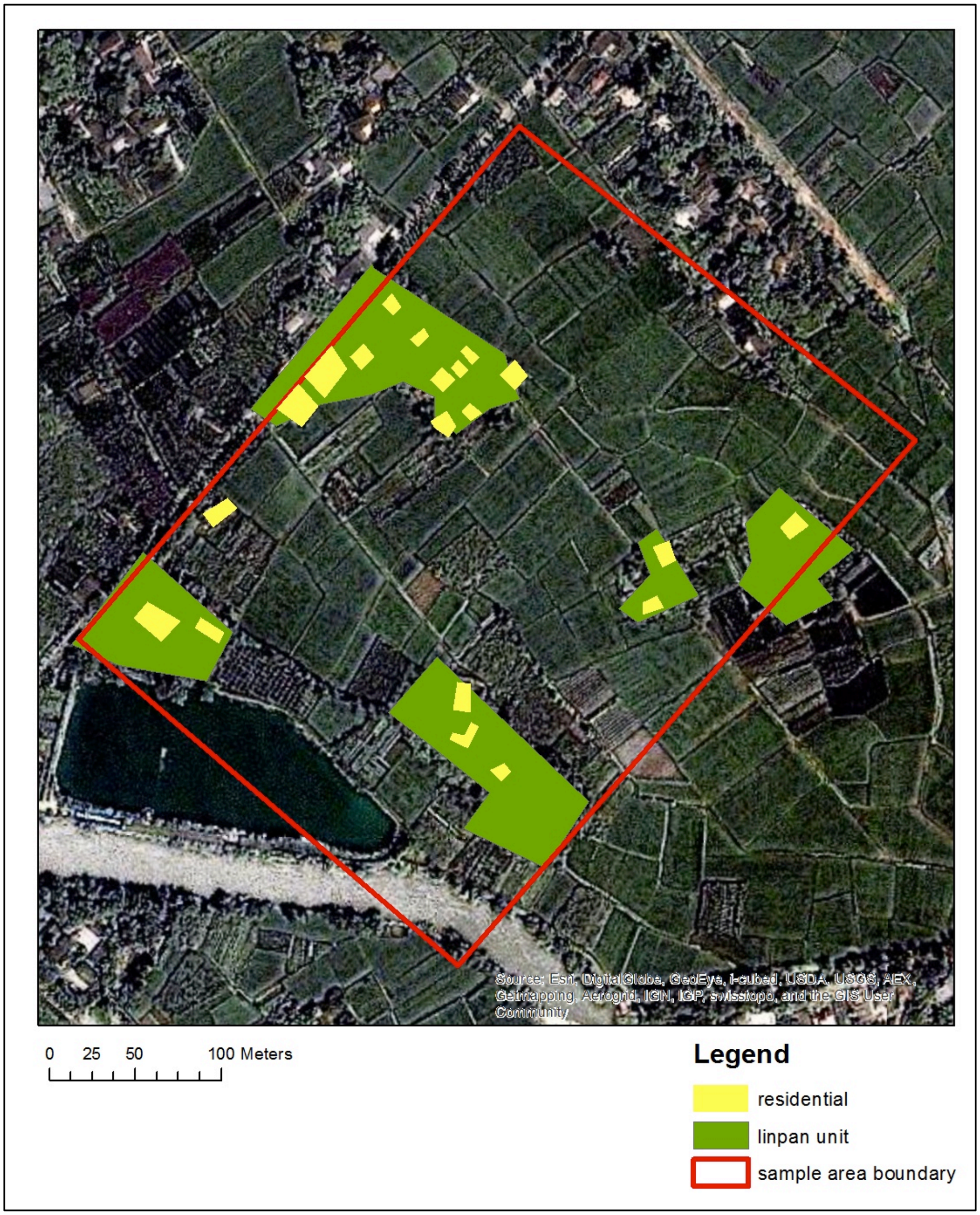


Table 5.9. Anlong Semi-concentration Sample Area Data

Anlong Semi Concentration Sample Area									
	Size of Sample Area (sqm)- Boundary layer	Commercial Area	Residential (Field Data Pts 2013 within bdry)	Residential Area (Remote Sensing/Maps)	Wooded (all areas in sample area)	Fields	Water	Linpan/Wooded (clusters contained within/intersect bdry)	
Data Source	116,883.32			ArcGIS Basemap 2005, adjusted with field data 2013	ArcGIS Basemap 2005	ArcGIS Basemap 2005	ArcGIS Basemap 2005	Data Source	Google Earth 2010
Patch Size: Range (min-max) (sq m)				54.81-5602.2	92.88-7242.02	180.87-1989.12		Range (min-max)	1171.25-7417.44
Patch Size: Average (sq m)				398.47	2,285.51	807.72		Average	4,250.34
Standard Dev				1,166.85	2,512.58	433.71		Standard Dev	2,153.74
Class Area: Total Sum	120,145.63	0.00		8,368.02	25,140.60	79,156.74	7,480.27	Total Sum	21,251.72
% of Total Area (CAP)				6.96	20.93	65.88	6.23	% of Total Area	
Patch Number: Total Count			21			98	2	Total Count	5

Intermediate Scale: Settlement Pattern

66 dwelling units were approximated in the proposed semi-concentrated settlement areas inside the boundaries of the intermediate scale sample area with an area of 513,313 m^2. This number comes from a poster inside the Anlong planning museum that listed the number of households each settlement group would contain (see also Fig. 4.11). It is assumed that each household would have their own dwelling unit.The intermediate scale contains settlement #1 with 55 households in an area of 10,0629.96 m^2, and settlement #2 with 11 households in an area of 1,979.26 m^2. This residential land use type had an average patch size of 6,0211.11 m^2. Both the area range and average were similar to both Jiang'an' and Anlong CURA. There were 2 planned

residential areas in the intermediate scale area, and the average number of dwelling units per residential land use patch was 33, with a range from 11 to 55 units. This is higher than those observed in Jiang'an and the Anlong CURA area. Thus the semi-concentration settlement plan increases the density, where the patch area size remains similar to the traditional landscape pattern, but there is a significant increase in the number of dwelling units in a given residential land use patch, and the number of patches diminishes.

Fig. 5.20. Anlong Semi-concentration Intermediate Scale Settlement Pattern Map

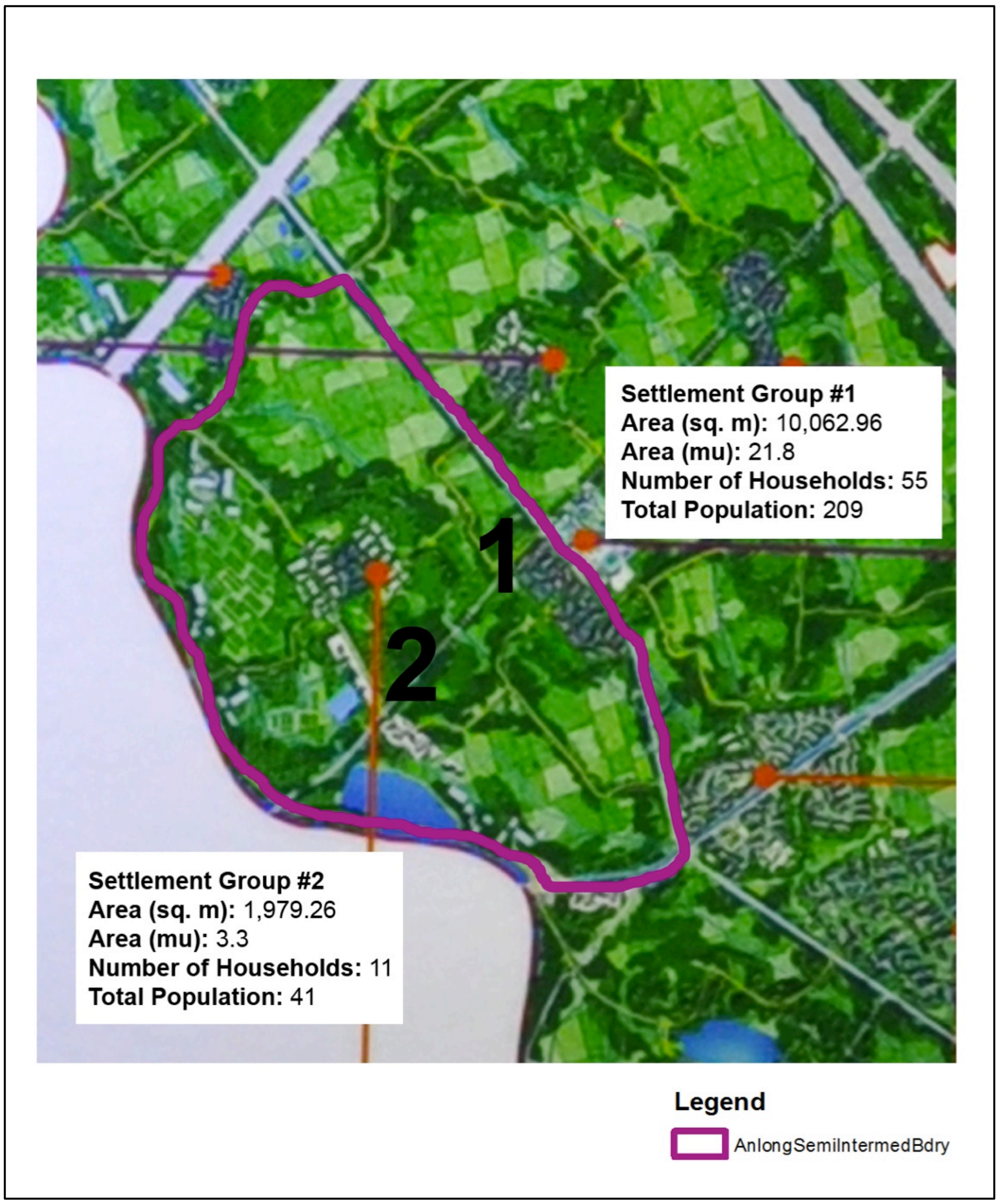


Table 5.10. Anlong Semi-concentration (Future) Settlement Pattern Data

Indicator	Measure
Intermed Area Size (m^2)	513,313
Patch Size: (Min-Max)	1,979.26 –10,062.96
Patch Size: (Mean)	6,0211.11
Patch number	2
Distance to 7th nearest neighbor	Not available
Total # of Dwelling Units (DU) in sample area	66
Total # of DUs in patches	66
Avg # of DUs in patch	33
# DUs range	11 - 55

Anlong Village Scale:

At the village scale, Anlong has a total area of 3.8 square kilometers and a population of approximately 3,399 (Anlong poster 2013). The population density at the village scale is approximately 894.47 persons per square kilometer. Of the traditional land use types (water, fields, residential and forest), agriculture accounts for 61.85% of land use, residential areas 14.92%, forested areas .82%, and water 6.12%. Together, these four land use types account for 83.71% of the land at the village scale.

Table 5.11. Anlong Semi-concentration Village Scale Data

Anlong Semi Concentration: Administative Village Scale									
Land Use Classes									
	Total land area (sq km)	Total Residential Area	Total Agricultural Area	Scenic area/Tourism	Green'/ Wooded Area	Water Bodies /Irrigation/Facilities	Transportation	Town organization /government	Other
Data Source	Anlong Board 2013	Anlong Board 2014	Anlong Board 2015	Anlong Board 2016	Anlong Board 2017	Anlong Board 2018	Anlong Board 2019	Anlong Board 2020	Anlong Board 2021
Total Area (sq km)	3.8	0.57	2.35	0.14	0.03	0.23	0.32	0.12	0.05
Class Area Proportion (CAP)	100.00	14.92	61.85	3.69	0.82	6.12	8.27	3.11	1.22

Summary:

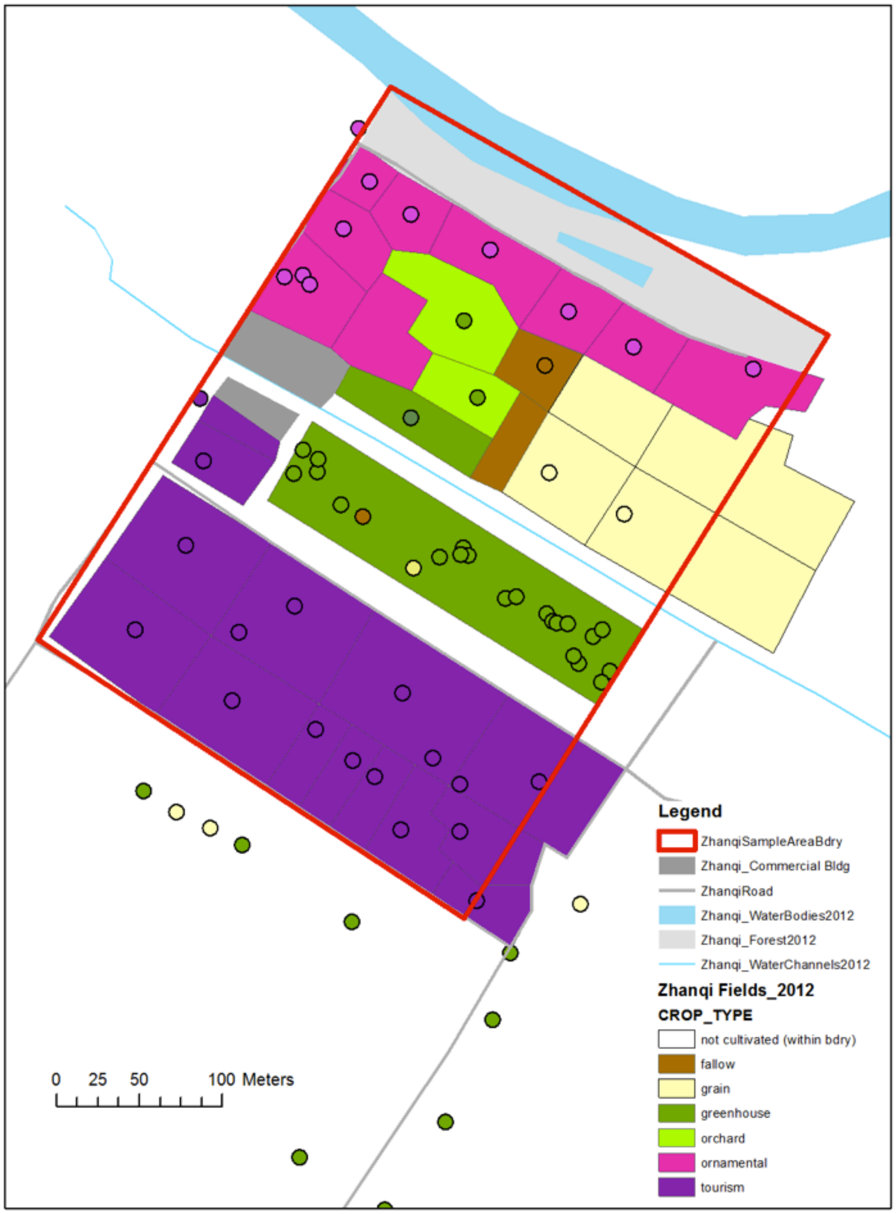
The Anlong semi-concentration sample area showed that at the time of field data collection, little in terms of the agricultural fields land use, size and configuration had changed during redevelopment construction. It is perhaps too early to tell if there will be changes to the size, use, and spatial structure of the land adjacent to the new semi-concentrated settlement. However, public posters and boards that display the upcoming changes provide clues to expected changes. For example, one poster identifies that 2,300 mu (1.53 square kilometers) of total agricultural land (3,539 mu or 2.35 square kilometers) will be used to grow ornamental landscape trees and flowers. That is 65% of arable land in the village. Only 150 mu (.1 square kilometers), just 4% of arable land will be used to grow organic vegetables. This second sample area inside Anlong helps to show similarities in the traditional landscape structure, and perhaps highlight some functional differences caused not by form, but by management practices. This can be seen in land use at the field scale. Similar to Jiang'an, this part of Anlong outside of the CURA eco-village model boundaries shows that most agricultural fields are now growing ornamental trees and shrubs. There were very few fields that grew vegetables or rice.

3. Zhanqi Village

Field Scale:

At the field patch scale, 33 raw data points were collected, all matched to field boundaries identified in satellite imagery. Of the 33 fields with identified crop use classes, nearly half (14) are classified as tourism. Most tourism fields contained lavender. Vegetables were found mainly inside a greenhouse that was part of a tourist area that required the purchase of an admission ticket to enter.

Fig. 5.21. Zhanqi Field Scale Map

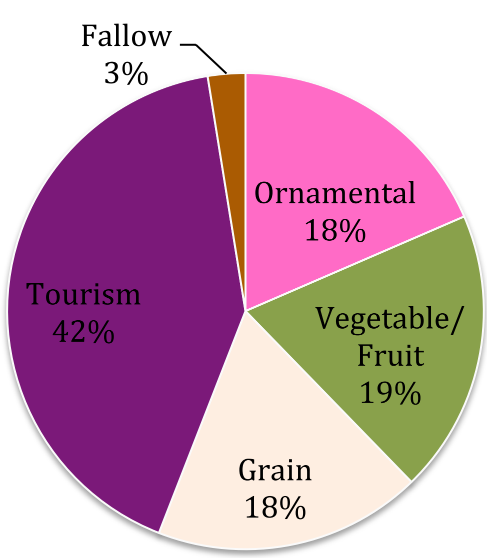


Dots represent raw data points collected in the field.

Table 5.12. Zhanqi Field Scale Data

Zhanqi: Sample Area Scale							
	Sample Area (sqm)- Boundary layer	Commercial Area	Residential (Field Data Pts 2013 within bdry)	Area (Remote Sensing/Maps)	Wooded (all areas in sample area)	Fields	Water
Data Source:	Google Earth 2012	Google Earth 2012	Google Earth 2012	Google Earth 2012	Google Earth 2012	Google Earth 2012	Google Earth 2012
Range (min-max) sq m		820.07-2307.41				746.7-12609.57	
Patch Size: Average Field Size (sq m)		3,127.48				3,168.72	
Standard Dev (sq m)		743.67				2,365.75	
Total Sum (sq m)	120,516.43	3,127.48			10,633.93	104,567.88	2,187.14
% of Total (CAP)		2.60			8.82	86.77	1.81
Patch Number: Total Field Count		2	0	0	1	33	2
% of Total Fields Sampled	123,210.12	2.54		0.00	8.63	84.87	1.78

Fig. 5.22. Zhanqi Field Scale: Class Area Proportion



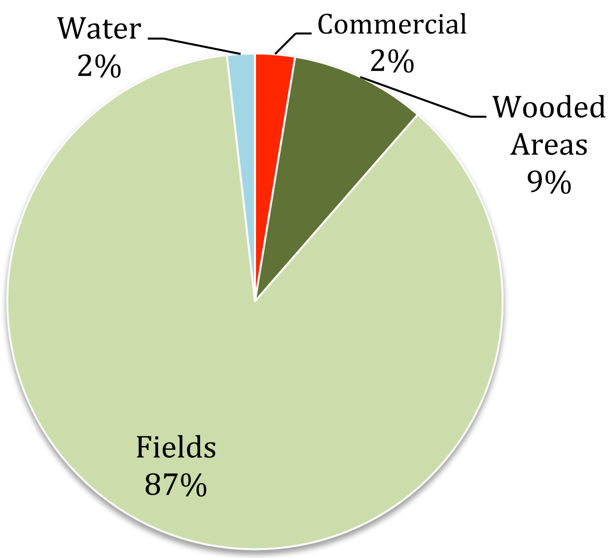
At the field class scale, Zhanqi had approximately 33 fields within the sample area using Google Earth satellite imagery from 2012 (see Fig 5.23). Field sizes ranged from 746.7- 12,609.57 m^2, with an average size of 3,168.72 m^2. Fields in the sample area had major crop types in including tourism, vegetables/fruit, grain, and fallow. 41.54% of fields in the sample area contained tourism crops as the major crop type within an individual field (patch). 19.24% of fields in the sample area had food crops (grains, vegetables, fruit) as the major crop type. Most of these were found in a greenhouse that is part of a tourism area. Ornamental accounted for 3.27% of the crop type coverage, and fallow accounted for 2.54%.

Sample Area Scale:

At the sample area scale, Zhanqi had four major land use types: fields, wooded areas, water and commercial use. This differs slightly from the traditional *linpan* land use pattern since there was no residential use and there is the addition of commercial use. Fields comprised 84.87% of the land use coverage in the sample area with an average size of 3,168.72 m^2. 8.63% of land use was wooded areas, and 2.54% of land use was commercial with an average area of 3,127 m^2. There were no *linpan* units that intersected with the border of the sample area.

Fig. 5.23. Zhanqi Sample Area Land Use Map

Fig. 5.24. Zhanqi Sample Area Land Use Type: Class Area Proportion



Settlement Pattern:

There are 469 households in the only residential land use area in Zhanqi, covering an area of 159,300 m^2 (8% of Zhanqi's total land area, according to a land use poster in Zhanqi. See Fig. 4.6). It is assumed that each household would have their own dwelling unit. This is twelve times the size of the average residential patch size in Jiang'an and in Anlong semi-concentration area. There were 469 dwelling units per residential land use patch was 56. This is much higher than those observed in Jiang'an and the Anlong CURA and semi-concentration areas.

Table 5.13. Zhanqi Settlement Pattern Data

Indicator	Measure
Intermed Area Size (m^2)	NA
Patch Size: (Min-Max) (m^2)	159,000
Patch Size: (Mean) (m^2)	174,443
Patch number	1
Average distance to 7th nearest neighbor (meters)	(not available)
Total # of Dwelling Units (DU) in sample area	469
Total # of DUs in patches	469
Avg # of DUs in patch	469
# DUs range	469

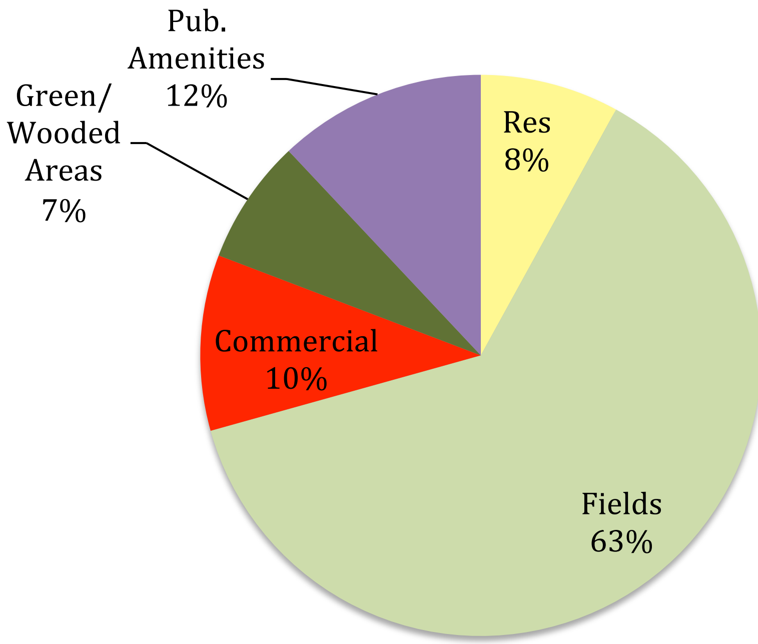
Village Scale:

At the village scale, Zhanqi had a total area of 1.99 square kilometers. The majority of land use was agricultural use at 62.62%. Commercial areas accounted for 10% of land use. 8% of land was in residential use in one large concentrated area (1 patch) that was .15 sq. km. Roads made up 8.8% of land coverage, and water was 3% of land use. The population density at the village scale was approximately 854.27 persons per square kilometer. However, it should be noted that the majority of the 1,700 people in the village live on only .15 sq. km of land.

Table 5.14. Zhanqi Village Scale Data

Zhanqi: Administrative Village Scale								
Land Use Classes							**Population**	
	Total land area (sq km)	Total Residential Area	Total Agricultural Area	Commercial Area	Green'/ Wooded Area	Public Amenities		Population total persons)
Data Source							Data Source	
Total Area (sq km)	1.99	0.15	1.24	0.2	0.14	0.24	Population	1700
Class Area Proportion (CAP)	100%	8%	62.62%	10.12%	7%	12%	Population Density (persons/sq km)	854.271357

Fig. 5.25. Zhanqi Village Scale Land Use Type: Class Area Proportion



Summary:

Similar to direct observations of Zhanqi village described in section 4.1, Zhanqi in this landscape spatial analysis hardly resembles the traditional *linpan* landscape pattern. One of the most dramatic changes is in the size and number of agricultural fields. The average field area in Zhanqi is nearly four times the size of fields in Jiang'an and Anlong. The number of fields in the sample area is also significantly less. Zhanqi contains one third of the number of fields present in Jiang'an and Anlong sample areas. Also different from the other villages, most of the fields in the Zhanqi sample area were for commercial use as an agricultural tourism attraction. The greenhouse in the sample area contained many varieties of food crops. However, in talking to villagers we met inside the greenhouse, the fruits and vegetables were not consumed locally and were for commercial or tourism purposes.

5.3 Summary of Results

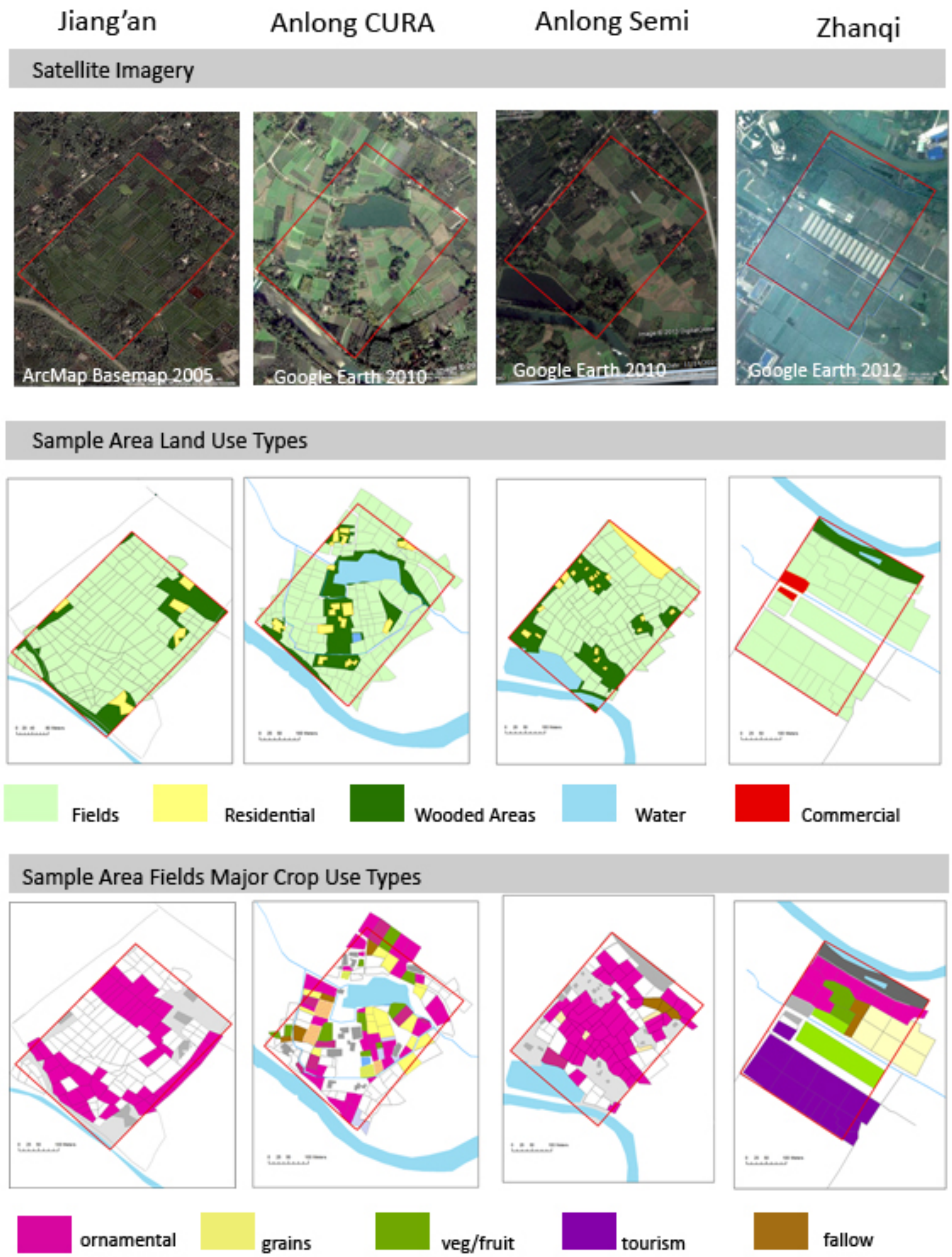
This spatial analysis, aimed at testing landscape structure characteristics that are indicators of resilience, helps describe patterns of the current *linpan* landscape structural characteristics and draw comparisons between different redevelopment models. I first describe how this spatial analysis can be used to form a baseline guide for the existing *linpan* landscape structure. I then summarize key points in evaluating how the alternative redevelopment models compare against the baseline.

From the wide set of data and statistics collected for landscape metrics across the four defined scales, Table 5.15 provides a summary of selected key measures that offer potentially meaningful comparisons between the four sample areas tested. Fig. 5.26 shows a graphic comparison of the field and sample area scales for the four different models.

Table 5.15. Summary Comparison Table for Selected Indicators and Measures

Scale	Indicator	Measure	Jiang'an	Anlong CURA	Anlong Semi	Zhanqi
Field	Landscape heterogeneity: patchiness at field class level	Crop Use CAP: Major crop use types among fields is diversified	Ornamental: 100%	Grain: 21% Ornamental: 42% Veg/Fruit: 13%	Grain 3%: Ornamental 78%:	Grain: 18% Veg/Fruit: 19% Ornamental: 18% Tourism: 42%
	Fields growing food crops	Percentage of field class area with food crops as major crop type (Class Area Proportion of field area)	0%	35%	3%	37%
Sample Area (300m x400m)	Landscape heterogeneity	Patch Richness: Presence of traditional land use types (W = water, F = fields, R = residential, T = wooded areas	W, F, R, T	W, F, R, T	W, F, R, T	W, F, T
		Field Patch Number	134	130	98	33
		Field Patch Size (Mean) sqm	766	753	808	3,169
		Field Patch Size (Min-Max) sqm	186 - 1,746	99 - 2,247	181 - 1,989	747 - 12,610
		Field Land Use Type: Class Area Proportion (CAP)	79%	65%	66%	85%
		Wooded Area Land Use Type: Class Area Proportion (CAP)	17%	24%	21%	9%
		Residential Land Use Type: Class Area Proportion (CAP)	3%	4%	7%	0%
	Biodiversity; Patchiness	Linpan Unit Patch Number	4	5	5	0
		Linpan Unit Patch Size (Mean)	8,683	5,903	4,250	0
Intermed Scale	Appropriate Scale: Settlement Pattern	Residential Unit Patch Size (Mean) sqm	13,021	4,530	13,466	174,443
		Residential Land Use Patch Number:	8	12	2	1
		Total Number of Dwelling Units in Intermed. Scale	59	45	112	469
		Number of Dwelling Units Per Patch (Average)	6	3	56	469
		Number of Dwellings Units Per Patch (Min-Max)	2 - 14	1 - 8	55 - 57	469
		Distance to 7th Nearest Neighbor (Average)	96	143	NA	NA
Village Scale	Landscape heterogeneity	Agricultural Land Use Type CAP	83%	NA	62%	63%
		Wooded areas (green) CAP:	NA	NA	0.82%	7%
	Appropriate Scale: Settlement pattern	Population Density (persons per s	864	894	894	854

Fig. 5.26. Summary Comparison of Spatial Patterns in Sample Areas



Forming a baseline for existing linpan typology

The summary table above shows that Jiang'an and both the semi-concentration and CURA sample areas of Anlong have similarities in several landscape structure elements at each of the observed scales. The semi-concentration sample area in Anlong is included for field size and number because little change has occurred in the fields outside of the semi-concentrated residential area. It is also included for the *linpan* units at the sample scale where *linpan* units were still present at the time of field research in July 2013. These four sample areas help to form a baseline for structural characteristics of the *linpan* landscape that support resilience. This baseline range for certain key indicators can help to guide future redevelopment plans that aim to preserve the *linpan* landscape. Of course, many other factors beyond landscape structure should also be considered. Table 5.16 illustrates how some key measures from landscape metrics and spatial analysis can be quantified and compared using the remote sensing and geospatial analysis techniques employed in this study.

This evaluation offers a first attempt at setting quantitative measures for the *linpan* landscape structure. Jiang'an, Anlong CURA and semi-concentration sample areas have similarities in many of the following characteristics that support resilience:

Field Scale:

Patchiness and Polyculture

The literature on resilience in agroecosystems highlights landscape patchiness and polyculture across scales as indicators of resilience in agroecosystems. Historically, the *linpan* landscape also grew a variety of grain, fruit and vegetables (Skinner 1940). This evaluation shows that only the Anlong CURA sample area exhibits a patchy landscape at the field scale, with major crop types interspersed between other major crop types (grain, ornamental and vegetable fields scattered throughout). Both Anlong CURA and Zhanqi had about half of the fields (patch number) with food crops as a major crop type (grains, vegetables and fruit). Although Zhanqi had a variety of major crop types at the field scale, the spatial arrangement of fields used for different purposes shows that the landscape is more ordered at this scale in terms of configuration. Fields growing tourism crops (lavender) are adjacent to other tourism fields (See Fig. 5.26 for visual comparison). This kind of ordered layout recalls an idea of what anthropologist Janet Sturgeon terms "landscape legibility" (Sturgeon 2005). Navigating the fields in Zhanqi were much easier compared to Jiang'an, Anlong CURA and Anlong semi-concentration fields based on the neat and ordered spatial configuration of its fields. This contrast highlights a characteristic about the traditional *linpan* landscape that may be lost after redevelopment. This difference is also tied to the size and number of agricultural fields explained below.

Sample Area:

Size and number of agricultural fields and *linpan* units

Jiang'an, Anlong CURA and Anlong semi-concentration sample areas have similarities in the size and average number of both its agricultural fields and *linpan* units. Fields in these three sample areas tend to range in size between 750 and 820 square meters. Each sample area also had approximately 100 or more individual fields. *Linpan* units in the sample area ranged in number from 4 to 6 with an average size ranging between 5,000 and 8,683 square meters. Zhanqi's field size was more than three times the size of these other sites and contained only one third of the number of individual fields.

Land use types

Jiang'an, Anlong CURA and Anlong semi-concentration had all the same land use types (water, fields, residential, and wooded areas). The Anlong semi-concentration had far less residential patch numbers, and the anticipated new settlement areas will be much greater in size than the residential areas in the CURA area of Anlong and Jiang'an. Only Zhanqi did not have residential land use in the sample area and had the addition of commercial land use.

Intermediate Scale:

The settlement pattern shows differences between all four sample areas, although Jiang'an and Anlong CURA share some similarities. Jiang'an and Anlong CURA had between 1 and 14 dwelling units per *linpan* unit (a residential land use type at this scale). This is vastly different from the 56 dwelling units in one residential land use patch in the semi-concentration area and 469 dwelling units in Zhanqi. The average distance to 7th nearest neighbor for Jiang'an and Anlong ranges between 90 and 150 meters. For the semi-concentration area of Anlong and Zhanqi, this number is expected to be much lower, although distance could not be calculated at this time.

Table 5.16. *Linpan* Landscape Baseline Typology

Scale	Resilience Indicator	Measure	*Linpan* Baseline
Field	Landscape heterogeneity: patchiness at field class level	Patch Richness: Major crop use types among fields is diversified	Presence of grain, vegetable and orchard/ornamental trees
	Fields growing food crops	Percentage of field class area with food crops as major crop type (Field area)	At least 50% of field class area is used for growing food crops*
Sample Area (300m x400m)	Landscape heterogeneity	Patch Richness (PR): Presence of traditional land use types	Presence of water, fields, residential and wooded area land use types
		Field Patch Number	Approximately 100 fields
		Field Size (Mean) m^2	Average field size range is between 750 - 820 m^2
		Field Class Area Proportion (CAP)	Field land use type makes up 65-70% of total sample area
	Patchiness	*Linpan* Unit Size Average (the bigger the better for ecosystem):	Range: 1,000 m^2 – 15,000 m^2 Average Size: approx. 6,000 m^2
		Linpan Unit Number:	Average 4
		Wooded Area CAP	Approx. 20%
Settlement Area	Settlement Pattern	Distance to 7th Nearest Neighbor (meters)	Range: 90 – 150 m
		Dwelling Units per residential land use patch	Range: 1 - 14
		Residential Land Use Average Size (m^2)	Range: 4,500 m^2
Village Scale	Landscape heterogeneity	Agricultural use Class Area Proportion	80% (based on Jiang'an alone- no redevelopment)
		Wooded areas (green) CAP:	20% (based on sample area)

Evaluation of alternatives

Jiang'an (traditional/ do nothing) model shows many structural characteristics of the traditional *linpan* landscape. However, the analysis also shows a significant loss of food production at the field scale, a potential functional loss of a resilient agroecosystem.

Anlong CURA eco-village model seems to be the alternative that most closely resembles structural and functional characteristics of both the traditional *linpan* landscape and resilient landscape characteristics. This is particularly true of its patchiness (land use diversity) across scales and particularly evident at the field scale, where many fields are still used to grow food crops and there is a mosaic pattern to the fields in terms of major crop use type.

For **Anlong's semi-concentration model**, it is too soon to tell the effects of redevelopment on land use patterns surrounding new settlement area. The most significant (anticipated) change is in settlement pattern at the intermediate scale. While the semi-concentration model at the sample area scale presently still contains *linpan* units, redevelopment plans show a drastic change in residential land use pattern that will greatly increase the number of dwelling units per residential land use patch and significantly decrease the number of residential land use patches. Fields at the sample area scale have so far largely been unchanged, yet they also exhibit a loss of food crop production. This model begins to deviate from the baseline typology on some indicators, most strikingly in the settlement pattern indicators.

Zhanqi's extreme concentration shows how this model falls outside of the range of the existing baseline *linpan* landscape typology on many indicators. The largest differences are the absence of *linpan* cluster patches and residential uses interspersed with other land uses and the scaling up of agricultural fields and residential land use, which are both larger in size and fewer in number.

Landscape Structure Indicators of Resilience in the Linpan Landscape

This analysis shows how landscape structure as indicators of resilience can be used to evaluate alternative development models. From the summary above, it is interesting to note that these indicators show that the Anlong CURA eco-village model is the alternative that best meets the landscape structure indicators of resilience (landscape heterogeneity, appropriate scale, biodiversity). However, government-led redevelopment policy will undo most of CURA's work, and residents that have been part of the farming co-op have been pressured to move to the new concentrated housing. The map of the semi-concentration plans for the entire village shows that the CURA area will change drastically. In relating back to conflicts between efficiency and resilience, such top-down policy will undermine this alternative model that performed well using the indicators and measures illustrated in this study. While this analysis helps to quantify some key characteristics of the *linpan* landscape structure that describe both an existing baseline typology and compare alternatives, it also highlights the need to look at indicators of resilience beyond those that measure landscape form. This is particularly evident looking at the data from the field scale. At this scale, one can see how much the *linpan* landscape has changed from its traditional function as a self-sustainable closed loop system (farmers subsist on what they can grow and sell) to one that is now influenced by social and economic factors, such as changes in market demand. Jiang'an and the semi-concentration area of Anlong show how the landscape has shifted from food crop cultivation to ornamental crops even though their landscape structure retains many characteristics of the traditional landscape structure. Such changes then seem independent of spatial pattern. This change from a self-sustaining system to one dependent on outside forces and variables may affect the resilience of the landscape both socially and ecologically. As the question was raised before, how then, does landscape structure as one variable interact with other variables that collectively affect resilience? For example, the traditional landscape pattern has been able to accommodate different crop varieties to meet market demand and still retain function as arable land. Thus, it may not be difficult to switch from growing trees to growing food crops again. What may be more difficult is changing land back into agricultural use once it is changed to man-made purposes (residential, commercial, industrial). In Zhanqi, the percentage of land used for agriculture at the village scale (62%) is significantly lower than that in Jiang'an, the 'do nothing' model (82%). If the long-term goal of the landscape is to maintain function as an agricultural landscape, care should be taken to ensure that the land is used for agricultural purposes to retain productive, fertile farmland.

To conclude, this illustrative analysis of spatial indicators shows how landscape structure is one variable among many that affect resilience. It is important to recognize and understand how landscape structure (form) affects function, and also how landscape structure is an important variable to consider in maintaining agroecosystem resilience with interconnected social and ecological systems. Structure can increase or decrease resilience by supporting the three aspects of maintaining resilience – the ability to buffer disturbances, adaptive capacity and self-organization. However, other indicators are needed to understand the range of variables that interact with each other that influence a landscape's long-term resilience.

CHAPTER 6: REFLECTIONS

In this thesis I set out to more rigorously define the goals and rationale of preservation and ecological planning of the *linpan* landscape in Chengdu Municipality. I first prescribed the inclusion of a resilience framework into planning goals that may help to balance short-term goals for efficient, productive landscapes with long-term goals to maintain social and ecological landscape function in the face of uncertainty. I then developed an evaluative tool that looks at the role of landscape structure (form) in supporting resilience function (buffer disturbance, self-organization, adaptive capacity). I used landscape metrics in combination with direct observation methods to identify indicators and measures specific to the *linpan* landscape and then illustrated their use to describe the traditional landscape pattern and compare alternatives.

This chapter presents reflections on the evaluative method including strengths and weaknesses, thoughts on planning for resilient landscapes like *linpan*, and offers possible next steps for further research on this topic.

6.1 Reflections on Methodology (landscape structure indicators)

Strengths

Field testing of indicators and measures of resilient landscape structure in the *linpan* landscape through qualitative methods and spatial analysis in 2012 and 2013 provide insight into the applicability of broader resilient landscape indicators and measures to local context. It illustrates that talking with local stakeholders, conducting research on the history and culture of the landscape, and directly observing the environment are critical to adapting broad indicators and measures to fit local context.

This analysis also shows how held assumptions may differ from actual conditions, and thus it is important for planners to spend time in the field. In the Pi County field sites, the assumption that the traditional model (Jiang'an Village) would most closely resemble historical descriptions of the *linpan* landscape as agriculturally productive proved untrue, not because of change in the configuration of the landscape, but because of changes in crops grown in response to market pressure.

The outcomes presented in this illustrative study show how context specific indicators and measures can describe a baseline of current existing landscape patterns as well as help to compare alternatives using quantitative measures. This can inform a decision-making process during redevelopment planning, creating a more rational "scientific" approach, as well as adding rigor to the process of meeting stated preservation goals.

It also shows how some measures, such as the *linpan* unit, have multiple functions. In this kind of landscape, the *linpan* unit is used as both a proxy for residential land use as well as for ecological patches. This is different from how land use planners traditionally separate land use types into singular functions such as residential, commercial, agricultural, or green space.

Weaknesses

This evaluation also helped to identify challenges in using landscape metrics. Some indicators and measures were difficult to compare, particularly for land uses at the sample area beyond patch size and patch number. Due to the lack of available GIS data, this evaluation is limited mainly to patch metrics (patch number, patch size). It does not consider corridors or other landscape metrics that are part of the patch-corridor-matrix model. This evaluation would benefit from actual GIS data, and local planners may already have this data.

Scale was also an important factor when drawing conclusions. The sample area is problematic for testing land use types other than the field class, such as residential areas, wooded areas, and *linpan* clusters. Although the sample area size used here (300 m by 400 m) was practical for the researcher's ability to collect field data, it might be too small to understand some of the land use composition and configuration characteristics.

The baseline measures may also be site specific even within the *linpan* landscape. Since all village sites were within Pi County, the *linpan* landscape structure may differ county to county, particularly in other counties that may have significantly different topography (i.e. hills).[11]

This thesis specifically looked at the role of landscape structure as indicators of resilience. But it leaves out the social components that affect resilience- management practices, learning, and

[11] A 2013 cross-cultural summer planning studio between the University of Washington, Sichuan University and National Cheng Kung University in Taiwan looked at planning alternatives for several villages in Pujiang County, Chengdu. Pujiang County is also considered part of the linpan landscape, yet its topography is quite hilly. While the villages grew different crops (mainly tea), the settlement pattern was similar to the dispersed settlement pattern in the village field sites in Pi County, where there is no discernible village center or concentrated settlement.

social organizations that also play an important role in socio-ecological resilience. This approach was taken knowing that to truly understand resilience in a densely settled agricultural landscape like *linpan*, social factors need to be considered as well. These factors should be considered in further research to better manage these kinds of landscapes for resilience.

Finally, this evaluation still leaves planning out of the hands of the local residents who will be most affected by redevelopment, but it is the hope that this tool can aid planners in their role as advocates in the planning process to represent the community and uphold the planning principles and ideals through increased transparency in decision-making.

6.2 Reflections on Planning for Resilient Landscapes

Globally, agricultural landscapes are under tremendous strain. They are expected to produce food for a growing population while facing threats from climate change and environmental degradation. In China, this problem is coupled with dramatic demographic shifts as the country becomes increasingly urbanized. The government is hard pressed to find solutions to both protect its productive landscapes and modernize rural society to reduce rural-urban inequality, thus creating contradictions between efficiency and resilience. In this context, resilience is even more important due to the rapid speed and large scale of change. The consequences of such changes are not predictable, and it is important to build adaptive capacity to prepare for unexpected problems that redevelopment processes may create.

In a local context, historically self-sustainable, agriculturally productive landscapes face dramatic, fast-paced change to their physical structure from top-down government redevelopment policy that often promotes homogenization of landscapes. Yet unique physical qualities often represent years and decades of traditional knowledge that merged social and ecological systems to keep both functioning over a long period of time. Thus, certain characteristics of landscape structure support the long-term health of both social and ecological components of the landscape. In agroecosystems, researchers have found that landscape heterogeneity, patchiness, appropriate scales and biodiversity across scales support socio-ecological resilience.

Situated in one of the most fertile areas of China, Sichuan's *linpan* landscape is a useful case study to observe national and local government development effects on the physical structure of a traditional socio-ecological landscape. It also shows how planning goals are often in direct conflict with each other. Here, it is planning goals for modern, efficient landscapes to spur economic development that conflict with planning goals to preserve traditional landscape elements and ecological function.

This thesis shows the challenges in balancing efficiency and resilience in a rapidly urbanizing society and environment like China. National policy strongly pushes for economic development goals. This is evident in the cadre evaluation indicators that hold local government officials accountable for meeting targets, and indicators are heavily weighted to prioritize achievement of economic development while environmental protection often takes a back seat. At the local level, Chengdu planners have begun to include ecological principles into planning objectives in the last several years, where policy language has recently emphasized the need to protect and preserve landscape characteristics that support ecological function. Although local planning goals champion a balance of economic development and environmental protection, it appears that local government officials ultimately have much power in carrying out redevelopment policy. Since they are compelled to meet economic development targets, how then can planning address conflicts between different planning goals?

Planners should advocate for a balance of all goals in the planning process. Where one goal is much more compelling in the eyes of officials, planners should champion for those goals that do not seem to be a political priority. The use of this kind of evaluation method that employs quantifiable measures and indicators from landscape ecology adds rigor to preservation and environmental goals by helping stakeholders in the planning process measure how well these goals are being achieved. It clarifies a baseline landscape typology (what should be preserved) that can guide redevelopment plans and process to meet all planning objectives, not just economic development targets.

6.3 Future Steps

After completion of this study as an illustrative test of landscape structures that are indicators of resilience, the following are a few suggestions for further inquiry.

1. Gather further data on other villages not affected by redevelopment to build case for 'baseline' typology. This study tested the indicators for three villages with four alternative models. While Jiang'an and the two sample areas of Anlong show similarities on some of the indicators and measures, more villages, preferably those that have not yet undergone redevelopment processes, should be studied. To make a stronger comparison with the sites used in this study, additional villages should also be in Pi County. Other Counties in the *linpan* landscape can be studied to compare their villages against this baseline and to see if the baseline needs to be adapted for topographic and geographic differences.

2. Include meaningful social indicators of resilience adapted for local context into the evaluation. While landscape structure is one variable that supports resilience in the *linpan* landscape, social indicators should also be included. Similar to the method employed here, meaningful indicators would support the three aspects of resilience I discuss: the ability to buffer disturbance, adaptive capacity and self-organization for both social and ecological systems. This can be measured through social surveys or interviews with local residents. From a literature review on agroecosystem resilience, additional factors that affect resilience include governance, practice and techniques, local knowledge and tradition (Kremen et al. 2012).

3. Measure ecosystem services. This evaluation would also benefit from measuring ecosystem services in the landscape to form a baseline and compare effects of redevelopment, such as water quality, soil quality, biodiversity of plant and animal species, or highlight what other variables may affect ecological function, such as farming practices that use different kinds of fertilizers, pesticides, etc., or man-made structures such as water treatment facilities.

4. Understand food system of region. This thesis analyzed the spatial form of the *linpan* landscape as an agroecosystem, but it was not clear from this study what the flows of food supply and demand are at different scales, such as the household, village, and region. It would be interesting to study where food crops grown locally in the villages go. It would also be interesting to find out where other crops grown (such as the landscape ornamental trees and shrubs) are bought and sold to further understand the inter-connectedness of this landscape to the region and beyond. After visiting the field sites, I began to notice the use of similar ornamental landscape trees and shrubs along the highways and around the new town and city centers I passed on my journey from Chengdu city center to the villages.

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Appendix 1: Participatory Evaluation in China

Participatory Evaluation Process:

Participatory monitoring and evaluation (PM&E) emerged out of the limitations that conventional evaluation and monitoring to include local voices in the evaluation process. "Conventional monitoring and evaluation mainly serve the needs of project implementers… [it] ignores the interests of other groups involved in research and development efforts, especially local people" (Vernooy et al 2003).

The process of PM&E is quite similar to multicriteria evaluation but has added emphasis on defining both who carries out the evaluation and monitoring and who benefits from the process.

PM&E Steps: (Vernooy 2003)

- Why? Define the goals of participatory monitoring and evaluation
- What? Define the objectives of participatory monitoring and evaluation
- What? Define indicators
- For Whom? Define the beneficiaries of participatory monitoring and evaluation
- Indicators to be used by planners and officials to make more clear their choices for redevelopment and communicate this with villagers.
- Who? Define who implements the monitoring and evaluation
- When? The timing of participatory monitoring and evaluation in your project

PM&E in China: Implementation, Successes and Challenges

According to Vernooy et al.'s 2003 *Voices for Change, Participatory Monitoring and Evaluation in China*, PM&E methods have been carried out by local NGOs and research institutes in Yunnan and Guizhou since the late 1980s with the goal of involving local village participation in natural resource management. The book focuses on two PM&E pilot projects. One was held in Guizhou province in 1999 that focused on effective and efficient water management in the village. The second project was held in Yunnan province in 2000 with the goal of increasing local participation in the decision-making of social, cultural and economic development in a mountain watershed area. "The objective was to design and implement a PM&E component that would complement ongoing research in both projects. The workshop format allowed participants not only to acquire conceptual and methodological insights into PM&E, but also to put them into practice immediately" (Vernooy et al. 2003). Reflections on the workshop experiences in both cases express project successes and challenges.

Successes:

In the Guizhou project, PM&E had many benefits. It increased collaboration between villagers, researchers, and local government officials. It also helped "build capacity, accountability, and confidence about adequate water management." (Vernooy et al. 2003). In Yunnan, field staff found that "PME has allowed us to bring the various people with whom we are working-the women and men in the villages and in government offices in particular-closer to each other." They also found that PM&E helped to spread the risk of failure among more stakeholders, including both the project team and farmers.

Challenges:

Both Yunnan and Guizhou PM&E projects identified China's top-down management structure and the long-term challenges to institutionalize PM&E methods as major challenges. "Top-down implementation and management styles prevent the continuation of the participation." (p. 13) In Yunnan, they reflected that "for PM&E to be efficient, it must be institutionalized at each level of project management and all stakeholders must understand its benefits." They further reflected that "institutionalizing participatory project management at the village level would take time. It will require empowering local people and changing the process of top-down decision-making to a multi-stakeholder-based, horizontal one. This, in turn, will require the institutionalization of participatory methods among our local government partners." In Guizhou, project leaders wrote that the "institutionalization of PM&E must become a priority." They worried about "how to deal with the Chinese political (top-down) system and ingrained thinking and behavior" as a barrier to PM&E's long-term effectiveness and adoption and "how to better involve government staff in the monitoring and evaluation process from beginning to end." Both projects in Yunnan and Guizhou also noted that PM&Eis a time-consuming method. "Participatory approaches also require a gradual learning process on the part of villagers, local staff, and government officials." The Yunnan team found that a few participatory meetings were not sufficient.

Appendix 2: New Socialist Countryside Cadre Evaluation (Ahlers and Schubert 2009)

Table 2: Qingyuan County XNCJS Project Evaluation Undertaken by Lishui City, 2008

Target Field	Indicator	Qingyuan County Index	Leading City Department
Economic development	Increase in the proportion of specialized agriculture as percentage of total agricultural output	0.5%	Department of Agriculture
	Total area of adjusted land (*tudi liuzhuan*)	20,000 mu*	Department of Agriculture
	Number of farmers who receive training to operate the farmers' digital information system	1725	Department of Agriculture
	Percentage of farmers who have received vocational training before taking new jobs	80%	Department of Labour and Pension
Village basic infrastructural development	Building of *new urban villages*	1	Department of Rural Work
	Number of low-income farmers' houses renovated (annual increase)	400	Department of Public Construction
Village welfare	School completion rate	93.28%	Department of Education
	New Rural Cooperative Medical System participation rate	90%	Department of Public Health
	Net increase in income of poor households	15%	Department of Poverty Alleviation
	Number of state-led cultural activities in the village	120	Department of Culture
Development of democratic politics	Rate of transparency accomplished in village accounting (*cunwu gongkai*)	90%	Department of Civil Affairs
Other	Increase in the proportion of "san nong"-related investment in the county budget	12.03%	Department of Finance
	Increase in micro credits by Rural Cooperatives (or Rural Cooperative Banks)	51,000,000 CNY	City level People's Bank of China

Note: * 1 mu = ca. 666,67 square metres.

Source: Lishui City XNCJS Office 2008.

Appendix 2: From Looney 2012.

Appendix 2: National Cadre Evaluation Standards for Building a New Socialist Countryside

Program	**Indicator**	**Desired Level High/ Low**	**Point Value (Points add up to 100)**
Economic Prosperity and Development *Total Point Value = 30*	1. Average Annual Growth Rate of the Agricultural Sector	H	3
	2. Agriculture as a Percentage of GDP	L	2
	3. Rural Employment as a Percentage of the Rural Working-Age Population	H	2
	4. Percentage of the Rural Population Employed in the Secondary (Industrial) and Tertiary (Service) Sectors	H	2
	5. Average Annual Growth Rate of Township Government Revenue	H	3
	6. Average Rural Income in Yuan	H	10
	7. Rural Gini Coefficient	L	2
	8. Rural Engel Coefficient	L	2
	9. Percentage of Rural Income Spent on Culture and Leisure	H	2
	10. Size of Rural Housing in Per Capita Square Meters	L	1
	11. Percentage of Rural Housing Constructed with Brick or Other Sound Materials	H	1
Improving Social Welfare *Total Point Value = 30*	12. Number of Agricultural Extension Workers	H	6
	13. Percentage of Rural Areas Covered by a Telecommunications Grid	H	2
	14. Percentage of Administrative Villages with Cable Television	H	2
	15. Percentage of Rural Children Attending School	H	2
	16. School Drop-out Rate for Elementary and Middle School Children	L	2
	17. Education Level of People Joining the Rural Labor Force	H	5
	18. Average Number of Technical and Vocational Skill Sets Acquired by Rural Labor Force	H	5
	19. Percentage of Township and Village Health Stations Meeting Quality Control Standards and Percentage of Upgraded Medical Equipment	H	2
	20. Number of Spaces with Infrastructure for Cultural (Educational) and Leisure Activities	H	2
	21. Population Growth Rate	L	2
Improving the Social Security System *Total Point Value =5*	22. Percentage of the Rural Population Participating in New Rural Medical Cooperatives	H	1
	23. Percentage of the Rural Poor Covered by the "Five Guarantees" Minimum Living Assistance Program	H	1
	24. Percentage of the Rural Poor Receiving Aid for Poverty Relief	H	1
	25. Percentage of the Rural Population Participating in Old Age Insurance	H	1
	26. Percentage of Rural Homeless and Residents of Dilapidated Housing Receiving Housing Assistance	H	1

Appendix 2 (cont.)

Beautification of the Environment *Total Point Value = 20*	27. Rate of Decrease in Farmland	L	2
	28. Percentage of Townships with Completed Plans	H	2
	29. Percentage of "Hollowed-out Homes" and "Hollowed-out Villages" Renovated	H	2
	30. Percent Green Space in Townships	H	2
	31. Percentage of "Paved, Lit, and Green" Township Roads	H	2
	32. Percentage of Administrative Villages Reachable by Cement Roads and Public Buses	H	2
	33. Percentage of Paved Main Roads in Villages	H	2
	34. Percentage of Administrative Villages where Most Villagers Use Clean Energy	H	1
	35. Percentage of Rural Households with Tap Water	H	2
	36. Percentage of Clean Toilets	H	2
	37. Percentage of Rural Household Garbage Subject to Centralized Waste Collection and Management	H	1
Civilized and Harmonious Rural Culture *Total Point Value = 15*	38. "Three People" Township Leaders as a Percentage of All Township Leaders	H	2
	39. Percentage of "Five Good" Village Leaders	H	2
	40. Percentage of Villages with the Same Person Serving as Village Party Secretary and Head of the Village Committee	L	1
	41. City-Level "Civilized Villages" as a Percentage of All Administrative Villages	H	1
	42. Percentage of "Civilized Family" Households	H	2
	43. Percentage of "Civilized and Trustworthy" Households	H	1
	44. Level of Satisfaction with Village Transparency	H	2
	45. Rate of Successful Mediation of Civil Disputes	H	1
	46. Rate of Major Accidents, Collective Petitioning, Mass Incidents, Violent Crimes	L	1
	47. Level of Satisfaction with Public Safety	H	2

Source: The Urban-Rural Innovative Development Blue Book for China's Building a New Socialist Countryside; cited in CSUS 2009: 196-199.

Appendix 3: Summary of Data (Field and Sample Area Scale)

		Ag Fields Sampled	Crop Use Types									
		Size of All Fields Sampled	Grain	Veg/Fruit	Grain Veg Mix	**Predom Food Crops Total**	**Ornamental**	**Orn/Food (Veg or Grain) Mix**	Tourism	Fallow	Unknown	No Data
Jiang'an Village	Data Source											
	Patch Size: Area Range (min-max)	320.37-1666.86	0	0	0	0	**320.37-1666.86**	0	0	0		
	Patch Size: Average	896.91	0	0	0	0	**896.91**	0	0	0		
	Standard Dev	372.00	0	0	0	0	**372.00**	0	0	0		
	Total Sum (CA)	43,948.78	0	0	0	0	**43,948.78**	0	0	0		
	Class Area Proportion (CAP)	100	0	0	0	0	**100**	0	0	0		
	Patch Number (Fields matched to data pts)	49	0	0	0	**0**	**49**	0	0	0		85
	Patch Number(Raw Data pts within sample area)	66	1	0	0	1	65					

	Sample Area Land Use							
	Size of Sample Area (sqm)- Boundary layer	Commercial Area	Residential (Field Data Pts 2013 within bdry)	Residential Area (Remote Sensing/Maps)	Wooded (all areas in sample area)	Linpan Unit (contained within/intersect bdry)	Fields	Water
Data Source	ArcGIS Basemap 2005		Field Data pts 2013	JiangAn AutoCad Map 2011		ArcGIS BM 2005	ArcGIS Basemap 2005	
Patch Size: Area Range (min-max)	120,134.76			462.49 - 1840.1	319.16 - 11517.44	1993.48 - 12185.98	185.63-1745.78	
Patch Size: Average					4,539.58	8,682.57	765.54	
Standard Dev				490.28	3,819.79	4,034.68	366.75	
Total Sum (Class Area)	130,194.39	0.00		4,430.98	22,697.92	34,730.29	102,582.75	482.74
Class Area Proportion (% of Total)				3.40	17.43		78.79	0.37
Patch Number (Total Count)			7	5	4	4	134	1

		Size of All Fields Sampled	Grain	Veg/Fruit	Grain Veg Mix	**Predom Food Crops Total**	**Ornamental**	**Orn/Food (Veg or Grain) Mix**	Tourism	Fallow	Unknown	No Data
Anlong (CURA)	Data Source	Fields from CURA Map matched to data pts 2013										
	Range (min-max)	150.66-1920.97	274.8-1802.37	238.91-1841.94	472.63-1164.52	**238.91-1841.94**	**150.66-1817.34**	185.61-1920.97	0	381.45-1125.56	220.31-470.74	
	Average (Mean Patch Area)	786.2	823.65	717	818.57	**782.85**	**761.542**	1038.346	0	720.08	353.91	
	Standard Dev	481.43	419.26	513.22	345.94	**455.84**	**479.95**	558.74	0	272.26	102.92	
	Total Sum	63682.23	13178.52	7887.05	1637.15	**22702.72**	**26653.97**	10383.46		2880.35	1061.73	
	% of Total (CAP)	100	20.69	12.39		**35.65**	**41.85**	16.31	0.00	4.52	1.67	
	Total Count (PN) (Fields matched to data points)	81	16	11	2	**29**	**35**	10	0	4	3	49
	Total Count (Raw Data points)	111	28	16	0	**44**	**48**	6	0	7	5	

	Size of Sample Area (sqm)- Boundary layer	Commercial Area	Residential (Field Data Pts 2013 within bdry)	Residential Area (Remote Sensing/Maps)	Wooded (all areas in sample area)	Linpan/Wooded (clusters contained within/intersect bdry)	Fields	Water
Data Source	**127,968.36**			CURAMap 2012	CURAMap 2012 with GoogleEarth 2010	Google Earth 2010	CURAMap 2012 adjusted with field data 2013	GoogleEarth 2010, CURA Map 2012
Patch Size: Area Range (min-max)				**84.58-809.39**	**161.57-5640.69**	**2702.45-14414.67**	**99.4-2247.18**	500.12-9813.5
Average (Mean Patch Area)				**390.38**	**2,386.97**	**5,903.19**	**752.74**	
Standard Dev				223.52	1,627.76	4,364.12	465.35	
Total Sum (Class Area)	150,220.91	**0.00**		6,246.04	35,804.54	29,515.95	97,856.71	10,313.62
Class Area Proportion (% of Total)				4.16	23.83		65.14	6.87
Patch Number (Total Count)				16	15	5	**130**	2

		Size of All Fields Sampled	Grain	Veg/Fruit	Grain Veg Mix	**Predom Food Crops Total**	**Ornamental**	**Orn/Food (Veg or Grain) Mix**	Tourism	Fallow	Unknown	No Data
Anlong (Semi)												
	Range (min-max)	180.87-1989.12	282.2-552.53	0	0	282.2-600.54	185.26-1871.26	180.87-1989.12	0	666.66-1159.3		
	Average	798.23	447.05	0	0	477.75	776.22	1246.82	0	838.49		
	Standard Dev	424.47	101.67	0	0	109.72	373.96	679.8	0	227.03		
	Total Sum	55077.75	1788.22	0	0	1788.22	42692.58	7480.93	0	2515.48		
	% of Total	100	3.25	0	0	3.25	77.51	13.58	0	4.57		
	Total Field Count (Fields matched to data points)	69	4	0	0	5	55	6	0	3		29
	Total Count (Raw Data points within sample area)	93	6	3		9	68	10	0	6		

	Size of Sample Area (sqm)- Boundary layer	Commercial Area	Residential (Field Data Pts 2013 within bdry)	Residential Area (Remote Sensing/Maps)	Wooded (all areas in sample area)	Linpan/Wooded (clusters contained within/intersect bdry)	Fields	Water
Data Source	**116,883.32**			ArcGIS Basemap 2005, adjusted with field data 2013	ArcGIS Basemap 2005	Google Earth 2010	ArcGIS Basemap 2005	ArcGIS Basemap 2005
Patch Size: Area Range (min-max)				**54.81-5602.2**	**92.88-7242.02**	**1171.25-7417.44**	**180.87-1989.12**	1401.05-6079.22
Patch Size: Average				**398.47**	**2,285.51**	**4,250.34**	**807.72**	3,740.14
Standard Dev				1,166.85	2,512.58	2,153.74	433.71	2,339.09
Total Sum (Class Area)	120,145.63	**0.00**		8,368.02	25,140.60	21,251.72	79,156.74	7,480.27
Class Area Proportion (% of Total)				6.96	20.93		65.88	6.23
Patch Number (Total Count)			21		10	5	**98**	2

		Size of All Fields Sampled	Grain	Veg/Fruit	Grain Veg Mix	**Predom Food Crops Total**	**Ornamental**	**Orn/Food (Veg or Grain) Mix**	Tourism	Fallow	Unknown	No Data
		Google Earth 2012	(rice)	(greenhouse =2, orchard =2)								
Zhanqi 2012	Range (min-max)	746.7-12609.57	2611.64 - 7185.68	1754.37 - 12609.57	0	1754.37-12609.57	934.77 - 3308.85	0	746.7-6195.26	1206.1-1454.14		
	Average Field Size	3168.72	4835.985	5030.445	0	5030.445	2111.64	0	3102.65	1330		
	Standard Dev	2365.75	1886.45	4412.49	0	4412.48	675.08	0		124.02		
	Total Sum	104,567.88	19,343.94	20,121.78	0	20121.78	19,004.78	0.00	43,437.14	2,660.24		
	% of Total	100.00			0	19.24	3.27	0.00	41.54	2.54		
	Total Field Count	33.00	4	4	0	8	9	0	14	2		
	% of Total Fields Sampled											

	Size of Sample Area (sqm)- Boundary layer	Commercial Area	Residential (Field Data Pts 2013 within bdry)	Residential Area (Remote Sensing/Maps)	Wooded (all areas in sample area)	Linpan/Wooded (clusters contained within/intersect bdry)	Fields	Water
Data Source					Google Earth 2012		Google Earth 2012	Google Earth 2012
Patch Size: Area Range (min-max)		820.07-2307.41					746.7-12609.57	
Patch Size: Average		3,127.48					3,168.72	
Standard Dev		743.67					2,365.75	
Total Sum (Class Area)		3,127.48			10,633.93		104,567.88	2,187.14
Class Area Proportion (% of Total)	**123,210.12**	**2.54**		0.00	8.63		84.87	1.78
Patch Number (Total Count)		2	0	0	1	0	**33**	2

Appendix 3: Intermediate Scale: Settlement Dispersion

	Jiang'an	Anlong CURA	Anlong Semi (future plans)	Zhanqi
Intermed Area Size (m2)	369,633	384,582.54	513,313	does not apply - only 1 res idential area
Patch Size: (Min-Max) (m2)	1,993 - 20,900	618 - 14,415	1,979.26 - 10,062.96	159,000
Patch Size: (Mean) (m2)	13,021	4,530.90	13,466	174,443
Patch number	8	12	2	1
Distance to 7th nearest neighbor (average distance in meters)	96.3	164.31	(not available)	(not available)
Total # of Dwelling Units (DU) in sample area	59	45	66	469
Total # of DUs in patches	50	35	66	469
Avg # of DUs in patch	6	3	33	469
# DUs range	2 -14	1 - 8	11 - 55	469

Appendix 3: Summary of Data (Village Scale)

Jiang'an: Administative Village Scale								
Land Use Classes							Population	
	Total land area (sq km)	Total Residential Area	Total Agricultural Area	Commercial Area	Green'/ Wooded Area	Public Amenities		Population total persons)
Data Source	Jiang'an (PPT)	Jiang'an (PPT)	Jiang'an (PPT)				Data Source	
Total Area (sq km)	3.12	0.45	2.583	0.0087		0.08	Total Pop (persons)	2697
Class Area Proportion (CAP)	100.05	14.42	82.79	0.28		2.56	Pop Density (persons/sq km)	864.42

Anlong: Administative Village Scale											
Land Use Classes										Population	
	Total land area (sq km)	Total Residential Area	Total Agricultural Area	Scenic area/Tourism	Green'/ Wooded Area	Water Bodies /Irrigation/Facilities	Transportation	Town organization/ government	Other		Population total persons)
Data Source	Anlong Board 2013	Anlong Board 2014	Anlong Board 2015	Anlong Board 2016	Anlong Board 2017	Anlong Board 2018	Anlong Board 2019	Anlong Board 2020	Anlong Board 2021	Data Source	Anlong Board 2013
Total Area (sq km)	3.8	0.57	2.35	0.14	0.03	0.23	0.32	0.12	0.05	Total Pop (persons)	3399
Class Area Proportion (CAP)	100.00	14.92	61.85	3.69	0.82	6.12	8.27	3.11	1.22	Pop Density (persons/sq km)	894.47

Zhanqi: Administrative Village Scale								
Land Use Classes							Population	
	Total land area (sq km)	Total Residential Area	Total Agricultural Area	Commercial Area	Green'/ Wooded Area	Public Amenities		Population total persons)
Data Source							Data Source	
Total Area (sq km)	1.99	0.15	1.24	0.2	0.14	0.24	Population	1700
Class Area Proportion (CAP)	100%	8%	62.62%	10.12%	7%	12%	Population Density (persons/sq km)	854.2713568