Fondazione Eni Enrico Mattei

Study on Payment for Ecological and Environmental Services in China

A Pilot Study on Payment for Ecological and Environmental Services in Lashihai Nature Reserve, China.

FINAL REPORT

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Summary

The study, funded by the World Bank and carried out in cooperation with Conservation International-China, aims at exploring the feasibility of using compensation for ecological and environmental services to address natural resource management issues in China. This report provides the preliminary findings of the pilot study on the Payment for Ecological and Environmental Services (PES) in the Lashihai Nature Reserve in the Yunnan Province of China. The Lashihai Nature Reserve was established in 1998 with the main purpose of protecting the Lashihai wetland, an area of special interest for migratory birds, listed under the Ramsar Convention. Major protection measures currently in force include a ban on and inspection of fishing, poaching and hunting, but a potential threat for the lake ecosystem remains, due to increased increasing unplanned tourism and agricultural activities.

The watershed provides ecological services of economic value to a wide range of stakeholders: biodiversity services (protected migratory birds species feed on farmlands surrounding the wetland with, however, a negative impact on farmers' yields), and landscape services (the Lashihai lake supplies water to the old town of Lijiang, which is used to fill in the traditional water system). Despite only being in use for three months a year, the landscape use of water from the Lashihai Lake is very important for the old city, which relies on tourism.

The lake's water quality is thus a concern, as it may be harming the tourism industry. The main pollutants come from non-point agricultural sources, especially in terms of fertilisers' use. The two main problems that the pilot study addresses are therefore the estimation of a suitable level of compensation to farmers for the damages inflicted to their yields by protected bird species; and the most suitable design of an incentive mechanism to induce farmers to adopt more environmental-friendly agricultural practices, in order to provide clean water for landscape services to the city of Lijiang. The study also notes that a PES solution to the problem is more likely to be cost effective and politically acceptable than an engineering solution involving water diversion to Lashihai Lake.

As part of the assessment of the PES option the study attempts to: estimate the value of the environmental services provided by farmers located around the Lashihai wetland in terms of maintaining biodiversity through provision of food supply to migratory birds, and restoring water quality for landscape use in Lijiang old town, through improved agricultural practices; estimate the costs of provision of these services, i.e. both the direct and indirect (opportunity) costs of provision; propose guidelines and recommendation for the local implementation of PES schemes in the specific pilot study area; draw more general conclusions on the usefulness of PES mechanisms in China, and how they could be implemented locally.

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1 Introduction: setting the problem into context

This report provides the preliminary findings of a pilot study on payment for ecological and environmental services (henceforth PES) in the Yunann province of China, conducted by Fondazione Eni Enrico Mattei (FEEM) in cooperation with Conservation International-China, under the World Bank funding (Italian CTF030815).

The pilot study aims at identifying the main ecological and environmental services, and the most appropriate payment schemes which can provide incentives to landholders to maintain or generate the services identified. The pilot scheme addresses two such services in the region, which are affected by the activities of farmers within the Lashihai Nature Reserve. First, the downstream waters of the Lashihai wetland play an important landscape function in the old tourist city of Lijiang, where the water canals have made the town deserve the sobriquet 'Venice of China'. Improved agricultural practices around the lake can thus benefit the city through improved water quality. Second farmers' activities within the nature reserve have the added environmental benefit of maintaining birds' biodiversity. The Lashihai Nature Reserve represents a unique protected habitat for several bird species, and hosts agricultural land owned by local farmers, who bear economic losses from birds' feeding on crops.

Relating to these two services the pilot study addresses two main problems: the identification of a suitable level of compensation to farmers for the damages inflicted to their yields by the protected bird species in the Lashihai Nature Reserve; and the most suitable design of an incentive mechanism to induce farmers to adopt more environmental-friendly agricultural practices, to preserve the quality of water for landscape services to the tourist city of Lijiang.

This report is organised as follows. First, based on a thorough review of the literature[1], Chapter 2 describes existing PES schemes, and provides an assessment of their effectiveness in maintaining key EES. The main experiences with PES schemes in China are then described in Chapter 3. Chapter 4 describes in detail the case study application: first, the problem is set into context (Sections 4.1 and 4.2); the key ecological services addressed are described in Section 4.3, while the methodology adopted to identify the causal links in the model – and potential entry points for altering the behaviour of key actors – is described in Section 4.4. Chapter 5 moves on to the quantification of the two EES – first in terms of costs of provision (Section 5.1), then the benefits derived (Section 5.2). In Chapter 6, potential design options for the PES scheme are discussed, while Chapter 7 presents some suggestions regarding the design of the scheme, including

[1] For details see an earlier deliverable from this project: D2: Best practice approaches to PES – theory and applications

participation incentives (Section 7.1), payment mechanisms (Section 7.3), payment levels (Section 7.4), the institutional set up (Section 7.5) and monitoring strategies (Section 7.6). Finally, Chapter 8 concludes this report.

2 PES Schemes: an overview

Ecosystems, natural or managed by humans, provide a wide range of benefits and ecological/environmental services (EES). These benefits can take various forms: ecosystems may provide goods which are used for consumption or production, such as food or water (provision service); they may serve to regulate other ecosystems' activities, for instance, regulating flow or pollution diffusion (regulating services); they may also sustain underlying processes which maintain productive assets, such as ensuring nutrient cycles (supporting services); and finally they may provide recreational, spiritual, religious and other non-material benefits (cultural services).

Despite their importance, these EES are often underprovided or even lost, especially when they are controlled by private interests: landholders, for example, have no incentives to preserve them, as the benefits are enjoyed by many people, while the costs of maintaining them are incurred only by landholders. In recent years, the compensation to landholders for the services generated by their land has been advocated as as an instrument to ensure that these services are maintained. PES seek to capture at least part of the benefits derived from environmental services (such as clean water) and to channel them to the landholders who generate them: PES provide landholders the right incentives to maintain a healthy ecosystem, they are a new source of income for landholders who can improve their livelihoods (Pagiola, et al., 2005), and have the additional advantage of generating funds that can be used to finance conservation projects.

The underlying rationale of PES schemes is relatively simple and appealing, yet implementing them may not be easy (Pagiola and Platais, 2003)[2]. The design of the schemes must necessarily be tailored to the local situation, not only in terms of the service traded, but also taking into account the current institutional constraints, as well as the capacity (financial and human) of potential suppliers and beneficiaries of the service. A taxonomy of the different PES schemes is given in Table 1. Some comments on the relative merits of these schemes are also provided.

From the theoretical point of view, there are three crucial elements in setting up the PES scheme. First: define, measure and quantify the EES for which a market is to be set up; second: identify and consult participants to the schemes; third: establish payment levels and the payment mechanisms. Moreover, recent PES experiences suggest some general lessons and rules of thumb for

[2] We should note that PES is based on the principle that the beneficiary pays. This is in contradiction to the much-adopted principle that the polluter pays. Both can lead to an efficient allocation of resources but the difference is of course in their distributional implications. Each case has to be considered from both principles and the PES adopted only if it is indeed distributionally fair.

implementing this market based instrument for environmental management in an effective manner: extensive consultation with local actors is necessary, and it must be commenced early on in the process; monetary payments to service providers may be supplemented by other, in-kind benefits, such as training, technology transfers, or investments in social institutions (health care, schooling,…); and the role of the Government, which has so far been prominent, needs to continue to be so, both as a direct buyer of EES, and as the authority to create an enabling environment for private market transactions.

Table 1: Main types of PES schemes

Type of PES	Participants	Type of EES	Requirements
Voluntary contractual agreements VCS	Private to private. Role of government limited to enforcement of property rights.	High-value EES, related to private good. Low cost of provision of EES. Small scale.	Clear and enforceable property rights. Negotiable contracts. Limited number of providers and beneficiaries.
Public payment schemes PS	Government to private, government to government, or government to other organisations (e.g. NGOs, Community Based Organisations,…)	Public good, significant externalities involved. High value of EES, but high cost of provision.	Generation of funds for government (e.g. taxes, user fees,…). Transparent institutions. Public participation.
Trading schemes TS	Private to private, with government setting initial standards and allocation of rights.	High value of EES, variable costs of provision. EES related to private good. Services provided by different providers must be perfectly substitutable.	Strong institutional setting. Strong monitoring and compliance mechanisms. Clear initial allocation of rights.

2.1 Assessing the effectiveness of PES schemes

Based on the analysis of existing experiences of application of PES schemes, we have identified key conditions under which such schemes are more likely to be effective. It is important to emphasize, however, that PES schemes are relatively recent, and this assessment exercise can only be partial. Moreover, and as stressed by Landell-Mills and Porras (2002) in the recent and extensive review of PES schemes worldwide, very few studies undertake an objective and comprehensive review of the costs and benefits associated with the implemented PES schemes, including their effectiveness in mitigating environmental deterioration. It is nonetheless possible to identify some general conditions, which are likely to increase the effectiveness of this tool in achieving the desired environmental objective, as well as its efficiency in relation to alternative tools, such as more traditional market permits, or environmental standards. These are synthesised in Table 2.

To summarise, PES schemes will only be effective if the payments reach the providers of the services and motivate them to change (or not to change) their land use practices. Payments to landholders must be on-going and open-ended: because the EES are a flow that will be maintained through the years, service providers must receive a stream of payments as long as they maintain the

ecosystem; payments should be targeted and tailored, both to the level of the service provided and to the quantity demanded. Since targeted schemes entail higher transaction costs, a balance needs to be found. Furthermore, experience shows the need for a strong institutional and political commitment. If most of the above conditions are satisfied, then PES schemes may be a valuable tool to ensure the maintenance of EES. Under other circumstances, it may be better to adopt more traditional tools for protecting the environment, such as standards and regulations.

Table 2: Key factors affecting the effectiveness of PES schemes

Type and value of EES	
	The service provided is unique, scarce, and not easy to substitute.
	The service to be transacted is clearly identified.
	It is easy to quantify the value of the service to the beneficiaries, and the costs of provision.
	The link between the service and the quality of the ecosystem providing it is clear.
	The market is not too large (both in terms of geographical extension and number of potential participants).
PES design	
	The PES scheme arrangement is flexible.
	Transaction costs are minimised.
	Compensation levels are based on the estimated value of the economic importance of the service to the beneficiaries.
	Payments are sufficient to cover the cost of provision (including the opportunity cost of alternative land use).
	Compensation reaches both landowners and users.
Social dimension	
	Stakeholders can actively participate in decision making.
	All the relevant stakeholders are consulted, including vulnerable and marginalized groups.
	The distribution of costs and benefits is deemed acceptable.
	The PES scheme does not have adverse impacts on equity and poverty.
	The beneficiaries are willing and able to pay.
	The funds generated are invested in ecosystem maintenance.
Institutional setting	
	The political situation is stable.
	A clear and uncontested assignment of property rights exists.
	An adequate institutional framework is in place.
	Compliance, land use change and the provision of the service are closely monitored.
	An enforcement strategy exists.
	PES are managed in a fair and transparent way.

2.2 Strengths and weaknesses of PES schemes

Our analysis suggests that PES schemes can be flexible, direct and promising mechanisms by which service providers are compensated for maintaining the ecosystem and providing environmental/ecological services, while the service beneficiaries pay for their benefits. According to recent experience, PES schemes may help increase the actors' awareness of the value of natural resources, facilitating conflict management and compromise seeking; generate new sources of

funding for conservation and environmental improvement activities; and transfer resources to socially and economically vulnerable sectors which offer environmental services.

There are several characteristics of PES schemes which may affect their efficiency (i.e. the costs at which the desired level of ecosystem protection is reached) and effectiveness (that is, the ability to achieve the stated environmental objective). The relative merits and shortfalls of the different types of PES schemes and payment mechanisms depend to some extent on the specific characteristics of their application. General strengths and weaknesses can be identified, as factors that one should take into account when assessing the potentialities of PES schemes in a specific context, and the type of payment mechanisms and institutional arrangement that is more likely to be effective and least cost:

- PES schemes require the allocation of property rights on environmental externalities. They rely on the clear establishment of causal relations between the activity generating the externality, e.g. land use, and the quantity/quality of the service generated. Building an accurate causal model is expensive and time consuming, and often insufficient resources are invested; at the same time, when the link is clear to both providers and beneficiaries, and they perceive it as important, PES schemes can still be effective – though not necessarily least cost.
- care must be taken in ensuring that the right institutional framework is in place, that the potential adverse impacts in terms of wealth distribution are mitigated, and that transaction costs are minimised;
- more sophisticated, targeted systems, where the payment level and mechanism are conditional on the actual value and level of service provided by different land uses, will tend to be more effective than undifferentiated systems, but will have higher transaction costs because they require more detailed negotiations, and possibly different contracts for each service provider. Experience has also shown that payments to landholders are more effective if, in addition to financial transfer, they also provide non-monetary benefits, such as training and capacity building, access to credit, or other collective or individual services (Mayrand and Paquin, 2004, Rosa, et al., 2003);
- finally, local level programmes may prove more effective than large scale, national PES schemes, or at least prove important in complementing larger initiatives.

3 Existing applications of PES schemes in China

The Government, at various levels, is the steward of natural resources and the environment in China. The increasing pressures on natural resources, coupled by the growing concerns for the environment, has led the Chinese government to explore new, more efficient and effective tools for natural resources management. PES schemes were thus introduced in the late 1990s, together with other tools, but their effectiveness is now being put to question: one of the major concerns with PES schemes in China is their low efficiency, given the high transaction and capital costs of the schemes.

The growing attention to PES schemes as instruments for environmental management is reflected in the recent environmental measures adopted in China, where the Chinese government has indeed developed and implemented some of the largest public payment schemes for ecosystem services in the world, and has been experimenting with PES schemes since the 80s, when the Ministry of Water Resources attempted to protect fragile watersheds through the contracting out of land in sensitive areas to households, conditional upon appropriate management practices being adopted (Liu, 2005). In fact, as early as 1991, market mechanisms for watershed management were introduced in Chinese legislation (Water and Soil Conservation Act), though with limited success.

Two major PES schemes have been recently introduced in China. The Sloping Land Conversion Program (SLCP) was initiated in 1999 to restore natural ecosystems and mitigate the adverse impacts of agricultural practices carried out in previously forested areas or marginal land, such as flooding, sedimentation of reservoirs, and dust storms. The Government has already spent over RMB 50 billion[3] which has resulted in the enrolment of over 7 million ha of cropland (Xu, et al., 2006), but financial constraints are forcing the slow down of SLPC implementation (Scherr, et al., 2006). The second major PES scheme is the Forest Ecosystem Compensation Fund (FECF), which targets the management of privately owned standing forests, with the aim of compensating land owners for the ecosystem services their land provides and for the land and resource use restrictions program participation entails. This scheme currently covers 26 million ha in 11 provinces, and it costs the Government about RMB 2 billion[4] annually, of which about 70% goes to farmers for an average payment of $9/ha.

Unfortunately, neither of these schemes have achieved all of their targeted results, and there is now growing concern over their financial sustainability (IIED, 2006, Xu, et al., 2006, White and Martin, 2002). According to Xu et al (2006), the NFPP and SLCP have made progress in the protection of forests – where logging bans, harvest reduction, and resource protection targets have

[3] Approximately 6,3 billion U.S.$ at current exchange rates (October 2006)
[4] Approximately 253 million U.S.$ at current exchange rates (October 2006)

largely been met. But as a result, about a half of the logging, hauling, and processing of assets (30 billion yuan) in state-owned forest enterprises has been abandoned. Furthermore, both schemes – and most of their assessments – fail to implement market-based instruments for environmental management, and rely heavily on state finances. The lack of coordination among different – often competing – institutions with management responsibilities over forests is rarely cited as an obstacle, yet it hampers the efficient and effective implementation of the PES schemes. Finally, the authors claim the projects have significant social impacts, which however have never been assessed. The government has ignored the engagement of local people in the program implementation. White and Martin (2002) highlight that the logging bans included in the SLCP and NFPP, which originally targeted public forests, have in some provinces been extended arbitrarily to community forests.

There are many other smaller scale examples of PES tools in China, such as the water rights trading scheme between Yiwu and Dongyang cities in Zhejiang Province, the evolving framework of integrated watershed management and payments being developed between Beijing, Tianjin and local governments in the upper watershed of the Miyun reservoir, or the experimental emissions-trading scheme conducted jointly with the Environmental Defence Fund and taking place in four provinces and three cities (Zhou, 2005).

A well know example is the PES between the Beijing municipality and the areas around the water reservoirs at Miyun and Guanting. Miyun is the main reservoir for the capital, providing over 80% of water resources for domestic use. To reduce the damages caused by excess siltation, Beijing and Tianjin negotiated with the two communities responsible for the watershed – Fengning and Chengteh. The agreement led to the establishment of a fund for forest conservation, which will be replenished annually by Beijing and Tianjin with US$125,000 and US$50,000 per year respectively. Beijing has also invested substantial resources in projects of sustainable use of water, including construction and pollution control in the Miyun and Guanting reservoirs areas (Zheng and Zhang, 2006).

These examples of local and regional initiatives suggest that significant interest and potential for the application of PES in China exist, even though to date such schemes have been in the more developed and rich provinces, such as Zhejiang, Fujian, Guangdong. There are several other shortcomings of current PES mechanisms, notably: (a) the need to ensure that PES schemes are financially sustainable, given the budgetary constraints faced by the Government (Scherr, et al., 2006), (b) the unclear nature of current land ownership and property rights over natural resources and (c) the lack of stakeholder participation in the design of PES systems.

So far, PES in China have been mostly driven by government intervention, with little demand or supply forces behind the implementation of PES schemes. The situation is gradually changing, as

people become more and more aware of the underlying ecological systems, beneficiaries are more willing to pay to maintain the service they enjoy, and service providers are more aware of their rights to cover the costs of service provision. Seemingly, the Government will continue to be heavily involved in the schemes but perhaps the country will move away from schemes where the Government is the sole buyer of the service to one when it will play a support role in creating and maintaining an enabling environment for private actors' transactions.

4 A pilot study for implementing PES Schemes in the Yunnan province

The rationale for PES schemes is appealing, but their application both internationally and in China has shown that many difficulties in implementation remain. In the final part of this report, a test case study is developed, to illustrate how PES schemes can be developed and implemented.

The main objectives of the pilot study are thus to explore the potential usefulness of PES mechanisms to ensure that biodiversity services are maintained, as well as that water quality for landscape use is restored. The specific objectives are to:

i) estimate the value of the environmental services provided by farmers located around the Lashihai wetland in terms of:
   a. restoring water quality for landscape use in Lijiang old town, through improved agricultural practices;
   b. maintaining biodiversity through provision of food supply to migratory birds.

ii) Estimate the costs of provision of these services, that is:
   a. direct costs of provision (current agricultural practices);
   b. direct and opportunity costs of alternative land uses (e.g. fruit trees, less intensive agriculture, eco-tourism development).

iii) Propose guidelines and recommendation for the local implementation of PES schemes in the specific pilot study area.

iv) Draw more general conclusion on the usefulness of PES mechanisms in China, and how they could be implemented locally.

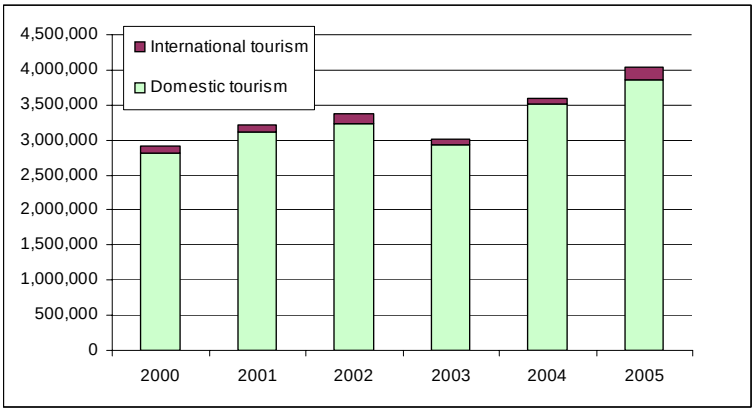
4.1 Lijiang old town

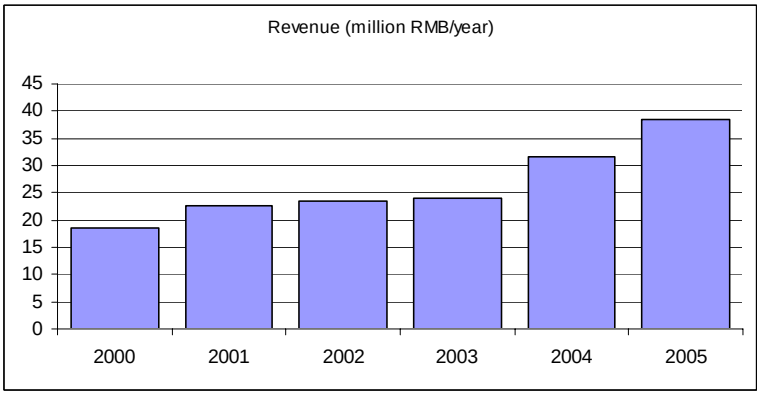
The old city of Lijiang is one of the largest and better preserved ancient villages in China. It is located in the northwest of the Yunnan province, in the middle reaches of the Jinsha River.

Figure 1: Location of Lijiang town

The tourism industry has grown very fast in the last year, as shown in Figure 2, and the city is a particularly popular destination for domestic tourism. The fast growth of this sector has certainly brought this small town prosperity, but it has also led to higher environmental pressure from increased population and water consumption.

Figure 2: Number of tourists visiting Lijiang old town





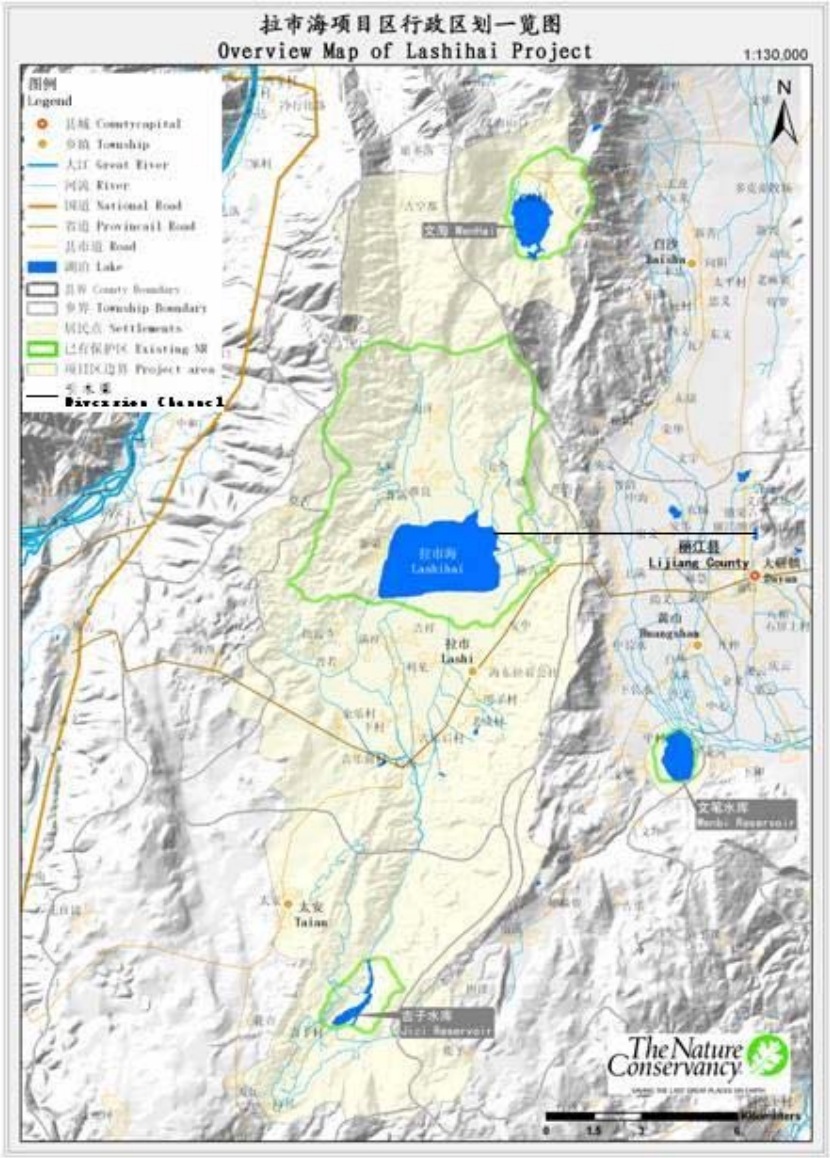
Lijiang experiences water scarcity, and the municipal government, as well as the local people, is concerned about the future development of water resources in the area. According to the Lijiang PPCC (people's political consultative committee) proposal in 2004, water resources should be considered as the highest priority in the city's development strategy. During interviews with the local municipal hydrology bureau and city planning and construction bureau, concerns were voiced over the quality of landscape water, used to fill in the picturesque canals of the city. Water pollution is a particular worry during the summer months when, because of water scarcity, the city diverts water for landscape use from the Lashihai Lake. Traditional agriculture practice and chemical pesticides and fertilizers are major sources of pollution of the water body.

4.2 The Lashihai Nature Reserve

The Lashihai Nature Reserve (LNR) was established in 1998 at the Yunnan provincial level, with the main purpose of protecting the Lashihai wetland, an area of special interest for migratory birds, listed under the Ramsar Convention. The Lashihai Wetland is a unique plateau freshwater lake with marsh meadows, located between 2,440 and 3,100 meters above sea level at the headwaters of the Yangtze River in the Hengduan Mountains. It is an important migration passage, breeding ground and wintering habitat of nearly 200 species, among which are 76 species of wild geese and ducks, and protected wildlife such as the black-neck crane.

The water outlet of the lake is connected to the Jinsha River with major hydrological functions of flood control, storage and water balance in the middle and lower reaches of the Yangtze River. As a biodiversity 'hotspot', Lashihai attracts 200-300 tourists daily particularly for bird watching and horse-riding. Major protection measures include strict control (including some bans) on fishing, and hunting, but a potential threat for the lake ecosystem is increasing unplanned tourism and agricultural activities.

Figure 3: The Lashihai Nature Reserve



4.3 The ecological/environmental services

4.3.1 Water resources

During the summer months (May to July) the Lashihai Lake supplies water to the Lijiang old town, named the 'Venice of China', a tourist destination where water canals provide a unique identity to the city, playing a relevant landscape function. The old city, which relies on tourism development, is facing water scarcity and poor water quality. In relation to the application of PES schemes for water management in the Yulong province, the main concern is the water quality of the Lashihai lake: poor quality of the lake is believed to harm the tourism industry in the old city of

Lijiang during the peak summer months. The concise presentation of chemical and biological parameters of surface waters in Lijiang old town (see Table 3) supports the idea that the deterioration of surface water quality should be related to both urban population and non-point agricultural pollution. Rising values of ammonia and coliform bacteria are an indication of the first type of pollution, whereas high values of total phosphorus are possibly related to high impact of agriculture on water quality. The parameter values in themselves are not always above the standard quality (see Table 4), but they do show a situation which continues to deteriorate through in the course of the years. More detailed information in terms of additional parameters, distributed monitoring stations and time series would allow a deeper investigation in causes and effects.

Table 3: Water quality in Lijiang old town – selected parameters

	2000	**2001**	**2002**	**2003**	**2004**	**2005**
pH	8.03	7.98	8.05	7.96	8.02	8.29
Conductivity (ms m^{-1})	30.80	29.50	31.40	32.00	33.70	35.60
DO (mg l^{-1})	6.70	6.00	6.70	6.20	6.80	
COD-Mn (mg l^{-1})	1.70	3.10	1.30	1.20	1.40	1.40
BOD_5 (mg l^{-1})	2.70	0.70	2.70	1.50	2.50	5.30
NH_3-N (mg l^{-1})	0.25	0.52	0.19	0.24	0.10	0.70
Tot- P (mg l^{-1})		0.05	0.08	0.08	0.06	0.15
Coliform (l^{-1})		7,800	86,400	23,000	14,800	36,400

(Source: Environmental Protection Bureau, Lijiang Municipality)

Table 4: Water quality standards in China

(Unit: **mg l^{-1}**)

	Class1	**Class2**	**Class3**	**Class4**	**Class5**	
pH	6-9					
Conductivity (ms m^{-1})						
DO (mg l^{-1})						
COD (mg l^{-1}) ≤	15	15	20	30	40	
BOD_5 (mg l^{-1}) ≤	3	3	4	6	10	
NH_3-N (mg l^{-1}) ≤	0.15	0.5	1.0	1.5	2.0	
Tot- P (mg l^{-1}) ≤	0.02 (lake & Reservoir 0.01)	0.1 (lake & Reservoir 0.025)	0.2 (lake & Reservoir 0.05)	0.3 (lake & Reservoir 0.1)	0.4 (lake & Reservoir 0.2)	
Coliform (l^{-1}) ≤	200	2000	10000	20000	40000	

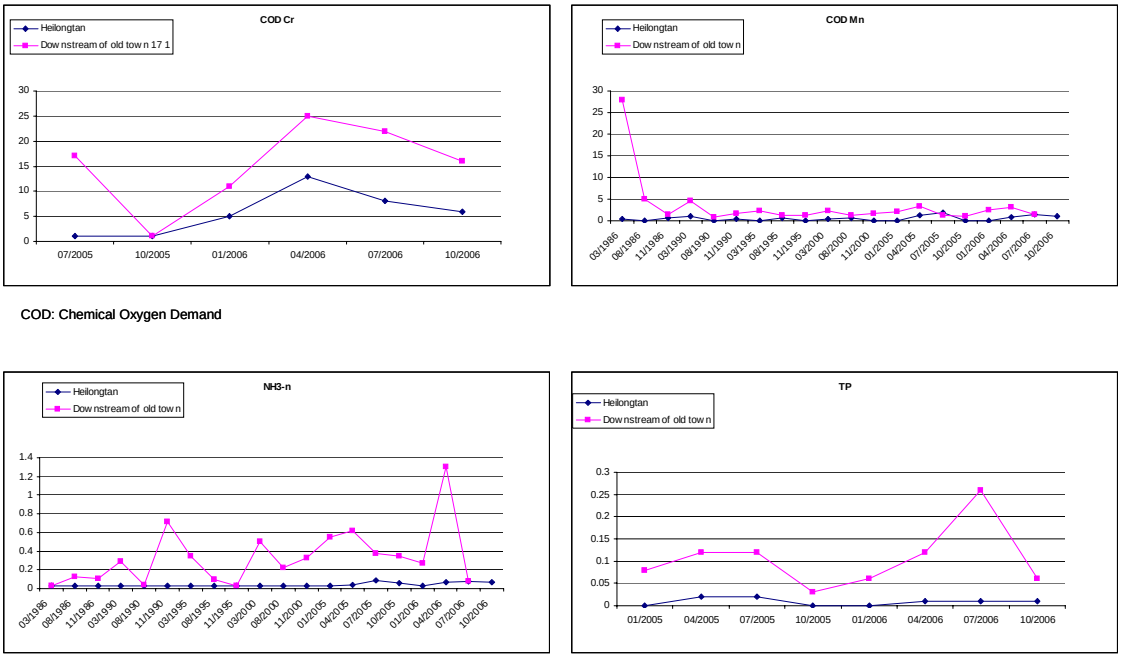
Class1: suitable for; source water and national natural protected areas
Class2: suitable for the first-grade protected zones of source water of centralized drinkable water, habitats of rare hydrobiontes, spawning area for fish and shrimps, and feeding grounds for young fish;
Class3: suitable for the second -grade protected zones of source water of centralized drinkable water, overwintering grounds for fish and shrimps, mitigation route, fish farming, and swimming areas;
Class4: suitable for industrial use water, entertainment water zones without direct contact with human body;
Class5: suitable for agricultural use, and landscape.

(Source: SEPA)

Farmers with plots around the Lashihai Lake, therefore, have the potential to reduce pressure on water quality by adopting more environmentally friendly agricultural practices[5]. The benefits of water improvements would be enjoyed mostly by the tourists in the old city, both national and international. The tourism industry itself would also benefit from initiatives leading to an improved water quality.

Interestingly, however, water quality is significantly impaired by urban activities in Lijiang, as the graphs in Figure 4. The comparison between selected parameters sampled upstream of the old town and downstream of the old town show that, at the latter sampling point, water quality is consistently worse. From existing data, it would seem that farmers contribute only marginally to the deteriorating quality of Lashihai wate.r In particular, the available data indicate significant urban pollution, and only anecdotal evidence suggests that farming is partially responsible for deteriorating water quality. In order to establish a clear causal link, it would be necessary to start systematic monitoring of water parameters that can be better linked to agricultural activities and pollution. As will become clear later on in the report, however, improving the efficiency of agriculture around the Lashihai lake is a no-regret option, that will improve the livelihoods of farmers and is likely to bring about benefits in terms of better water quality.

Figure 4: Water quality – selected parameters. Upstream and downstream of old town.



COD: Chemical Oxygen Demand

NH3-n: Nitrogen, Ammonia

TP: Total Phosphorus

[5] Note that there is an implicit assumption here, namely that the status quo in terms of agricultural practices and, subsequently, water quality is accepted as "legal". That is, it is assumed that farmers in the LNR have the right to use their land as they wish, although in line with the general legislative framework of China. On the contrary, the people in the Lijiang old town do not have the right to clean water. This implicit assumption is supported by the views of the people interviewed during the course of the project, and the current stand of the local government.

In addition to the problem of water quality, there is increasing concern in the area about the availability of freshwater. As mentioned earlier in this section, it is increasing scarcity of freshwater resources that forces the old city of Lijiang to rely on the Lashihai Lake for supplying landscape water in the summer months. It is therefore expected that, in the future, conflicts over water resources will become more common: on the one hand, increasing water demand for domestic, industrial and agricultural consumption is set to be realized; on the other hand, deteriorating water quality will make it more difficult to obtain water fit for human consumption, thus raising both the need to find additional water sources, and the costs of water pollution. Increasing the capacity of water treatment to guarantee the good quality of landscape water could be an option to lessen tensions over water use.

The issue of water availability is rather sensitive in the area, in particular because the Government is planning to build another water diversion infrastructure. Already at the end of the 80s, as a solution to agricultural irrigation in the Lijiang Basin, a water diversion tunnel was constructed. The present water storage capacity is 24 million m^3 that is capable of diverting 13~16 million cubic meters of water to the Lijiang Basin. The Comprehensive Planning for the Lashihai Lake was approved in 2004. The planned targets include increasing the water storage capacity of Lashihai Lake to 71.31 million m^3, and the water diversion capacity of 36.96 million m^3. Meanwhile, efforts have been made to strengthen the measures for wetland conservation and ecological construction in the region.

Table 5: Cost of planned expansion of diversion system

Measure	Cost
Flood control and water sluicing project	74.3397 million yuan
Water conservancy and erosion control	13.5803 million yuan
Environmental protectio	9.5611 million yuan
Land conversion to lake areas	122.2308 million yuan
Total cost	219.7119 million yuan

It can be easily guessed that the proposed project has encountered oppositions from various stakeholders. In particular, the project would lead to flooding of an area with 44 village groups in the four administrative villages of Junliang, Meiquan, Haidong and Hannan in Lashi Township, requiring the government to buy land located. 2440.75m～2443.76m asl. The total area flooded would amount to about 7 km^2, including 8571.72 mu of arable land and 77.04 mu of orchards and gardens – the loss of flooded arable land reaches as high as 25.7% of the total arable land in the township – and residential construction area of 21078.16 m^2 (of which, 9905.58m^2 is rural residence). The affected population is 235 from 31 households, 135 of whom are employed in the

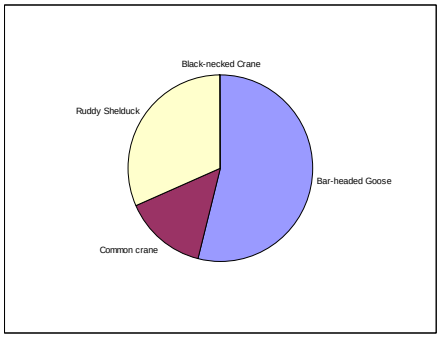
agricultural sector. One holiday village will also be flooded. In addition, small sections of special facilities, e.g. transport roads, telecommunication and power transmission installments will also be flooded, so are some of the facilities in Lashihai Lake. The planned reservoir would lead to the displacement of 3,886 people – around 24.9% of the township's total. There is therefore a call for finding alternative ways of reducing tensions over water use – both existing and potentially emerging in the future.

The reliance on engineering solutions for increasing water supply is no longer the main target of water policies worldwide, but rather there is an increasing attempt to manage the demand for water – promoting water saving behaviour and technologies, less water demanding crops, or more water-efficient irrigation technologies, etc. in an attempt to solve the water allocation problem. In the rest of this report, therefore, we do not consider any engineering type solution as a feasible option to the problems being addressed and look exclusively at options in the PES domain.

4.3.2 Bird biodiversity

As mentioned in the previous section, the LNR is a bird sanctuary, providing habitat and nesting grounds to a variety of migratory bird species, including some protected birds. Some of these species rely on crops as a food source, as summarised in Figure 5. There is a second positive externality of farming activities, as crops are a fundamental component of birds' diets.

Figure 5: Birds species feeding on agricultural crops



As in the previous case, the providers of the service are the farmers located around the Lashihai Lake, while the beneficiaries are the tourists visiting the reserve. In addition, the local tourism industry also benefits, as it is based on birds-watching. In the Lashihai NR, eco-tourism has significantly grown in the past years, as shown in Figure 6.

Figure 6: Tourism in Lashihai Nature Reserve

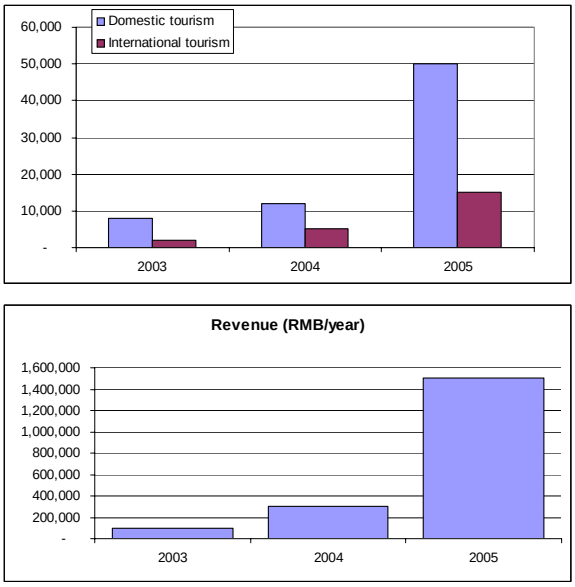


Table 6 summarises the key characteristics of the main birds that cause crop loss to farmers in the Lashihai Nature Reserve.

Table 6: Birds damaging agriculture – key characteristics

	Habitat	Diet
Bar-headed goose (*Anser indicus*)	During the breeding season, bar-headed geese live near mountain lakes and prefer areas with short grass. In winter they seek out grazing areas that are cultivated, relying on wheat, barley and rice crops.	Grass, wheat, barley and rice
Ruddy Shelduck (*Tadorna ferruginea*)	Freshwater, desert and semi-desert, temperate grassland, mountains	Grasses - graminivore, seeds - granivore, insects - insectivore, molluscs - molluscivore, fish - piscivore
Common crane (*Grus grus*)	Bogs, damp heathlands and shallow freshwater wetlands, swampy forest clearing.	Berries and other plant parts, insects, worms and even small animals. During winter, they feed mainly on plants.
Black-headed Gull (*Larus ridibundus*)	Lakes, rivers, moors, grassland, coasts	Opportunist, insects, earthworms, also plant material and scraps. During winter, they feed mainly on plants.

4.4 Problem structuring

The previous Sections identified and briefly described the two ecosystem services which are the focus of the pilot project. The service providers and beneficiaries were also identified, as summarised in Table 7. In this Section, the methodology adopted for conceptualising the problem and identifying potential responses is described.

Table 7: Summary of EES, service providers and service beneficiaries

EES Service	Service providers	Service Beneficiaries
Improved water quality for landscape services	Farmers around the Lashihai lake	Citizens of Lijiang Tourism industry – Lijiang old town Visitors to the old town
Maintenance of birds' biodiversity	Farmers around the Lashihai lake	Tourism industry – Lashihai Nature Reserve Visitors to the nature reserve Global benefits – biodiversity preservation*

*Global benefits are traditionally not included in local PES schemes.

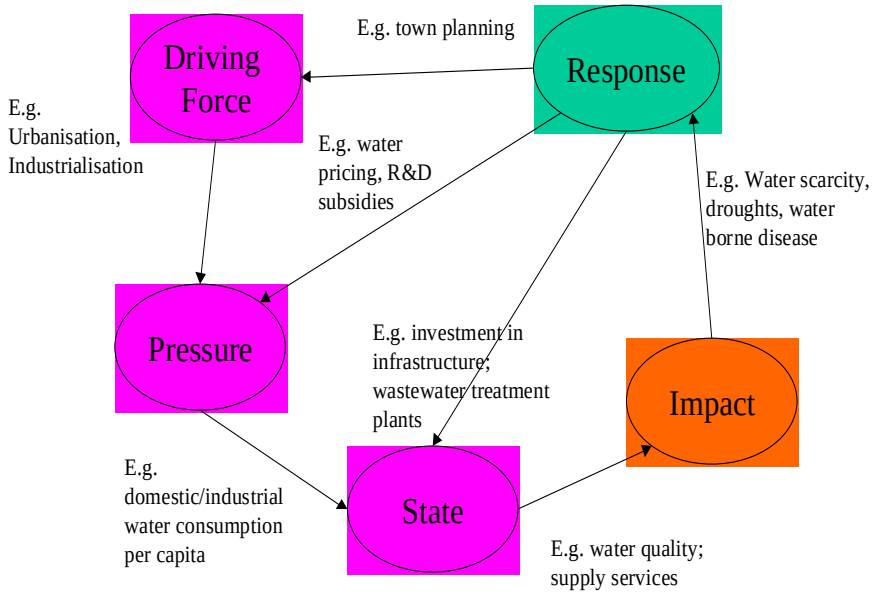
In order to identify possible leverage points for the maintenance of key ecosystem services provided by farmers in the Lashihai Nature Reserve – that is, factors which, when externally modified, can lead to altering the behaviour of the system – a qualitative model of cause-effect relationships, linking human actions and the environmental system was developed. The reference is the DPSIR framework (Driving Force – Pressure – State – Impact – Response), developed by the European Environmental Agency for environmental purposes (EEA, 1999).

The DPSIR framework allows for the integration of the various factors identified as having a role in the problem under scrutiny, their connection in context-dependent cause-effect chains, thus describing the relationship between the underlying causes and impacts on a system, identifying and assessing current (or potential) policy responses to de-couple pressures and impacts. The DPSIR framework is widely used to structure various factors – human and environmental, traditionally summarised by means of specific indicators – to allow for a holistic and multi-dimensional view of causal relationships in human-environmental systems. It is based upon the consideration that one or more driving forces cause pressures on a system, which in turn determine the system's state. Analysing changes of the state, impacts can be assessed and evaluated, and responses identified, through the use of specific indicators designed to simplify the comprehension of the complex interlinkages between multisectoral human action and the co-evolutions of ecological, economical and social states, thus helping in drawing informed decisions, and identifying alternative options and policy interventions.

Driving forces are any (human) activities, processes, and patterns which affect the quality and/or quantity of the system. Driving forces can be classified according to macro-groups, such as agriculture, industry, urban development, etc. Driving force indicators answer the question: "what is having an effect on the system?". Pressure indicators quantify the driving forces by measuring the stress imposed on the system by the driving force indicators, and answer the question of "how do driving forces affect the system?". State indicators simply describe the conditions of the system, and are of descriptive type, focusing on the characteristics to be analysed. They describe a static situation, whereas pressure and impact indicators are dynamic. Impact indicators describe the

consequences of pressures on the system – that is, they describe how the state of the system changes as a result of applied pressures. Policy responses and their effectiveness are described by response indicators, which provide the basis for the analysis of policy alternatives.

Figure 7: A DPSIR conceptual model



In the case of the Lashihai Nature Reserve PES scheme, the DPSIR framework was used to conceptualise the underlying model linking farmers' activities to, on the one hand, the quality of water used for landscape services in Lijiang old town; and, on the other hand, protected birds' population in Lashihai Nature Reserve.

First we identified human activities and their pressures on the environment on the case study area ("What are the driving forces and pressures of human activities on the study case?"). Then we examined the expected consequences on the state of the environment and their expected impacts on the socio-ecosystem ("What are the effects of human activities on the state of the environment, and what are the overall impacts on the study case?"). In a second phase, the factors identified in the two broad categories were further clustered, to single out driving forces, pressures, state variables, and impacts, as shown in Figure 8. Following the DPSIR approach, this exercise has allowed the analysis of the cause-effect chains between human activities and their impacts. In particular, the key indicators to monitor the state of the environment – and, therefore, the effectiveness of the PES scheme in maintaining the two EES – have been classified in several categories (ellipse "State" in Figure 8):

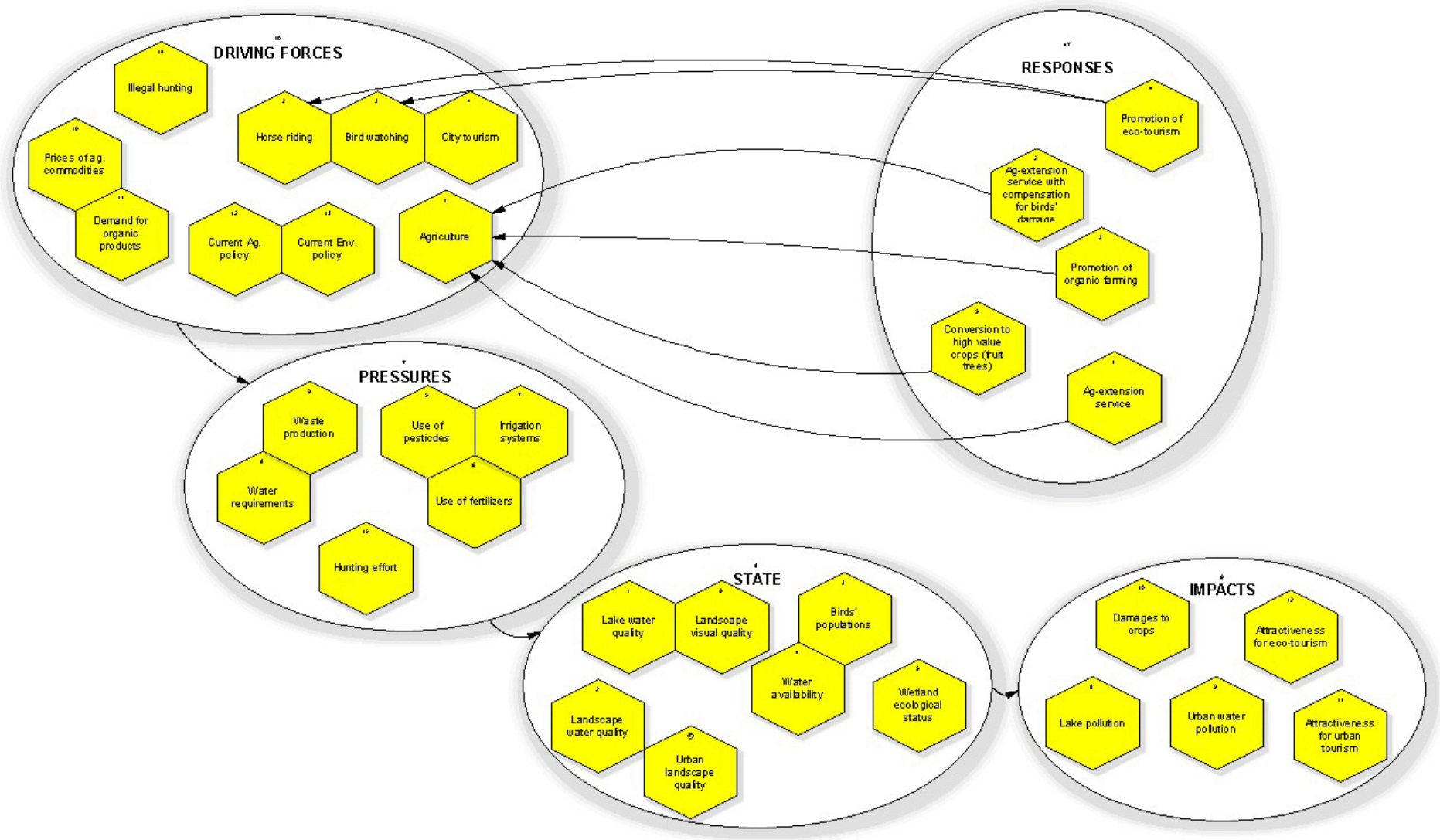
i) water quality: both in lake (introducing among the routine monitoring indicators some parameters directly linked to agricultural activities, such as nitrates), and in Lijiang (visual impact, e.g. algae concentration);
ii) biodiversity: abundance of birds' population;
iii) water availability, e.g. hydrological water balance of the lake; and
iv) ecological status of the wetland.

The state of the environment with respect to the two identified EES is determined by the interactions among several factors ("Pressures" in Figure 8), the most important of which are agricultural practices (use of chemical input, irrigation systems,…) and illegal hunting of birds. In turn, these are driven by root causes ("Driving forces" in Figure 8), such as economic development (of both tourisms in Lijiang old town and the Lashihai Nature Reserve); government policies regulating agriculture and tourism development; and market demands for agricultural produces. Through the impacts on the state of the environment, these root and underlying causes push the system towards a state of unsustainability ("Impacts" in Figure 8), both economic (reduced livelihood opportunities for farmers in the Lashihai Nature Reserve, adverse impacts on the tourism sector,…), and ecological (lake pollution, reduced birds' population,…).

Once the most relevant factors describing the system and its causal links have been described, existing and possible interventions to alter or maintain farmers' behaviour within the framework of PES schemes were identified and made explicit, together with the targets of a preliminary set of measures to which PES could be attached ("Responses" in Figure 8). These are discussed more in detail in Chapter 6, but include the promotion of organic farming to break the link between chemical inputs in agriculture and deterioration in the quality of lake water; full compensation for birds' damages to prevent illegal hunting; conversion to high value crops, such as fruit trees, to improve the livelihoods of the farmers in the Lashihai Nature Reserve.

The detailed analysis of the key state and impact factors and strategic alternative development options is set out in Annex I.

Figure 8: A DPSIR conceptual model for human-environmental cause-effect chains in the Lashihai Nature Reserve



5 Quantification of the EES

In order to assess whether a market based instrument such as PES scheme is a viable option one needs to quantify the costs and benefits of service provision. Whenever the monetary benefits to the beneficiaries outweigh the costs of service provision, PES schemes are likely to be successfully implemented as market based instruments. In other cases, when additional considerations may come into play – such as the existence of service benefits which cannot be captured by the market or by individuals, as they have a public good nature – the government may still wish to implement PES schemes, but the financial sustainability of the system may be problematic. The quantification of the costs and benefits of service provision is also needed for authorities to set the initial payment level – that is, the sum of money that should reach the service providers to give them enough incentives to maintain the service, and the sum that should be charged to the beneficiaries who enjoy the service.

5.1 Estimating the costs of provision

5.1.1 Losses to farmers from the bird sanctuary

Farmers who cultivate land around the lake suffer substantial yield losses because of the migratory birds that feed on their crops[6]. The Nature Reserve Management office holds a registry of farmers' claims for compensation of the damages caused by birds. The claims are verified in the ground by part-time employees of the Nature Reserve Management, who are local villagers, and are computed according to the extension of the plot damaged by birds, an estimate of the yield lost to birds, and market prices for the crop. The estimated losses are in the range of 2,000,000 RMB per year[7], yet compensation to farmers for the biodiversity service they provide, set at about 800,000 RMB per year[8], falls short of this amount[9]. There is therefore a concern

[6] In particular, the main bird species that feed on farmland are: the bar-headed goose; the common and black-necked cranes; and the ruddy shelduck (Conservation International China).

[7] Approximately 250.000 U.S.$ at current exchange rates (October 2006). Source: CI-China.

[8] Approximately 100.000 U.S.$ at current exchange rates (October 2006). Source: CI-China.

[9] Meeting with officials of the Lashihai Nature Reserve Management Bureau, Yulong County Forestry Bureau, Lashihai Nature Reserve, Yulong, China, 17 July 2006.

that farmers may harm the protected wildlife, unless adequate compensation is received, or alternative livelihood opportunities offered.

Table 8: Estimated damages to farmers – selected birds species

	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Affected land (mu*)	9,800	11,200	10,750	10,400	9,600	10,200
Affected land (ha)	653	747	717	693	640	680
Estimated economic loss (RMB)	1,637,000	2,096,800	1,852,800	1,742,900	1,704,600	2,039,600

*1 ha is 15 mu
(Source: Lashihai lake Nature Reserve - Experts' estimates)

5.1.2 Losses to the town of Lijiang from poor water quality in Lashihai Lake

As far as the second environmental service is concerned (i.e. the quality of water in Lijiang), it is much more difficult to establish a clear, quantitative link between the reduction in fertilisers' and pesticides' input and the resulting improvement in water quality. The quantitative model would require accurate data on fertilisers and pesticides applied; on the observed water quality; on climatic patterns; on soil type and land use.

Unfortunately, most of this information is not available for the pilot area. The routine monitoring carried out by the Environment Agency in China does not cover indicators which relate directly to agricultural pollution – such as concentration of nitrates and phosphorous for pollution from fertilisers, and the concentration of pesticides substances to be selected depending on the main pesticides used in the area. Alternatively, an exposure-index can be calculated, which assesses the toxicological effects of the different substances used. There are some spot observations, measurements, which were undertaken by CI-China, and which indicate significant pollution of the water bodies from non-point agricultural sources. In particular, the study measured the concentration of dimoethoate[10] in water sampled collected from both the Lashihai lake and the canals in Lijiang old town. The tests show a high concentration at the inlet of the Lashihai lake (79.7 ng/l), and an even higher concentration in Lijiang's canals (247 ng/l in the middle of the town, and 365 ng/l in

[10] Dimoethoate is an organic-phosphate insecticide which is effective both through direct contact and through ingestion. It is used in several commercially available insecticides.

the lower part of the town). Even though these concentrations are still low relative to most standards (20-50 mg/l), the data shows an increasing deterioration of water quality in the city's canals. Furthermore, the study team also found 44 empty bottles of pesticides – some of which are forbidden in China – in the Lashihai wetland area. However, without a long time series, it is not possible to build a quantitative model. While there are some data on the input of fertilisers and pesticides, as well as on crop yields, detailed information on soil type, slope, etc is also not available for the selected area. Without the quantitative data to calibrate a model linking the hydrology of the lake with agricultural practices of farmers surrounding it, it is not possible to quantify how much it would cost farmers to reduce their input of chemicals, for a given improvement in water quality. This cost would be in terms of forgone crop yields, as a result of the reduced input. As we shall see later on, however, this gap does not invalidate the exercise, as there is scope for improving agricultural practices reducing chemical inputs without causing a reduction in farmers' yields: a more efficient agriculture will bring about improvements in water quality without farmers having to suffer an income loss, and there would be enough benefits from improved water quality to cover any other costs of making changes to agricultural practices.

5.2 Estimating the value of the identified environmental services

Assigning values to EES is one way for improving decision making for natural resource management, taking into account all the implications of different land use options. The economic value of an environmental service is generally measured in terms of how much beneficiaries are willing to pay for the commodity, net of the costs that suppliers incur in maintaining the EES. In the application of PES mechanisms, which are based on the creation of market for transacting the EES to be maintained, enhanced or restored, the values which need to be estimated are strongly related to the perception of people (in this case, of service beneficiaries). In this context "value" is intended as the measure by which EES contribute to people's welfare, i.e. it does not

exist *per se*[11], and refers to the change in people's welfare resulting from changes in the level of EES provision (in terms of its quantity or quality).

Several techniques are available to evaluate EES[12]. One could for instance assume that the revenues generated by eco-tourism activities around the Lashihai Nature Reserve are a proxy for the value of the EES provided by farmers in terms of maintaining a healthy bird population. Given the current social and economic development level of the area, however, the value of the tourism industry is likely to provide only a lower bound for this EES, as there is still potential for the industry to grow without necessarily hurting the Nature Reserve. Alternatively, one could use the expenditure for travelling to the Nature Reserve as approximating the individual estimates of biodiversity services provided by the reserve itself. In this case, however, the travel costs incurred by tourists are not deemed a suitable proxy for biodiversity value, as most of the tourists do not travel to the Lashihai Nature Reserve as a final destination, but rather visit it because of its proximity to Lijiang old town. In the evaluation of the EES related to maintaining a good quality of water for landscape use in Lijiang old town would incur a different problem, namely, it would be extremely difficult to disentangle from the value of the tourism industry – or from travel costs –

[11] Some may argue that ecosystems, such as wetlands, or biodiversity, have an intrinsic value, irrespective of whether humans enjoy it or not. According to this view, preserving environmental goods and services is a matter of moral obligation. In the perspective of PES mechanisms, however, only goods and services, which can be traded in market-like transactions should be considered, whereas other tools and means are needed to ensure that the existence value of the natural environment is preserved.

[12] There are a variety of techniques to estimate the value of EES, and environmental goods in general. The different techniques can be classified in three broad categories. At a first level, one finds market based methods, which rely on existing traded commodities somehow related to the EES to be valued. Surrogate market approaches infer values from data on behavioural changes observed in actual market related in some way to the missing market for environmental resources. Finally, non-market based methods (or stated preference approaches) rely on simulated markets (Carson, 1991) to elicit people's valuation of the EES. All these technique rely on economic theoretical axioms and principles of welfare economics, assuming that individuals are willing to pay for environmental gains and, conversely, are willing to accept compensation for some environmental losses. It is thus individual preferences which place value on changes in environmental assets, and valuation techniques attempt to measure changes in welfare as reflected by individuals' willingness to pay (WTP) or willingness to accept (WTA) compensation for changes in the level of EES provided (Hanemann, 1991).

that portion that can be attributed to water quality, rather, than, say, the quality of service, or architectural beauty. Our analysis thus relies upon the adoption of a stated preference approach, which is used to assign values to EES which do not have a real or estimated market/social value[13].

Conscious of the shortcomings of this approach, the choice of using a simplified survey was also based upon the intent to raise awareness among tourists of the services generated by farmers and villagers around the Lashihai wetland, thus facilitating the potential introduction of a charge to raise funds for compensating service providers.

5.2.1 Preliminary results

The questionnaire for the survey is the result of a joint effort between the research teams in Europe and China. The first draft of the survey was tested on about 50 respondents, and changes were made to the structure and wording of the questionnaire to better reflect the needs of the Chinese language and the response and concerns of the focus group. The final survey was carried out on a total sample of 254 respondents – of which 50 were interviewed in the Lashihai Nature Reserve, and the remaining 204 in Lijiang old town.

The purpose of the survey was the elicitation of visitors' preferences with respect to the quality of their experience in either the old town or the Lashihai Nature Reserve, and to assign an economic value to the identified environmental services.

[13] In situations where market values cannot be observed, either directly or indirectly, market-like behaviour can be inferred through surveys or direct questions. A crucial challenge is to ensure that the simulated market is precise enough in its description, yet simple and realistic for the respondents. Stated preference approaches are the only techniques available to capture non-use environmental values, but are very resource intensive and fraught by biases, if not carefully carried out. Contingent valuation (CV) is perhaps the most widely used stated preference approach, eliciting information concerning individuals' preferences through the use of surveys, questionnaires, and interviews. An alternative method is given by choice experiments: whereas CV surveys are focused on valuing a specific change in the EES, in choice experiments (CE) respondents are presented with a menu of alternatives relative to the EES quantity/quality and alternative policy options. Through this approach, preferences for individual components of the policies can be valued independently. The emphasis of CE is on examining the attributes of environmental programmes, and provides analysis with more complete understanding of individual preferences.

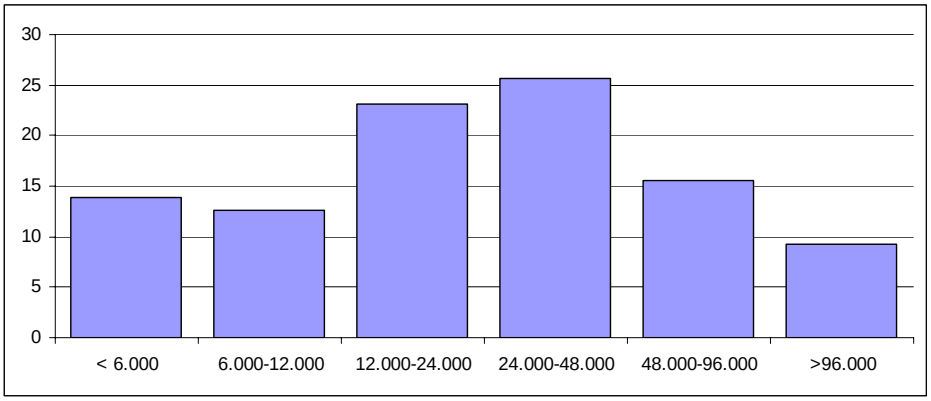
The questionnaire elicited respondents' view in relation to both the visual impact of poor water quality in the canals of Lijiang old town, and their real or hypothetical willingness to spend money to visit the Lashihai Nature Reserve for bird watching or other eco-tourism activities.

Before describing our sample, it is important to highlight that, for the purpose of implementing PES schemes, the values which are considered are those for the beneficiaries only – that is, we only consider local benefits rather than global benefits of, say, biodiversity or environmental protection. This restriction stems from the rationale underlying PES schemes, which are based on market transactions and, as such, need willing sellers as well as buyers.

5.2.2 The sample of respondents Descriptive Statistics

Most of the respondents are Chinese nationals, about 67% of the respondents are male, and over 50% have a university degree. The distribution of average yearly income is presented in the figure below, and is a good approximation for the general distribution in China.

Figure 9: Average yearly income distribution (RMB/year)



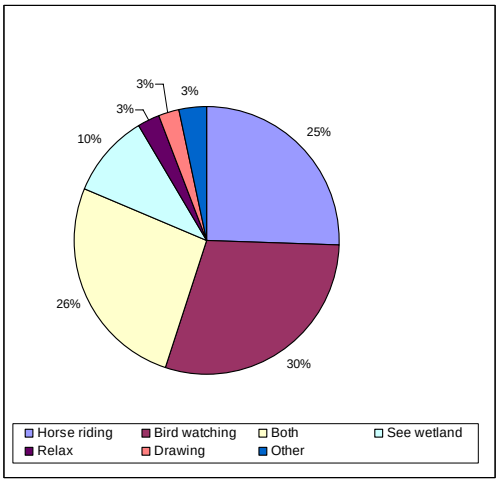
Regarding people's experience of the tourist sites, about 27% have visited Lijiang more than once – 38% of these have been to the city twice, while 13% have visited it more than 10 times. Significantly fewer tourists have visited the Lashihai Nature

Reserve more than once – 87% of the interviewees have visited it for the first time. The mean length of the trip to Lijiang is 3.4 days[14] – with a maximum stay of 15 days.

Over 40% of the respondents reported that they have not paid the government tourist tax of 40 RMB, an amount which all tourists who stay overnight in Lijiang old town are supposed to pay. Only 8% of the respondents reported staying for one day only in Lijiang old town. This discrepancy could have two potential explanations: either most of the tourists do not sleep in the historical centre of Lijiang, thus avoiding paying the tax; or, as has been voiced several times, the hotels – who are also required to charge tourists the visiting tax – do not enforce this requirement consistently. Furthermore, according to the latest regulation, the tourists do not necessarily have to pay the 40 RMB at their hotel, but they have to pay the visitors' fee when visiting the Yulong Snow Mountain. If they have paid at the hotel and can show the receipt, they do not have to pay again.

The majority of the people who visit the old town (63%) do not intend to visit the Lashihai Nature Reserve. The main reasons for visiting the Lashihai Nature Reserve are bird watching (30%) and horse riding (25%), while 26% of the respondents do both activities. Interestingly, the Lashihai Nature Reserve is also a source of inspiration for artists.

Figure 10: Main purpose for visiting the Lashihai Nature Reserve

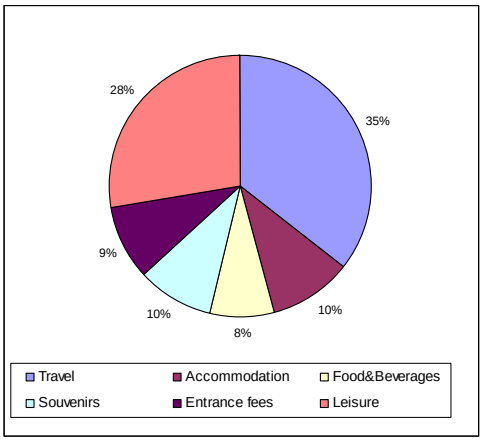


[14] Note that several respondents answered very large numbers – which have been cleaned from the sample. Te maximum stay for tourist purposes has been fixed at 15 days.

Birds seem to be one of the major attractions to the Lashihai Nature Reserve – with 63% of the respondents stating that they would not visit it if there were no birds. The absence of birds would significantly – and negatively – affect the pleasure derived from a visit to the reserve, with 61% of the sample stating that they would derive significantly less pleasure from a visit to the reserve in the absence of birds, or if the opportunities for bird watching were significantly decreased.

Expenditure for the trip to Lijiang is, on average, 1,950 RMB per trip. The majority of these expenses are for travelling, as shown in the figure below. In fact, 47% of the respondents have travelled to Lijiang by plane – the town is far from major cities, and there is no railway station.

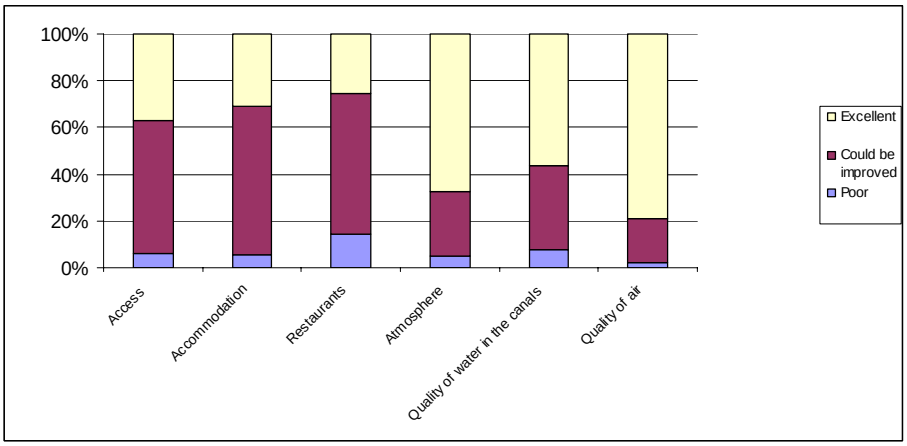
Figure 11: Average expenditure – trip to Lijiang



It is interesting to explore respondents' opinion with respect to the level of service offered by the tourism industry in Lijiang old town, and their perception with respect to environmental problems the city may face. The results are reported in Figure 12.

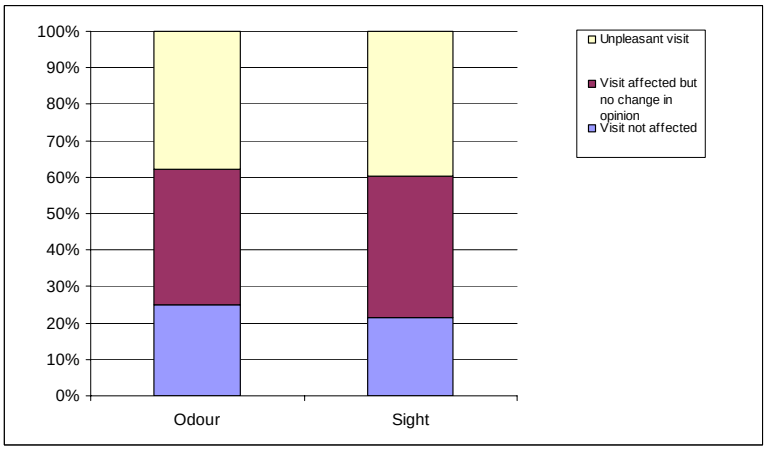
On average, people are satisfied with the services, but think that there is still room for improvement. Contrary to expectations, most of the people think that water quality is excellent. This result is somewhat in opposition to the perception of local authorities, who perceive water quality in the Lijiang canals as poor and harming the tourism industry.

Figure 12: Respondents' opinion on main services of Lijiang old town



In fact, of the tourists returning to the city, only 9% have had bad experiences in the past because of the poor quality of the water in the canals. When asked whether they had direct experience with impaired quality of water in the canals, respondents ranked foul smell and impaired vision very similarly, as shown in Figure 13. In particular, respondents were introduced to the problem of poor landscape water quality in the old town, and were subsequently asked whether experiencing such event would affect the enjoyment of their visit.

Figure 13: Respondents' opinion on landscape water quality



5.2.3 Willingness to pay for EES

The average and median willingness to pay for the protection of water quality and for biodiversity conservation are given in Table 6. The mean value of the former is

lower than the latter which is probably a consequence of the majority of respondents not perceiving water quality as a problem in Lijiang (as shown in Figure 12). The median WTP is in fact the same for both EES. It is interesting to note that only one respondent explicitly stated a WTP of zero – indicating a strong protest voting. The respondent also clearly state that, in his/her opinion, the government should be paying for preserving key EES. On the other hand, 78 respondents (30%) stated that they would not pay to improve water quality.

Table 9: WTP for the two EES (RMB per annum)

	Mean WTP	**Median WTP**	**Min**	**Max**	**Sample size**
WTP for landscape water quality	10.3	8	0	157	254 (138 non-zero)
WTP for biodiversity in Lashihai Nature Reserve	33.4	8	0	2500	254 (116 non zero)

Recalling that PES schemes relying on market transactions require willing buyers as well as sellers of the service, we approximate the use value of the two EES on the basis of the tourists visiting the two resorts.

Table 10: The value of EES to service beneficiaries (RMB per annum)

	Number of visitors	**Value of the EES (mean WTP)**	**Value of the EES (median WTP)**
WTP for biodiversity in Lashihai Nature Reserve	65,000	2,171,000	520,000
WTP for landscape water quality	4,042,300	41,635,690	32,338,400

As shown in Table 10, the mean and median willingness to pay lead to very different value of the two EES: between 2.2 million and 520 for biodiversity in the Lashihai Nature Reserve, and between 41.6 million and 32.3 million for water quality. The range is much wider for preserving birds' species, because of the presence of an

outlier which raises significantly the mean willingness to pay. This will be taken into account when setting the payment levels for the EES, as discussed in Section 7.4.

6 Identifying PES options

The last step in the problem is the qualitative cum quantitative assessment of the different designs and targets of interventions of potential PES options (i.e. the strategies which PES could be adopting, sectoral targets, etc) in terms of their impacts on the variables of interest, namely water quality in the Lijiang old town canals in the summer, and the affected birds' population. Other important variables are also considered: in particular, the expected impact of the various designs of PES measures on farmers is explicitly addressed, as it will be crucial in determining the feasibility of the policy intervention. A qualitative assessment of the options is summarised in Table 11.

Table 11: Impacts of alternative PES options in the Lashihai Nature Reserve

PES Option	**Pressure on water quality**	**Income of farmers**	**Water quality**	**Birds' populations**	**Visit to Lashihai NR**
Do nothing	High input of fertilisers and pesticides	Stable	Continued deterioration	Stable or declining (poaching)	Stable or declining (less bird-watching opportunities)
Alt. A: Agricultural extension Services	Decreased input of fertilisers and pesticides	Possibly increase	Improvement	Stable or declining (poaching)	Stable or declining (less bird-watching opportunities)
Alt. B Agricultural extension services compensation for birds damage	Decreased input of fertilisers and pesticides	Possibly increase	Improvement	Stable or increasing	Stable or increasing (increase in birds population)
Alt. C Promotion of organic farming	Decreased input of fertilisers and pesticides	? Depends on market demand	Improvement	Possibly decreasing (less food sources)	Possibly decreasing (less bird-watching opportunities; visual impact if greenhouses are used)
Alt. D Conversion to high value	?	?	?	Possibly decreasing, depending on	Possibly decreasing, if birds'

crops (e.g. fruit trees)				ecological niche of birds	population decreases
Alt. E Promotion of eco-tourism	Less pressure in the short term if fields are abandoned. Increased pressure in the longer term if no sewage system is built.	Possibly higher, but decreasing marginal returns	Possibly improving in the short term, but possible deterioration in the long term	Possibly declining, if fields are converted (less food sources for birds)	Possibly increasing. In the long term, potential loss of bird-watching opportunities

Finally, a preliminary list of implementation costs and expected benefits elements for each potential PES strategy can be identified, as summarised in Table 12.

Table 12: Expected costs and benefits of alternative PES options in the Lashihai Nature Reserve

PES Option	**Direct costs**	**Indirect costs**	**Expected benefits to farmers**	**Expected benefits to tourism industry**
Do nothing	No additional costs	Negative externalities on birds' population and tourism in Lijiang		Decreased income in summer months – smell and visual impacts of poor water quality.
Alt. A: Agricultural extension Services	Cost of extension services		Current use of pesticides and fertilisers is probably excessive. Hence, farmers would benefits from lower input costs, without losing in terms of crop yield.	Expect an improvement in water quality and quantity, hence possible benefit to the tourism in Lijiang old town.
Alt. B Agricultural extension services with compensation for birds damage	Cost of extension services. Cost of compensation (possibly higher than current level)		Expect that current use of pesticides and fertilisers is excessive. Hence, farmers would benefits from lower input costs, without losing in terms of crop yield. Furthermore, they would be fully compensated for damages caused by birds.	Expect an improvement in water quality, hence no damage to the tourism industry in Lijiang old town. Expect a stop to illegal bird hunting, hence benefits in terms of increased birds population.
Alt. C Promotion of organic farming	Initial cost of setting up organic farming structures, and of encouraging farmers to change. Cost of marketing strategies and products' promotion.	Possible negative impact on birds' population, as less food sources.	Expect organic farming is not economically viable, at least in the short term.. May need to subsidise the activity for one to two years.	Tourism in Lijiang old town would benefit from improved water quality, but tourism to LNR may suffer from visual impairment if organic farming is carried out in greenhouses, and a

				possible decrease in birds' population
Alt. D Conversion to high value crops (e.g. fruit trees)	?	?	?	?
Alt. E Promotion of eco-tourism	Cost of promoting LNR as a tourist destination locally and internationally. Capacity building cost – conversion of farmers to entrepreneurs.	Increase pressure on sanitation, possibly deterioration of water quality.	Expect this option not to be viable for all, unless cooperatives can be formed, and the site be promoted to attract an increasing number of tourists.	Benefits to both sites.

6.1 Potential PES options

In this section, we discuss potential strategies for ensuring that the two EES services are maintained. In particular, the different land use options that the local authority may wish to promote.

The environmental effectiveness of PES schemes requires a clear understanding of the linkages between human activities of interest – farming around the Lashihai Lake, in this case – and the EES provided – maintenance of biodiversity in terms of migratory birds' population, and the preservation or improvement of water quality for landscape use in Lijiang old town. The decision of whether PES mechanisms are the most suitable policy tool to select, however, also depends on the relative costs and benefits of service provision and service enjoyment. Table 13 summarises the key elements of such a calculation: it identifies the service providers (farmers in the Nature Reserve) and service users (the tourism industry). It provides a first estimate of the cost of provision of the two environmental services, and their value to the beneficiaries.

Table 13: EES provision and enjoyment – summary of key factors

	Biodiversity service: birds' population	**Landscape service: quality of water**
Service providers	Farmers around the Lashihai Lake	Farmers around the Lashihai Lake
Cost of provision to the service provider	Average yearly damage (2000-2005): RMB 1,845,613	Not yet assessed. It is however expected that the cost of provision to the farmers will not

	(damages inflicted to crops) US$ approximately 233,470	be high, as they are unlikely to be on the production possibility frontiers – reducing inputs of fertilisers and pesticides is likely not to lead to lower yields
Service beneficiaries	Tourists visiting the Lashihai Nature Reserve for bird watching (national and international)	Tourists visiting Lijiang old town (national and international)
Value of the service to the beneficiary	WTP survey – 520,000-2,171,000 RMB per year	WTP survey – 32,338,400-42,635,690 RMB per year

The results presented in this report are partial, as the quantitative estimates of service benefits are indicative, and a more thorough investigation with local tourists, perhaps combined with an analysis of the tourism industry in Lijiang, would give a more reliable estimate of the value of the EES to tourists. Similarly, the causal link between farming practices and water quality has not been estimated quantitatively: without a quantitative causal model, it is therefore not possible to infer the costs incurred by farmers for the provision of given water quality improvements. Some general conclusions can nonetheless be derived, as will be discussed more in detail below.

6.1.1 Exploring alternative land use options

Agriculture is one of the main activities on which people living in the Lashihai Nature Reserve rely. Agriculture and livestock is still the major part in the economic system, which accounts for about 70% in whole system. Due to the policy and resource limitation, sizes of forestry and fishery become smaller. Non-farm and off-farm activities become an increasing share, e.g. construction, tourism business, restaurant business (see Table 14).

Table 14: Economic structure in Lashi Township (RMB)

Activity	2000	2001	2002	2003	2004	2005
Agriculture	48.2%	52.1%	48.8%	46.9%	46.2%	45.2%
Forestry	2.5%	2.4%	2.3%	2.2%	2.2%	1.8%
Husbandry	26.6%	26.4%	27.9%	28.8%	29.3%	29.8%
Fishery	3.1%	2.1%	2.0%	1.6%	0.9%	0.5%
Transportation	6.9%	5.1%	6.0%	6.6%	7.0%	6.1%
Restaurant	2.5%	2.3%	2.6%	2.6%	2.8%	2.9%
Tourism	1.2%	1.2%	1.2%	1.4%	1.3%	1.3%
Industry	2.6%	2.0%	1.9%	2.0%	2.0%	1.7%
Construction	2.5%	2.2%	2.5%	2.5%	2.3%	2.3%
Others	4.0%	4.2%	4.7%	5.4%	5.9%	8.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

(Data Source: CI)

Thus, given the importance of agriculture and the fact that agricultural activities are widely held to be responsible for deterioration in the water quality of the lake, a more detailed analysis has been carried out for Option D above.

In particular, the following alternative agricultural practices were considered, in addition to the status quo:

- Shift to traditional crops and fruit trees (D.I)
- Shift to traditional crops and livestock (D.II)
- Shift to traditional crops, livestock and fruit trees (D.III)

For each of the options, a cost and benefits analysis was carried out[15], and the results are summarised in Table 15. The values reported are the net present costs and benefits of alternative land use options over a time period of 15 years.

This analysis assumes an average size of individual farmers' land of 8 mu, and a labour input of 260 days per annum. According to experts' opinion, these figures reflect the average situation observed in the area around the Lashihai Lake. Two cropping seasons are considered for traditional crops: a winter cropping season, when farmers cultivate mostly wheat, barley and rape; and a summer growing season, when corn and soybeans are produced. Irrigated flat land in the Lijiang region has two growing seasons, one after the other: farmers thus harvest twice in a calendar year. In scenario DI and DIII, it is assumed that half of the land is used for fruit trees (apple,

[15] The analysis was carried out by Prof. Zuo Ting, Deputy Dean & Professor in development studies, College of Humanities and Development, China Agricultural University.

peach and pear trees, for which the average market price is used). In the case of livestock, the assumption is that farmers raise 5 pigs on a farm size of 8 mu (starting from 3 months piglets). Direct costs considered include the price of purchased inputs (fertilisers and pesticides); the cost of land, and the cost of labour. In D.II and D.III, the costs of the animals and animal feed are also included.

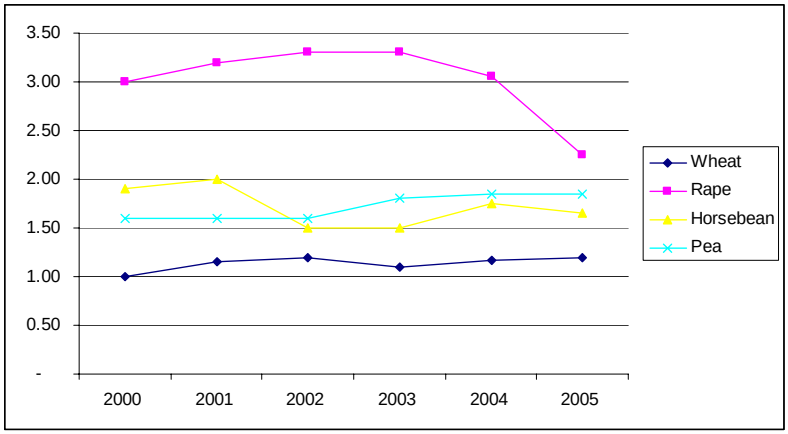
Table 15: CBA of alternative agricultural practices

Option	**Costs (RMB/mu)**	**Benefits (RMB/mu)**	**Benefit/cost Ratio**
D0. Baseline case (crop only)	15390	12675	0.82
DI. Crops and fruit trees	10815	13620	1.26
DII. Crops and livestock	21295	18220	0.86
DIII. Crops and livestock and fruit trees	12265	19165	1.56

What emerges from the analysis above is that the most profitable alternative cropping patterns for the area are crops and fruit trees, either in isolation, or together with livestock. A mixed system of crops and fruits is already practiced in some areas around the Lashihai Nature Reserve, and thus can be further encouraged. To increase farmers' profits, one could also encourage the introduction of livestock husbandry, which should reduce the dependence on chemical fertilizers. Furthermore, in the last scenario, fodder crops intercropped under fruits may help reduce cost of feedstuff used, thus further increasing the attractiveness of this development scenario for individual farmers.

One limitation of the model is that it assumes stable prices for the crops, even though, as shown in the figure below, there are some variations. Furthermore, in near the future prices of grain will slightly increase due to the limited cultivated land.

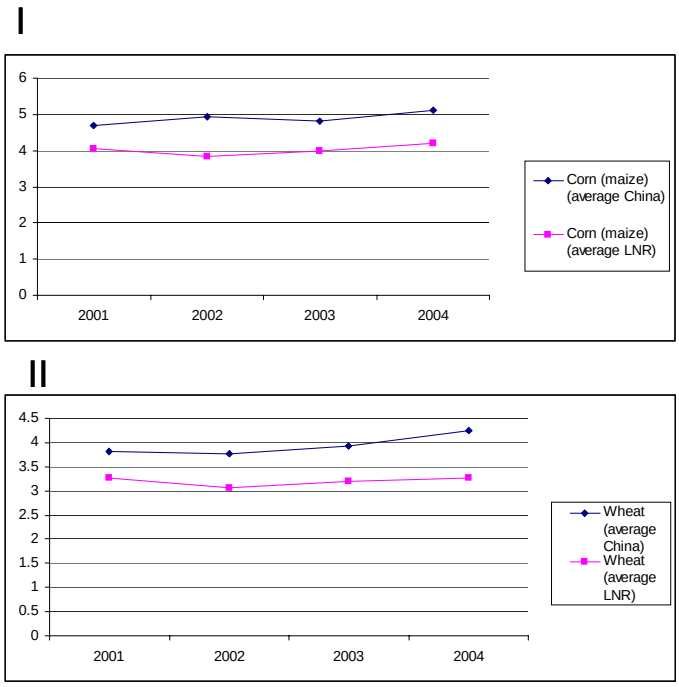
Figure 14: Variation of crop prices – selected crops



The main purpose of changing the agricultural practices of farmers around the lake, however, is not to increase their profits, but rather to decrease the impacts that their activities have on the water quality of the lake – and, in turn, on the tourist city of Lijiang. It is thus necessary to understand the status quo in terms of agricultural yields, use of chemical inputs, and water quality in the lake.

Analysing current yield data for the area, it appears that current agricultural sector in the Lashihai Nature Reserve is operating below efficient levels. In particular, the yields of crops are low, even compared to the average for China (see Figure 15, which compares average yield per hectare in the Lashihai Nature Reserve to the average for China for selected crops).

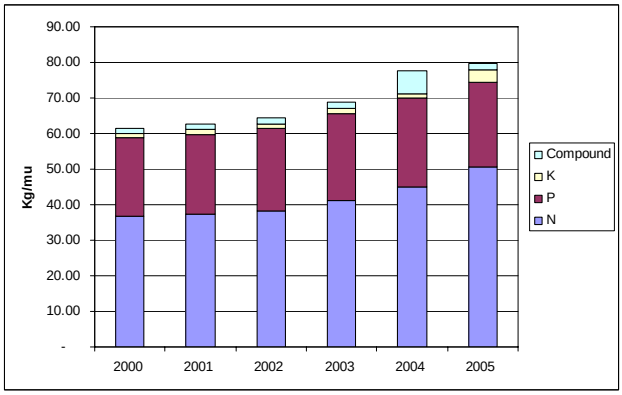
Figure 15: Average crop yield per ha – China vs. Lashihai Nature Reserve



(Source: CI-China data and FAO Statistical database)

The trend in the use of fertilisers in the area is depicted in Figure 16, while Table 16 compares the average use of selected fertilisers in China and the Lashihai Nature Reserve. It is apparent from these data that the average use of total fertilisers in the Lashihai Nature Reserve per hectare of land is well above the average for China and has more than doubled since 1997.

Figure 16: Use of fertilisers in study area(average kg/mu in a year)



(Source: CI-China data)

Table 16: Fertilisers input in Lashihai Nature Reserve as compared to the average for China

		2000	2001	2002
N (Kg/ha)	Average China	40.35	40.39	45.87
	Average LNR	553.34	562.36	572.10
P (Kg/ha)	Average China	15.69	16.01	17.90
	Average LNR	329.29	333.99	349.46
K (K/ha)	Average China	6.32	7.27	7.67
	Average LNR	17.65	19.20	19.99

(Sources: Lashihai Nature Reserve: CI-China; China: FAO Stat)

Even though one must be cautious about the accuracy of the estimated consumption of fertilisers in a small area such as the Lashihai Nature Reserve, since there are no official data, it is possible that the very large difference observed can be explained empirically. There are two possible explanations: on the one hand, the average for the whole of China is artificially low, given pockets of low development and subsistence agriculture with little input; on the other hand, since farmers in the Lashihai Nature Reserve have two cropping seasons (one in winter, one in summer), their input of fertilisers is consequently increased – even though with little impact on average yields, perhaps because of poor soil conditions or farming techniques.

Let us now look at what would happen to the input of chemical fertilisers under the proposed reorganisation of agriculture in the Lashihai Nature Reserve. Table 17 below summarises the estimated yearly input of fertilisers for the alternative land uses. It would seem that differentiating the types of crops cultivated in the area with high value fruit trees is expected to reduce the input of chemical fertilisers used around the Lashihai Nature Reserve, while at the same time increasing farmers' revenues. Note that pesticides play a minor role in agriculture in the area – partly because the cold climate implies a lower incidence of pests. In the input-output modelling exercise, therefore, pesticides input was grouped together with other factors of production, such as electricity for irrigation, plastic sheeting, etc.

Table 17: Input requirements of alternative land use options (chemical fertilisers)

Option	**Total Fertilisers (Kg/mu) (average annual input over a 15 years period)**	**Total Fertilisers (kg/ha)**	**Variations with respect to the status quo**
D0. Baseline case (crop only)	65.62	984.31	0%
DI. Crops and fruit trees	61.26	918.95	-7%
DII. Crops and livestock	47.30	709.54	-28%
DIII. Crops and livestock and fruit trees	46.02	690.28	-30%

In the model, chemical fertilizers use was modelled based on the following function:

$F_t = 0.98 * F_{t-1} + 3.43$, where F_t is the input of fertilizers at time t. The parameters of the function have been derived through econometric techniques from observed data[16].

Further specification of the data and the result is however necessary: under the assumptions of the CBA model, in scenario DI Crops&Fruits, the use of chemical fertilisers may increase over time to maintain a stable yield, while in scenario DIII Crops&Livestock&Fruits, livestock manure will be used to make up for the lower input chemical fertilisers – strengthening the attractiveness of this farming options in terms of improved profitability, but reducing the positive impacts in terms of reduced fertilisers use.

In addition to information on the use of fertilisers input, to assess the impact that a given change has on water quality one would need to develop a fully quantitative cause-effect model. With the data available, this exercise is not possible. For one, the Environment Protection Agency does not monitor regularly water quality parameters that are normally associated with agricultural pollution, such as nitrates; secondly, detailed information on soil type and slope for the area are missing; thirdly, although the linkages between water quality and agricultural practices are often discussed, in

[16] Report by Prof. Zuo Ting.

practice they are extremely difficult to assess, given the strong interdependencies among different factors – such as climatic factors, temperature, land types and slopes, biotic factors in the water body, and the overlapping effects of different sources of pollution (i.e. for the nutrient those related to civil settlements). For the same reasons extrapolations or analogies from the international literature are not feasible, and the exercise would not be helpful for policy making, as it could lead to decisions based on misleading or outright wrong estimates.

The net impact on lake water quality cannot therefore be assessed in a quantitative manner with the available information, but one can nonetheless draw some general, qualitative, conclusions. First of all, the data in Table 3 show that turbidity of the lake water is also relatively high, indicating potential problems with respect to soil erosion, in addition to excessive inputs of fertilisers. This would indicate the need to improve agricultural practices. Secondly, current agricultural practices are highly inefficient in terms of fertiliser use – an input-output ratio, which is well above the average for the rest of China. Thirdly, the net impact of changes in agricultural practices, promoting joint production of traditional crops, high value fruit trees, and livestock on water quality cannot be determined: if, one the one hand, the net input of chemical fertilisers may be expected to decline in the medium run, this declining trend is the result of farmers substituting away from commercial fertilisers to manure. As a consequence, the aggregate level of fertilising substances used – chemical and natural – may not decline, or even increase, with uncertain consequences on water quality. Fourthly, encouraging an increase in fruit trees at the expenses of more traditional crops may have adverse impacts on the birds' population, thus causing a decrease in the other valuable EES identified in the region. This depends on the ecological niches of birds – which will determine whether they will be able to change their diet and feed on fruit. Further research needs to be done in this direction, before a substantial change in cropping patterns can be encouraged. Moreover, even if birds could feed on trees as opposed to the traditional crops, the monetary damages that farmers would suffer may be much higher, given the higher value of the crop. Lastly, a shift in the cropping mix may also reduce significantly the water needs of agriculture: for instance, current

cultivation technologies for wheat require around 600 m^3/mu of water, while corn and tomatoes require only 300 m^3/mu and 200 m^3/mu respectively. This would help address the water quantity problem in Lijiang and indirectly also act to improve water quality

In the light of the above considerations, PES schemes for the promotion of improvements in water quality through agriculture should focus on income-neutral or income-improving changes in farming practices, supporting a shift towards more efficient use of fertilisers and other inputs or technologies to decrease soil erosion. In the face of unchanged (or potentially improved) yields with less chemical inputs farmers would reduce their direct costs. As a consequence, this change could lead to improved water quality, although the extent of this impact cannot be assessed at this stage in a quantitative manner. The quantitative model linking different agricultural practices to water quality would also be needed to estimate the costs of service provision. However, promoting "soft" changes which are income-neutral or income-improving, the estimation of the costs of service provision to the farmer is relatively less important – what is important in this case is the cost of implementing "soft" measures (extension service) relative to the value that beneficiaries attach to the service.

6.1.2 Extension services

Inducing farmers to adapt farming systems to more environmentally sound practices is likely to be cost-effective. According to expert opinion, the use of chemicals in agriculture is above the optimal levels in many parts of China, indicating that farmers are not on the production possibility frontier. Preliminary data from the Lashihai Nature Reserve and experts' opinion seem to support this hypothesis.

Combined strategies targeting both fertilisers and pesticides inputs, and land use (e.g. cultivation of less demanding crops and/or, cover crops) could be implemented, through carefully designed capacity building campaigns and extension services. More stringent monitoring of farmers' activities would allow ensuring the implementation of those practices, but also the enforcement of Chinese legislation on pesticides and fertilisers use in agriculture, which is already well developed.

Lower inputs and improved land use would be likely to lead to mitigation of environmental impacts, and eventually to an improvement in the water quality of the landscape water used in Lijiang old town. Furthermore, the costs of such strategy are likely to be lower than the value of the service, in terms of ensuring that the tourism industry in Lijiang is not (substantially) damaged by foul smells or visually impaired water canals. This would indicate that less traditional PES schemes could be implemented in this context for improving water quality. That is, instead of direct (cash) payments to farmers for the EES deriving from their activities, capacity building and extension services could be provided. Funds to carry out these activities could still be sought from the service beneficiaries, in ways to be defined by the relevant Ministries.

In addition to improving water quality, the reduction of inputs in agricultural land may bring about other benefits for the environment, reducing the negative impacts that such inputs may have on wildlife in general, and on breeding birds in particular. Although no scientific studies have been carried out in the Lashihai Nature Reserve, international experience indicates the possible existence of this positive synergy. For the full benefits of the synergies with the maintenance of healthy birds' population, farmers would need to be compensated for the full costs inflicted by birds' habits.

With the current knowledge of the area, it is not possible to conclude whether the improvement in water quality brought about by income-neutral changes in farming practices would be sufficient to ensure that a perceived improvement is achieved in Lijiang old town, or whether some instances of poor water quality would still remain. The reason is that there is insufficient data in terms of inputs to agricultural production in the areas surrounding the Lashihai Lake to (econometrically and environmentally) estimate the causal link between farming practices and water quality. There is anecdotal evidence that, during periods of heavy rains, water quality of the lake deteriorates, indicating substantial runoff of suspended sediments, fertilisers and pesticides from the surrounding farmland. Further research is needed in this direction, to estimate the water quality improvement brought about by an income-neutral reduction in the use of fertilisers and pesticides. Should this be the case, a

comparison will need to be made between the expressed willingness to pay of tourists in Lijiang old town for the restoration/preservation of good water quality and the costs that farmers would incur in terms of lower yields from a further reduction in input: if the former exceeds the latter, more traditional forms of PES schemes may be successfully implemented, compensating farmers for the forgone profits and the ensuing improvement in water quality.

6.1.3 Organic farming

Contrary to the general view that the promotion of organic farming could be a win-win solution, improving water quality on the one hand, and ensuring a steady income stream to farmers, the qualitative analysis of the case study area indicates that organic farming as it is currently practised may not generate as many benefits as anticipated. Organic farming – which, by definition, forbids the use of chemical inputs – would probably lead to significant improvements in water quality of the lake and thus of landscape water for Lijiang old town.

What makes the promotion of organic farming problematic in the Lashihai Nature Reserve, however, is not the cost of the option. If the EES deriving from farming activities around the lake were limited to improved water quality, then this strategy could be desirable, providing that the ensuing benefits as expressed by Lijiang tourists outweigh the costs of introducing organic farming. Yet, and as discussed in the previous sections, farmland is a prime source of food for important migratory bird species, and is located within a nature reserve of significant scenic beauty. Organic farming in Yunnan – and in such a small stretch of land – requires farmers' plots to be enclosed in greenhouses, partly to prevent the crops from contamination from neighbouring, traditional, fields. The impact that this shift in agricultural practices would have on the provision of birds' biodiversity is likely to be negative: if most of the farmers go organic, food sources for the birds would be significantly reduced, with a likely decrease in the birds' population. If, on the other hand, few farmers shift to organic, the damages that traditional farmers suffer from birds feeding would increase, thus increasing the costs of the PES schemes (compensation for damages), and perhaps jeopardising the existence of some of the bird species (poaching).

Two additional problems could be cited with the promotion of organic farming in the area. First, organic farming in greenhouses requires a substantial initial investment of about $3000/Mu. At present this comes from private the sector and the amount that can be supplied that sector is unclear. Second a soil survey around Lashihai Lake showed that the radioactive element in soil is above the allowed concentrations: the organic crops produced around the lake will therefore face a high risk of not meeting certification standards.

Yet, organic farming would have an added advantage: according to experts' view, it would lead to significant water savings – in the order of 80% – thus contributing to solving the problem of current and future water conflict and improving water quality.

For organic farming to be a feasible option, therefore, one would need to explore the possibility of adopting practices that differ substantially from the observed trend in Yunnan (namely, without the use of greenhouses). According to several experts, organic farming can be successfully practiced outside greenhouses, but farmers need to be subsidised in the transition period (approximately two years). Contract farming and the setting up cooperatives to exploit economies of scale, which is indeed the way organic farming is currently organized, may be a strategy to be expanded.

The short term costs of organic farming are likely to be high in terms of short-term forgone profits and marketing costs for the green products. In the medium to long term, it is not clear whether farmers would be able to earn enough through specialised market niches – this will also depend on the development of the market for organic food, which at the moment is more international than domestic. According to the Organic Consumers Association[17], organic food is set to grow substantially in China, and organic production in the country has been increasing by 30% annually, with exports growing by 50% in recent years (China Green Food Development Centre). Several sources indicate that Western buyers of organic products are increasingly turning to China for organic products[18]: there therefore seem to be good prospects for this initiative.

[17] http://www.organicconsumers.org/organic/china100804.cfm

[18] See, for instance, http://www.foodnavigator.com/news/news-ng.asp?n=59043-western-food-makers

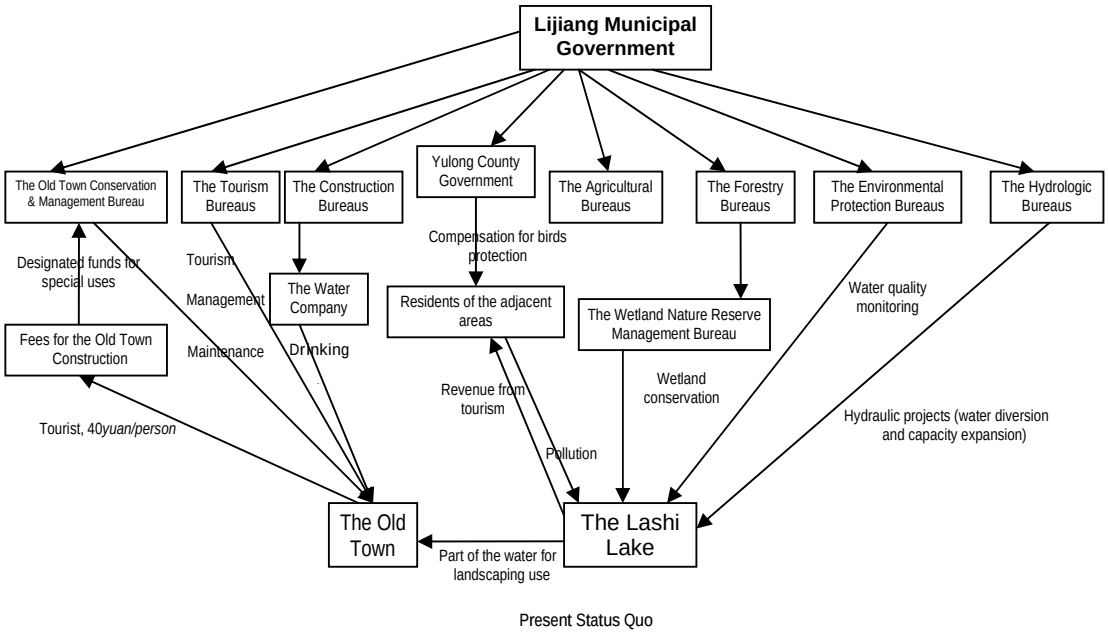
7 Institutional set up

The different options of land use that could be encouraged through the implementation of PES schemes have been discussed in previous sections. In this concluding section, we will discuss the institutional set up which could be used for the PES mechanism. In particular, the authority needs to decide how the funds are channelled to the farmers who choose to voluntary participate in the scheme, and how the needed financial resources are to be raised from service beneficiaries.

7.1 Current institutional set up

Locally, water management is still highly fragmented, and based on sectoral plans and priorities. The principles of Integrated Water Resource Management are still a novelty in China, at the local level in particular, where agencies' agenda still dominate policy making. Figure 17 represents graphically the current institutional organisation for water management and environmental protection in the area, highlighting the key roles and responsibilities of the institutions.

Figure 17: Institutional organisation for water management in the Lijiang municipal area



(Source: Conservation International –China)

It is clear from the figure above that there is still a high degree of fragmentation, which may diminish the effectiveness of conservation strategies. For instance, the Agricultural Bureau does not seem to be involved in managing the Lashihai wetland. Yet land use around the lake – in particular for agricultural purposes – does have significant impacts on water quality as well on the extension of the wetland. Similarly the Hydrological Bureau is concerned with water diversion and storage infrastructure – and in fact is planning to further increase storage capacity of the lake through a new dam. Currently, this office does not seem to work in collaboration with the other institutions with a responsibility for managing the lake and protecting the nature reserve – hence conflicts of interest and policies are likely to emerge.

The study of the current institutional set-up highlights several problems (Conservation International – China):

a. lack of institutional integration: there is a clear lack of agreement and consultation among managing institutions, who continue to take a sectoral approach to managing water resources in the area. In addition to causing problems with respect to planning and implementation, this lack of coordination also impedes funds transfers from one office to another.
b. poor management and development strategy for the tourist industry in the Lashihai Nature Reserve. Tourism activities are currently fragmented, managed by two institutions (the Anzhong Folk Ecotourism Cooperatives of Haidong Administrative Village Office and Meiquan AVO). There is a lack of a clear development vision, and marketing capacity remains low. As a consequence, planning for tourism infrastructure is not well organised, and the impact of the tourism industry on the nature reserve is not minimised.
c. Insufficient resources – human and financial – for the protection of the environment. At the moment, funds for conservation activities come from funds raised by the Lijiang Municipal People's Government and Yulong People's County Government. Funds are by large insufficient to plan for minimising the impact of socio-economic activities on the natural environment, and for ensuring the protection of the nature reserve.

7.2 Farmers' participation in the scheme

Two main lessons can be drawn from the review of best practices experiences that can be successfully applied in the context of the pilot study.

First of all, best practice approaches highlight how there is a trade-off between the level of targeting of the payments, and the costs of implementing the scheme. In the context of this pilot study, it is suggested that the payment scheme be kept as simple as possible, as negotiation and transaction costs are likely to be high. This is especially true in the light of the fact that the aim of the authorities should be to involve as many farmers as possible in the scheme, in order to ensure significant positive benefits for water quality.

Secondly, the assessment of best practice experiences indicates that monetary payments work best when they are coupled with non-monetary benefits, such as training or transfer of technology. In this specific case, extension services to encourage more environmental-friendly agricultural practices are to be implemented as non-monetary benefits of PES scheme. Once again, it is important to emphasise that farmers are likely to benefit from a more efficient use of fertilizers which would reduce their input cost without however significantly impact on crop yields.

A strategy that could increase the chances of success of the PES scheme for landscape water quality is to make the compensation for biodiversity services conditional upon farmers adopting agricultural practices which require lower input of chemical fertilisers.

To maximise the benefits for the environment, but also promote the long term development of the region, the PES scheme could have an additional component, and encourage selected farmers to adopt organic farming practices – without the use of greenhouses to avoid negative impacts on the birds' population and on the landscape of the nature reserve. It is probably desirable to limit participation in the organic farming component of the PES scheme to those farmers with land in sensitive areas – that is, right on the lake shore, or on land with a significant slope, where run-off is more problematic. In the short term, farmers are likely to suffer a significant income loss during the transition from traditional farming to organic farming, because of the

high investment and the fact that yields decline in the early years and the product cannot be certified as organic until the soil is free of chemicals. Limiting participation in the scheme to only the critical farmers will help to keep the implementation costs low. Furthermore, organic farming practices should be coupled with strategies to decrease land erosion or vulnerability of the land.

7.3 Charging service beneficiaries

The analysis of international practices has shown that the financial sustainability of PES scheme is of paramount importance. Moreover, the possibility to raise the required funds from the beneficiaries is one of the appeals of this market based instrument in the face of considerable budget constraint for environmental protection and conservation. The review of the past experiences in China has once again highlighted how financial constraints are hampering the implementation of existing PES schemes. In this section, some suggestions are provided as to how the funds could be raised, to pay for extension services, compensate farmers for the damages caused by protected birds, and incentivate those farmers whose land is located in sensitive areas to go organic.

First of all, and in line with the attempt to reduce as much as possible transaction and implementation costs, the strategy to raise funds from service beneficiaries should be easy to implement. Two are the targeted beneficiaries: one the one hand, the visitors of the Lashihai Nature Reserve and, on the other hand, tourists to Lijiang old town.

The review of best practices suggests that, whenever possible, existing institutions and payment vehicles should be used. This strategy reduces implementation costs, and, at the same time, ensures that local actors are already familiar with the institutions managing the scheme.

Thus, it is suggested that the visitors' fee to the old town of Lijiang is used as a payment vehicle for collecting the revenue necessary to fund extension services and, in part, organic farming. Additional funds could be sought by introducing a differential fee – which charges foreign tourists more than local tourists. Usually, the

price elasticity of demand is lower (demand is less affected by changes in price of the commodity) and the willingness to pay is higher for international tourists that for domestic ones. An additional strategy needed to recover sufficient funds for the implementation of PES schemes to maintain landscape water services is to increase the rate of tourists who actually pay the tourist tax in Lijiang old town. This issue will be discussed more in the monitoring strategy section below (see Section 7.4.1).

Beneficiaries of birds' biodiversity maintenance, at the local level, are mostly the visitors to the Lashihai Nature Reserve. In this case, the easier strategy would be to introduce an entrance fee to the reserve. The fee should be set at an appropriate level (reflecting the WTP as given in Table 6) so as not to discourage tourist development of the site, which is just picking up.

Alternatively, a fee could be introduced on the eco-tourist activities: but this would probably harm local communities by lowering the profits from tourism. One of the main potential shortcomings of PES schemes is the risks of negatively impacting on wealth distribution: considering the development reality of the LNR, it therefore does not seem advisable to introduce a "user fee" on eco-tourism activities for raising the funds to compensate farmers for the maintenance of birds' biodiversity (see Section 7.4.2).

In summary, two fee systems could be introduced to raise the funds to pay farmers for the EES they provide through their agricultural activities:

- the existing tax for visitors of the old city could be increased by a given amount. This expedient, coupled with a more accurate check on visitors to ensure that a higher proportion pays the due, would raise funds to cover the cost of extension services and, if possible, part of the up-front cost for organic farming. We are not clear, however, whether a transfer of funds from the township to the agricultural department is in fact feasible.
- An entrance fee to the Lashihai Nature Reserve could be introduced to raise funds for compensating farmers the yield loss to birds' species.

7.4 Setting payment levels

One of the most difficult exercises for the effective and efficient implementation of PES schemes is the definition of the appropriate payments levels. The funds that farmers receive should be sufficient to fully cover their true cost of providing the service. In this section, we will discuss some issues related to payment levels, and suggest an order of magnitude that can be considered by local authorities for implementing the scheme. Both uniform and dual systems of fees are discussed. In the latter, international tourists are asked to bear a larger share of the costs for compensating farmers for the EES provided. This approach is justified empirically, as international tourists are usually are more willing – and able – to pay to protect natural resources. The system of differentiated fees has worked well in a variety of other context, both in developing and developed countries.

7.4.1 Water services

As discussed at length in previous sections, without a quantitative model linking farmers' behaviour to different levels of water quality it is not possible to have an estimate of the cost of service provision. Given, however, the current situation of the agricultural sector in the area, extension services are deemed a win-win solution to both improve farmers' income and water quality. The additional fee imposed on the tourists of Lijiang should therefore be sufficient to cover the cost of providing agricultural extension services to all the farmers who wish to enrol in the scheme – the largest number possible. An approximation for the costs of extension services is summarised in Table 18, including the subsidies for organic farming. These have been estimated at US$50/ha, assuming a 50% loss in the shadow value of land in the area (currently around 50RMB/mu, or around 100US$/ha) caused by lower yields and a lack of a market for green products in the short term, which would fetch a higher price than non-organic products[19].

[19] Expert's opinion, prof. Zuo Ting. The shadow value of land has been derived from Prof. Zuo Ting's field survey.

Table 18: Estimated cost of extension services (RMB per annum)

	Number	Units	Unit cost (US$)	Total cost (US$)	Total cost (RMB)
ES Staff	1	7 villages	2,400 (salary)	16,800	132,806
Subsidies for organic farming*	1	1,487 ha	50	74,337	587,642

*upper bound: considers a subsidy of 50US$/ha for all the cultivated land around the lake, not only the critical land. This may only be needed for one to two years.

The costs summarised in Table 18 would be covered by an increase in the Lijiang visiting fee of RMB 0.3 RMB – an increase of about 1% on the current level. This estimation is based on a uniform fee applied to both domestic and international tourists, and on a basis of 60% of visitors paying the fee (see Section 5.2.2).

To the above costs one would need to add sufficient funds for marketing organic products, to ensure that farmers' reliance on state subsidies decreases over the years. This could be done by providing funds to cover networking costs to link the initiative to other initiatives in China (such as the BioFach initiative to promote organic farmers among smallholders as a means to reduce poverty[20]). These funds should be managed by the Municipal Agricultural Bureau (see the following Section).

It is therefore suggested that the local government implements a dual-system, through which international visitors will bear a higher burden of the additional fee. In particular, it is suggested that the entrance fee for domestic visitors is increased by 1%, from 40RMB to 40.4 RMB, while the entrance fee to international visitors can be increased by 5% - from 40 RMB to 44 RMB. The estimated funds that would be generated by this increase are reported in Table 19, and would be sufficient to cover the costs of extension services, organic farming, and some funds would be available for marketing and networking activities.

[20] http://www.biofach-china.com/main/eefmgjhs/eefmtw9y/page.html

Table 19: Suggested increase in Lijiang visitors' fee – water only

	Domestic	International	
Increase	1%	5%	
RMB	0.4	2	
Number of paying visitors	2,315,700	109,680	
Funds generated (RMB/year)	926,280	219,360	1,145,640
Funds generated (US$/year)	117,174	27,749	144,923

As the number of tourists visiting the city is not known with certainty, it may be the case that the funds raised are well above the needs for the year. In this case, the additional resources could be channelled to a revolving fund, which can serve as buffer for unexpected expenditure, to hedge the risks in commodity price volatility, etc. The funds would need to be managed jointly by all the institutions involved, as discussed in Section 7.5.

Finally, it is important that visitors are informed about what the additional fee will be used for: this awareness campaign strategy is likely to lower opposition to the increase.

7.4.2 Birds

As discussed in Section 5.1, there are some estimates available of the damages inflicted by birds to farmers. Based on these estimates, and on the number of visitors entering the LNR every year, it is possible to estimate an entrance fee that would cover fully the cost of provision, as summarised in Table 20.

Table 20: Suggested entrance fee to LNR – uniform system

BIRDS	RMB	US$
Average cost of provision per year (2000-2005)	1,845,613	233,470
Number of domestic tourists	50,000	
Number of international tourists	15,000	
Total number of tourists	65,000.00	
Entrance fee	28.4	3.6

Note, once again, that the estimates are based on a uniform fee applied to domestic and international tourists. Furthermore, the fee that would need to be imposed on visitors to the nature reserve is well above the median WTP of 8RMB (approximately 1US$) – that is, the WTP of the majority of respondents. Setting the entrance fee at such high level may, therefore, significantly disrupt the development of the tourism industry. As in the previous case, it is therefore suggested that a differentiated fee is charged to local and international tourists, to take into account the lower median WTP and the fact that, on average, international tourists will be willing to contribute more towards the conservation of biodiversity. If the impact on visitors is not found to be significant, the entrance fee can be raised in the future. The introduction of a dual system may help raise additional resources with respect to a unified fee set at 8RMB but, in the short term, the funds raised through the PES scheme will not be sufficient to fully compensate farmers for the damages caused by birds – with an estimated shortage of RMB 845,613 per year (approximately 107,000 US$). This is more or less the compensation currently disbursed by the Lashihai Nature Reserve Management bureau: the PES scheme could therefore help, in the short run, to bridge the gap between the observed damages and the compensated damages, thus reducing the incentives for farmers to harm the birds' populations, and facilitating the work of the Nature Reserve Management bureau. In the medium to long run, additional funds could be raised through charging a higher entrance fee, once the impact on the tourism industry have been assessed.

Table 21: Suggested entrance fee to LNR – dual system

		Entrance fee RMB	Entrance fee US$
Number of domestic tourists	50,000.00	8	1
Number of international tourists	15,000.00	40	5
Total Revenue		1,000,000	126,500

As in the case of the funds for water services, it is important to make sure that tourists are informed about the use of the entrance fee – that is, that the purpose is to compensate farmers for the service they provide in terms of maintaining birds' biodiversity.

7.5 Institutions involved

In both cases, the fees could have a two-tier system, with foreign visitors paying more than local visitors, thus reflecting both the higher purchasing power, and the higher willingness to pay. Ideally, both fees should be handled by existing institutions. This would reduce transaction costs, and ensure the long term sustainability of the PES scheme.

7.5.1 Using current institutions

The Lijiang Municipal Tourism Bureau (MTB) is mandated by the Lijiang Municipal Government to draft and formulate short term goals and plans for tourism development in the municipality, as well as to formulate the management regulations for the sector. The MTB is also responsible for market Lijiang as a tourist destination. The visitors' tax to the city can be managed by the MTB, and the additional fee meant to cover the cost of agricultural extension services – and, if possible, a shift to organic production for a limited number of farmers – would need to be transferred to the Lijiang Municipal Agricultural Bureau (MAB).

The MAB is currently responsible for implementing national agricultural laws, for setting out development policies for the agricultural sector in the Lijiang municipality, to undertake research in agricultural production. The MAB is in charge of agricultural extension services: a campaign to train farmers into low impact agriculture, or organic farming, can be funded through the additional fee for visiting Lijiang old town. Extension services will also be needed to improve the current input-output ratio, ensuring farmers use chemical inputs – fertilisers and pesticides – appropriately and that more efficient farming practices are introduced.

The LNR is managed by a local management office depending on the Yulong County Forestry Bureau (LNR-FB). The compensation for biodiversity service provision should therefore be managed by the LNR-FB. Farmers are already receiving some compensation for the damage they suffer, according to the Regulation on the Compensation for Personal Injuries and Property Loss Caused by the key protected terrestrial wild animals in Yunnan Province (1998). This compensation is however not sufficient to fully cover the yield losses experienced by farmers (see Section 5.1).

It is important to point out that, as several government institutions would be involved in the implementation of the PES scheme, there is a strong need for coordination among them: first of all, compensation for birds' damage should be conditional upon farmers adopting environmental-friendly agricultural practices that minimise both chemical input and soil erosion. Close cooperation between the LNR-FB and the MAB is therefore a pre-requisite for the functioning of the scheme. In particular, extension services need to certify both farmers' participation and compliance with good agricultural practices.

To facilitate institutional interaction, a common database of participating farmers should be kept in the LNR-FB premises, where farmers' performances can also be recorded. The database will also record farmers' compensatory claims for lost crops to birds, and the damage assessment and ground-verification carried out by either the agricultural extension workers or the LNR-FB employees.

Clear mechanism for transferring the additional funds received by the MTB to the MAB should also be set out, which ensure transparency and accountability.

In order to foster cooperation among institutions, it is important to obtain full support from the top political level in the area – in this case, the office of the Mayor. The Mayor has the power to mandate institutions to cooperate, share information and transfer funds. Care must be however taken in relying too much on the Mayor's power, as the Mayor would be unlikely to assign leadership for the implementation of the PES scheme to one institution or department, as this would have political implications on other institutions and departments, whose support for the PES scheme may be reduced.

7.5.2 New institutional set up

As described in Section 7.1, however, there is currently a lack of collaboration among the existing institutions, and it may therefore not be feasible – at least in the short run – to implement the PES scheme through the existing structure. This is particularly important, as the scheme foresees the transfer of parts of the funds raised through the tourist tax by the Lijiang Tourist Bureau to the Agriculture Bureau, with the purpose of funding extension services to improve agricultural practices in the Lashihai Nature Reserve.

If, after initial consultations with the existing institutions it appears that the PES mechanism cannot effectively work with the current institutional arrangement, it is suggested to form an ad-hoc committee – which could be called Ecological Resources Management Committee – with the task to coordinate and oversee conservation affairs in the Lashihai Nature Reserve. The Committee will then be responsible for ensuring that extension services reach local farmers, that funds and fees are collected, and compensations disbursed. Representatives of existing institutions can be part of the Committee (e.g. particularly Lijiang Municipal Government, The Old Town Protection & Management Bureau, The Tourism Bureau, The Construction Bureaus, Yulong County Government, The Agricultural Bureau, The Forestry Bureau, The Environmental Protection Bureau, The Hydrologic Bureau, and The Wetland Reserve Management Bureau). An independent monitoring agency could also be set up.

It must however be pointed out that creating new? institutions requires (often considerable) financial resources, which would need to come from the funds raised through tourism and entrance fees – thus necessarily reducing funds available for conservation and compensation activities.

Before proceeding to creating new institutions, therefore, it is necessary to explore in depth the possibility of strengthening collaboration among existing organisations, thus enabling to rely on them for the implementation of PES scheme.

7.6 Monitoring compliance

For the scheme to be effective there must be some strategies in place to ensure compliance of participating actors. In particular, the following actions are suggested:

- the MTB must ensure that the fee to visit the old town of Lijiang is paid by (almost) all the visitor. If a dual system is applied, though which local tourists are charged a lower fee, it is important that compliance by both domestic and international tourists is assured.
- The additional payment must be used to fund agricultural extension to encourage local farmers to adopt a less input intensive farming. They should therefore be transferred to the MAB.
- The human resources of the extension services can also be used to monitor farmers' compliance with the scheme. This should include both monitoring the use of chemical inputs in agriculture, as well as the implementation of more efficient farming techniques.
- In the meanwhile, it is of paramount importance that the Environmental Protection Bureau begins routine monitoring of indicators for agricultural pollution, in order to monitor the impact of changing agricultural practices on water quality.
- The LNR-FB will remain responsible to monitor and assess the damages suffered by farmers, for computing the compensation. Compensation, however, should be conditional upon good agricultural practices being implemented by farmers, thus close cooperation with the extensions services is needed.
- To ensure that less fertilisers and pesticides are used, it may be a good strategy to check the sale of fertilisers: controlling the supply of chemicals rather than the demand may be more efficient and less costly, as it would avoid having to monitor a multitude of small-holders. Some monitoring and enforcement at the level of the individual farmer will nonetheless remain necessary, given current evidence of illegal use of pesticides.

8 Conclusions

Past experience in China and international experience more widely seem to indicate that setting up PES schemes for watershed services is fairly straightforward, due to the relative ease in identifying beneficiaries and providers, although some difficulties remain in quantifying the linkages between land management practices and outcomes. In the case of China, these types of PES schemes could not only help to improve protection of upper watershed services in face of weak enforcement of existing regulations, but could also serve as a useful platform to resolve the conflicts surrounding these services (Scherr, et al., 2006).

In China, the private sector represents a potentially large source of financial resources to pay for ecosystem services through, e.g., offset for pollution credits. There are already various examples in the country, such as the State Forestry Administration's Forest and Vegetation Restoration Fee (*senlin zhibei huifufei)*, or the various fees levied by local governments for ecological damages caused from construction and engineering projects. It is now necessary to move to the next stage, in which PES schemes – and design processes – have to be standardised across the country, and the financial flow generated invested in ecosystem restoration or protection activities.

This report has explored, through a mixture of qualitative and quantitative approaches, the potentials for applying PES schemes to preserve two key ecosystem services provided by farmers surrounding the Lashihai lake, in the Lashihai Nature Reserve: the maintenance/restoration of good water quality for landscape use in Lijiang old town; and the maintenance of birds' biodiversity in the Nature Reserve. It has noted that such solution, while they may have problems, are better than possible engineering alternatives that would increase water availability through investment in water diversion infrastructure.

The preliminary analysis of the two EES and their provision indicates that there is a substantial willingness to pay on behalf of the service beneficiaries to maintain the EES. This is particularly true for preserving birds' species, although the significant

difference between median and average WTP suggests that it is the result of a few people with a very high WTP. The higher WTP for bird preservation may simply reflect the greater enjoyment that visitors derive from the nature reserve relative to the value of cleaner water in the town's canals. It may also reflect respondents taking into account factors other than private enjoyment when establishing their WTP for bird preservation, such as ethical consideration. Lastly, they may consider that good quality water is in their rights, and thus they may be less willing to compensate farmers to change their behaviour in hat regard. In the case of birds' biodiversity, the preliminary results indicate that there is scope for establishing a PES scheme, although it may not, in the first instance cover the full costs of compensation. Furthermore, as the payment means through which funds can be channelled to farmers – either directly or through a Trust Fund – is relatively easy to design.

In the case of water quality, however, the linkage between farmers' activities and service provision is still not quantified, and in fact it is complex to even identify. One of the fundamental variables needed for the effective and efficient implementation of PES schemes – namely, that there is a clear link between the activities of service providers and the level of the service itself – may be lacking. The quantitative analysis on agricultural practices does nonetheless leave open several opportunities, as it is clear that farming activities are not efficient at the moment: crop yields is below the average for the Country, while the input of total fertilisers is well above the average. There is therefore scope for improving water quality through "soft" measures, such as extension services to improve farmers' practices, both in terms of yield, and to reduce soil erosion – another problem potentially present in the area, given the observed turbidity of lake water. It needs to be stressed that, because of the lack of data, there cannot be a certainty that water quality will improve following the adoption of organic or more environmental friendly agricultural practices. Anecdotal evidence, however, coupled with the currently high level of inefficiency in the use of inputs in the agricultural sector, does indicate that some improvement will be discernible. Furthermore, the adoption of more adapted and efficient agricultural practices,

promoted by agricultural extension services, and a limited uptake of organic farming will lessen another major observed problem in the area – a problem that is likely to become more acute in the future. Through improved efficiency, a change in the crop mix, and the adoption of water saving technology, water demand for agriculture can be substantially decreased, reducing the attractiveness of an engineering solution to the problem. Not only is acting on the demand side of water more efficient in economic terms than acting on the supply side, but it is also likely to have lower social as well as environmental costs.

Importantly, this analysis seem to indicate that the two services must be addressed together in a bundled manner, with PES schemes targeting both simultaneously: this approach does not only allow for the exploitation and enhancement of potential synergies, but also the identification and avoidance of perverse effects that interventions to preserve one service may have on the other – such is the case of the promotion of organic farming. In summary, the PES scheme implemented to improve water quality of the Lashihai Lake and maintain birds' biodiversity in the Lashihai Nature Reserve should have the following characteristics:

- the existing tax for visitors of the old city could be increased by a small amount. This expedient, coupled with a more accurate check on visitors to ensure that a higher proportion pays the due, would raise funds to cover the cost of extension services and, if possible, part of the up-front cost for organic farming;
- an entrance fee to the Lashihai Nature Reserve could be introduced to raise funds for compensating farmers the yield loss to birds' species;
- participation in the scheme for farmers has to be be voluntary;
- to ensure large participation, however, it is advisable to peg compensation for birds' damages to the adoption of less input intensive agricultural practices;
- provide extension services to all farmers who wish to enrol, with the aim of achieving higher efficiency in the use of chemical fertilisers. Farmers should not be paid to switch to less intensive practices, as the change is likely to be either income neutral or income improving;

- farmers who have land in sensitive areas should be encouraged to switch to organic farming. In the short term, the change will impose costs on farmers, which will need to be covered by the scheme.

Finally, it is important to ensure that the reasons for the increase in the visitors' fee to Lijiang old town, or the introduction of an entrance fee to the LNR, are made explicit. Awareness campaigns with both the tourists and local citizens are a good strategy to ensure that the value of the EES provided by the famrers in the LNR is recognised, thus reducing resistance to the contribution requested from visitors to ensure the maintenance of the key EES.

Two key general lessons can be drawn from this study: first of all, whenever possible, it is advisable to use existing institutions and payment vehicles; secondly awareness campaigns are a necessary strategy to ensure acceptance of, and compliance with, the scheme; thirdly, a clearly defined monitoring strategy needs to be in place, and the participation conditions must be transparent and adhered to; finally – and given the experience elsewhere in China – it is of the utmost importance to exploit fully one of the most attractiveness characteristics of PES schemes, that is, their potential financial sustainability. Local authorities need to ensure that the funds needed to undertake agricultural extension services, promote organic farming, and compensate farmers for yields lost to birds, are collected in addition to the current revenues, otherwise the long term viability of the scheme will be compromised.

There must be extensive consultation with the existing institutions and local actors to assess the viability of the proposed scheme and institutional set up. The analysis of the existing system seems to indicate that there is a low level of cooperation among institutions, and planning is very much still at the sectoral level (report by Conservation International – China). With respect to this point, it is of the utmost importance to obtain the support of high level political and administrative institutions. In particular, the Mayor's office has the power to induce cooperation among different departments and institutions, in addition to deciding whether the PES scheme is well suited to address the problems of Lijiang. Obtaining the leadership of the Mayor will

therefore be a key factor determining the success or failure of the PES scheme. If, after the consultation exercise, it appears clear that it is not feasible to induce existing institutions to collaborate to the degree needed for the successful implementation of the PES scheme, a trans-institutional committee could be set up, with the purpose of managing the PES scheme and overseeing its implementation. It must however be emphasised that setting up new institutions increases significantly the transaction costs of the scheme, reducing the funds available for conservation and compensation activities: both the desirability of the scheme and its financial sustainability may therefore be jeopardise. The option of creating a new, ad hoc, institution should only be explored if the attempts to use the current system fail.

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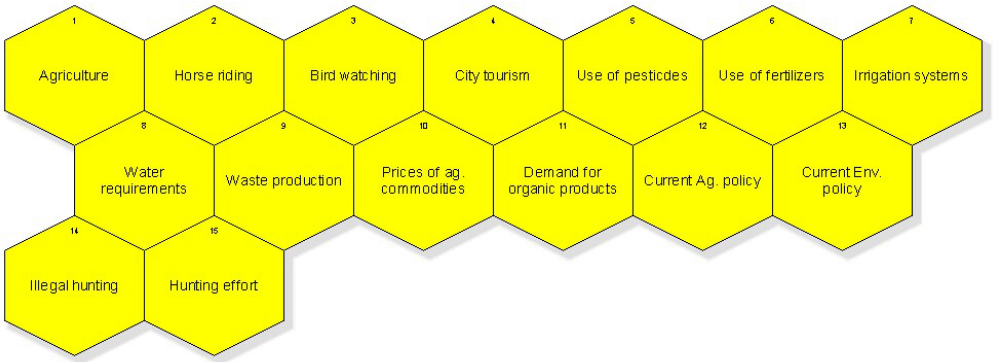
Annex I. State and impact factors & strategic options

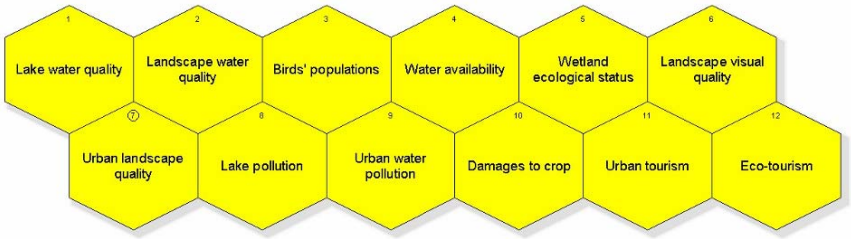
Formalisation of the problem conceptualisation

1) Identify human activities and their pressures on the environment



What are the driving forces and the pressures of human activities on the study case?

2) Examine the expected consequences on the state of the environment and their expected impacts on the socio-economic system.



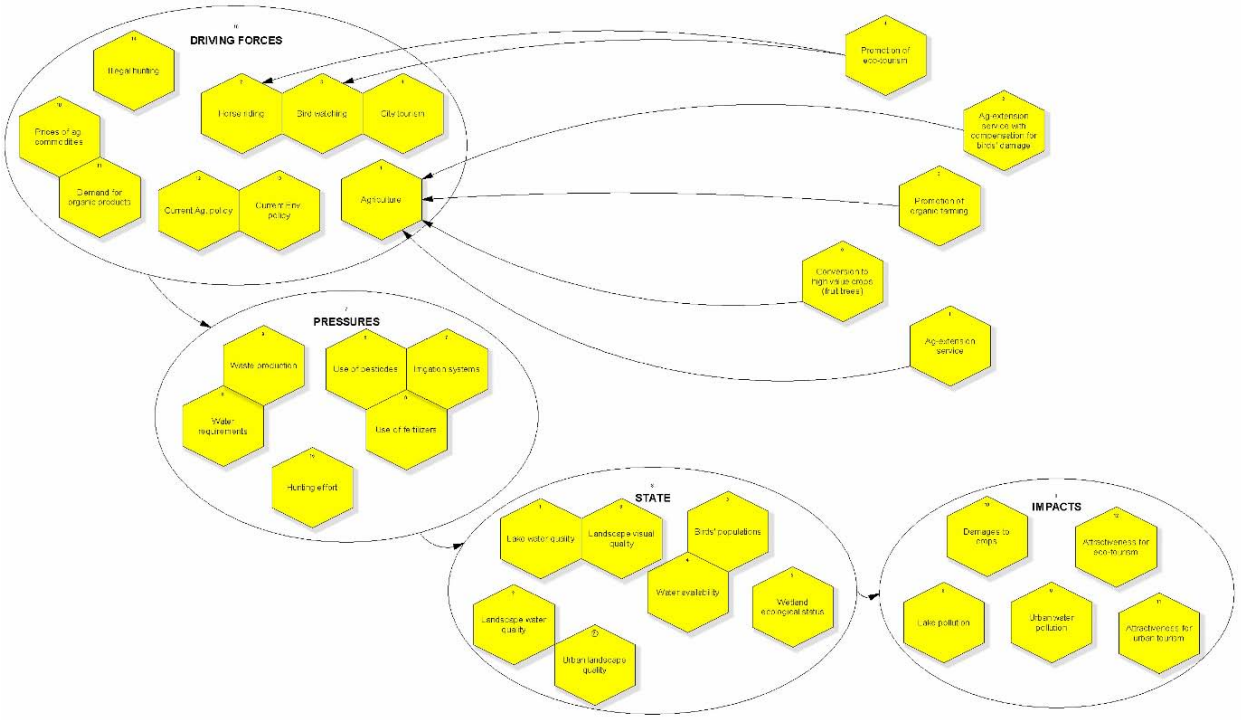
What are the effects of human activities on the state of the environment and what the overall impacts on the study case?

3) Form clusters, singling out driving forces, pressures, state, impacts

4)


DRIVING FORCES
Illegal hunting
Horse riding
Bird watching
City tourism
Prices of ag. commodities
Demand for organic products
Current Ag. policy
Current Env. policy
Agriculture
PRESSURES
Waste production
Use of pesticdes
Irrigation systems
Water requirements
Use of fertilizers
Hunting effort
STATE
Lake water quality
Landscape visual quality
Birds' populations
Landscape water quality
Urban landscape quality
Wetland ecological status
Water availability
IMPACTS
Damages to crops
Attractiveness for eco-tourism
Lake pollution
Urban water pollution
Attractiveness for urban tourism

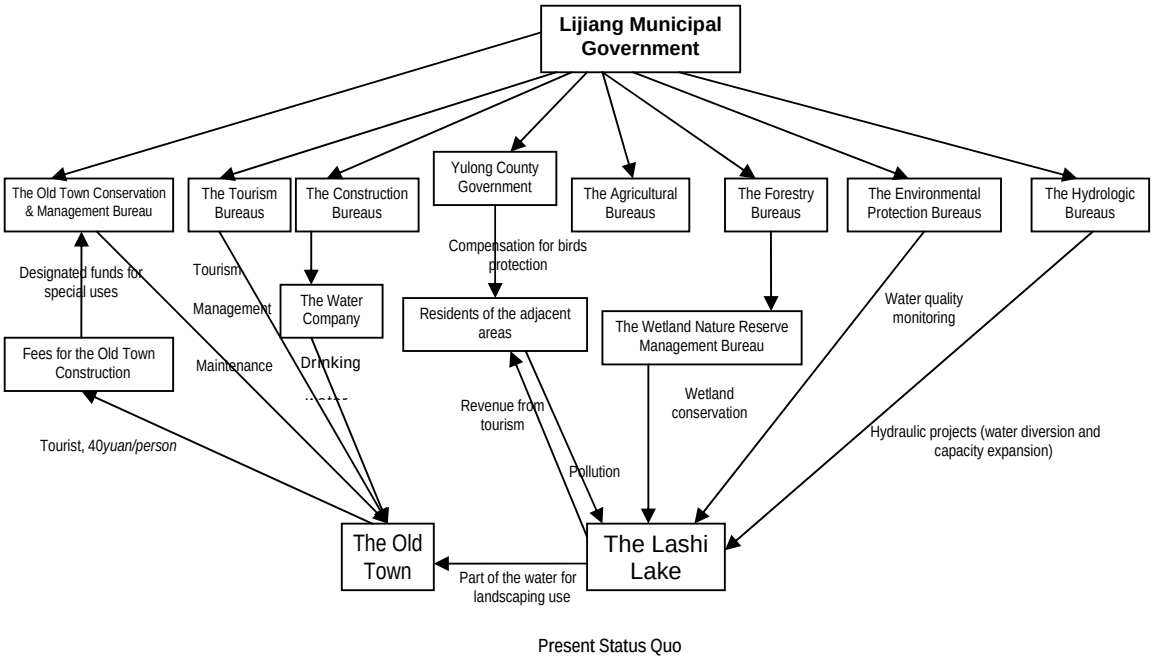
5) Analyse the cause-effects chains



Annex II. Detailed institutional review

(Draft)

Conservation International China)



Full names for the institutions used in the diagram:

Lijiang Municipal Government: Lijiang Municipal People's Government;

The Old Town Protection & Management Bureau: the Old Town Protection & Management Bureau of the World Heritage Site of Lijiang;

The Tourism Bureau: Lijiang Municipal Tourism Bureau, The Old Town District Tourism Bureau of Lijiang Municipality, Yulong Naxi Ethnic

The Construction Bureaus: Lijiang Municipal Construction Bureau, The Old Town District Construction Bureau of Lijiang Municipality, Yulong Naxi Ethnic Autonomous County Construction Bureau of Lijiang Municipality;

Yulong County Government: the People's Government of Yulong Naxi Ethnic Autonomous County;

The Agricultural Bureau: Lijiang Municipal Agricultural Bureau,

The Forestry Bureau: Lijiang Municipal Forestry Bureau, the Forestry Bureau of Yulong Nanxi Ethnic Autonomous County, Lijiang Municipality;

The Environmental Protection Bureau: Lijiang Municipal Environmental Protection Bureau (EPB), the EPB of Yulong Nanxi Ethnic Autonomous County, Lijiang Municipality;

The Hydrologic Bureau: Lijiang Municipal Hydrologic Bureau, the Hydrologic Bureau of Yulong Naxi Ethnic Autonomous County, Lijiang Municipality.

The Wetland Reserve Management Bureau: the Lashi Lake Plateau Wetland Provincial Nature Reserve Management Bureau in Lijiang of Yunnan.

Issues in the mechanism for water resources protection in Lashi Lake

1. A lack of integrative institutional arrangement

Presently, water resources protection implemented in Lashi Lake are basically sectoral efforts, in which, there exists a lack of agreement and coordination between involved sectoral departments, and between the low and high levels of authorities. In future implementation of the pilot project for PES, there is a high possibility that the compensation may not be able to reach those needed. This is attributable to the fact that the use and collection of fees are practiced on a sectoral/departmental basis, and it is very difficult for other sectors and departments to be able to administrate or use the compensation funds.

Therefore, the implementation of the pilot project for PES in the Lashi Lake entails strengthening of the collaboration between various governmental departments, and the coordination between the government agencies and the local communities. This intends to build concerted efforts of all parties so as to promote the ecological protection in the Lashi Lake area.

2. Low management level in the tourism development and management in the Lashi lake area

Currently, tourism in the adjacent areas of the Lashi Lake is mainly developed by the 13 tourism centers administered by the Anzhong Folk Ecotourism Cooperatives of Haidong Administrative Village Office (AVO) and Meiquan AVO. Rendering horse rides, bird watching, boating loop tour on the lake, experience of folkways and customs, as well as visiting the Meiquan Waterfall are the main tourism products in the area. Despite the fact the tourism development has developed into some initial scale, due to poor quality of the management staff and limited management capacity, effective market contacts could not be established, resulting in low management effectiveness and, to some extent, constraining tourism development in the Lashi Lake area. Consequently, this ideal model (of full community participation) has not yet achieved optimal management efficacy.

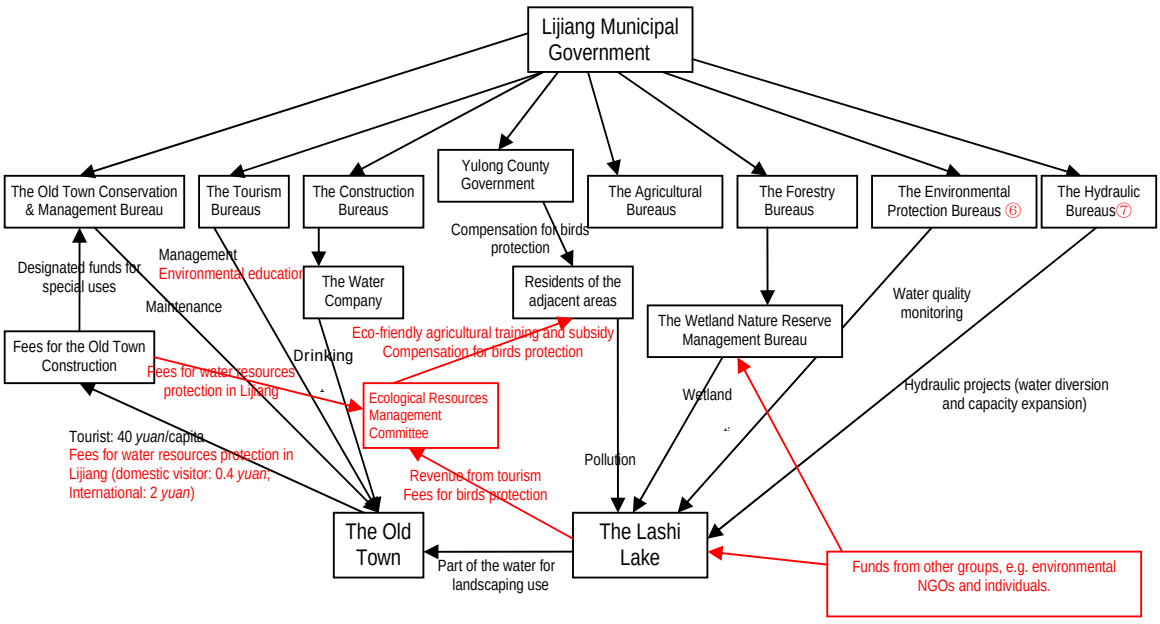
Possibly, one better approach is to invite a professional tourism management company to collaborate with the AVOs in the development and management of the scenic area. Such cooperation, in one way, will not only give full play to the villagers' entrepreneurship of being owners and to mobilize their enthusiasm, but will also avail advanced management experiences, which will allow a harmonious development of both economic benefits and resources protection. A mutual growth through

accumulation of conservation assets from tourism development will contribute to the sustainable development of the region, and to operate the management by tailoring community participation in a more active approach.

3. Unitary/limited funding sources for ecological protection

At the moment, the funds for ecological protection in the Lashi Lake area are largely self-raised by Lijiang Municipal People's Government and Yulong People's County Government. Due to the fact that Lijiang Municipality is still economically underdeveloped, and lacks the capacity to pay a large amount of protection fees over a long periods of time. On the other hand, the goals of government actions are manifold and prone to impacts from other economic, political or social goals. There exist the possibilities that the goals for resources protection will be adversely affected.

Under such circumstances, more liberal thinking, innovation in the investment and funding mechanisms, broadening funding channels are imperative to actively build funding support from the environmental NGOs, other groups and individuals so as to support the actions for water resources protection in the Lijiang Municipality and the Lashi Lake area.



After implementation

Recommendations on implementing PES:

1. Establish a cross-sector management committee by the name of Ecological Resources Management Committee, coordinating whole watershed conservation affairs in Lashi Lake. The committee should be established at the municipal level. It should take responsibility for providing agricultural extension services to local farmers, as well as imposing and distributing the compensation funding for the damages caused by birds. The committee should consist of government officials from different departments, particularly Lijiang Municipal Government, The Old Town Protection & Management Bureau, The Tourism Bureau, The Construction Bureaus, Yulong County Government, The Agricultural Bureau, The Forestry Bureau, The Environmental Protection Bureau, The Hydrologic Bureau, and The Wetland Reserve Management Bureau. Moreover, an independent institution for monitoring should be set up. It should monitor the whole process of decision-making, assessment, and operation of PES funding, and check responsible stakeholders. Those two institutions should be accountable to the Lijiang Municipal Government.

2. To charge the visitors for "fee for resources protection in Lijiang", or to appropriate this part of the funds from the construction budget for the Lijiang Old Town. The rate can be 0.4 yuan per capita for domestic visitors and 2 yuan for international visitors (as they have high willingness to pay for environmental protection). This part of the funds will be channeled to the Ecological Resources Management Committee, and split into two parts for use: (1) for conducting technical training of environment-friendly agricultural techniques for the households in the adjacent areas of The Lashi Lake. Such efforts aims at maintaining or even raising the unit productivity of crops on the basis of decreasing the use of chemical fertilizers and pesticides; (2) for subsidies to the households who are adopting agricultural cultivation techniques that are eco-friendly, at the rate of 25 yuan/mu.

3. In response to the poor income status, from self-organized tourism development by the households in the adjacent areas of the Lashi Lake, it is proposed to set up a tourism development company, which is managed by Ecological Resources Management Committee, with high management level in the Lashi Lake area21. It will cooperate with the AVOs to develop and manage the scenic area. Under the guidance of the tourism bureaus, they will try to promote and improve the contents, scale and quality of tourism (products) in the Lashi Lake, and to improve the revenue from tourism and raise the living standards of local households. With unanimously organized activities of rendering of horse rides, bird watching, boating on the lake, and so on, a fee for waterfowl protection will be collected from visitor at 8yuan/capita, which will be paid to the local households as compensation for the loss from waterfowl deprecation to their crops and farms.

21 Mr. Luo Kangrui, Chair of the Board of Directors of Shui On Group in Hong Kong and some other investors, after a visit to the Lashi Lake in Lijiang, have shown strong interest in investing in the area. See the website link for more details: http://www.yndaily.com/html/20061219/news_92_67052.html

4. Besides the above two sources of funds for protecting water resources and waterfowls, efforts should be made to absorb funding support from environmental NGOs, other groups and individuals to support the actions for water resources protection in Lijiang Municipality and the Lashi Lake area.

Roles of involved institutions

(1) Lijiang Municipal Government: It shall enhance the supervision and inspection on the use of the water resources protection fees in Lijiang and establish the accountability system for the violations and abuse of the fund use to make sure the designated funds is channeled for special uses only. The government should also make use of every opportunity to introduce large projects, investments and to try its utmost to mobilize the planning and design capacity both at home and abroad so as to build the Lashi Holiday and Vacation Center into a top-class scenic area. This will allow visitors to experience the more pristine natural landscape and the ethnic folkways of original ecology while appreciating the traditional ethnic cultures in the Old Town urban area. Ultimately, the government needs to build the branding of a vocational and holiday resort of Lashi Lake, and to better the contents, enlarge the scale and improve the quality of tourism in The Lashi Lake to ultimately achieve expedited and sound development of the Lashi Lake area.

(2) The Tourism Bureaus: Under the leadership of the Municipal Government, the Tourism Bureaus need to formulate the immediate plans and the master plan with long-term vision goals for tourism development in The Lashi Lake, and to institute relevant management regulations. They also need to guide the tourism agencies/operators to conduct environmental education to better the understanding of visitors about water resources protection so that their willingness to pay compensation fees can be enhanced. They also carry the responsibilities to enhance tourism management in The Lashi Lake area to increase income from tourism in the adjacent communities. In connection with the bird watching tourism activities, environmental education needs to be conducted in such a way that people's understanding toward waterfowl protection will be bettered.

(3) Yulong County Government: The government needs to continue to provide compensation in cash to the households adjacent the Lashi Lake to remediate the loss of crops to food sources of waterfowls in the area.

(4) The Agricultural Bureaus: The agricultural bureaus should conduct the extension of agricultural cultivation techniques that are environment-friendly and provide technical assistance/guidance amongst the farming households in the adjacent communities (through the establishment of a professional agricultural training center). This aims at maintaining, or even raising the unit productivity of corps while reducing the volume of chemical pesticides and fertilizers used in agricultural production. At the same time, information about market supply and needs of agricultural produce will be delivered to the households, and efforts will be made to guide the restructuring of the agricultural sector, resources configuration and overall balance in the composition of different crop varieties.

(5) The Forestry Bureaus (the Wetland Reserve Management Bureau): the Bureaus should strength waterfowl protection and monitoring, and build support of the domestic and international research institutes and NGOs to implement projects for biodiversity conservation in the Lashi Lake area. They should also work together with the agricultural bureaus to develop the criteria for compensating local households.

(6) The Environmental Protection Bureaus: In response to the status quo of incomplete water quality monitoring system and a lack of available data about The Lashi Lake, the Bureaus should strengthen the monitoring of water quality in the Lashi Lake, particularly the collection of water quality indicators about agricultural chemicals and organic pollutants, which will be used to assess the outcome of conservation actions.

(7) The Hydrologic Bureaus: In the process of capacity expansion of reservoirs, they need to take a stand to focus more of their attention on restoring ecological services of wetlands, and joint their efforts with the above measures to protect the water resources in the Lashi Lake.

Annex III: Assessment of Land Use and Livelihoods Surrounding the Lashihai Wetlands

(Draft)

ZUO Ting

Introduction

Lashihai Wetlands are located in Lashi Township of Yulong County, Lijiang Municipality, Yunnan Provinces. The whole watershed area of Lashihai is about 257 sq km, and the Lashihai Lake area is about 1000 hectare, which also links to other 3 lakes or reservoirs. Lashihai Wetlands are important habitats for migratory birds. Nevertheless, Lashihai Wetlands are not only the habitat of birds and other wildlife, but also the core resource base supporting village people surrounding the Lashihai Lake. There are about 18 thousands people, 3249 households (2005) living in the watershed, of which, 95% are ethnic Naxi people, and 4% are ethnic Yi people. Naxi people lives in the flat basin area, while Yi people lives in the mountain area.

In the past, Lashihai watershed provided sufficient resources to support people surrounding the lake for their subsistence livelihoods. The traditional productivity of agriculture, livestock and fishing was relatively higher. Averaged annual yield of fish from the lake was around 300 metric tones and gross income from fishing reached to RMB 3 million, or RMB 1000 per household. Since 1990's the whole lake centered agroecosystem became challenging and vulnerable. There was a significant change of land use in 1994. Before 1994, the water volume of lake changed seasonally, some land near lake was only cultivated for spring-harvested crops, and flooded in summer. In 1994, a dam was built to expand the capacity of lake and increase the supply of water to Lijiang City. The expansion of lake capacity resulted in loss of 4 thousands Mu of cultivated land. In 1998, the Lashihai Natural Reserve was established, regulation of controlled fishing was promulgated (fishing ban in winter season for bird) to protect the food chain and habitat of birds. Due to the lack of coordination and increasing demand of market, fishing ban in winter season resulted in overfishing in spring season whish was normally the reproduce period of fish. The government plans to implement the second capacity expansion project to ensure the water supply to Lijiang Old City in dry season. The conflicts among fishing, bird protection, agriculture crops, tourism service, lake capacity expansion occurs. Therefore, PES scheme should be studied and alternative land use and livelihoods options should be considered.

This report is the summary and analysis based on the field trip Lashi Township and villages in August, 2006.

Current Land Use and Livelihoods

The land use and livelihood pattern is very diverse. Agriculture and livestock is still the major part in the economic system, which accounts for about 70% in whole system. Due to the policy and resource limitation, sizes of forestry and fishery become smaller. Non-farm and off-farm activities become increasing, e.g. construction, tourism business, restaurant business.

Table: Economic structure in Lashi Township (RMB Yuan)

Type	2000	2001	2002	2003	2004	2005
Agriculture	14376251	15929917	15402241	15131061	15570000	15600000
Forestry	743902	735562	724552	714130	740000	620000
Husbandry	7927612	8075897	8825617	9269012	9870000	10290000
Fishery	909910	640114	646704	525404	320000	170000
Transportation	2043871	1560261	1902371	2118641	2360000	2120000
Restaurant	735470	692060	830130	841670	960000	1000000
Tourism	372080	377360	380480	455900	440000	460000
Industry	790060	601380	609470	648060	670000	590000
Construction	738438	667740	773940	798041	790000	780000
Others	1190050	1277072	1488522	1726895	1980000	2870000
Total	29827644	30557363	31584027	32228814	33700000	34500000

(Data Source: CI)

Table: Profile of Administrative Villages of Lashi Township

Ad. Village	No. of nature villages	No. of Households	Population	No. of Labors	Geography setting	Crop Land (Mu)	High rate crop land (Mu)	Fruit garden (Mu)	Income per capita
Nanyao	3	468	1747	1072	Mountain	2473	462	190	1434
Junliang	7	714	2965	2070	Basin	3057	2078	200	1605
Meiquan	3	554	2222	1268	Basin	2482	2482	250	1662
Haidong	7	553	2195	1100	Basin	5023	5023	1077	1754
Hainan	4	619	2576	1199	Basin	5055	5055	1100	1666
Jiyu	4	798	3239	1720	Basin	5792	3641	861	1790

(Data Source: Lashi Township Statistics)

Hillside Agriculture in Nanyao Yi Village

In the mountainous Yi villages (Nanyao Village), there exit hillside agriculture, grazing animal husbandry and collecting of forestry products, which are different from land use and livelihood patterns of Naxi village surrounding Lashihai Lake. The elevation of Nayao is highest in the township, major crops are potato, buckwheat, turnip (as fodder crop). Most of agricultural land (5/6) has been converted for tree plantation by the national Slopy Land Conversion Program. Now, major source of income comes from the program, in average, each household has 20 mu or more land converted, for one mu of converted land, the household has gotten 260 Yuan subsidy. Because of lack of fodder, pig raising is in small scale, only for self consumption in

winter. Goat grazing is considerably important, which is second source of cash after government subsidy of land conversation program. Although Nanyao Yi village is the most vulnerable group in the watershed, since it is not directly surrounding the lake, this report will mainly describe the villages surrounding Lashihai lake.

Agriculture in Basin Villages

Size of agricultural land is quite small, varying from 4-9 mu per households, and around 2 mu per person. Naxi people has long history of agriculture. The seasonal flooding of lake created fertile land. Agriculture yield in basin area is relatively higher. There are two crop seasons: winter-spring season and summer-autumn season. In winter-spring season, there are wheat, barley, rape seeds, peas, horse beans, etc. cropped. In summer-autumn season, corn, soybean, red beans, potato, etc. cropped. New crops introduced recently, such as fodder crops, oil crops (oil sunflower). Some crops are intercropped with each other, e.g., wheat intercropped with peas, corn intercropped with soybeans. Most of products serves half purpose of market, half purpose of home consumption (including as fodder of livestock). Vegetable, in some villages, become major commercial crop for increasing city demand. In winter season, wheat, rape seeds and horse bean are often threatened by birds, every year, around 400 Mu of crops near the lake will be completely damaged.

Organic fertilizers are still popularly used, while, chemical fertilizers are increasingly used. Livestock manure is used as “basic” fertilizer before sowing. For summer-autumn crops, compost will be made and used. Due to increased opportunity cost of labor, chemical fertilizers gradually plays key roles in maintain yield. From 1997 to 2004, the total cultivated land in Lijiang was reduced about ten percents, while chemical fertilizer used was doubled, averaged chemical fertilizer used per mu increased from 18.3 Kg/mu to 39 Kg/mu. The increased use of chemicals (including pesticide and plastics) will result in long-term non-point pollution to soil and water.

Table: Chemical use in Lijiang Prefecture

Year	Averaged chemical fertilizer used Kg/mu	Total Chemical fertilizer used (Tonnes)	Total Cultivated land (Mu)
1997	18.31036745	27905	1524000
1998	19.72609053	29959	1518750
1999	25.10834486	38122	1518300
2000	25.917988	39181	1511730
2001	30.56898823	45704	1495110
2002	32.52390572	48298	1485000
2003	36.61205674	51623	1410000
2004	39.00143062	54524	1398000

(Data Source: Yunnan Statistics)

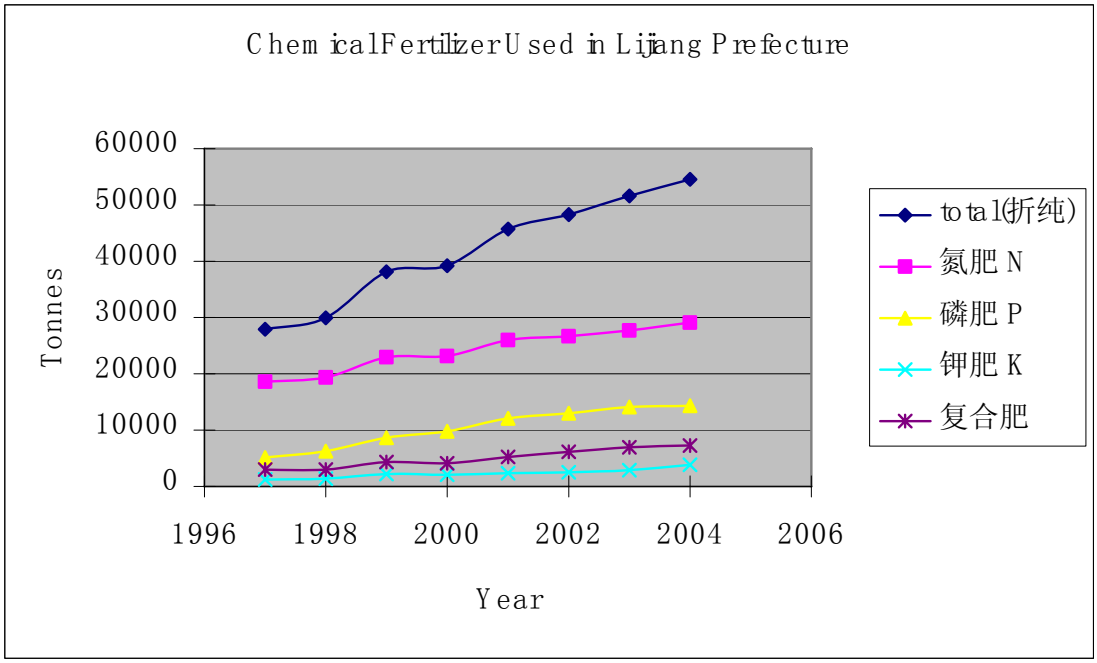
Due to the small scale of economics, low price of crop and increased cost of inputs, sole crop system is not profitable, villagers have to use grain produced as fodder for pig and other livestock to prolong the value chain, so that profit can be made from a crop-livestock system.

Table: Production Cost of Different Crops

Unit: Yuan/Mu

	Seeds	Chemical Fertilizer	Pesticide	Plastics	Labor (man-day)
Corn	20	200	20		18～19
Wheat		50～60	30～40		10～15
Barley		50～60	15		10～15
Rape seeds		120	30～40		15
Horse bean		50～60	15		10
Red baens		30			<6
Rice					>20
Vegetable（Chili）		110		35	10
Vegetable（cabbage）	20	450			>25
Yam					>40

(Data Source: Collected from field survey)



Fruit Garden

There is a long history of fruit tree plantation, but before, most of fruit produced was for home consumption, since the booming of tourism development and new variety introduced, fruit garden become more profitable than annual agricultural crops. Fruit trees in Lijiang includes apple, peach, pear, and some local species, e.g. Huanghong

(in Chinese, a small apple), walnut, etc. Villages used to plant fruit trees in dry land (where there is no irrigation for agricultural crops). Peach is most expensive but difficult for preserve if not sold out immediately, price of apple is stable and pear is easy for management. In fruit garden, vegetables or other foliage fodder crops (菊苣) are normally intercropped.

In general, annual income from fruit garden is higher than agricultural crop (e.g. corn). Now, in the whole township, area of fruit garden reaches to 9000 mu. However, more investment is needed in first 3-5 years when there is no fruit harvested. For some small and poor households, credit and technical supports are needed. In contrast to agricultural crops, fruit garden need more pesticides.

For upland area, owing to Slopy Land Conversion Program, some fruit and economic trees planted, e.g. apricot tree, medlar, Qingciguo, etc. Since the low land fertility and poor management, there is no real benefit from the program.

Production cost of fruit garden

	seedling	Chemical fertilizer	pesticides	plastics	Labor input Man-day
Apple	240	150	200	32	>15
Pear	320	50	50		
Peach	200	150	200	32	

(Data Source: Collected from field survey)

Vegetable Greenhouse

Coping with the demand of tourist market of Lijiang, particularly to best use the climate resources, in many villages, villagers have built greenhouses for vegetable plantation. One greenhouse occupies about half mu of land (more than 300 square meters), costs 8000 Yuan for investment of frames, plastics, etc. Several villagers are trying to produce green/organic vegetables, but need further certification. Government provides some assistance for greenhouse construction. In the summer, chili, tomato, cucumber are common, sword beans are produced, in winter, carrot, radish, spinach, etc. are produced. In average, each day, about 50 Yuan can be earned from a greenhouse. Now, there is no certification system, the gap of price between “green” vegetable and common vegetable is not significant.

In addition to the initial investment, annual cost for vegetables in one greenhouse are: 70 Yuan of pesticide, 200 Yuan for chemical fertilizer (with supplement of organic manure), and 240 Yuan for labor hiring. Some families combine greenhouse facility with pig pen and biogas facility together, which will save a lot of cost for fertilizer. Some owners started to test and use new biological fertilizers which seems no environmental pollution.

Pig Raising

Pig raising is a very common activities in Lashi villages. There are two kinds of pig raising farm, small proportion is large scale commercial pig farm, some pig farm raise 120 heads of pigs in pen. Such big pig farm holder raise sow and breeds piglets. The piglets are sold out after they grow up to 100 Kg weight. In addition to the fodders produced by the family farm (green fodders and corn), huge amount of commercial fodders (corn or complex fodders) are bought, around 40 thousands Kg (for 120 heads of pigs).

For most villagers, only 2-4 pigs are raised in one year, villagers buy piglets of 3 months old and then fatten them. Such small scale pig raising itself is not cost-benefit effective, if all the fodder be bought from the market. Pig raising, to a certain extent, is for subsistence purposes, including manure making, meat and fat (as cooking oil) and a "machine" transforming minor resources (e.g. food residue) to a large one. In such traditional pig farm, female labor pays dominant role in feeding pigs, while in a large commercial pig farm male labors are necessary.

Fishing Fishery

Fishing is a very old business in Lashihai villages. Before most of households surrounding enjoyed partial agriculture and partial fishery. Income from fishing is used to be one third of all income. There is one village, its name is called "Fishing Village"(Dayu Cun). The fishing technology in past was lower which allowed a sustainable use of fish resources. After 1996, "tragedy of commons" happened in Lashihai Lake, fish resource declined rapidly. The production of fish in 1996 was the largest, reached to 380 Tonnes, and now it is only around 20 Tones of small fish. Now, there are still few fishing farmers (10%) who capture small fish, edible seaweed, water dragonfly, and snails, etc.. There are different opinions on the causes to the decline of fish resource. The impact of fishery resource decline is fundamental, which affects the food chain of migratory birds, and finally strengthen the damage of agricultural crops.

Tourist Service of Horse Riding

The tourism development in Lijiang also bring tourists to Lashihai villagers. In fact the lake, lake side and traditional cultural in Lashihai are attractive. In winter season, tourists come to watch birds. However, an all year around tour activity is provide horse to tourist for riding. Now, around the lake there are about 3 to 5 horse riding filed.

Horse riding business is managed by the village collective. For example, the horse riding cooperative in Anzhong Village consists of 43 members of households (whole village has 57 households). Each household have one labor and one horse in the cooperative. 43 household labors are divided in to four groups to rotationally come to the field. Each labor get 800-1000 Yuan per month.

Horst riding business merges well within the local agroecosystem, Naxi people used to use horse for carrying and Lijiang short-leg horse is a famous breed of horse. Horse raising can consume a lot of agriculture crop product and elongate the agriculture

value chain at home. Some of local products (fruits, nuts, handicrafts) can be directly sold in the horse riding field.

Quantitative Assessment of Different Land Use Options

In this session, several different land use models will be analyzed. The model of Crops+Fruits is the common one, in which chemical fertilizer will be use more and more to maintain a stable yield. The Models of Crops+Livestock and Crops+Livestock+ Fruits are recommended ones to alternate the common one, in which livestock manure will be used to replace chemical fertilizer. And fodder crops intercropped under fruits will reduce cost of feedstuff.

Model of Crop

In the models below, we assume:

- each management unit of farm has two labors,
- mu of cultivated land,
- there are two crop seasons, winter crops are wheat and barley, summer crops are corn and soybean.
- The management period lasts 15 years.

According to the analysis, this model is not cost-benefit effective. This model is not sustainable due to the continuously increased cost of chemical fertilizr.. This is why Chinese small farm holders have to become integrated ones.

Table: Input of the Model of Crop

Year	Land (Mu)	Rent of land (Yuan/m)	Labor (day)	Labor Price (yuan/day)	Fertilizer (Kg)	Price of Fertilizer Yuan/kg	Cost of Pesticide and others
1	8	50	260	30	50	2	60
2	8	50	260	30	52.43	2	60
3	8	50	260	30	54.811	2	60
4	8	50	260	30	57.145	2	60
5	8	50	260	30	59.432	2	60
6	8	50	260	30	61.674	2	60
7	8	50	260	30	63.87	2	60
8	8	50	260	30	66.023	2	60
9	8	50	260	30	68.132	2	60
10	8	50	260	30	70.2	2	60
11	8	50	260	30	72.226	2	60
12	8	50	260	30	74.211	2	60
13	8	50	260	30	76.157	2	60
14	8	50	260	30	78.064	2	60
15	8	50	260	30	79.933	2	60

Table: Output of the Model of Crop

Year	winter crops (kg/mu)	price of winter crops (yuan/kg)	sumer crops (kg/mu)	price of sumer crops (yuan/kg)
1	400	1	500	1.2
2	400	1	500	1.2
3	400	1	500	1.2
4	400	1	500	1.2
5	400	1	500	1.2
6	400	1	500	1.2
7	400	1	500	1.2
8	400	1	500	1.2
9	400	1	500	1.2
10	400	1	500	1.2
11	400	1	500	1.2
12	400	1	500	1.2
13	400	1	500	1.2
14	400	1	500	1.2
15	400	1	500	1.2

Table: Cost and Benefit of Model of Crops

Year	Present Value of benefit - Present Value of Cost (B-C)	Discounted Value- Discounted Value	Discounted Value/Discounted Value (B/C)
1	-1480	-1480	0.8438819
2	-1518.88	-1481.545064	0.840435
3	-1556.9824	-1481.380107	0.8370843
4	-1594.32275	-1479.62088	0.8338264
5	-1630.9163	-1476.377039	0.8306582
6	-1666.77797	-1471.75244	0.8275767
7	-1701.92241	-1465.845413	0.8245788
8	-1736.36396	-1458.749033	0.821662
9	-1770.11668	-1450.551376	0.8188234
10	-1803.19435	-1441.335756	0.8160605
11	-1835.61046	-1431.180959	0.813371
12	-1867.37825	-1420.161466	0.8107523
13	-1898.51069	-1408.34766	0.8082024
14	-1929.02048	-1395.806029	0.805719
15	-1958.92007	-1382.599354	0.8033
Total	-25948.9168	-21725.25258	0.8235486

Model of Crops + Livestock

In the models below, we assume:

- each management unit of farm has two labors,
- mu of cultivated land,
- there are two crop seasons, winter crops are wheat and barley, summer crops are corn and soybean.
- Apart from agriculture, the household raise 5 pigs start from 3 months piglet.
- In this model, the pigs manure replacing the fertilizer in great part, but the feedstuff have to pay.
- The management period lasts 15 years.

According to the analysis, this model is not cost-benefit effective. Because small pig farm normally can not afford commercial fodders.

Table: Input of Model of Crop + Livestock

Year	Land (mu)	Market Price of Land yuan/mu	Labor （day）	Market Price of Labor(yuan /day)	Fertilizer (kg/mu)	price of fertilizer (yuan/kg)	pesticide and others (yuan/mu)	Feedstuff, 5 pigs, 6 month, (kg)	price feedstuff (yuan/kg)	price of piglet (yuan/ 5head)
1	8	50	300	30	10	2	50	2700	1.1	200
2	8	50	300	30	13.23	2	50	2700	1.1	200
3	8	50	300	30	16.3954	2	50	2700	1.1	200
4	8	50	300	30	19.4975	2	50	2700	1.1	200
5	8	50	300	30	22.5375	2	50	2700	1.1	200
6	8	50	300	30	25.5168	2	50	2700	1.1	200
7	8	50	300	30	28.4365	2	50	2700	1.1	200
8	8	50	300	30	31.2977	2	50	2700	1.1	200
9	8	50	300	30	34.1018	2	50	2700	1.1	200
10	8	50	300	30	36.8497	2	50	2700	1.1	200
11	8	50	300	30	39.5427	2	50	2700	1.1	200
12	8	50	300	30	42.1819	2	50	2700	1.1	200
13	8	50	300	30	44.7682	2	50	2700	1.1	200
14	8	50	300	30	47.3029	2	50	2700	1.1	200
15	8	50	300	30	49.7868	2	50	2700	1.1	200

Table: Output of Model of Crop + Livestock

Year	winter crops (kg/mu)	price of winter crops (yuan/kg)	sumer crops (kg/mu)	price of sumer crops (yuan/kg)	livestock (kg/head)	price of livestock (yuan/kg)
1	400	1	500	1.2	100	7
2	400	1	500	1.2	100	7
3	400	1	500	1.2	100	7
4	400	1	500	1.2	100	7
5	400	1	500	1.2	100	7
6	400	1	500	1.2	100	7
7	400	1	500	1.2	100	7
8	400	1	500	1.2	100	7
9	400	1	500	1.2	100	7
10	400	1	500	1.2	100	7
11	400	1	500	1.2	100	7
12	400	1	500	1.2	100	7
13	400	1	500	1.2	100	7
14	400	1	500	1.2	100	7
15	400	1	500	1.2	100	7

Table: Cost and Benefit of Model of Crop + Livestock

Year	Present Value of benefit - Present Value of Cost	Discounted Value-Discounted Value	Discounted Value/Discounted Value
1	-1630	-1630	0.8758568
2	-1681.68	-1640.343348	0.8724229
3	-1732.3264	-1648.20994	0.8690838
4	-1781.95987	-1653.758645	0.8658361
5	-1830.60067	-1657.140105	0.8626768
6	-1878.26866	-1658.497132	0.859603
7	-1924.98329	-1657.965077	0.8566119
8	-1970.76362	-1655.672192	0.8537007
9	-2015.62835	-1651.739969	0.8508668
10	-2059.59578	-1646.283465	0.8481079
11	-2102.68387	-1639.411614	0.8454214
12	-2144.91019	-1631.22752	0.8428051
13	-2186.29199	-1621.828742	0.8402568
14	-2226.84615	-1611.30756	0.8377744
15	-2266.58922	-1599.751236	0.8353558
	-29433.1281	-24603.13654	0.8555837

Model of Crop+Fruit

In the models below, we assume:

- each management unit of farm has two labors,
- half (4 mu) of cultivated land, there are two crop seasons, winter crops are wheat and barley, summer crops are corn and soybean,
- another half (4 mu) of the land used for fruit garden (apple, peach and pear).
- The management period lasts 15 years.

According to the analysis, this model is cost-benefit effective. However, due to the linkage between fruit and crop is not supplementary, the effectiveness is not higher.

Table: Input of Model of Crop + Fruits

Year	Land (Mu)	Rent of land (Yuan/m)	Labor (day)	Labor Price (yuan/day)	Fertilizer (Kg)	Price of Fertilizer Yuan/kg	Cost of Pesticide and others
1	8	50	160	30	45	2	54
2	8	50	160	30	47.53	2	54
3	8	50	160	30	50.0094	2	54
4	8	50	170	30	52.4392	2	54
5	8	50	170	30	54.8204	2	54
6	8	50	170	30	57.154	2	54
7	8	50	170	30	59.4409	2	54
8	8	50	170	30	61.6821	2	54
9	8	50	170	30	63.8785	2	54
10	8	50	170	30	66.0309	2	54
11	8	50	170	30	68.1403	2	54
12	8	50	170	30	70.2075	2	54
13	8	50	170	30	72.2333	2	54
14	8	50	170	30	74.2187	2	54
15	8	50	170	30	76.1643	2	54

Table: Output of Model of Crop + Fruit

Year	winter crops (kg/mu)	price of winter crops (yuan/kg)	sumer crops (kg/mu)	price of sumer crops (yuan/kg)	fruits (kg/mu)	price of fruits (yuan/kg)
1	400	1	500	1.2	0	1.5
2	400	1	500	1.2	0	1.5
3	400	1	500	1.2	500	1.5
4	400	1	500	1.2	1000	1.5
5	400	1	500	1.2	1000	1.5
6	400	1	500	1.2	1000	1.5
7	400	1	500	1.2	1000	1.5

8	400	1	500	1.2	1000	1.5
9	400	1	500	1.2	1000	1.5
10	400	1	500	1.2	1000	1.5
11	400	1	500	1.2	900	1.5
12	400	1	500	1.2	900	1.5
13	400	1	500	1.2	900	1.5
14	400	1	500	1.2	800	1.5
15	400	1	500	1.2	800	1.5

Table: Cost and Benefit of Model of Crop + Fruit

Year	Present Value of benefit - Present Value of Cost	Discounted Value-Discounted Value	Discounted Value/Discounted Value
1	-2352	-2352	0.6297229
2	-2392.48	-2333.671479	0.6257352
3	567.8496	540.2765639	1.088283
4	3228.972608	2996.667572	1.4768807
5	3190.873156	2888.51848	1.4686171
6	3153.535693	2784.54835	1.4606079
7	3116.944979	2684.587421	1.4528432
8	3081.086079	2588.473059	1.4453135
9	3045.944358	2496.049452	1.4380098
10	3011.505471	2407.16732	1.4309233
11	2377.755361	1853.878187	1.3386033
12	2344.680254	1783.154826	1.332328
13	2312.266649	1715.278899	1.326235
14	1680.501316	1215.98184	1.2360421
15	1649.37129	1164.120844	1.230661
	28016.80681	22433.03134	1.2592725

Model of Crop+Fruit+Livestock (CFL Model)

In the model below, we assume:

- each management unit of farm has two labors,
- half (4 mu) of cultivated land, there are two crop seasons, winter crops are wheat and barley, summer crops are corn and soybean,
- another half (4 mu) of the land used for fruit garden (apple, peach and pear).
- Apart from agriculture and fruit, the household raise 5 pigs start from 3 months piglet.
- In this model, the pigs manure replacing the chemical fertilizer in great part, intercropped chicory within fruit garden as green fodder crop used as animal feed.

- The management period lasts 15 years.

According to the analysis, this model is highly cost-benefit effective. Therefore, it is our recommended model. In this model, crop, fruit and livestock is combined in one agrosystem, use of material and energy is more efficient. .

Table: Input of Model of Crop + Fruit + Livestock

Year	Land(mu)	Market Price of Land(yuan/mu)	Labor（day）	Market Price of Labor(yuan/day)	fertilizer (kg/mu)	price of fertilizer (yuan/kg)	pesticide and others (yuan/mu)	Feedstuff, 5 pigs, 6 month, (kg)	price of feedstuff (yuan/kg)	price of piglet (yuan/ 5head)
1	8	50	200	30	5	2	50	100	1.1	200
2	8	50	200	30	8.33	2	50	100	1.1	200
3	8	50	200	30	11.5934	2	50	100	1.1	200
4	8	50	210	30	14.7915	2	50	100	1.1	200
5	8	50	210	30	17.9257	2	50	100	1.1	200
6	8	50	210	30	20.9972	2	50	100	1.1	200
7	8	50	210	30	24.0072	2	50	100	1.1	200
8	8	50	210	30	26.9571	2	50	100	1.1	200
9	8	50	210	30	29.848	2	50	100	1.1	200
10	8	50	210	30	32.681	2	50	100	1.1	200
11	8	50	210	30	35.4574	2	50	100	1.1	200
12	8	50	210	30	38.1782	2	50	100	1.1	200
13	8	50	210	30	40.8447	2	50	100	1.1	200
14	8	50	210	30	43.4578	2	50	100	1.1	200
15	8	50	210	30	46.0186	2	50	100	1.1	200

Table: Output of Model of Crop + Fruit + Livestock

Year	winter crops (kg/mu)	price of winter crops (yuan/kg)	sumer crops (kg/mu)	price of sumer crops (yuan/kg)	fruits (kg/mu)	price of fruits (yuan/kg)	livestock (kg/each)	price of livestock (yuan/kg)
1	400	1	500	1.2	0	1.5	100	7
2	400	1	500	1.2	0	1.5	100	7
3	400	1	500	1.2	500	1.5	100	7
4	400	1	500	1.2	1000	1.5	100	7
5	400	1	500	1.2	1000	1.5	100	7
6	400	1	500	1.2	1000	1.5	100	7
7	400	1	500	1.2	1000	1.5	100	7
8	400	1	500	1.2	1000	1.5	100	7
9	400	1	500	1.2	1000	1.5	100	7
10	400	1	500	1.2	1000	1.5	100	7
11	400	1	500	1.2	900	1.5	100	7
12	400	1	500	1.2	900	1.5	100	7
13	400	1	500	1.2	900	1.5	100	7
14	400	1	500	1.2	800	1.5	100	7
15	400	1	500	1.2	800	1.5	100	7

Table: Cost and Benefit of Model of Crop + Fruit + Livestock

Year	Present Value of benefit - Present Value of Cost	Discounted Value-Discounted Value	Discounted Value/Discounted Value
1	310	310	1.0431154
2	256.72	250.4096762	1.0354425
3	3204.5056	3048.90463	1.4392445
4	5853.335488	5432.223427	1.7654757
5	5803.188778	5253.301278	1.7539731
6	5754.045003	5080.778555	1.7428451
7	5705.884103	4914.409717	1.7320759
8	5658.686421	4753.959147	1.7216503
9	5612.432692	4599.200741	1.7115543
10	5567.104038	4449.917505	1.7017745
11	4922.681958	3838.095731	1.6170848
12	4879.148318	3710.645346	1.608308
13	4836.485352	3587.787452	1.5997987
14	4194.675645	3035.195131	1.517521
15	4153.702132	2931.669334	1.5098883
	66712.59553	55196.49767	1.5625344

Discussion and Conclusion

Lashihai watershed is important to sustainable development of Lijiang. The watershed and local people contributes a lot of efforts (and livelihood loss) to ecological and environmental service, e.g. cultivated land conversion in upland, logging ban, seasonal ban of fishing, provision of habitat for birds, provision of water to downstream city by limit of use of chemicals, provision of scenic landscape, etc.. Payment to the ecological and environmental services produced by the watershed and local people is an expression of social environmental equity. Local people should equitably share the benefit from Lijiang tourism development. PEES may either support the livelihoods of local people or support the management of the watershed, which both links to the land use..

Land use in Lashihai watershed is unique, which centered to the lake, but different components (fishery, agriculture, fruit, livestock and ethnic culture) link with each other. An integrated land use approaches based on local agroecosystem should be adopted to effectively use local resource. The current land use and agroecosysytem in Lashihai watershed is vulnerable, under the pressure of market, lake capacity expansion and tourist pollution. CFL Model (the integrated management of ecosystem to enhance the internal material flow of crop + fruit + livestock is needed to sustain villagers' livelihoods, while use of chemical fertilizers will be reduced) should be introduced and strengthened. CFL Model will benefit to both the water quality and bird habitat. It is suggested project support each administrative village a paid extension staff based on PEES scheme, to strengthen the experiment and extension on "green fertilizer", etc..

In order to raise the economic value of land us in the integrated and "green" way (less or no chemical fertilizer), labeling oriented market institutional intervention should be considered as one activity of PESS scheme to provide a preferential condition of local products. Such labeling could be a geographic one, which can also play role of advocacy and propaganda.

Although the whole watershed is a integrated one, the inside heterogeneity is higher. A bottom-up and participatory process of the planning and designing of PEES scheme is necessary. A platform should be built to involve all stakeholders, e.g. villagers as primary stakeholders, government agencies (township government, NR administration, tourism agency, water resource administration, etc.), downstream communities, etc.