

# **Renewable Energy and Agriculture:**

Promoting Biogas in the Rural Communities of the  
Lashihai Wetland Nature Reserve

Amanda Lee  
Clark University '09  
SIT Yunnan, China  
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## **Introduction**

“China’s economic miracle will end soon because the environment can no longer keep pace.” – Pan Yue, deputy environmental director (Larson, 21)

In recent years, the causes and impacts of global warming have increasingly garnered press on an international scale. Scientists have confirmed global warming as being mostly anthropogenic (Rosenthal and Revkin; Xuequan). More wildlife species have become endangered or extinct (Roach) and natural disasters such as storms have increased in severity (“New study”; Schmid). With the 2008 Beijing Olympics quickly approaching, the international community has turned its eye to China and its policies, including those towards the environment. Since last year, news articles including a report made by the Netherlands Environmental Assessment Agency, have been released stating that in 2006, China surpassed the United States in being the world’s greatest carbon dioxide emitter (Gregg, Andres, Marland 1). China, with a burgeoning population of over 1.3 billion people (China Population Development and Research Center) and an average GDP growth rate of 9.4 % (Xiong), is still struggling to make headway on environmental protection. To understand the current mentality of many Chinese people, who believe that environmental degradation is an acceptable consequence of economic development, the history of environmental protection in China must be examined. From there, potential for increasing sustainable development and reducing pollution through means of renewable energy will be investigated using a rural village in the Lashihai Wetland Reserve as a case study.

*Pre-Modern Views of Nature*

During the era of imperial rule, texts often preached environmental wisdom and harmony with nature. However, these written statements were not inspired by tranquil relations between human and nature but more in reaction to emerging environmental crises (Elvin 738). Confucian beliefs that supported the idea of man conquering nature combined with the country's need to support a growing population resulted in much deforestation and over-extraction of natural resources (Economy 36-37). In the fourth to sixth centuries, landscape poetry emerged, and a few centuries later, landscape painting followed suit. Although the central focus of both arts was on the meaning of nature, as well as harmony between man and nature, neither was able to prevent people from continuing to degrade the environment (Elvin 755). The archaic Chinese view of nature during the late imperial period was not uniform. Instead, Elvin states, they ranged the whole spectrum from wanting to attack and conquer nature to thinking that Heaven passed judgment on humans by means of natural phenomena (755).

*Mao's Environmental Legacy*

The aforementioned Confucian beliefs only partially inspired the views that still remain today. It was during the Modern era, under Mao and Deng, when they truly prevailed and became deep-rooted in Chinese society. Up to the Communist Revolution of 1949, wars waged domestically between the Nationalists and Communists as well as the war against Japan drew the country's attention away from the prevailing famine, environmental degradation, and mass migration to cities (Economy 46). During the first five to seven years after the revolution, Mao tried to address the first and latter issues by rebuilding the economy and agriculture base.

Nevertheless, people still built industrial factories along rivers that they used as drainage while completely failing to treat waste water (Economy 47).

In 1958, Mao launched the Great Leap Forward where he instigated a land reform that redistributed land amongst the peasants. This empowered the peasants in that they could make collective decisions on publicly owned resources and gain collective capital (Muldavin 247). Village leaders could depend on assembling teams to either defend or exploit these resources. Since the main purpose of the Great Leap Forward was to again increase grain yields, peasants planted seeds closely, participated in deep plowing, and heavily used fertilizers and tractors without concern about employing such environmentally harmful methods (Economy 52). Economy lists an example where peasants in Guizhou dug up to 13-foot deep trenches in order to sow seeds (52). A famous picture of this period is one of children being supported by a field of wheat which further encouraged production of an unreasonable and impossible amount of crop output (China: A Century). Combined with unsustainable agricultural methods was the mass movement to make steel and iron in hopes of surpassing the West. Peasants throughout the country, working within township-village government-owned enterprises (TVE's), built backyard furnaces to smelt useful sundry items such as pots, bicycles, and bed frames into useless metal (Economy 53). The Great Leap Forward came to an end with the Great Famine of 1961-63 when the movement dissipated with results contrary to its name.

Mao was quick to start a new movement, the Cultural Revolution, in 1966 which lasted until his death in 1976. The Cultural Revolution kept in line with the Great Leap Forward in that it solely focused on grain and industrial production without paying heed to environmental regulations. As a result, people destroyed forests and pastures, filled lakes, and created artificial plains in order to expand the

area of arable land (Economy 54). Industry emphasized increased output without using appropriate or clean technologies thus much energy and raw materials were wasted (Economy 54). Factories – which Mao ordered, under his ‘Third Front’ policy, to be relocated further inland to avoid foreign attack – spewed toxic waste into mountain ecosystems, including the water (Economy 54).

The greatest difference between the Cultural Revolution and The Great Leap Forward was that instead of promoting collectivization, the Cultural Revolution semi-privatized land. With this came the loss of products and labor as collective rights (Muldavin 247-8). In reaction to this new economic insecurity, peasants looked for short-term opportunities where they would race to exploit natural resources before others could (Muldavin 249). For the rest of the country, in order to overthrow any dissent within the Party, Mao encouraged citizens to revolt against officials (“China: A Century”). People were thrown into a constant fear of being accused as bourgeois or counter-revolutionary with penalty of death or hard labor. This prevailing mentality cast the country into a state of chaos where factions of Red Guards, youth all claiming to be followers of Mao, became violently out of control. It is no wonder that when universities shut down and people were silent with fear, no one could protest against any environmental degradation or any other widespread social injustices.

Towards the end of the Cultural Revolution, some notable improvements happened. In 1972, China participated in the United National Conference on Human Environment in Stockholm. Yet, according to Barbara Finamore, a senior attorney for the Natural Resources Defense Council in New York City, China was not entirely receptive to implementing new environmental policies:

[China’s] Stockholm delegates took a hard-line position that global environmental policies were primarily designed to benefit developed countries, which they felt were trying to force standards on developing countries before they could actually develop. One of

the reasons China attended the 1972 Stockholm Convention was to make their position clear (Clay A526).

Regardless, in 1973, Beijing held the first National Environment Conference because of advocacy by Premier Zhou Enlai. In 1974, the State Council established the Environmental Protection Leading Group. These advancements towards environmental protection came late in Mao's career and Sanders, amongst other scholars, expressed disappointment that despite Mao's promotion of empowering the public and collective action, public goods and spaces were not protected (1204).

### *Deng's Continued Decentralization*

Deng Xiaoping's legacy was mainly in economic reform through means of further opening the market and decentralizing the state. An example of such is the Household Responsibility System where land was divided into household-plots. Thereafter, local government, instead of villagers, gained management over any remaining communal capital, such as irrigation ditches, terraces, and forest and grassland reserves (Muldavin 253).

On the environmental front, Deng made some progress. In 1979, the first Environmental Protection Law was passed. However, Deng simultaneously launched the 'Four Modernizations' campaign which promoted rapid growth and technologic development of agriculture, industry, science and technology, and national defense (Patterson 53). The campaign's first step to developing quickly was examining existing industries and methods. Afterwards, improved technology and the construction of new factories largely increased industrial productivity (Patterson 53). As a result, peasants could only control production and they gradually made fewer and fewer decisions about land and resource management due to the market replacing

collective action (Muldavin 254). In 1979, Arthur H. Patterson made the following observation in his environmental research paper:

Although the people of China display much affection and concern for their environment (as, for example, in their artwork, parks, and decorative plantings), the realities of a “survival” economy have not allowed for environmental protection...[furthermore] laws [have been] passed requiring the provinces to reduce...pollution [however] a recent news article noted that China has closed four industrial plants...which were polluting the town of Kweilin (Guilin). However, the justification for the closings was not health related, but rather that Kweilin’s value as a tourist resort was being threatened (57).

The One Child Policy was also established in 1979 in order to curb the China’s population, which increased by 71% during Mao’s reign (Sanders 1203). Although population control decreases human impact on the environment by putting less pressure on resource consumption, the means by which this policy was and is implemented has been highly controversial. Under Deng, Sanders remarked, “[population control was] enforced through exhortation, forced abortions and stringent penalties for transgressors” (1207).

Regarding TVEs, they were even further established during this period by managing and designating more raw materials for local industries, such as textile and cigarette factories, instead of subsistence food for the peasants (Muldavin 255). TVEs contributed greatly to environmental degradation due to a lack of necessary technology and skill. Muldavin provides an example where people used wasteful methods to excavate coal and minerals, thus resulting in heavy air and water pollution (255). Furthermore, TVEs and other small factories did not have any environmental management divisions nor did they fall under the jurisdiction of any individual ministry or bureau (Jahiel 764), allowing them to have administrative and operative freedom.

As for state action on environmental protection under Deng, between 1979 and 1982, former Environmental Protection Offices were promoted to Bureaus (EPBs). These new first-tier organizations enjoyed extended benefits through additional personnel, access to local government officials, power to call meetings and issue orders, and establish specialized subunits (Jahiel 767). However, Jahiel points out that factories and individual bureaus, with the support of local governments, were still able to protest EPB efforts in creating effective policies (767).

At this time, central government leaders were still largely ignorant of environmental problems and placed economic growth as top priority (Jahiel 768). Deng further set back environmental protection by continuing to reform Chinese bureaucracies through staff reduction and consolidation. Efforts to decentralize cut back on EPB staff and put the bureaus themselves under the authority of other local government departments. Thus, EPB's power and independency decreased significantly (Jahiel 768).

Throughout the 1980's, the rate of deforestation increased. Sanders reasons that the increase was due to the privatization of trees in that households would cut them for firewood, construction, or to increase their farm size (1210). Since communes had collapsed by this point, village leaders could no longer rely on assembling collective efforts to protect common goods, many of which had been already privatized (Sanders 1210).

The 1990's brought a mix of events. By 1990, local EPB's could fine for excess discharge of pollutants (Sanders 1206). Yet, the Deng administration demoted EPB's to second tier or abolished them altogether due to an 18 administrative unit restriction placed upon first-tier organizations. In 1993 and 1994, county administrations were reduced in size. Despite these setbacks, the growing

environmental problems in the countryside could not be ignored. By the late 1990's, China faced issues of soil erosion, desertification and salinization, water and air pollution, solid waste pollution, water shortages, and loss of biodiversity which had been worsening since 1979 (Sanders 1207). In 1996, the Fourth National Environmental Protection Conference convened. According to environmental historian, Abigail R. Jahiel:

...for the first time, both the heads of the Communist Party and the Chinese State (at the time Jiang Zemin and Li Peng respectively), attended an environmental conference. At the conference, several environmental officials and local leaders voiced distress over the severe shortage of environmental staff and lack of funding to support staff increases (773).

The State Council, in response, issued a statement calling for localities to improve their environmental protection mechanisms and to close heavily-polluting TVEs. Regardless of the statement, TVEs continued to exist because local governments had entrepreneurial interests vested in them while environmental agencies were rendered powerless (Jahiel 774). The peasantry also supported TVEs since they were highly profitable and thereby started chemical works, paper mills, or brickworks without hesitation (Sanders 1209). There was also a movement where farmers began working in factories for a higher profit. The remaining farmland that was still in use decreased in quality with the increasing use of chemical fertilizers and pesticides (Sanders 1210).

Nearly all emissions had higher absolute levels in spite of Deng's efforts to control pollution (Sanders 1208). In regards to public reaction, Sander notes an attitude which still prevails today:

Greater concentrations of suspended particulate matter and acid rain in the atmosphere in the cities, water shortages and the increasingly polluted nature of what water was left were, for most Chinese, accepted as the necessary *quid pro quo*, a price worth paying for the material comforts they were increasingly enjoying (1209).

However, by 1994, China recognized the severity of its environmental degradation and invited civil society to address the predicament by legalizing non-governmental organizations or NGO's.

### *NGO's and Current Prospects*

In 1998, China promoted its National Environmental Protection Agency to ministerial status, thereby creating the State Environmental Protection Agency (SEPA), (Clay A525). The promotion was seemingly contradicted when further efforts to decentralize reduced SEPA's staff from 321 to 200, and in doing so, effectively decreased SEPA's capacity to train government officials on environmental protection (Schwartz). The effects passed down to local levels where officials prioritized economic initiatives in place of environmental in order increase likelihood of promotion. The former yielded immediate benefits, such as creating jobs, thus the priority of local officials was and still is to avoid implementing environmental protection policies which yield long-term and uncertain benefits.

Since China could no longer rely on a strong, centralized government to enforce nationwide orders, more responsibility was given to civil society. The first environmental NGO in China, now called Friends of Nature, was established in 1994. Since then, officially, more than 2,000 NGO's have registered in addition to unregistered NGO's. The process of registering involves finding a relevant supervisory organization with similar interests to the NGO's so that the department will approve of the NGO's mission statement (Chen). An application will be submitted for the NGO to become officially affiliated with a state-approved, supervisory organization. If the application is accepted, the approval statement will then be taken to the local civil affairs office. The supervisory organization does not

provide funding to the NGO but only requires an annual report in order to monitor NGO activities. Thus, the NGO is relatively independent in decision-making and fund allocation although adequate financing for projects is often an issue. Moreover, if an NGO is not registered officially, the organization will have even more difficulty accessing government data and fundraising.

Governmental non-governmental organizations, or GONGO's, have fewer such problems with funding and potential conflicts with the government. This is in part due to their registration with a supervisory organization and direct affiliation with the government. Members of GONGO's tend to be former government officials who have a stronger influence than NGO's over local officials in advancing their initiatives (Schwartz). However, even with access to governmental data, officials, and SEPA, more appeal to trained professionals in the field, and a higher likelihood of publishing higher quality research than NGO's, GONGO's actions are restricted by governmental objectives. Any research undertaken must be pre-approved by the government and criticism, especially of the central government, is censored. Schwartz asserts that GONGO's, in spite of their advantages, have less autonomy and room for progressive, bold ideas than NGO's.

While China has gradually opened to receiving assistance from NGO's, foreign and domestic, the central government has also announced steps it will take to address environmental problems, especially those involving energy and pollution. In 2006, SEPA opened Environmental Impact Assessments for public participation (Liu). In 2007, the Chinese government announced that by 2020, 15 percent of total energy consumption would come from renewable resources, and renewable energy usage would total the equivalent of 600 million tons of coal ("China aims"). Furthermore, plans include promoting renewable energy in rural areas in order to alleviate fuel

shortages (“China aims”). In anticipation, this paper addresses the question of if renewable energy, specifically biogas, is an optimal solution to saving energy and reducing pollution in the rural communities of the Lashihai Wetland Reserve. Furthermore, has the implementation of biogas in these communities been successful? Why or why not? What are potential solutions to the obstacles in popularizing biogas and other renewable energy technologies in rural areas?

### **Study Site**

The Lashihai Wetland Nature Reserve (26°53'N 100°08'E), specifically the area around Lashi Lake, was chosen as a study site due to its unique location and ecological significance as habitat for endangered fauna and flora. Lashihai is located eight kilometers from Lijiang City in Lashi Township, Yulong County, northwest Yunnan Province, southwest China. The surrounding mountains are part of the Hengduan range of the Tibetan Plateau. According to the datasheet provided by Peng Guihong, Lashihai forms the headwaters for the Yangtze River and has an elevation between 2441m – 3100m with an area of about 3560 hectares. Lashi Lake itself has an area of 800.39 hectares. The total population in the wetland is about 20,000 people (Liu) who are of Naxi and Yi nationalities.

### *Significance and Value*

A data sheet, compiled by Peng Guihong, notes that Lashihai regularly provides habitat for over 20,000 species of waterfowl and at various life stages, many rare species. Examples of which are the globally endangered *Mergus squamatus*, the nationally red-listed Black Stork (*Ciconia nigra*), Black-necked crane (*Grus nigricollis*), Common Crane (*G. grus*), Whooper Swan (*Cygnus cygnus*), Marsh

Harrier (*Circus aeruginosus*), Common Kestrel (*Falco tinnunculus*), Common Buzzard (*Buteo buteo*), and Bar-headed Goose (*Anser indicus*) which is endemic to the Tibetan Plateau. In addition, Lashihai is often the nesting grounds and wintering habitat for rare migratory birds including 76 species of wild geese and ducks. With regard to flora, Lashihai has been chosen as one of the three special plant zones in China, supporting the nationally endangered *Ottelia acuminata* species.

In terms of anthropogenic use, water from the lake provides drinking water to Lijiang's Old City. The lake has also been dammed since 1993 in order to stop the outflow of water. In 1994, the first tunnel was constructed to bring lake water to Lijiang's Old City. Another tunnel was built several years later. Although Lashi Lake is still a seasonal lake, it has been turned into a reservoir whose water level is artificially controlled by humans, causing significant ecologic and societal problems. In a Treehugger interview with Yu Xiaogang, director of the NGO Green Watershed, he states that, "The local community has suffered from loose land along the reservoir [due to the construction of the dams]. Because the people have lost their livelihood, many people are using illegal nets to fish, and this too has caused the fishery reserve to become degraded," (Yu).

Tourism, in total, attracts 2 billion yuan annually (Green Watershed). Locals have opened a new source of income by starting horse-riding companies. There are approximately ten horse farms where mostly domestic tourists can hire horses to ride around the lake. There is also a bicycle company that offers tours but is not as popular most likely because of the effortlessness of horse riding.

## **Conservation Efforts**

Lashihai was designated a provincial wetland reserve in 1998 under the management of the Lashihai Nature Reserve Administration. Designation as a reserve was first proposed by the County Forest Bureau. Thereafter, experts from the Kunming Institute of Zoology and the Chinese Academy of Science came to evaluate the ecological value of Lashihai. No immediate new laws were passed to enforce protection of the area. In 1999, the County Forest Bureau proposed management regulations which were approved of in September of 2003 by the Provincial People's Congress. In 2005, the National People's Congress investigated Lashihai and used it as a basis to create national legislation regarding wetlands.

According to the Lashihai Nature Reserve Administration deputy director, the most serious environmental problem is pollution of the lake by chemical fertilizers and pesticides used by local farmers. Waste pollution is also a problem. Yet, Peng's report states that, according to the Lijiang Municipal Hydrologic Monitoring Station's data, the water quality of Lashihai is clean and national Grade II. As of now, no plans have been made by the Nature Reserve Bureau to reduce the use of chemicals on farmlands. However, a visitor center in conjunction with an education center will be built in the near future to educate tourists on the reserve and how they can reduce their impact on the wetland. The Nature Reserve Administration, with the help of the Green Watershed (NGO), illegalized the use of small fishing nets (An; Hu; Tan). The bureau also manages overfishing and traditional tools and techniques for fishing. Other conservation efforts, compiled after a series of interviews with NGO and government staff, are listed in Table 2.

**Table 2: Timeline of conservation work in Lashihai Wetland Reserve**

| Year | NGOs   | Government  |
|------|--|---|
| 1998 |  | The Lashihai Provincial Wetland Nature Reserve is established along with the Nature Reserve Administration. |
| 1999 |  |   |
| 2000 | In July, Green Watershed establishes its watershed committee management office in Da Yu Cun.   |   |
|      | Mid-year, The Nature Conservancy (TNC) begins its conservation and development management planning at Lashihai   |   |
| 2001 |  | In December, small fishing nets that highly disrupt the lake ecosystem are illegalized                      |
| 2002 | Yunnan Econetwork (YEN) starts the Sapling Volunteers to plant trees around Lashihai.  |   |
| 2003 | TNC begins its Alternative Energy Project at Lashihai  | In spring, villagers in An Shang Cun first start installing biogas systems.                                 |
| 2004 |  |   |
| 2005 |  |   |
| 2006 | TNC begins its Wetland Project   |   |
| 2007 | In August, YEN establishes its office in An Shang Cun and opens the Green Youth School, providing free environmental and renewable energy education for village children. YEN also helps 14 households with maintenance of their biogas systems. | In November, the Nature Reserve Bureau helps breed fish and restock Lashi Lake                              |
| 2008 | YEN and the An Shang Cun chief survey all biogas owners to discern the degree of system maintenance required   |   |
|      | YEN's exhibition halls on Lashihai biodiversity and renewable energy projects opens to the public  |   |

*NGO Renewable Energy Projects in Detail*

## I. The Nature Conservancy

Since 2003, the Nature Conservancy (TNC) has helped more than 1000 households in Lashihai install alternative energy devices including solar water heaters, biogas digesters, and fuel-efficient stoves. In addition, TNC has coordinated five alternative energy demonstrations at schools. TNC achieved their results, as staff member Li Jingruo explicated, by working closely with the local government, especially the Rural Energy Office of the Forest Bureau, to discern the needs of the villagers and the types of renewable technologies to promote. To pay for the renewable energy devices, TNC provided a grant in combination with a government fund. These subsidies allowed villagers to pay for only a small percentage of the full cost.

The process of starting the Alternative Energy Project (AEP), Li explained, began with TNC scientists identifying a project site in need of critical protection. After TNC chose Lashihai, the NGO legalized operations by signing a contract with the township government, energy office, and technology supplier for each sub-project under AEP. Afterwards, the project area manager helped monitor the installment of the renewable energy devices and visited each household to ensure that villagers were maintaining and using the mechanisms. Regarding maintenance problems, technicians gave basic training to villagers at the time of installment. Afterwards, the villagers themselves had to maintain their systems. In the event that they could not solve a problem, the responsibility was given to the energy station or company. Overall, from TNC's perspective, AEP has been a success although education and training on renewable energy technology is still underdeveloped at Lashihai.

In terms of working with other organizations, TNC has collaborated with Yunnan EcoNetwork when the AEP was still in progress. Funding mostly came from international organizations and American companies such as Agilent Technologies, Johnson & Johnson, the United States Environmental Protection Agency, and the United Nations Environment Programme. Currently, no new renewable energy projects at Lashihai have been planned although the TNC has recently conducted surveys of the wetland's biodiversity (Yang) which will further assist people in understanding the value of Lashihai and their impact on Lashi Lake.

## II. Yunnan EcoNetwork

Yunnan EcoNetwork (YEN) focuses on environmental education in combination with action. The Sapling Volunteers program was conceived in order to educate people on environmental protection and carbon biosequestration through wetland restoration. YEN established the Green Youth School in An Shang to further educate people, mainly village children, on how to use biogas - the most prevalent renewable energy technology in An Shang - and other actions they could take to protect their local environment (Chen). Classes are held four times each week and are taught free of charge. YEN also works with the government in identifying ways to help villagers understand how to use and maintain their biogas systems. More information on YEN's current and future projects will be elaborated upon in the following sections.

### *What is Biogas? How Does It Work?*

Biogas is produced through anaerobic digestion of organic waste in an anoxic container called a biogas digester. First, organic waste matter, originating from

animals or plants, is broken down by bacteria into simple organic acids and then converted into biogas by methane forming bacteria. The biogas is then transferred to appliances built specially for biogas in the house through a sturdy, plastic tube. A gauge in the kitchen determines if there is enough pressure for the biogas to provide energy for kitchen devices, such as an energy-efficient cookstove or rice cooker. A separate tank is connected to the digester to contain overflow. Farmers can then remove excess slurry from the separate tank to use on their farmland as organic fertilizer.

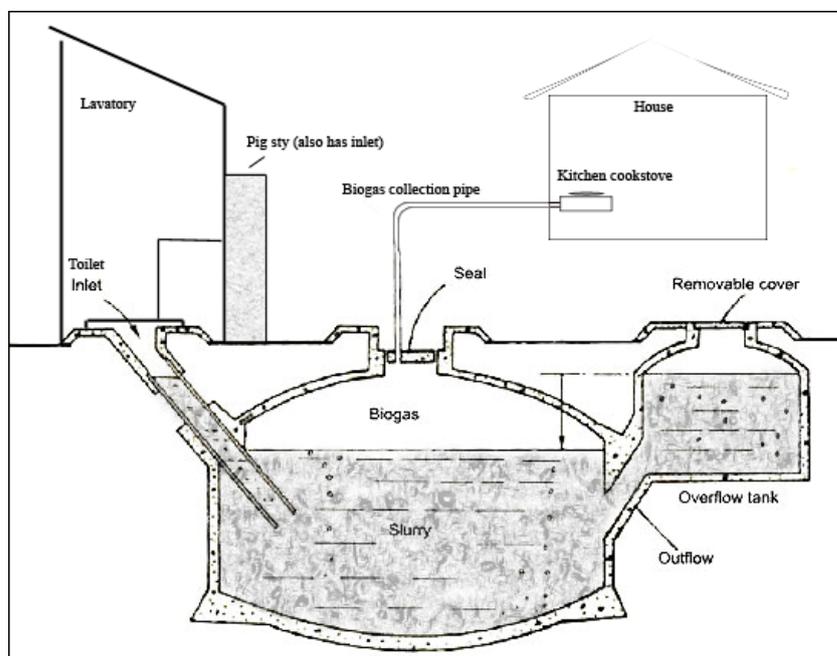


Figure 1: Household biogas system. Human and pig waste is used to produce biogas which flows through a hose to the kitchen. The biogas powers cookstoves. Extra slurry goes into an overflow tank which provides the family with ready-to-use organic fertilizer. (Adapted from [isis.org.uk](http://isis.org.uk))

### *History of Small-Scale Biogas*

Biogas is not a new technology to China nor has it been ignored by state leaders. Biogas was first introduced to China in the 1930's while household digester systems were first developed in the 1950's. As early as 1958, Chairman Mao approved of biogas and wanted it to be used for cooking, lighting, and fertilizing throughout China (Jinming 2). His successors have also approved of biogas. Yet, the technology did not start getting promoted in China until the 1970's when the

government began paying more attention to pollution in rural areas. At this time, development was slow and fluctuated greatly. According to Li Jingming, Secretary General of the China Biogas Society, 6000 households were using biogas in 1970 and within ten years, 7.23 million households in total were using biogas (2). However, by the mid-1980's, the majority of these systems were abandoned as only 453,000 digesters were in use by the end of 1986 (Jingming 2).

The 1990's brought improvements in technology with regard to more efficient and sturdier digester design and construction. Some digesters were designed to incorporate effluent from pig sties, in conjunction with human latrines, into the waste input. This model has been used at Lashihai and other rural locations where people own pigs and partake in small-scale animal husbandry. Thus, by 2000, 9.8 million biogas digesters existed in China (Jingming 3). Afterwards, there was a sharp increase in financial support for biogas development. The total investment, from 2001-2006, reached over six billion yuan (Jingming 4) which boosted the number of biogas digesters to over 15 million by the 2006 (van Nes 102). It is expected that over 50 million biogas digesters will be built by the end of 2010, accounting for more than 20% of rural households (Byrne and Wang 20).

### *Why Use Biogas?*

Biogas provides many benefits. In rural areas of China, people tend to use wood to cook indoors. Byrne, Wang, and Ritter of the Center for Energy and Environmental Policy state that, "In rural areas in China, an open fire inside the dwelling is commonly used for cooking and heating...the emission of health-damaging pollutants in the form of incomplete combustion products can be quite high" (ix). Thus, using biogas would reduce the collection of wood and deforestation,

which is already a problem at Lashihai. Biogas also increases sanitation as all the waste is controlled and deposited into one area. Once the slurry and sludge have been treated for an adequate amount of time, they can be used as organic compost and cut back the use of chemical fertilizers and pesticides. In addition, slurry can replace untreated human and livestock manure which contributes to health hazards through water pollution and residue on crops. In the Woodrow Wilson International Center for Scholar's environmental 2007 special report, Jennifer L. Turner and Linden J. Ellis write:

Deforestation, overgrazing of grasslands, excessive pesticide use, and uncontrolled disposal of solid, hazardous, and medical wastes not only endanger China's rich biodiversity, but also represent major threats to human health through soil and water contamination and reduced land on which to make a living (136).

Lastly, using biogas is economically beneficial as it could potentially replace all electricity and heating costs if enough biogas is produced.

### **Case Study: An Shang Village**

The history of biogas in Lashihai is important to understand before investigating its effects on a smaller scale. You Kai, a technician with the county renewable energy department whose name has been changed for security reasons, provided the following information. Biogas was first introduced to Lashihai in 1996. Currently, 1,700-1,800 households out of over 3,000 households use biogas. Only 400-500 have adjoining pigsties in their biogas setup. An average of at least 181 kW·h of electricity, provided by hydropower from Hebei Province, is used annually per capita. If one kW·h is 5.5RMB, people spend on average 995.5 yuan each year on electricity. Biogas can save 90-95% of energy each year which calculates to 895.5RMB – 945.7RMB annual savings. One couple even saved 980RMB annually

(Ma and An). This is no small sum if the average farmer earns around 1000RMB annually.

Biogas systems are relatively expensive, compared to the average income, which is why the local government provides a 1000RMB subsidy to each household that agrees to install biogas. One system costs 1,400RMB – 1,600RMB for materials alone. The installation, if farmers can afford to hire workers, costs around 1,500RMB given that there are 25-30 workers who demand 50RMB for one full day's worth of labor. Thus, many farmers prefer not to pay workers and install the biogas digesters themselves. However, afterwards, building new lavatories and pig sties require additional labor and materials which is why some biogas setups are left incomplete.

An Shang is located on the south side of Lashi Lake and is a mostly Naxi village with a few migrants from Sichuan. Due to the limited amount of time available to conduct this study, I only surveyed this village and interviewed members of its community. An Shang has a surprisingly high proportion of households that have installed biogas. In 2003, the local government helped subsidize, 1000RMB, the construction of biogas digesters (You). However, upon further investigation, most of the biogas digesters had already fallen out of use. Only 2 out of 15 households surveyed still used their biogas in addition to the 14 households that are known to still use their biogas (see Appendix A) due to YEN providing free repair parts, cookstoves, and basic maintenance advice. In total, only 16 out of 35 households in An Shang currently use their biogas, less than 50%.

## **Discussion**

The proportion of biogas digesters or other renewable energy technologies that have fallen out of use is not uncommon. Even TNC has experienced problems

ensuring success after helping subsidize, along with the local government, their AEP. Thus, understanding the reasoning behind the neglect and abandonment of the biogas digesters was vital in creating effective solutions to these problems.

It seemed that in 2003, when many of the systems were first installed, the government simply provided subsidies to peasants without supervising the entire installation process. The survey YEN and I conducted revealed that many owners, at the time of construction, lacked the time and labor to finish building lavatories and pig sties. For these cases, the connection from the waste input sites to the digesters was never completed. Since biogas owners are mostly farmers and out working in the fields everyday, they may not have had enough time or perhaps did not want to make the effort to manually input waste into the digester. At many sites, the digesters were far away from the house and pig sties, making manual input more inconvenient and laborious than necessary. In other situations, where the biogas had been used, there was a leak in the piping or somewhere in the setup itself that had not been fixed. The damaged parts had not been replaced for unknown reasons. Thus, many of the systems had been promptly abandoned due to poor site planning, incomplete construction, and lack of information in how to use and maintain biogas. Even though TNC and YEN have provided basic training, it is evident that many households need further monitoring and training in order for people to feel confident in using biogas.

Based on the personal observation, it was clear that the villagers who had abandoned their biogas systems may have also had reasons that were rooted in social problems. For instance, one biogas owner was a middle-aged man living in a typically constructed mud-brick house that had an obvious tilt. A deep crack ran down the middle of one of the side walls. Clearly, his house was in disrepair and his health was not in its prime as he looked to be in his sixties though he was only in his mid-forties.

It was no wonder that he had other concerns to attend to rather than ensuring that his biogas digester was in working order. In other instances, adolescent children were sent to work by many families. Instead of pursuing education, they were earning income for the family. With such pressure to be relatively financially stable, environmental education and investment in renewable energy fell to the wayside.

If more time was available, a survey would have been conducted to see what youth of various ages thought of biogas, renewable energy, and environmental protection. More villagers would also have been interviewed to gain a broader perspective on their circumstances and what families who still used biogas, abandoned their biogas, or did not have biogas thought of renewable energy and local environmental problems.

## **Conclusion**

Mr. Chen Yongsong, the director of YEN, and I spent considerable time brainstorming and proposing solutions to the obstacles YEN and the local government faced in promoting the use of biogas. The best solution to ensuring the success of biogas is to monitor the villagers during the process of installing and using biogas systems despite the time and labor-intensive nature of monitoring. Furthermore, both adults and children in the village need education and training. Even though basic training was already given on how to use biogas, perhaps a new approach is necessary. For instance, if local villagers held workshops for their peers, people might feel more confident in using biogas after seeing that a local could operate it with ease. If NGO's do not have enough time or staff to do regular check-ups on biogas owners, a few families in each village, including An Shang, could be assigned to check up on their neighbors and friends to make sure there are no problems with the biogas systems.

Somehow, NGO's need to communicate to communities that these renewable energy projects are their own and that they can take ownership of them even though it was the government and NGO's who first promoted renewable energy. In addition, technical lingo is difficult to understand by anyone unfamiliar with engineering. Thus, simple, user-friendly manuals on how to use biogas, complete with pictures or illustrations, would also be helpful in disseminating information amongst new biogas owners.

Aside from providing free replacement parts, YEN also hosts free classes to children living in An Shang. Mr. Chen, teaches four classes each week to a total of fourteen students. The subjects include environmental and wetland protection, renewable energy, specifically biogas, and English. Mr. Chen started these classes because his organization takes a non-confrontational approach to environmental activism. YEN opts to enlist volunteers to plant trees and students to teach instead of actively criticizing current legislation or opposing environmentally harmful government projects. Mr. Chen personally believes that the upkeep and dispersal of biogas is dependent on future generations and their attitudes towards renewable energy. All his students are primary to middle school aged since older adolescents are too busy going to high school or working. Most if not all of them come to class regularly and all the An Shang villagers have established good relations with Mr. Chen. However, four classes a week for young students is not enough. Mr. Chen plans to train more volunteers to teach classes as well as invite community members to teach traditional Naxi arts, such as embroidery. YEN is also looking into incorporating more environmental education in schools and increasing its number of students. Consequently, YEN has agreed to take over the educational aspect of TNC's Lashihai project in exchange for more funding.

In regards to tourism, the horse farms impact the wetland by allowing horses to roam even up to the lakeside at times, if tourists request. Horses also contribute to waste pollution though farmers sometimes gather their manure to use for their biogas or even as fertilizer. Tourists, who happen to be mostly domestic, also litter the streets. All the trash accumulates in open-air piles and is not collected on a regular basis. Even locals toss trash onto the sides of streets or into gutters without a care. Perhaps if more locals used biogas, more horse waste would be collected though other mechanisms which could be used to control the pollution such as catchment bags when horses are being ridden around the lake. Any requests from tourists to go into the wetland and by the lake must be kept in check and refused. Designated trails for horses, and perhaps one day hikers, must be agreed upon by all horse farms so that the impact upon the wetland would be minimal. Whether these regulations must be instigated by the local government or by workers within the horse farms has yet to be determined though NGO's could certainly apply pressure as well. Alternative, more eco-friendly tourism could also be promoted such as biking instead of riding horses. If hiking trails are built, tourists could enjoy views of the lake that way along with the assistance of local guides. Since most of the tourists are domestic, they will have to be informed of the measures being taken to protect the wetland in order to manage litter. YEN plans to open an exhibition hall this summer to educate local villagers as well as tourists. The hall is split into two sections: one on renewable energy, the other on local biodiversity with an emphasis on birdlife. Both display posters and models of renewable energy and birdlife in hopes of also engaging local children. Mr. Chen plans to decrease daytime traffic, which puts pressure on the surrounding environment, by attracting tourists with nighttime activities such as traditional Naxi cultural

performances. If successful, the performers will earn income while preserving their culture and local shops can serve refreshments to earn extra profit.

The Nature Reserve Administration determined that chemical pesticides and fertilizers were the main pollutants of Lashi Lake. Although biogas slurry can help reduce the application of chemicals on farmland, it cannot completely replace chemicals unless waste input increases. Thus, alternative, organic farming techniques must be taught in order to encourage the disuse of chemicals. YEN has started an organic garden that mostly local kids, some are from elsewhere, take care of. Mr. Chen hopes that the children will start telling their parents about their activities and encourage organic farming that way since it is difficult to convince adults to change their methods and behavior. The low percentage of biogas owners who actually use biogas is sufficient evidence.

Many of these problems are enabled by the lack of community in An Shang and other villages. When a couple was asked if they felt An Shang had a strong sense of community, the answer was not as much as it used to. The couple could influence some people in the village but not all. Gradually, families in An Shang have become more isolated and independent of each other. If people still had a strong sense of community, perhaps people would be more receptive to learning about protecting public goods such as the wetland, the lake, and the surrounding forests. Perhaps a proper trash management system would be put in place for all the villages in Lashihai. And perhaps overfishing could be properly managed by the new fishery association. However, there is hope that if a new generation is environmental aware, perhaps change can happen on a broader scale and a faster rate. The next step could be infiltrating high schools in order to continue the environmental education YEN has

already started and fostered in younger children. Along with that, new economic opportunities, in eco-tourism and sustainable development, could be offered.

Yet, not all environmental problems are within or imposed by the community. Another main obstacle for Lashihai is the anticipated increase in water level of the lake due to the finished reinforcement of another dam. This will put even more pressure on farmers to find more arable land, and potentially increase the rate of deforestation on the surrounding mountains. Moreover, if the water level rises that significantly, the area of actual wetland will decrease and affect migratory birds in need of open habitat. Whether or not villagers approve of the water level rising is questionable, as this decision was under the jurisdiction of the local government.

Connecting with other localities and even Lijiang could bring solutions instead of problems. Since people in Lijiang are of higher affluence, and the climate is mild, they could potentially afford to invest in photovoltaic cells that could power not only Lijiang but Lashihai. Both localities could set a nationwide example in making a joint effort to advance renewable energy technology and sustainable development, particularly eco-tourism.

Many villagers believe that efforts towards conservation must be instigated by foreign sources. Environmental and indigenous cultural conservation have traditionally been started by outsiders. Despite that, to attain such lofty goals, the affected community must be engaged and demand that these aims be met. Since the central government, in the form of SEPA, can only put a limited amount of top-down pressure on local bureaus to follow legislation, ultimately environmental protection advocacy is dependent on grassroots efforts. With the steadily growing number of NGO's, both domestic and international, more research is being done on environmental problems and the social conditions that foster them. These kinds of

organizations can potentially connect the grassroots movements by disseminating new information and new technologies. This kind of strengthening is necessary if biogas – as well as other renewable energy – is to become a reality, not just in theory, but in practice.

### **Acknowledgements**

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## Appendix A

**An Shang Village Biogas Owner Survey**  
**Total: 15 Households**

| Family | Date of Installation | Notes on State of System                       | Use/Disuse?                             | Problems  |
|--------|----------------------|--|---|---|
| 1.     | 2003/2/27            | Incomplete*                                    | Used for one year. Currently in disuse. | Pipes are leaking gas.  |
| 2.     | 2003/2/27            | Incomplete*                                    | Never used.                             | Not enough labor to finish the system.  |
| 3.     | 2003/2/27            | Incomplete*                                    | Used for half a year.                   | The biogas piping has been destroyed. Use of biogas stopped thereafter.               |
| 4.     | 2003/2/27            | Incomplete*                                    | Never used.                             | Not enough labor to finish the system. Lack of materials.                             |
| 5.     | 2003/2/27            | Incomplete*                                    | Never used.                             | **  |
| 6.     | 2003/2/27            | Incomplete*                                    | Never used.                             | **  |
| 7.     | 2003/2/27            | Incomplete*                                    | Never used.                             | Site has been changed into a parking lot.   |
| 8.     | 2003/2/27            | Incomplete*                                    | Never used.                             | Head of the household has been away on business for many years.                       |
| 9.     | 2003/2/27            | Incomplete*                                    | Used for one year.                      | Piping is too old.  |
| 10.    | 2003/2/27            | Incomplete*                                    | Only used a few days.                   | There is a leak in the system.  |
| 11.    | 2003/2/27            | Only has a toilet on which the system depends. | In use.                                 | Kitchen stove is outdated and inefficient. Kitchen overall is in need of maintenance. |
| 12.    | 2003/2/27            | Only has a toilet on which the system depends. | Never used.                             | **  |
| 13.    | 2003/2/27            | Only has a toilet on which the system depends. | In use.                                 | Piping is too old.  |
| 14.    | 2003/2/27            | Incomplete*                                    | Only used a few days.                   | There is a leak in the system.  |
| 15.    | 2003/2/27            | Only has a toilet on which the system depends. | Never used.                             | Piping is too old. Lacking an energy-efficient stove.                                 |

\* denotes that the biogas system is missing a toilet and a pigsty.

\*\* denotes that owners were not available to answer questions. Information was obtained through observation and assistance from the chief of the village.

## Appendix B: Route Itinerary & Subjective Account

My entire study was conducted in the 拉市海 Lashi Lake area. I went directly from Lijiang at the end of our two-week field excursion. Depending on which side of the lake one goes to, a ride in a 班车 *ban che*, that looks more like a pick-up truck with a cover on the bed, was 4-6RMB. The first few days were spent in the village of Da Yu in the Green Watershed's field office until we all had a week of vacation. After returning, I still had no work to do or field work done, so I switched NGO's and went across Lashi Lake to 安上 An Shang where I stayed at the Yunnan EcoNetwork's field office. From there, we visited households, held interviews in the office, and easily went to and from Lijiang when need be via Mr. Chen's car or *ban che*. The *ban che* can be flagged down from the side of the road if in Lashihai; in Lijiang, there is a parking lot within 中义市场 Zhong Yi Shichang. Take the *ban che* going to 海南 *hai nan* if going to An Shang. *Ban che*'s will leave once there are enough passengers, usually three if not four heading to the same area (North or South Lashihai). There are always *ban che*'s at the parking lot until around 6pm and later.

Originally, I sought out local environmental organizations to see how they operated in comparison to international. I was supposed to work with Green Watershed at their field office. When I arrived, I was welcomed by a few staff members who are very nice people. Unfortunately, they did not speak any English so I gathered that they did not really know what to tell me in terms of my ISP. Accommodation consisted of a bed space upstairs at their field office, in reality, a rural house that is apparently owned by someone else. Downstairs has an office and open-air kitchen where a cook makes three meals a day, Naxi style. Eating vegetarian

was no problem. Promptly after arriving, they told me we would have a week-long vacation due to Labor Day. Instead of waiting until May 1<sup>st</sup>, we all left April 29<sup>th</sup>/30<sup>th</sup> and agreed to return on May 8<sup>th</sup>. When I got back on the 8<sup>th</sup>, one of my supervisors called me to tell me they would return on the 9<sup>th</sup>. Well, I went into Lijiang to start my research and also meet with my supervisors who finally, after a week, decided to brief me on their projects. I learned a bit more than what I had gathered from the PowerPoints they had given me, in Chinese. However, they still did not say exactly how I could help them with their work. Turned out that neither of them returned to the office that day and only one would come back the following day. I waited some more and he never showed up, so I called Lu Laoshi to try and figure out what I could do. I was more than two weeks into the ISP and had no fieldwork or idea what I was going to do.

That was when I found out about the Yunnan EcoNetwork (YEN). I had looked at their website a while ago and agreed to visit their office. The director, Mr. Chen, spoke English very well and discussed, on the spot, how I could help his organization. He drove me to take a look at the nearby horse farm and showed me the exhibition hall that was still under construction. I felt immediately that he would be much more proactive and helpful with my project. Thus, I moved to YEN's office straightaway. YEN's office is called the Green Youth School. It also has a rural house setup with the main house providing housing, a classroom for children, and bedrooms for Mr. Chen and Mr. Lau, the cook. There is a separate side house for volunteers. In back is a garden that children tend and a functioning biogas and solar water heating system. I found it quite inspiring that the school had the technologies it was promoting, that Mr. Chen believe in taking action instead of just talk. Although I am sure Green Watershed has accomplished quite a lot and that Mr. Yu Xiaogang's

publicly broadcasted efforts opposing dams have made an impact, I found that their field office did not do much in the field. Most of the time was spent in the office, on the computer, playing games or making data spreadsheets. Thus, I felt much more confident in my project now that I was working with YEN.

Now, if one is an opinionated woman working for this organization, as progressive as Mr. Chen may be, he and Mr. Lau both have sexist tendencies. They do not believe that a woman can/should do heavy lifting or work that involves construction or wiring. I do not know if this is out of politeness or a long enrooted tradition, but I had to actively prove these beliefs wrong by taking on light construction – hammering nails – and electric work – putting wiring into PVC pipes - which I both enjoyed. When I inquired about feminism in China, Mr. Chen explained that rural womyn are powerful in the house but that men are powerful outside the house. There are still certain rules on behavior, such as a married woman not being allowed to socialize, alone, with men other than her husband. Otherwise, other womyn would question her motives and gossip. Mr. Chen also did not think China had a womyn's rights problem as it seemed to me, he thought feminism was about womyn trying to act more like men which is debatable. Yet to Mr. Chen and Mr. Lau's credit, they seem to be more progressive than other male villagers, one of whom tried quite hard to grab the hammer out of my hand as I was about to put nails into a wall.

That was my biggest frustration though at times, Mr. Chen and I had some misunderstandings. He would expect me to get certain work done without vocalizing exactly what he wanted me to do. An example would be creating 'rules.' He wanted me to take rules from the U.S. and apply them to the Green Youth School. However, I do not think I am the proper person to ask about rules in the U.S. due to my personal

politics, thus I suggested that the kids create the rules themselves, which would be most democratic. He agreed but still insisted that I come up with some rules – such as opening hour signs, caution notifications (for steps and low walls, that sort of thing) – things we would not consider ‘rules’ in the U.S. When I asked him what our opening hours were, he did not understand the question and kept ranting about the ‘rules’ he wanted me to write. At some other point, I was working on my paper when he told me the kids would be having English class. I had taught the previous week’s English class and so he expected me to take time to play a game with the kids and help them learn English. Unfortunately, I did not have the time and he had put me on the spot after telling the kids I would teach them a game. So that was my second biggest frustration – misunderstandings due to the language barrier and silent/last minute expectations.

Rewards balanced out the frustration. Mr. Chen and I had insightful discussions, in both Chinese and English, about the grassroots environmental movement in China. I got to teach and play games with the village kids who all had their own distinct personalities and character. I was able to gain insight into village life first by helping Green Watershed’s cook farm and secondly, by surveying members of An Shang and seeing their living conditions. Firsthand experience is invaluable and I do admire Mr. Chen for the work he has done and plans to do, for the Green Youth School is truly a one-man operation. I am not sure what will happen when he leaves, in about half a year, but hopefully more volunteers will come help and more people will be able to share ideas and keep the school going.

## Appendix C: Future Studies

There is a lot that can be done.

1. Research YEN's progress in monitoring existing biogas systems. Then determine further solutions to the abandonment of biogas and other renewable energies.
2. Determine the effectiveness of environmental education at Lashihai and how it can be improved and/or expanded. Working with YEN would be helpful for this sort of project as volunteers have opportunities to actually teach kids and visit local schools.
3. Gauge villagers' needs (at An Shang or any other villages, even a comparison-study would be helpful) and attitudes towards environmental protection.
4. Study wildlife conservation and biodiversity at Lashihai – NGO's have already worked on compiling databases.
5. Compare wetland management of Lashihai to other wetlands in China, especially regarding the consequences of building dams on the lake.
6. Develop plans for sustainable development and eco-tourism. Perhaps ways horse farms can reduce their impact on the wetland.
7. Identify and implement solutions to replace the use of chemical fertilizers and pesticides.
8. Determine if the current renewable technology being promoted is the most effective or if other technologies should be promoted instead.
9. Study traditional Naxi arts and crafts and cultural preservation

## **Appendix D: Resource Persons**

1. Mr. Chen Yongsong  
Email: cys@yen.ngo.cn

2. The Nature Conservancy: Lashihai  
Ms. Julie Perng (native English speaker) – jperng@tnc.org.cn  
Ms. Li Jingruo (AEP project) – jli@tnc.org.cn  
Ms. Yangbo (Wetland project) – yangbo@tnc.org.cn

3. Green Watershed  
Mr. Yu Xiaogang (Kunming)– 1388.850.5121

Field staff at Lashihai:  
Ms. Tan Guangli – 1357.839.5615  
Mr. Hu Chenggui – 1368.876.1060

## Works Cited

- An Resi (pseudonym – director). Personal Interview. 16 May 2008.
- Byrne, John, Wang, Young-Doo, and William Ritter. “Health, Ecological, Energy and Economic Impacts of Integrated Agricultural Bioenergy Systems in China and Institutional Strategies for Their Successful Diffusion.” *Center for Energy and Environmental Policy* (2004): i-104.
- Byrne, John and Yoong-Dong Wang. “A Review of China’s Renewable Energy Policies and Potentials.” *Center for Energy and Environmental Policy* (2005): i-92.
- Chen Yongsong. Personal Interview. 18 May 2008.
- Chen Yongsong. Personal Interview. 21 May 2008.
- Chen Yongsong. Personal Interview. 22 May 2008.
- China: A Century of Revolution*. Prod. Ambrica Productions, Inc. and WGBH Educational Foundation, 1997.
- “China Aims High in Renewable Energy Usage.” *ChinaDaily* 04 Sept. 2007. 29 May 2008 <<http://www.chinadaily.com.cn/china/>>.
- China Population Development and Research Center. “China Population Information and Research Center (CPIRC).” 04 Jan. 2007. 28 May 2008 <<http://www.cpirc.org.cn/en/eindex.htm>>.
- Clay, Rebecca. “China: The Next Environmental Superpower?” *Environmental Health Perspectives* 110.9 (2002): A525-A527.
- Corell, Robert W. “Arctic Climate Impact Assessment.” *Arctic Council and International Arctic Sciences Committee and American Meteorology Society*. United States Senate. 16 Nov. 2004. <<http://www.acia.uaf.edu/PDFs/Testimony.pdf>>
- Economy, Elizabeth C. *The River Runs Black*. Ithaca: Cornell University Press, 2004.
- Elvin, Mark. “The Environmental Legacy of Imperial China.” *The China Quarterly* 156 (1998): 733-756.
- Green Watershed. “*Lashihai shengtai buchang xiangmu*.” PowerPoint presentation. 2008.
- Gregg, Jay S., Andres, Robert J., and Gregg Marlan. “China: Emissions Pattern of the World Leader in CO2 Emissions from Fossil Fuel Consumption and Cement Production.” *Geophysical Research Letters* 35 (2008): 1-5.
- Hu Chenggui. Personal Interview. 9 May 2008.

- Jahiel, Abigail R. The Organization of Environmental Protection in China. *The China Quarterly* 156 (1998): 757-787.
- Jingming, Li. "Rural Biogas Development in China." *Methane to Markets*. 22 April 2008 <[http://methanetomarkets.org/resources/ag/docs/china\\_profile.pdf](http://methanetomarkets.org/resources/ag/docs/china_profile.pdf)>.
- Li Jingruo. Email Interview. 14 May 2008.
- Larson, Christina. "The Great Leap Forward." *The Washington Monthly* July/August 2007: 16-25.
- Liu, Yingling. "SEPA Releases New Measure on Public Participation in Environmental Impact Assessment Process." *Worldwatch Institute*. 24 Feb. 2006. 14 May 2008 <<http://www.worldwatch.org/node/3886>>.
- Ma Dawei and Chuang Xiaoan (pseudonyms). Personal Interview. 18 May 2008.
- Muldavin, Joshua. "The Paradoxes of Environmental Policy and Resource Management in Reform-Era China." *Economic Geography* 76 (2000): 244-271.
- "New Study Ties Global Warming to Stronger Hurricanes." *USA Today*. 12 Sept. 2006. 29 May 2008. <<http://www.usatoday.com/tech/science/default.htm>>.
- Netherlands Environmental Assessment Agency (MNP). *China Now No. 1 in CO2 Emissions; USA in Second Position*. 5 Dec. 2007. 28 May 2008. <<http://www.mnp.nl/en/dossiers/Climatechange/index.html>>.
- Liu, Ning. "Lashihai Watershed SCP." PowerPoint presentation. Sept. 2002.
- Patterson, Arthur H. "Environmental Observations on Modernization in China." *Environmental Review: ER* 3.2 (1979): 19+52-61.
- Peng, Guihong. "Information Sheet on Ramsar Wetlands (RIS): Name of the Site: Lashihai Wetland." *Ramsar Convention Bureau*. 11 Oct. 2004.
- Roach, John. "By 2050 Warming to Doom Million Species, Study Says." *National Geographic News* 12 July 2004. 29 May 2008 <[http://news.nationalgeographic.com/news/2004/01/0107\\_040107\\_extinction.html](http://news.nationalgeographic.com/news/2004/01/0107_040107_extinction.html)>
- Rosenthal, Elisabeth and Andrew C. Revkin. "Science Panel Calls Global Warming 'Unequivocal'." *The New York Times* 02 Feb. 2007. 17 May 2008 <<http://www.nytimes.com/2007/02/03/science/earth/03climate.html>>.
- Sanders, Richard. "The Political Economy of Chinese Environmental Protection: Lessons of the Mao and Deng Years." *Third World Quarterly* 20.6 (1999): 1201-1214.

Schmid, Randolph E. "Experts Say Global Warming is Causing Stronger Hurricanes." *USA Today*. 15 September 2005. The Associated Press. 29 May 2008 <<http://www.usatoday.com/weather/climate/default.htm>>.

Schwartz, Jonathan. "Environmental NGOs in China: roles and limits." *Pacific Affairs*. 77.1 (Spring 2004): 28(22). *General OneFile*. Gale. Clark University. 14 May 2008 <<http://goddard40.clarku.edu>>.

Tan Guangli. Personal Interview. 9 May 2008.

Tuner Jennifer L. and Linden J. Ellis. "The Nexus of Health and Environment: Update on Western Kentucky University's China Environmental Health Project." *China Environment Series 2007* (2007):135-136.

van Nes, Wim J. "Asia Hits the Gas: Biogas from Anaerobic Digestion Rolls Out Across Asia." *Renewable Energy World* (January-February 2006): 102-111.

Xiong Bin. "Behind the Miracle – Economic Developments & Social Changes in China." PowerPoint presentation. Yunnan Normal University, Kunming, China. 7 Mar. 2008.

Xuequan, Mu. "Human-caused Climate Change Widely Impact Earth" Ed. *China Daily*. 15 May 2008. Xinhua News Agency. 28 May 2008 <[http://www.chinadaily.com.cn/world/2008-05/15/content\\_6686421.htm](http://www.chinadaily.com.cn/world/2008-05/15/content_6686421.htm)>.

Yang Bo. Email Interview. 25 May 2008.

You Kai (pseudonym – technician). Personal Interview. 15 May 2008.

Yu Xiaogang. Interview with Alex Pasternack. "Goldman Environmental Prize Winner Yu Xiaogang on Hydropower and Community in China." *Treehugger*. 12 Apr. 2008. 25 May 2008 <[http://www.treehugger.com/files/2008/04/goldman\\_environ.php](http://www.treehugger.com/files/2008/04/goldman_environ.php)>.

Yu Xiaogang. Personal Interview. 9 April 2008.