OAK RIDGE NATIONAL LABORATORYOPERATED BY MARTIN MARIETTA ENERGY SYSTEMS, INC.
POST OFFICE BOX 2008, OAK RIDGE, TENNESSEE 37831 6285

ORNL/FTR--3790

DE91 001529

ORNL
FOREIGN TRIP REPORT
ORNL/FTR - 3790

DATE: October 15, 1990

SUBJECT: Report of Foreign Travel of R. D. Perlack, Research Staff, Energy Division

TO: Alvin W. Trivelpiece

FROM: R. D. Perlack *RT*

PURPOSE: The purpose of the trip was to conduct a preliminary evaluation of biomass energy development in Yunnan Province, China. The evaluation included an assessment of the potential to grow and convert biomass to electricity, and an evaluation of the institutional relationships, which would be critical to the establishment of a collaborative biomass energy development project.

ITINERARY:

9/15 - 9/16	Travel to Beijing
9/17 - 9/21	Beijing
9/22 - 9/28	Kunming, Maoding and Yoan County, Yunnan Province
9/29 - 10/1	Hong Kong
10/2 - 10/2	Travel to Knoxville

ABSTRACT: This site visit was undertaken to evaluate the potential of an integrated biomass energy project, including the growing and handling of biomass feedstocks and its conversion to electricity. Based on this site visit, it was concluded that biomass production risks are real and further research on species screening and experiments is necessary before proceeding to the conversion phase of this project. The location of potential sites inspected and the logistics required for handling and transporting biomass may also be a concern. The commitment of support (labor and land) and leadership to this project by the Chinese is overwhelming exceeding all pre-site visit expectations. In sum, there is a definite opportunity in Yunnan for an integrated biomass energy project and a potential market for U.S. technology.

I. Summary Discussion

The purpose of this site visit was to evaluate the potential of an integrated biomass energy project, including the growing and handling of biomass feedstocks and its conversion to electricity, that would be beneficial to China's energy development and environmental needs. The project could encourage energy use and production patterns that would lessen the prospects for global climate change. Yunnan Province was selected as a place in which to investigate the advantages of growing and using biomass crops to generate electricity because it has a wide range of climatic, environmental, and socioeconomic conditions as well as the availability of technical expertise.

Yunnan is in the Southwest region of China bordering Myanmar, Laos, and Viet Nam. Yunnan is variable in climate, topography (600 to over 4000 m in elevation), and soils. In the populated areas, forests have been extensively cleared for agriculture and grazing. Environmental degradation in the form of soil erosion and siltation with its concomitant impacts is a major problem in Yunnan. Like most areas in China, Yunnan is suffering from a critical shortage of energy. The unavailability and unreliability of electric power during the dry season has idled industrial production and has constrained the development of new rural industry.

The availability of underutilized biomass resources in Yunnan was found to be negligible. Any biomass-fired electric generating facility would therefore require a dedicated supply. The potential project sites for growing biomass fall within the three counties (Youanmou, Maoding, and Yoaon) in rural Yunnan Province. Soil erosion control through reforestation is high priority in this area (about one million hectares have been planted). However, most plantings have been restricted to one species (*Eucalyptus globulus*) on mountain slopes to about 2000m elevation. The terrain is hilly to mountainous with elevations of 1400 to over 3000 meters and rainfall of 700 to 900 mm. A distinct six month dry season occurs from November to April. It was felt that site and climate limitations on biomass productivity would significantly confine areas appropriate for biomass energy plantations. The available plantation area is estimated at 5,000 to 8,000 hectares in each county with an average productivity potential seven to eight dry tonnes per hectare per year.

Specific plantation establishment procedures were discussed with local forest experts during the site visit. These procedures are very labor intensive and consist of the following sequence of operations. First, the land is cleared of scrub vegetation and then terraces are constructed. Second, on each terrace a pit is dug for each seedling, fertilizer (a compost of straw, residues and animal wastes) is added to the pit, and the seedling planted. If mortality is high there may also be some seedling replacement. Finally, weeds are controlled around each seedling until a canopy forms (usually within the first year of growth). No other cultural management operations are performed outside of weed control. Based on this sequence of operations, plantation survival rates were observed to be about 60%. Plantation establishment activities would take place during the early part of the dry season (November through January) and would cost about 1300 to 1500 yuan per hectare (\$4.71 yuan = \$1). Costs of feedstocks were estimated at about 20 to 30 yuan/dry tonne. There are many types of conversion technology that can be used to convert biomass to electricity. Based on a range of efficiencies and installed costs per kW, electricity from a biomass-fired plant would likely vary from about 0.16 to 0.30 yuan/kWh. This estimate assumes that there would be no major infrastructural requirements.

It was concluded that biomass production risks are real and further research on species screening and experiments is necessary before proceeding to the conversion phase of this project. The location of potential sites inspected and the logistics required for handling and transporting biomass may also be a concern. The commitment of support (labor and land) and leadership to this project by the Chinese is overwhelming exceeding all pre-site visit expectations. Sufficient technical expertise and enthusiasm exists in forestry and may exist with electricity generation technology. In sum, the evaluation teams believe that there is a definite opportunity in Yunnan for an integrated biomass energy project and a potential market for U.S. technology.

II. Activities

The purpose of the meetings in Beijing were to get support for the project at the national level and to collect any information that may be relevant to the project. Judged on these grounds the Beijing meetings were highly successful. The purpose of the Yunnan Province portion of the trip was to assess the potential of biomass energy plantations, to evaluate the energy sector, and to assess local institutional capabilities. On all accounts the Yunnan portion of the trip went beyond expectations in terms of what we had hoped to learn. We were accompanied to all meetings in Beijing by Madame Liang and Mr. Cheng. Mr. Cheng would also accompany us to Kunming and rural Yunnan Province and serve as interpreter and NEPA representative.

Saturday, September 15 and Sunday, September 16

Jack Ranney and I departed Knoxville on Saturday morning and arrived in Beijing late Sunday evening.

Monday, September 17

In the morning, we met Milt Russell (University of Tennessee and ORNL Collaborating Scientist) and Madame Liang Sicui and Mr. Cheng Weixue both of the National Environmental Protection Agency of China. We discussed our schedule for the Beijing portion of our visit -- the Ministry of Agriculture, National Environmental Protection Agency, Energy Research Institute, Ministry of Forestry, and the Ministry of Energy.

Ministry of Agriculture. We were officially greeted by the Vice Minister, Mr. Chen Yao Bang, Madam Deng Ke-Yun (Deputy Chief, Bureau of Energy and Environment), Mr. Xie Zhiheng (Division Chief, Energy and the Environment), Mr. Liu Congmeng (Division Director, American and Oceania Affairs), and numerous lower ministry officials. We briefly discussed the purpose of our visit and project in Yunnan. The Minister openly expressed support for the project. After the Vice Minister left, we discussed in considerable more detail the project, the purpose of our site visit, what we hoped to accomplish, and our information needs. Madame Deng discussed the rural energy situation in China noting the dominance of biomass fuels and China's efforts at reforestation and dissemination of biogas digesters. In regards to our project in Yunnan, she mentioned that considerable species screening research was already underway and that many areas were being planted with fast-growing species. Overall, she was very interested in the project. In closing the meeting, Madame Deng informed us that lower level departments in the Agriculture Ministry in Yunnan would be directed to cooperate and support the project.

National Environmental Protection Agency. In the afternoon, we were greeted by Mr. Zhang Kunmin, Deputy Administrator and Mr. Xia Kunbao, Deputy Director, Foreign Affairs Office. We were informed that the Administrator, Mr. Qu Geping, was ill and would not be able to meet us. Because of Madame Liang's association with the project, NEPA was well-aware of the purpose of our visit and information needs. Mr. Zhang gave us some background information on China's reforestation efforts -- the Northern greenbelt program to halt desertification, fuelwood plantings, and timber plantations. He noted that reforestation in China now comprises about 10% of the total land area. (China is the World's leader in reforestation as measured by the number of hectares planted.)

Tuesday, September 18

Energy Research Institute. Mr. Xin Dingguo, Deputy Director, welcomed us to the Institute. Also attending this meeting were Mr. Liu Xueyi (Chief, Energy and Environment), Mr. Qu Shiyuan (Division Chief, Energy Planning and Policy Studies), Mr. Wang Beng Cheng (Vice Chief, Energy Conservation and Efficiency), Mr. Han Yinghua (Research Fellow). We briefed them on the purpose of our visit, the intent of the project, what we hoped to accomplish, and our information needs to prepare the feasibility report. In general, they were supportive of the idea of using biomass to generate electricity; however, they noted that we should also look at coal and hydro before proceeding.

The Institute staff told us there has been an improvement in the rural energy situation in China over last decade. They noted that Yunnan is responsible for only 1.6% of total energy consumption in China and on a per capita basis energy consumption in Yunnan is only 88 kg (coal equivalent) or one-half the national average. The Institute is working on a number of conservation and energy efficiency programs to help the rural energy situation in China. They noted that China has disseminated over 100 million improved cooking stoves, which has had the effect of saving millions of tonnes of firewood (30 million TCE). They are also promoting biogas digesters for rural households and township industries, solar collectors, and wind electric generators.

In general, the staff of the Institute are very knowledgeable and forthcoming. We told them that we would be in contact after returning to the U.S. to request specific information and data. Mr. Xin stated that if the project looks promising the Institute would like to cooperate in the preparation of a collaborative proposal. The Institute would submit the proposal to the state planning commission for incorporation in their energy plans.

Ministry of Forestry. We presented to the Ministry of Forestry the same general information on our project and our information needs for the feasibility assessment. We met with Mr. Zhu Guangyao, Deputy Director, Mr. Yuan Haiying, Deputy Division Chief of Foreign Affairs, and Mr. Li, who served as an interpreter. Mr. Zhu told us that about 400,000 hectares are planted each year with some of these plantings in fast-growing trees. Moreover, he said that existing biomass resource growth provides only half of the energy requirements in rural areas. Hence, there is need to expand tree plantations for fuelwood in rural areas. A general impression from this meeting was that they were not convinced of the idea of using biomass to generate electricity. They were interested in the technical aspects of species screening and selection, but felt that the costs of establishing tree plantations were very high and work was needed to bring these costs down. Currently, their average production cost per hectare for fuelwood plantations is about 2250 yuan. They have a goal of reducing this cost. In closing, Mr. Zhu said that we could expect support from the local forestry

officials in Yunnan. We promised to give them some information from DOE's Biomass Production Program. In general, the meeting with this Ministry was less informative than with previous meetings.

Wednesday, September 19

Ministry of Energy. We met with Madame Shu HuiFen and staff. After our project overview presentation, they discussed the rural energy situation in China and the research that they have undertaken, which began in earnest after the second oil crisis. Today, they have about 3,000 staff working on this renewable energy application, which is primarily focused on biogas digestion and firewood. They noted that they have a number (45) of pilot counties where demonstrations of renewable energy technologies are being made. With regard to Yunnan Province, the Ministry said that there were many areas without access to grid supplied electricity. In area with grid supplied power, there is a shortage of generation. The Ministry mentioned that they have a program to develop the hydro resources and to construct more coal-fired capacity. The Energy Ministry gave us some important background information on the rural energy sector. Because of their strong interest in the project, they said that they would notify the Yunnan Rural Electrification Bureau to cooperate with us during our visit. The Energy Ministry admitted that they have not considered the use of biomass to generate electricity; however, they expressed considerable interest in the concept.

Thursday, September 20

Our NEPA hosts scheduled Thursday for a day of siteseeing.

Friday, September 21

Travel to Kunming. In Kunming, we were greeted by staff of the Environmental Science Institute. We discussed our agenda for the upcoming week in Yunnan Province. Later in the afternoon, we visited the Breeding Centre for Rare Plants, located on the outskirts of Kunming. The Breeding Center was formed in 1988 by the Yunnan Provincial Government and NEPA to preserve endangered species in Yunnan. There are about 300 species that are considered threatened. There are plans to establish two other centers in Yunnan. This meeting provided some background information about local efforts in species screening and genetic selection.

Saturday, September 22

Environmental Research Institute. This morning meeting was attended by at least 30 people (many of the staff of the Institute). We presented a more detailed plan for the project with our information needs for specific tasks -- biomass resource evaluation, energy sector assessment, and institutional assessment. We later learned that our project description paper, which was given to Madame Liang in July in Oak Ridge, had been translated and sent to the Institute. Before our meeting started, they were already well-aware of what we had to accomplish. They clearly had spent considerable time in making arrangements to visit sites and to discuss the project with people who could provide answers. This enthusiasm for the project and knowledge of what we needed to accomplish was certainly beyond our expectations.

The Institute said that we will visit three sites in the Chuxiong Prefecture. The Prefecture is a minority area (Yi people) with considerable local autonomy. There is good crop growth (tobacco the biggest cash crop with rice, corn, other grains, sugar cane, and vegetables grown). However, the

deforestation that has taken place has led to declining agricultural productivity and increasing poverty. In 1950, this mountainous prefecture was 50 percent forested. Today, forests cover about 24 percent of the area. We were told that the local people have a very strong desire to replant the area and "get back" their forest landscape past.

The tree plantings that have taken place in this area primarily involve eucalyptus with smaller areas of acacia and pines. The experts in Kunming are the ones that have identified the species for planting. We were told that biomass productivity averages 20 to 27 tonnes/ha/year and the trees can go through two to three coppice cuttings. (We did not believe these estimates.) They have selected eucalyptus because of its fast growth qualities and the fact that oil can be extracted from the leaves, which provides a source of income for the local people. Because of the high nutrient drain from eucalyptus, they are experimenting with the interplanting of nitrogen fixing trees, such as acacia. To help set an example to the local people, we were told that the prefecture governor has engaged in tree planting to demonstrate that the ecological viability of the area can be restored.

In general, this meeting with the Institute was very informative and gave us a good summary of what we could expect during our site visit to Central Yunnan Province. (This meeting ended earlier than usual in the p.m. so that the staff could watch the opening Asian Games ceremonies taking place in Beijing.)

Sunday, September 23

Travel to Youanmou and Maoding Counties. We observed a considerable amount of reforestation taking place in Yunnan Province. Steep sloped areas outside of Kunming and towards Maoding and Youan counties were planted in eucalyptus. The eucalyptus helps to stabilize the slopes and provides an additional income source (oil extracted from leaves) for the farmers.

We expected to see the electric grid end soon after we left Kunming. However, we were surprised to see how extensive grid lines were distributed in this area of Yunnan Province. Visual observations also indicated that the lines were well-designed and built to high standards. We were later told that technical line losses were about seven percent for the central network and about 15 percent at the local distribution level. Other infrastructure (primary and secondary roads and bridges) was also in reasonably good condition.

After arriving in Youanmou county, we met briefly with local officials and forestry experts before inspecting three sites on our way to Maoding county. These officials and experts accompanied us through most of our stay in the Chuxiong prefecture (see list of contacts in Appendix 2). The first area we inspected was at about 2200 meters elevation and had an annual precipitation of 800-900 mm. This site was degraded with considerable evidence of stunted growth and animal browsing. Jack Ranney concluded on the spot that this site would not support sufficient biomass growth for conversion into electricity. The site was better left for conservation.

The second and third site inspected on Sunday were marginally better than the first, but were not suitable for establishment of fast-growing trees for conversion into electricity -- growth would simply be too low (under 4 tonnes/ha/year). We told our hosts that these areas were only suitable for conservation plantings to stabilize the slopes and reduce erosion. Based on these casual observations, we could not recommend Maoding County for further consideration.

Monday, September 24

Site Inspections. In the morning, inspections of two experimental plantations were made. The first inspection was just outside of Maoding. At this site, we gathered information on man days required for various plantation establishment procedures -- site preparation, fertilization, planting, and weed control. Biomass growth on this site was high, but this site was not typical of land that would be available for the biomass project. The second inspection was located on the outskirts of Yoaon County. On this site, biomass growth was quite high. The site also had alternate row plantings of eucalyptus and acacia. The dominance of one species under multiple species was not evident. This site demonstrated that high growth was indeed possible in this area, although precipitation was only about 800 mm per year. However, we did not feel that this site would be typical of the land that could be made available to the project.

After the two morning inspections, we went into Yoaon County and met the county magistrate and party secretary. The afternoon was spent inspecting a mountain area where there had been extensive reforestation. From the top of the mountain, they pointed out areas that could be available to the project. It was impossible to judge the quality of this land. Although we were not able to personally inspect the potential site, we felt quite confident that the land in Yoaon County would be much preferred to the sites visited in Maoding. The remainder of the afternoon was spent traveling to the prefecture capital, Chuxiong.

Tuesday, September 25

Tuesday was spent in meetings with the Vice-Governor of Chuxiong Prefecture, local magistrates and officials, and our travelling counterparts from Kunming. We discussed the overall intent and objectives of the project and gave them our impressions of what we observed during the previous two days. The Vice-Governor made a presentation on the socioeconomic and energy conditions in the Prefecture. He noted that the Prefecture had many autonomous minorities and was a relatively poor area. The total area of the Prefecture was 29,258 km² with 90% of this land classified as mountainous with elevations of 560 to 3660 meters. Today, about 25% of the land area is considered forest (an increase of 2% over the last 5 - 7 years). They have planted about 1 million hectares and have plans to replant another million hectares. A long range goal is to have half of the area forested. We were told that many farmers were beginning to see some improvements in agricultural production as a result of tree planting efforts.

We were told that electricity consumption was about 300 million kWh and 80% of the generation came from outside the Prefecture. Apparently, there is a serious shortage of power, which is constraining the development of their economy (agricultural processing and minerals development). In spite of a lack of power, they have managed to increase income levels by practicing more intensive cultivation and adopting new crops. In Maoding County, electricity consumption is currently about 12.6 million kWh. They project a need for 42 million kWh by the year 2000, if they are to expand output of agricultural products, develop new township industries, and meet the needs of increasing populations. Maoding officials noted that they were constructing a small hydro (80kW), but for all intents and purposes there was no potential for hydro in their county. They estimated that a small coal-fired station would cost about 1500 yuan/kW to construct. Currently, coal costs about 44 yuan/tonne delivered. In Yoaon County, consumption and estimates of future needs are similar (9.3 million kWh with a projected need of 35 million kWh in Year 2000). Officials from both Counties

said that the amount of power from the grid is only meeting minimal needs. During the dry season (January to May), there are acute shortages of power in both counties.

When asked about how they would use additional power both counties responded agricultural processing and the development of small industries. This part of the discussion led into some of the operational aspects of decentralized generation. We were told that the local electricity distribution systems were under local control. Specifically, if a small decentralized generation plant were constructed, local officials could control how this power would be allocated and distributed. It would not go into the larger grid system for distribution outside of the Prefecture. Apparently, there are some specific rules with regard to size of the generation plant and pricing. If the plant is larger than 50 MW, the power must be made available to the larger grid at some specified rates. It was difficult to discern what these rates might be as there are a number of prices that are in effect -- state-controlled (0.05 yuan/kWh), enterprise (0.16 yuan/kWh), and market prices (0.20 - 0.30 yuan/kWh).

After the discussions of the power sector, we talked about some of the logistical problems with a biomass facility -- construction of forest roads (20,000 yuan/km), transport costs (0.23 - 0.29 yuan/tonne-km), and harvesting rates. Officials said outright that they did not see a problem with a biomass facility. Labor is available when needed and there would be no conflicts with agriculture. The Vice-Governor and local prefecture officials expressed a "can-do" attitude and a very strong interest in the project. They offered whatever services and support it would take to make the project a success.

Wednesday, September 26

We travelled from Chuxiong to Kunming. On the way we stopped to inspect seed orchards, experimental tree plots, and a phosphate mining area that was in the process of being reclaimed.

Thursday, September 27

Academy of Forestry. We were greeted at the Academy by its President, Madame Li Li Sha. The Academy of Forestry is a comprehensive research organization housing the Institute of Forest Science, the Institute of Forest Economy, the Institute of Forest Preservation, and the Institute of Forest Industry. They manage three experimental plantations and are responsible for the Provincial forestry research (e.g., species screening and selection, test trials, cash tree plantations). After Madame Li's overview of the Academy, we discussed specifics on what we had observed and learned about forest plantations in rural Yunnan. We tried to corroborate much of the information that we had gathered. They were very cordial and accepted virtually all of our conclusions about the production of biomass for energy -- average productivity rates, site restrictions, elevations limitations, avoidance of single species and a need to undertake more species screening research, rotation ages, spacings, etc. As with all of our meetings, they gave their full support to the project.

Provincial Agriculture, Husbandry, and Fisheries Bureau. The purpose of this meeting was to discuss in more detail rural electrification and decentralized generation. Unfortunately, the expert in this area was unable to attend. We spent this meeting listening to an overview of household rural energy use and plans. They described their conservation (rural household stove program) and their energy supply programs. They have an annual goal of disseminating 300,000 stoves under the current 7th 5-year plan. They hope to expand this goal to 500,000 under the 8th 5-year plan. In the area

of increasing supplies, they are actively promoting biogas digesters, solar collectors, wind electric generators, and micro hydros. After the meeting, we visited a household biogas digester.

Friday, September 28

In the morning, we gave a summary presentation of what we had learned, our impressions, and our preliminary conclusions about an integrated biomass energy development project in rural Yunnan. This meeting was attended by 30 plus staff of the Institute of Environmental Science and the Academy of Forestry, including Professor Pei (Kunming Institute of Botany). We told them that we were impressed by their ardent interest in the project. They were also told about the potential risks involved in growing biomass and that they would need to do additional research in basic species screening to reduce these risks before a project could proceed to an implementation phase. We also gave them a ballpark estimate of likely electricity generation costs. In sum, they concurred with all of our conclusions and expressed interest in moving forward on the project.

An afternoon meeting was held with senior Institute staff to discuss our future plans. We told them that we would send them a copy of our report for comment.

Saturday, September 29

On Saturday we departed Kunming and travelled to Hong Kong. We would spend the next three days at the residence of Bill Barron, a former ORNL researcher and now lecturer in Environmental Management at the University of Hong Kong.

Sunday September 30

Sunday was spent relaxing, discussing notes, and preparing for the seminar at the University of Hong Kong.

Monday October 1

Jack Ranney and I presented a seminar on biomass-fired electric power in China at the University of Hong Kong. The seminar was basically an overview of our project and what we learned during our site visit. The seminar was attended by approximately 30 faculty and staff. After the seminar we discussed the future of the project with Bill Barron and Peter Hills (Director of the Center for Urban Planning) and their potential involvement.

Tuesday October 2

Tuesday was spent travelling to Knoxville.

APPENDIX 1. ITINERARY

September 15 -16	Travel to Beijing
September 17	Meetings with the Ministry of Agriculture and the National Environmental Protection Agency.
September 18	Meetings at the Energy Research Institute and The ministry of Forestry.
September 19	Meetings with the Ministry of Energy.
September 20	Escorted Siteseeing in Beijing.
September 21	Travel to Kunming and visit to the Breeding Centre for Rare Plants in Yunnan.
September 22	Meetings at the Environmental Science Institute.
September 23	Travel to rural Yunnan Province with inspection of potential project sites.
September 24	Site inspections.
September 25	Meetings with Chuxiong Vice-Governor and local officials.
September 26	Travel to Kunming with site inspections.
September 27	Meetings at the Academy of Forestry and Agriculture, Husbandry, and Fisheries Bureau.
September 28	Meetings at the Environmental Science Institute.
September 29	Travel to Hong Kong.
September 30	Seminar preparation and free time.
October 1	Seminar at the University of Hong Kong.
October 2	Travel to Knoxville.

APPENDIX 2. CONTACTS

Xie Zhiheng, Chief of Division, Senior Agronomist, Ministry of Agriculture

Zhang Kunmin, Deputy Administrator, National Environmental Protection Agency

Xia Kunbao, Deputy Director Foreign Affairs, National Environmental Protection Agency

Liang Sicui, Senior Program Officer, National Environmental Protection Agency

Zhang Lei, Program Officer, National Environmental Protection Agency

Chen Yao Bang, Vice Minister Professor, Minister of Agriculture

Deng Ke-Yun, Senior Engineer, Ministry of Agriculture

Liu Congmeng, Division Director, Ministry of Agriculture

Cheng Weixue, Program Officer, National Environmental Protection Agency

Han Yinghua, Research Fellow, Energy Research Institute

Zhu Guangyao, Deputy Director, Ministry of Forestry

Yuan Haiying, Ministry of Forestry

Xin Dingguo, Deputy Director, Energy Research Institute

Liu Xueyi, Chief Associate Research Professor, Energy Research Institute

Qu Shiyuan, Division Chief and Senior Researcher, Energy Research Institute

Wang Beng Cheng, Energy Research Institute

Yang Tonglun, Vice-Division Chief, Planning Commission of Yunnan Province

Li Jia Gui, Vice Prefectural Chief, People's Government of Chuxiong

Zhou Ru Hai, Vice-Director, Yunnan Institute of Environmental Science

He BoQian, Senior Engineer and Secretary, Environmental Science Institute of Yunnan

Yang Quan, Senior Engineer, Environmental Science Institute of Yunnan

Xu Kaiming, Vice-Director, Yunnan Provincial Environmental Protection Committee

Pei Sheng-ji, Professor, Kunming Institute of Botany CAS

Wu JuKui, Vice President, Southwest Forestry College

Li Li sha, President, The Academy of Forestry

Yan Shu Ping, Deputy Manager, Yunnan Forest Department

Guo Hui Guang, Chief Engineer, Institute of Yunnan Environmental Science

Zeng GuangQuan, Ecological Research Division, Environmental Science Institute of Yunnan

Zhou Yinglu, Director, Chuxiong Prefecture Forestry Bureau

Liu fu Chan, Institute Director, Environmental Science Institute of Yunnan

Li Guang Run, Vice Chairman of Yunnan Environmental Protection Committee

Yang ZhiZhong Director of Ecological Division, Environmental Science Institute of Yunnan

Shy HuiFen, Senior Engineer, Ministry of Energy Resources

Chen Changdu, Director, Beijing University, Center of Environmental Sciences

Ye Wen-Hu, Deputy Director, Peking University Center of Environmental Sciences

Dr. William F. Barron, Centre of Urban Studies and Planning, University of Hong Kong

Dr. Peter Hills, Director, Centre of Urban Studies and Planning, University of Hong Kong

- END -

DATE FILMED

11 / 20 / 90