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FEATURE BOX

Exploring for Solutions to the Water Challenges on the East Mountain Plateau in Yunnan Province

By Patricia Kambesis

The East Mountain Plateau, within Yunnan's Mengzi and Kaiyuan counties, is a remote rural region in southwest China where some 30,000 people live in scattered small farm villages and where, during the dry season, serious water supply shortages pose significant hardships to the daily life of the residents. (See Photo 1). The East Mountain Plateau is also within southwest China's extensive limestone karst region where water sinks into the limestone landscape and flows underground through extensive cave systems, inaccessible at the surface, especially during the winter dry season when it might not rain for weeks at a time.

Cave systems, which are natural conduits that carry underground rivers, present a unique challenge to the understanding and management of ground water resources in karst regions. With the exception of cave entrances noted on some topographic maps, most caves are not apparent from topographic maps, satellite and LANDSAT imagery, or aerial photographs—the tools that many earth scientists, hydrologists, and resource managers use to visualize the shape, form and, orientation of landforms, and to study the regional hydrology. Caves and their features exist in an environment with no natural light and contain a myriad of physical and psychological obstacles. Specialized methods in hydrogeologic investigations are required to exploit safe drinking water sources in karst regions.

One of the most effective techniques for understanding the movement of groundwater in a karst area is to physically map the underground conduits. This method involves small groups of survey teams who traverse the underground system and record geographic measurements and diagrammatic field sketches of the route. In addition to the subsurface work, the teams also conduct surface inventories of karst features. The data from both field activities are georeferenced, processed, and then integrated into three-dimensional representations that illustrate the relationship between the surface topography, cave systems, and their associated surface karst features.

A significant challenge to the hydrologic field work is the fact that many of the cave systems in southwest China extend deep below the ground surface and accessing them requires specialized skills for negotiating vertical shafts that range from 10 meters to more than 300 meters in depth. Traversing the vertical routes require ropes with complex rigging and related equipment and a high level of associated skills in order to collect the mapping data, a prerequisite for the exploitation and protection of karst water resources.

A major effort of Western Kentucky University's (WKU) China Environmental Health Project (CEHP) is to provide training in each these technological areas to researchers and students at Chongqing's Southwest University (SWU). With major support from the U.S. Agency for International Development and the ENVIRON Foundation, the longstanding partnership between WKU and SWU has

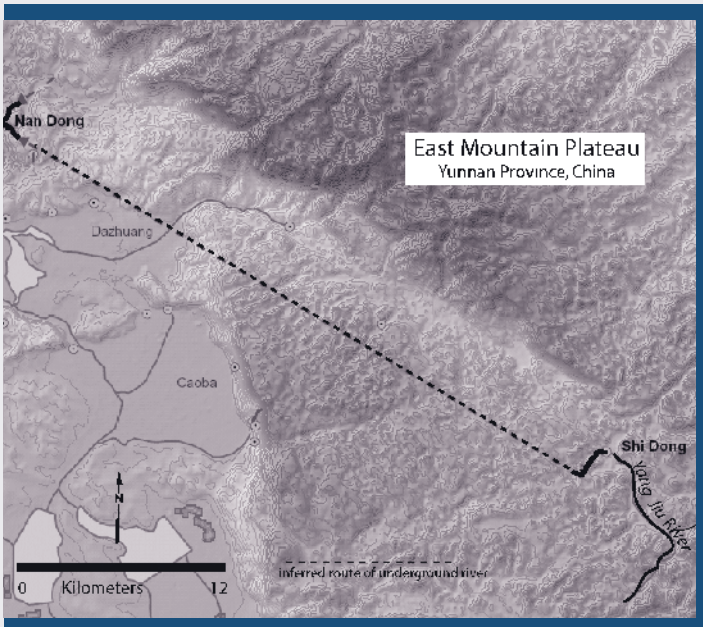
provided the backdrop for a series of week-long training workshops in basic underground survey methods, single rope techniques with a strong emphasis on safety, karst resource inventory methods and associated GIS computer mapping applications that were conducted on the SWU campus.

Each round of training workshops was followed by a 10-day hands-on expedition where the students and researchers, under the tutelage of their CEHP instructors, conducted karst feature inventories, and negotiated and mapped limestone shafts and their associated river passages. After each field day the students and researchers processed their data and added it to the ever-growing geographic/hydrologic database used to study local karst hydrology and its relationship to water supply and quality.

The East Mountain Plateau proved to be a challenging demonstration site for hydrologic work because of its remoteness, the depth of the water table, and the sheer size of its catchment area. The Yangjiu River is the only surface stream of any significance and it sinks at Shi Dong (Rock Cave) becoming an underground river once it passes under the cave dripline. The river reemerges as the spring waters of Nan Dong, a show cave located some 32 kilometers away. This connection was established during a water tracer study conducted in the mid-seventies where salt was injected in Shi Dong and detected in Nan Dong. Though the tracer study established the hydrologic relationship, the actual flow route of the underground river can only be inferred (see map 1)—successful access to the subterranean water, which many thirsty communities need, cannot be based on inferences. The cave passages of Shi Dong are traversable for three kilometers before the cave ceiling drops to meet the cave stream. Without specialized cave diving expertise and equipment, this route cannot be followed. The challenge of the expedition was to find and map other routes from the top of East Mountain Plateau down to the subterranean river some 400 meters below. There is no dearth of potential entry points as the East Mountain Plateau is pierced by literally hundreds of shafts, sinkholes and small cave entrances. Any and probably more than one of these can lead to the underground river. The sheer size of the catchment area makes that an almost "needle-in-the-haystack" proposition. However, this is the nature of cave exploration and documentation—in addition to the skills necessary to map and explore one also needs a heavy dose of persistence.

It is a brisk, cool day in February 2008 and the Chinese-U.S. team has been working on the East Mountain Plateau for the past week, looking for potential entry points into the subterranean river system that they know lies beneath their feet. Dozens of vertical shafts have been located during the preceding week so team members have reorganized into small survey parties whose job is to descend and map each underground route until they reach either a terminus or an underground river. "On rope!" shouted Zhang Qiang as he rigged his descending device to the 9mm thick piece of rope that would take him to the bottom of a 30-meter limestone shaft and to the rest of his survey team. (See Photo 3). This is the fourth

Photo 1: Dry-season winter landscape of the East Mountain Plateau. Photo Credit: Pat Kambesis



Map 1: Topographic overlay showing relationship between Yang Jiu River after it sinks into Shiu Dong, its inferred underground route, and the spring resurgence at Nan Dong. Map by M. Futrell and Pat Kambesis 2009.

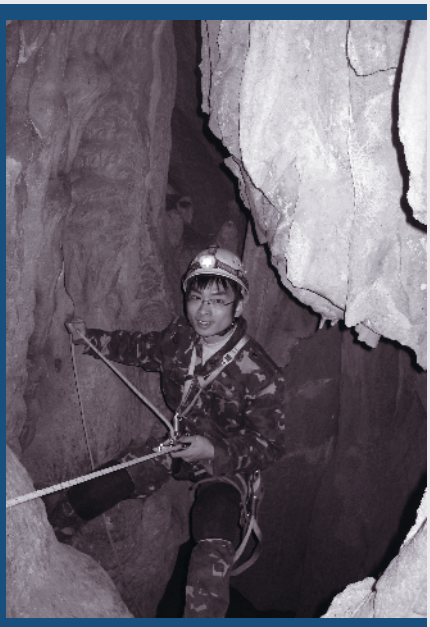


Photo 2: Zhang Quang descending a limestone shaft into the East Mountain Plateau. Photo: Pat Kambesis

shaft that the team has documented and explored this day and it looks promising. With painstaking effort Zhang and his mapping team spend the rest of the day charting a route that they hoped might lead to the elusive underground river beneath the East Mountain Plateau. At the end of their day they noted that the cave passage did not end so they left a labeled flag where the survey could be resumed the next day. That evening as Zhang and his team processed their field data and transformed it into a working base map, the pattern of the cave system and its relationship to the surface topography began to emerge. Though the ultimate destination of the segment of underground river that they mapped was some 30 kilometers way, it was a strong beginning towards helping to understand and alleviate the water shortages that are so prevalent in the karst regions of south central China.

Patricia Kambesis is the Associate Director of Education at Hoffman Environmental Research Institute at Western Kentucky University (WKU). She oversees WKU's Karst Field Studies Program which offers week-long field courses during the summer months. She also teaches GIS and karst field methods. Kambesis has extensive experience exploring, mapping and documenting caves systems in the US and internationally. She began working in the vast karst regions of southwest China in 1991 and has continued that work through the China Environmental Health Project. She can be reached at Pat.Kambesis@wku.edu.

COMMENTARY

Benchmarking Existing Building Performance: China's Green Building Movement Gets a Critical Asset

By Xu Wei and Don Anderson

With greenhouse gas emissions on par with the United States, China's mandate for mitigation is strong but challenging for such a fast growing economy. Building energy consumption accounts for approximately one-third of China's total emissions.[1] With rapid economic growth and urbanization, the building sector is expected to account for even higher emissions in the near future. Presently, China's existing building stock is 43 billion square meters, with annual new construction of 2 billion square meters, equivalent to building 50 new Manhattan office inventories each year, which accounts for more than 40 percent of world's new construction. Despite the massive amount of construction in Chinese cities, buildings in China represent one of the largest and most achievable targets for responding to current energy challenges and reducing associated greenhouse gases.

Mitigation is particularly challenging in the building sector in China because the speed of construction and desire for high performance energy technology is often followed by marginal product support that can produce inefficient operation. For example, many building service providers in China supply modern energy-efficient technology to a building but fail to provide adequate training to ensure proper use of the equipment to deliver energy savings over the life of a building. Moreover, designers of high-profile buildings may not stick around long enough to ensure that occupants understand building systems and building energy performance meets design intent. Such designers may not even be established players in the Chinese marketplace or just do not take the time to develop an understanding of what happens after design, such as how implementation causes operational challenges that impact energy performance.

The concept of "green buildings" can be confusing and sometimes against flashy new "green designs" may miss practical opportunities for buildings to be truly green—namely, be efficient in use of energy and water resources over the life of the building. Buildings represent one of China's key focal points for environmental performance improvement that includes energy, carbon and water, so establishing functional, verifiable market approaches to promote green buildings is critical.

VALUE OF BENCHMARKING TOOLS

There have been many multi- and bilateral projects focused on sustainable urban development in China, but most focus on transport or on a single green building. The popularity of U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) certification is growing in China, with an estimated 300 projects certified or registered,[2] but to date, only the U.S.-China Sustainable Buildings Partnership (SBP) has focused on providing policymakers and the marketplace with free tools and frameworks to drive large-scale action. Initiated in 2008, SBP is a collaboration between ICF International, China Academy of Building Research (CABR), Tongji University, and Q&S Engineering with

funding from the U.S. Agency for International Development and the Energy Foundation China Sustainable Buildings Program. The work of these partners focuses on three long-term goals that will evolve into fundamental assets to serve China's green buildings movement for years to come:

1. Create a building energy performance benchmarking tool that will allow Chinese owners, designers, and managers to compare their buildings and designs to similar Chinese buildings.
2. Promote green buildings concepts associated with existing buildings to ensure that the green buildings movement aggressively achieves verifiable results—energy and water savings—over time.
3. Develop practical, proven, and accessible guidance resulting in significant energy savings that can be tracked across China's massive standing stock of commercial buildings.

These three goals are complimentary. A benchmarking tool can inform potential savings and provide an environment for setting performance targets, tracking progress and rewarding achievement. As large portfolios of buildings move to benchmark and track performance, Chinese policymakers will have data to fill a void that has hampered their ability to see and act on the opportunities to promote better preformance across the built environment. These goals are also designed to move China beyond simple performance improvement mandates, which has been the primary approach to performance improvement to date. In the building sector, these mandates, including the current national call for 20 percent energy intensity reductions per unit of GDP, have proven difficult to enforce or monitor and are historically delivered without a "how to" component. Thus the benchmarking tools can also be utilized to measure the peformance of local governments in meeting central government energy efficiency and GHG reduction targets.

STEPS TOWARDS EVALUATING CHINESE BUILDINGS

A benchmarking tool can also be useful to the Ministry of Housing and Urban-Rural Development (MOHURD) for analyzing and developing national building sector policies and programs, and is complimentary to its current effort of building data collection in cities throughout China. MOHURD promulgated *Criteria of Evaluation of Green Buildings* in March 2006, by which green buildings may be classified into three levels, from one to three stars, with three as the highest. According the *Criteria*, buildings are evaluated on six aspects including energy savings, water savings, materials, indoor environment and operations management. Each aspect includes controlled, general, and optional items. The controlled items— like meeting national standards for indoor air temperature and humidity—are mandatory, while the general and optional items—such as incorporation of design features that promote natural ventilation[3] and installing cutting-edge or harder to implement items, like having more than 10 percent on-site renewable power generation[4] — have more flexibility. However all are used for evaluating and rating the buildings.

In March 2008, the China Green Building Council was established, initiating technical research and evaluation on green buildings. In 2007, MOHURD launched *Guideline for Building Energy Performance Rating* and six national-level building energy efficiency rating organizations were set up. In each province and municipality directly under central government, two or three local building energy efficiency rating organizations have been formed. According to the requirements of the State Council's *Administrative Regulations on Energy Conservation of Residential Buildings*, the energy efficiency of all governmental office buildings and large public buildings must be evaluated, and other buildings may be rated on voluntary

Left - New commercial office buildings tower over older low-rise buildings in Shanghai, China's largest and fastest-growing commercial building market. Photo Credit ICF Consulting; Right - China Benchmark Development Workshop at China Green Buildings Council on August 20, 2009. Photo Credit ICF Consulting.

basis. According to MOHURD's requirements, buildings must be benchmarked as energy efficient as a prerequisite to green building labeling. Benchmarking is a useful means of evaluating building energy efficiency, as well as a helpful tool to analyze public building energy consumption. Therefore, the introduction of a benchmarking tool for China's building stock will promote energy efficiency and facilitate growth of green buildings in China.

Promotion of green building operations as the follow-on to green design for existing buildings is also critical. This will ensure that real savings accrue as the green building movement matures and provides focus on China's huge standing stock, where operational improvements can reduce building energy use by over 15 percent using proven techniques.

In 2008, under MOHURD's guidance, the China Green Building Committee was established, on which both authors serve. One of this committee's first activities was a workshop on benchmarking of existing building performance, setting the stage for a formal, high-level approach that moves beyond green design.

U.S. ENERGY STAR BENCHMARKING TOOL

In the United States, a similar benchmarking initiative funded by the Environmental Protection Agency (EPA) has created Portfolio Manager,[5] a web-based tool currently used by facility managers for 140,000 sites, and enthusiasm for mandated use in California and other state and municipalities should increase the tools market penetration considerably. The web-based delivery of this benchmark allows a variety of market entities to make decisions with a comparative eye toward environmental performance. This benchmark is used by the ENERGY STAR program as a fundamental element of program participation and recognition. Partners are encouraged to start by understanding how their buildings' performance compares, and use this comparison to guide expectations for improvement. At the same time, partners with large portfolios of buildings can get a single benchmark value for the entire portfolio, which is a good indicator for how their operational costs compare to peers and

competition. In addition, designers can use the benchmark to set a future performance target for their designs, to be checked after one year of occupancy. The U.S. Green Building Council's LEED program uses the EPA benchmark to convey credits associated with existing building green certification. The State of California is mandating benchmarking of state buildings using utility data and will eventually extend this requirement to other buildings. This initiative, where utility data "feeds" a benchmarking function is innovative and, according to one of China's largest residential portfolio owners, a possible option for China.

CHINA BENCHMARKING TOOL DEVELOPMENT

China Academy of Building Research and Tongji University have carefully examined these U.S. applications of a national benchmark and will move forward with a solution that meets China's needs. To start, data is being analyzed in Shanghai and Beijing to develop city benchmarks that can be prototyped using Excel and easily applied, tested and refined. Both cities have had aggressive promotion of techniques primarily associated with existing office building performance improvement, so there are many individual buildings and some portfolios that will be available to test the benchmark. ICF's partnership with property management companies like Savills has raised their capacity to manage billions of square meters of commercial buildings in China. In the case of Savills, techniques for reducing existing building energy use have been proven and documented using utility data in Beijing and Shanghai. As part of their business model, Savills is offering both energy efficiency services and a utility bill tracking solution developed by ICF International to set and check targets over time. As the prototype benchmark is rolled out for testing, companies like Savills will be a ready audience with data for testing the benchmark.

At the same time, CABR is working with ICF International in Shenzhen, Guangzhou, Chengdu and other cities to provide tools and resources for improving performance, including tracking options that will contribute to the ability of these cities to use a prototype benchmarking tool. In addition, these cities have collected data in coordination with MOHURD that will be useful in both developing and testing benchmarking algorithms. Tongji University also has building performance data and experience in developing a pilot benchmarking web resource in Shanghai. Working together with ICF International, this team will build collective expertise that will move a functional and accessible benchmarking asset into the Chinese marketplace.

Showcasing and initial training on the benchmarking tool in several major cities has drawn much attention from government agencies, technical institutions and property management organizations that are interested in building energy savings and green buildings. Trial benchmarking in some buildings revealed comparative energy performance, helped identify ways to save energy and motivated facility staff to action. Many municipal governments have expressed interest in applying the benchmarking tool as part of their energy-efficient management and innovation for local large public buildings.

In the future, China will need to aggressively promote the application of a benchmarking tool, including recruiting new trial cities and trial buildings and updating a building energy consumption database. The tool will initially be localized, including identification of appropriate variables and the development of a methodology applicable to Chinese building energy consumption patterns. Development will be phased to include, at first, commercial office and mixed use buildings, then public sector buildings, followed by hospitals and schools. Finally, the local district heating systems in northern China will be included. As more

cities and building types are included, China will move toward a national tool that is available to an increasingly meaningful majority of buildings, and, a critical resource for addressing greenhouse gas emissions.

Since 2006, Professor Xu Wei has served as the director of Institute of Building Environment and Energy Efficiency at the China Academy of Building Research. He is the Chairman of China Committee of Heating Ventilation & Air Conditioning , the Vice President of Chinese Association of Refrigeration, Vice Chairmen of National HVAC and Cleaning Equipment Standardization Technical Committee, the Vice President of National Technical Committee on Building Energy Efficiency of Standardization Administration of China, and Commissary of Building Energy Saving Expert Committee of the Ministry of Housing and Urban-Rural Development.

Don Anderson currently works at ICF International. He is a green buildings and corporate sustainability specialist with 25 years of experience supporting both U.S. and international programs. He is a recognized authority on building energy performance and has advised several of the largest green and energy-efficient buildings programs in the United States. Over the past decade, he has assisted public and private sector clients in transferring experience from those programs to fast-developing global building markets, notably in China. He can be reached at: DAnderson@icfi.com

ENDNOTES

[1] "State Council Energy Saving Emissions Reduction Comprehensive Implementation Measure Notice." (January 22, 2007). Ministry of Housing and Urban-Rual Developmen. [Online]. Available: http://www.mohurd.gov.cn/zcfg/jswj/jskj/200706/t20070629_158556.htm.

[2] Mo, Kevin (2010 2 April). "A historic moment: USGBC and China GBC sign MOU." http://www.usgbc.org/News/PressReleaseDetails.aspx?ID=4349. 6 Jul 2010.

[3] Evaluation Standard for Green Building GB/T 50378-2006. (2006). [Online]. Available: http://wenku.baidu.com/view/4c6fc42d2af90242a895e567.html .

[4] "China's green building evaluation standard and comparison to the LEED rating system." [Online]. Available: http://neec.no/uploads/Article,%20China%20green%20building%20standard.pdf.

[5] Available at: www.energystar.gov/istar/pmpam/.

Dams, Glaciers, and Ecological Migration: GreenRiver's Work Protecting China's Rivers

By Deng Wen (Translated by Ada Yue Wu and Kexin Liu)

China is a country defined by its two greatest rivers—the Yangtze and the Yellow. Both rivers have shaped the country's cultural, social, and economic development since ancient times and today their waters support much of the country's agriculture and drinking water, and provide transport and electric power to help fuel China's economic growth. To get a sense of scale, the Yangtze is the world's third longest river and its mighty flow runs through 13 provinces of China. On an annual basis, major grain production along the Yangtze River Basin accounts for about half of the total domestic production. However, the unprecedented magnitude and pace of China's urbanization and industrialization over the past thirty years has come at a great cost to water quality and quantity in these two great rivers. As pollution and over extraction grows, the ecological health of China's two "lifeblood" rivers is compromised, threatening the water security of the entire country.

The worsening water quality and water shortages in these and other rivers have gained the attention of policymakers, the news media, and the general public in China, sparking new laws, regulations, investment, and projects. Many of the new policies to protect China's rivers have not yet been as effective as intended, in great part because implementation at the local level is by and large disconnected from the decision-makers in Beijing. In part to address this local-center policy gap, a growing number of grassroots organizations have emerged to target river basin protection. One of the oldest Chinese environmental nongovernmental organizations (NGOs) that work in this area is GreenRiver, which was founded in 1995 in Sichuan Province.

Over the past 15 years, GreenRiver has been collaborating with a number of domestic and international partners in three main arenas: (1) studying the ecological impacts of various human and industrial activities on the Yangtze River; (2) educating the public of their findings; and (3) advocating for actions from policy, academic, and business communities. In the past few years, GreenRiver has expanded its work to address the striking lack of information on how climate change is impacting the river ecosystems on the Yangtze and Yellow rivers. Described below are a few of GreenRiver's recent projects that have focused on ecological migration, glacier retreat, and dam building.

FIELD STUDY OF YANGTZE RIVER SOURCE REGION'S ECOLOGICAL MIGRATION (2006-2010)

Sanjiangyuan in the south of Qinghai Province is a unique convergence of the headwaters of three great rivers in Asia—Yangtze, Yellow, and Lancang (Mekong). Dubbed as "China's water tank," this relatively undeveloped region in western China is characterized by particularly fragile and sensitive ecosystems.

So far the Chinese government has issued various sustainable development policies and initiated a number of projects aimed at protecting the ecological environment of the Sanjiangyuan area. These policies are designed not only to promote a healthy interplay between the environment and economic development in the area, but also to further safeguard the

ecological security and sustainable development of the middle and lower reaches of China's major rivers. One of the key initiatives is the two-year *Ecological Protection and Construction Project* that was launched in August 2008 to limit development, including animal husbandry in order to protect the fragile Sanjiangyuan area. The project has already relocated 7,921 herder households (43,000 individuals) and represents the largest and most costly ecological reconstruction project in China's history. According to the government's plan, it will take five years to complete the relocation of all the remaining herdsmen and their families, who will depend on the government to provide them job training and to assist them in finding new jobs and adapting to the new urban life. After relocation is complete, Sanjiangyuan will become completely unpopulated.

In 2006, with the support the U.S,-based foundation Blue Moon Fund and Beijing-based NGO Global Environment Institute, GreenRiver launched a five-year investigation of ecological migrants in the source region of the Yangtze River. GreenRiver's team of eight carried out the research on impact the Chinese government's migration policies have had on communities and the environment in the Sanjiangyuan area. The project is the longest field study GreenRiver has undertaken with team members—who were a mixture of seasoned anthropologists, graduate students, and a videographer—spending an average of one month in the field every year.

In 2009 after years of investigating the migration policies, the area's ecological environment, the social issues triggered by the massive resettlement program, and the status of indigenous culture, GreenRiver's issued a final report with a number of recommendations to relevant government agencies. This report contained highly valuable research findings that were captured not only in writing, but also in photos and video clips.

In addition to conducting surveys of the environmental health and living conditions of relocated communities, GreenRiver also attempted to help the resettled herders adapt faster to urban life. For example, in a migration village located in Ge Er Mu Kun Lun of Qinghai Province, GreenRiver volunteers provided urban living skill and knowledge training sessions to new migrants. Volunteers also helped herders launch a website to better communicate their needs and promote their culture. During the process, GreenRiver volunteers also helped herders look for new jobs or for business opportunities, such as marketing Mani stones. Mani stones are stone plates, rocks and/or pebbles, inscribed with the six syllable Tibetan Buddhist prayer mantra *Om mani padme hum* (hence the name "Mani stone").

GLACIER RETREAT MONITORING IN THE YANGTZE RIVER SOURCE REGION (2005- 2010)

With glaciers melting and sea level rise, people living on lowland coasts and islands will very likely be forced to abandon their homes in the near future. The international community has already taken proactive measures by mobilizing aid and assistance to deal with this threat, but GreenRiver believes the fate of the communities who live at high altitudes has not been given the level of attention they deserve from both domestic and international experts as well as aid organizations. Due to global warming, the glaciers in the Yangtze River source region have been undergoing substantial recession since 2004. Glaciers are the blood of mountains. Once glaciers disappear, mountainous areas will soon lose their most critical source of water. Extreme weather conditions and natural shocks will also become more frequent. Herders living in the valleys in mountainous areas could also lose their homeland as a result of glacier melt.

In 2005, partnered with staff scientists from China Academy of Science's Cold and Arid Regions Environmental and Engineering Research Institute, GreenRiver's volunteers formed a Yangtze River source region glacier

inspection team and later launched a project on glacier retreat monitoring. Through surveying, photographing and videotaping, the team studied the evolution of glaciers and their impact on the surrounding areas. GreenRiver plans to publish the survey results with the hope of raising public awareness about glacier retreat in the Yangtze River source region, and to influence the Chinese government's policymaking for China's high altitude areas.

Since 2005, GreenRiver volunteers have been traveling back and forth to the Yangtze River source region to study and collect data on the glaciers. One major initiative has been for volunteers to set up markers to record the speed and magnitude of movement of glacier retreat. These markers are not only for scientists who study glaciers and climate change, but also to provide a compelling demonstration for the broader public on the impact of global climate change on glaciers in the ecological fragile Yangtze River source region.

INVESTIGATION OF ENVIRONMENTAL IMPACT OF UPSTREAM DAM BUILDING ON THE YANGTZE RIVER (2008-ONGOING)

About 2,000 dams have been built or are currently under construction in the Yangtze River Basin. However, the planning and construction of these dams have been proceeding without a systematic study of the environmental, cultural, and social impacts on the submerged areas. GreenRiver believes that ecological and cultural diversity in the region are facing serious threats from highly questionable dam projects that show no sign of slowing down.

To understand the environmental impact of upstream dam building on the Yangtze River, in 2008 and 2009, GreenRiver staff, scientists, and volunteers investigated 50 dams on the upstream of the Yangtze that had either been completed or were under construction. GreenRiver's team visited the submerged areas around the construction zones of dams on the Jingsha, Dadu, and Ming rivers and their tributaries. Where possible the team collected information about the geological distribution of local plants and animals before and after the construction of those dams, using satellite data, photos, videotaping, and site samples. While gathering this data the team became much better acquainted with the daily lives and culture of the local people. In addition, GreenRiver also provided technical and educational support to local communities.

Through the news media, GreenRiver began to raise public awareness of the environmental and cultural impact of dam building and also to urge the government to speed up its efforts in the protection of the ecology and culture in the reservoir areas near dam construction projects in the upper Yangtze.

In the next five years, GreenRiver plans to complete the investigation and publicize information on the ecological and cultural impacts of 150 other dams in the Yangtze Basin. The team will follow up the changes in ecological patterns around dam areas after each dam is completed. GreenRiver will also keep track of the life of local people and make comparative studies based on information collected before and after the construction of dams. The final products of this project will include academic papers, books, and documentaries. With these, GreenRiver hopes to gain insights about dam building related ecological and cultural protection issues in China and to be able to provide recommendations to relevant government agencies.

2010 YANGTZE RIVER GLACIER RESCUE INITIATIVE (LAUCHED MAY 22, 2010)

Cosponsored by the China Environmental Fund, GreenRiver, Chinese Mountaineering Association and several other research and news

media partners, this initiative consists of six core activities that aim to increase understanding of glacier melt in the upstream of the Yangtze River. Through field surveys, GreenRiver and its partners plan to collect data and build mathematical models of glacier melt and retreat in these ecological fragile headwaters. By demonstrating the process of glacier retreat, the initiative is expected to promote scientific studies, civil society participation, and to draw media attention to this ecological crisis. The key goal of this initiative is to promote the protection of the headwater area. The six core activities of this initiative are a mixture of scientific research, policy outreach, and public education.

(1) New Glacier Markers. GreenRiver will recruit mountain climbers and glacier explorers to climb up to the major summit in the source region of the Yangtze River, Ge La Dan Dong summit, in the aim to closely observe the glaciers and to set up the fifth marker set up by GreenRiver to record glacier retreat.

(2) Eco-anthropological Study. GreenRiver will invite glacier researchers, botanists, and anthropologists to explore Quer Mountain, to study glaciers, forestation and the traditional cultural activities of local herding communities and how they are being impacted by glacier melt.

(3) Youth Education. University students from other parts of China will be guided onto the Xuebao Summit to witness firsthand the recession of glacier and will attend a "Youth and Climate Change Future Forum" organized by GreenRiver.

(4) Business Outreach. GreenRiver will invite Chinese entrepreneurs to form two mountain climbing groups to investigate glacier retreat and discuss CRS-related issues at a forum organized by GreenRiver.

(5) Journalist Involvement. GreenRiver will invite news media members to join in an event that includes climbing and crossing the Gong Ga Glacier and report on glacier retreat along the trip.

(6) Public Outreach. This final activity will feature a series of events, the core of which being a music concert held in Si Gu Liang Hill located in Xiaojin, Sichuan Province. GreenRiver plans to invite musicians and music fans in major cities across China to play simultaneously one identical song with the theme of environmental friendliness. All of the participating groups are expected to perform in a natural setting and the entire event will be broadcasted nationwide.

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GreenRiver staff and volunteers in the field placing glacier markers for the Yangtze River Glacier Rescue Initiative.
Photo Credit: Deng Wen/GreenRiver

FEATURE BOX

Danish-Chinese Partnerships: Increasing the Use of Renewable Energy in China

By Leah Strauss

A SHIFTING WIND FOR RENEWABLES IN CHINA

Although the first wind farm in China was built in 1968, no surveys were made or reports published on the performance of any farms until 2006.Indeed, renewable energy was not a major government priority until the passage of the Renewable Energy Law in January 2006, which set ambitious renewable energy targets. In January 2007, the wind power targets approved were 5GW and 30GW in 2010 and 2020, respectively. Even though this law represented a pivotal moment for wind farms, the potential for ineffective development was great due to the insufficient capacity of stakeholders and a lack of understanding of the past and future effectiveness of wind farms. Enter the Danish-Chinese Wind Energy Development Program (WED), a three-year project to address these and other pressing issues surrounding the effective harnessing of wind energy in China.

With the support of Danish International Development Assistance (DANIDA), the WED program, from 2006 to 2009, used knowledge transfer and capacity development to enhance the sustainable use of wind energy in China. WED also aimed to further develop the regulatory framework for wind energy at the national level and establish networks for stakeholders. Key government legislation central to the project included the Renewable Energy Law, which entered into law in January 2006. Working at the national and provincial level, the WED program included a triad of main elements: (1) wind energy planning, (2) supporting institutes of expertise, and (3) training of stakeholders. The WED program started in the three Northeastern provinces of Heilongjiang, Jilin and Liaoning with the goals of ensuring high quality of data, improving methodologies in project design, and bettering management and operation.

Wind Energy Planning and Evaluation

Under the WED, two projects unfolded for the wind energy planning and evaluation component which consisted of the development of a Feasibility Study Template (based on feasibility studies in the three provinces) and a best practices example based upon a Post Construction Evaluation Study on six large-scale wind farms. Within China, establishing effective feasibility studies was of great concern due to two problematic factors: namely, that energy production was repeatedly inconsistent with predictions, and the average full load hours were below 2000 hrs per year. Therefore, WED instituted a modified template for feasibility studies specifically for large-scale wind farm projects above 50 MW. The Post Construction Evaluation Study was created to contribute to a more transparent base for decision-making of stakeholders in the Chinese wind sector, including developers, investors and government.

Supporting Institutes of Expertise

The China Meteorological Administration (CMA) is the major implementing institution with regards to wind resources. The CMA is currently engaged in project activities in wind resource assessment, including a nationwide 5-year program to assess the wind resources of China in its entirety called the "High Resolution Wind Energy Assessment Project." The WED project contributed to the improvement of the quality of modeling techniques for the application of the project's results. Throughout the WED program, knowledge was shared with the CMA regarding: the concept of MESO-scale wind models; the use of the WAsP model (Wind Atlas Analysis and Application Program); conduct training in wind measurement techniques; wind data analysis; and the preparation of wind atlases and micro-siting. Risø National Laboratory, Technical University of Denmark (Risø DTU) developed, among others, the WAsP software, a microscale modeling tool for wind farm energy calculations.

Grid Integration

One of the main restrictions to the scale-up development of wind power in China is grid integration. In partnership with China Electric Power Research Institute (CEPRI) –the institution responsible for implementing wind power grid integration nationally—WED focused on improving a dedicated Grid Code for wind farms and a standard for wind power grid integration. Through the transfer of Danish technology and cooperation on capacity building between Denmark and China, the program established the assessment methodologies for grid integration and capacity in order for the grid to accommodate wind power.

Training of Stakeholders

The WED program revolved around capacity building of institutions. Implicit with this bolstering of institutional capacity was the training of stakeholders. Through the course of the program, all methodologies, procedures, models etc. were developed with the goal that they would be made available to all interested parties in the public and private sector.

THE RENEWABLE ENERGY DEVELOPMENT PROGRAM

The Renewable Energy Development (RED) program aims, like WED, to enhance the development of the renewable energy sector in China. Yet, the RED program goes beyond being a continuation of Chinese-Danish cooperation on wind energy. Running from 2009-2013, it will support the establishment of the National Renewable Energy Comprehensive Research Center (RE Center), in China and promote the use of not only wind, but biomass and solar energies.

The RED program, through the creation of the RE Center, aims to address the government's goals in regards to renewable energy development and climate change. The RE Center will be responsible for policies and strategies, regulatory frameworks, technology R&D, and the promotion of the commercialization of technologies.

China's 11th Five-Year Plan (2006-2010) called for greater energy conservation measures and environmental protection, along with the furthering of renewable energy sources development. The aim is for the share of RE in total energy consumption to reach 10 percent by 2010 and 15 percent by 2015.

Two components comprise the RED program, the first of which consists of supporting the development and implementation of sub-sector strategies for wind, biomass and solar energies, in partnership with China's planning institutions. It also includes the establishment of a Renewable Energy Information and Analysis Center. The second component involves the development and implementation of innovative renewable energy technologies. This will be done by ensuring that Danish-Chinese institutional and business partnerships are in place for further cooperation.

One major new initiative of the program involves RED's dissemination strategy. In an effort to make RE knowledge more accessible to the wider public and broaden the reach of the program, RED is being taken to the elementary school level. In two popular videos explaining the story of Danish wind-power, pupils in China learn about wind power in Denmark. The videos are also being shared widely with provincial governments as well as power and grid companies.

For more information see: WED website www.dwed.org.cn and RED website www.cnred.org.cn

For WED program documents search for The Wind Energy Development on the Ministry of Foreign Affairs of Denmark website: http://www.danidadevforum.um.dk/en/

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COMMENTARY

Towards a More Sustainable Chinese Aluminum Industry

By Louis B. Schwartz and Ryan N. Hodum

RECOGNIZING THE CONUNDRUM

The primary aluminum industry is one of the six largest users of energy in China. Out of the nearly 3.43 trillion kilowatt-hours (kWh) of electric power consumed in China in 2008, China's primary aluminum industry accounted for more than 5 percent of the total, or approximately 182 billion kWh. On average, power consumption per metric ton (MT) of output of primary aluminum in China was approximately 14,500 kWh/MT as of early 2008, not much higher than the world average.[1] As of early 2008, with then current technology, energy costs accounted for roughly 35 percent of the total cost per MT of primary aluminum production in China.

China's aluminum smelting capacity has increased dramatically from approximately 2 million tons per year in 1997 to nearly 20 million tons per year as of the end of 2009. China's output of primary aluminum has grown from approximately 6.5 million MT in 2004 to approximately 13 million MT in 2008. Because of the repercussions of the economic downturn resulting from the worldwide financial crisis beginning in the fall of 2008, the 2009 aluminum output (~12.6 million MT) was slightly less than 2008 output—as of mid-year 2009 approximately 41 percent of China's aluminum smelting capacity was idle.[2] However, by mid-2010, China's output of primary aluminum had rebounded sharply with a 45.6 percent increase year-on-year. Chinese aluminum output is now on track to exceed 16 million MT for all of 2010.

Though China now both produces and consumes approximately one-third of the world's aluminum, at 6.5kg/person (as of 2007), China's per capita consumption is only 25 percent of per capita consumption in the United States; this presages continued growth in both aluminum production and energy consumption by the Chinese aluminum industry in the years ahead.

The growing power requirements of the fast developing primary aluminum industry over the past decade have contributed to the rapid development of the power industry in China, which remains dominated by coal-fired power plants.[3] For many years power usage in the Chinese primary aluminum industry was exacerbated by preferential power pricing at the local level—a technique widely used by local governments to entice development of new smelters. An important consequence of the heavy consumption of power by the Chinese primary aluminum industry has been the drive by aluminum producers to build their own "captive" coal-fired power plants to serve their aluminum operations.

In recent years there have been a large number of Chinese aluminum smelters that have integrated coal mining, power production and aluminum smelting; this is particularly true of Shandong and Henan provinces, which are rich in coal deposits.[4] These integrated coal/power/smelting operations are said to have a 50 percent

cost advantage over non-integrated smelters. China's large state-owned aluminum smelters, however, almost universally are not integrated and instead rely on purchasing their power requirements from utilities; and the price that utilities charge is not market based, but rather is distorted by central government policies that sacrifice rational energy markets to continued economic growth. The lack of a strong market to determine power prices also is a significant contributing factor to chronic overcapacity and excessive energy use in the aluminum industry. The policies promoting aluminum production highlight China's growth conundrum—protecting economic growth through wasteful energy consumption increases environmental degradation and undercuts energy security, both of which threaten sustained economic growth in the long run.

ADDRESSING THE ENVIRONMENTAL AND ENERGY TOLL OF THE CHINESE ALUMINUM INDUSTRY

The severe challenges that rapid economic growth poses to the country's environment and energy security have been the drivers of the Chinese government's national policy to reducing pollution emissions and conserve energy (*jieneng jianpai*), which is putting pressure on the Chinese aluminum industry to become more energy efficient and have less impact on the environment. Specifically, Beijing has implemented a series of tax, investment, and energy pricing policies to reduce the energy and environmental impact of the Chinese aluminum industry.

These new policies complement earlier efforts to clean up this industry. For example, the massive ramp-up of smelting capacity in China beginning in the late 1990s was accompanied by a steady, concerted and successful effort to mothball the environmentally and energy unfriendly mid-20th Century Soderberg aluminum smelting technology that predominated in the People's Republic of China for most of its first 50 years.

A suite of other measures is wrestling greater efficiency out of the Chinese primary aluminum industry. The February 22, 2008 notice from the National Development and Reform Commission (NDRC), which directed the elimination of all preferential power rates, has had the effect of increasing power costs for the Chinese aluminum smelting industry, though the downturn in the economy in 2008 created slippage in this important policy. The national goal of reducing energy consumption per 10,000 Yuan of GDP by 20 percent during the 11th Five-Year Plan period (2006-2010) has set concrete objectives throughout the economy. In early June 2009 the Chinese government issued the *Notice of the State Council Concerning Adjusting the Equity Proportion of Fixed Asset Investment Projects.* The June 2009 notice further increases the equity requirements for fixed asset projects that are characterized by heavy energy consumption, including primary aluminum smelting. In 2004 the Chinese government increased the equity proportion for new aluminum smelter projects from 20 to 35 percent; the June 2009 notice raises the equity portion of new investment to 40 percent.

An important part of the drive to wrestle energy and environmental savings from the Chinese aluminum industry is reigning in the chronic over-capacity that exists in the industry, which in turn has resulted in such irrational (from a macroeconomic, energy and environmental standpoint) behavior as exports of primary aluminum. This overcapacity also showed up recently in massive increases in fabricated aluminum product exports, which has unleashed a rash of anti-dumping and anti-subsidy investigations from Canada to Australia. It is significant that after China's largest aluminum producer Chinalco undertook significant measures to reduce its energy consumption after it entered into the NDRC's "1000 Enterprises Energy Conservation Program." (See Box 1).

Box 1. PROFILE OF CHINA'S ALUMINUM GIANT CHINALCO

The Aluminum Corporation of China (Chinalco) has grown to be the world's second largest refiner of alumina and the world's third largest producer of primary aluminum. As of the end of 2007 Chinalco had assets totaling 201.4 billion Yuan (up from 30 billion Yuan in 2001) and an operating income of 131.7 billion Yuan. For the second year in a row in 2007 Chinalco's profits exceeded 20 billion Yuan. Chinalco is among the top ten Chinese enterprises in terms of the number of patents it owns.

From 2001 through the spring of 2009 Chinalco cumulatively invested nearly 10 billion Yuan in science and technology research and development, over 5 billion was spent over the last three years on energy conservation and emission reductions in the company's bauxite mining, alumina refining, primary aluminum smelting and fabricated aluminum products processing operations.

With respect to its aluminum smelting operations, more advanced controlling technologies for the company's pre-baked aluminum smelting processes, which Chinalco developed itself, have been implemented in the corporation's ten branches. This new technology alone can reduce energy consumption per metric ton (MT) of primary aluminum produced by 140 kWh. Particularly since 2006, when Chinalco joined the *1000 Enterprises Energy Conservation Objectives Undertaking* initiated by the NDRC, it has actively sought to close the gap in operations between itself and world-class aluminum enterprises and worked to conform its operations to world-class standards. As part of this effort, Chinalco entered into letters of responsibility with the corporation's nearly 100 enterprises, setting goals and distributing concrete terms of responsibilities across the the entire organization.

According to Chinalco's 11th *Five Year Plan Energy Conservation and Emissions Reductions Objectives*, by 2010 (as compared with 2005), the total amount of sulfur dioxide emissions are to be reduced by 10 percent, energy consumption per 10,000 Yuan of industrial value-added is to be 20 percent lower[4], the volume of water discharge per 10,000 Yuan of value added is to decline by 30 percent, overall utilization rates of mineral resources are to increase by 5 percent and overall utilization of industrial solid waste is to increase by 5 percent. On June 17, 2009 the National Audit Office released its audit on Chinalco as part of its random sampling of the top 1000 enterprises in China. The outcomes of Chinalco audit, while confirming that the company has made noticeable progress in its efforts to conserve energy and reduce emissions, also pointed out instances where Chinalco subsidiaries have not completed certain energy conservation and emissions reductions tasks; for example, there are 31 boilers at 13 Chinalco subsidiaries which have not completed desulphurization upgrades and that Baotou Aluminum Co., a branch of Chinalco, saw its energy consumption per unit of primary aluminum produced rise by 1.83 percent. A spokesperson for Chinalco said that in response to the audit report, Chinalco has made investigations into these situations and has formulated a follow-up plan. With respect to Baotou Aluminum's increase in per unit energy consumption, Chinalco reports that the company spent 1.66 billion Yuan in 2008 to install the most advanced 400KA aluminum smelting technology and to shut down Baotou's outdated 135KA primary aluminum and related carbide production lines, both of which consumed much greater amount of energy.

Box 1. CONTINUED

Chinalco is also operating and/or putting together a series of secondary aluminum production lines, which cumulatively save 2.8 billion Kwh of energy compared to the same output at Chinalco's primary aluminum smelting operations; the secondary lines include Phase I of Chinalco's Qingdao 200,000 tons per year secondary aluminum facility and the Guangdong, Nanhai alloy project, which produces secondary aluminum from the scrap aluminum generated by the sizable Chinese aluminum processing (particularly extrusion) industry concentrated in Nanhai.

Also on the horizon are new regulations that require investors in new fixed asset projects to submit a detailed energy efficiency blueprint; any project that does not develop an energy efficiency program for a proposed new investment will not be allowed to proceed with the investment. Besides targeting primary aluminum smelting at the initial development stage, other initiatives target primary aluminum smelters that are already operating. One significant stumbling block for Beijing to begin to achieve its goal of reducing energy consumption per unit of GDP by 20 percent by 2010 is the resistance put up by local governments who are more interested in fostering economic development in their regions, often by encouraging the establishment of more energy and resource intensive industries. As new aluminum smelting capacity grows, however, China continues to close the most energy-intensive smelters; on August 8, 2010 the Ministry of Industry and Information Technology published a list of more than 2,000 energy-intensive plants that are required to close. That list includes seventeen small aluminum smelters (ranging from 60 to 90 kiloamperes) with a combined capacity of more than 420,000 tons per year. The August 2010 Ministry of Industry and Information Technology order to close energy intensive plants may allow China to realize its 2010 goal on time, despite having just a 14.4 percent improvement in the first five years of the effort.

EFFECTIVE USE OF TAX POLICY: LIMITING INCENTIVES TO OVERPRODUCTION OF ALUMINUM

The negative effects on China's energy and environmental policies of large-scale exports of primary aluminum caused the Chinese government to reduce Value Added Tax (VAT) rebates on exports of primary aluminum from China beginning in 2004. However, even after VAT rebates on primary aluminum exports were reduced to zero the exports of primary aluminum continued, which led the Chinese government to impose export tariffs. To avoid these tariffs, Chinese aluminum producers used exports of fabricated aluminum products, which then sparked the Chinese government in July 2007 to change VAT rebates for exports of certain categories of processed aluminum products, such as aluminum profiles. When Chinese producers responded to those tariff changes by beginning to export large quantities of minimally processed aluminum products, such as tube products, as a means of avoiding tariff and VAT rebate policies respecting primary aluminum, the Chinese government was forced to further regulate those categories as well. This in turn finally resulted in a decline in exports of such minimally processed products. The large number of anti-dumping and anti-subsidy investigations and actions by

A glimpse inside some small aluminum plants in China. Photo Credit: Louis B. Schwartz and Ryan N. Hodum

nations around the world in recent years reflect in part the incompleteness of Beijing's use of tariff policy to reign in the Chinese aluminum industry. The years of cat-and-mouse games between regulators and the aluminum exporters underscores the truth of the Chinese aphorism: "you have policies, we have countermeasures" (*ni you zhengce, women you duice*).

THE ROLE OF PREFERENTIAL POWER PRICING: A LEVER TO LIMIT OUTPUT AND ENFORCE ENVIRONMENTAL CONTROLS?

In mid-July 2009, the State Electricity Regulatory Commission, NDRC and the State Energy Bureau jointly issued the *Notice on Relevant Questions Concerning Perfecting the Work of Demonstration Sites for Direct Sales to Power Users by Power Generating Companies*, marking a new stage in the reform of the electric power industry and a new effort to use power pricing to control aluminum production, among other industries. The *Notice* has the potential to become an important route to rationalizing the Chinese aluminum industry, in part by favoring larger users of electricity that have more advanced technology, and weeding out the smaller, less efficient and less environmentally friendly companies. According to the *Notice* the price of power will be separated into the price of on-grid power and the price of transporting the power and large users may directly negotiate the on-grid price with power producers. With respect to the price for the transportation of power, the *Notice* provides for a 10 percent discount for 110 kV power transportation and a 20 percent discount for 220 kV power transport.

Industry insiders say that the effect of the implementation of the *Notice* is to greatly reduce the cost of production of large power users. On the other hand, small and mid-sized companies will not be able to avail themselves of the benefits of the *Notice*, which will result in a growing discrepancy between the total cost of production of small and mid-sized enterprises and the total cost of production of the larger enterprises benefiting from the *Notice* (provided that the policymakers in Beijing are able to enforce a suspension of preferential power pricing often afforded to aluminum smelters by local governments). The goal of the planners is that this discrepancy will lead to the

gradual closing of the smaller, less efficient and less environmentally friendly plants. Based on the current average price per kilowatt-hour for industrial users averaging 0.6Yuan/kwh, at a 10 to 20 percent discount, the larger enterprises will have a price benefit of between 0.06 Yuan and 0.12 Yuan. According to one analysts' calculation, where the average power use per MT of primary aluminum is 14,500 kWh, the cost of power accounts for approximately 35-40 percent of total production costs. If the power discount per kWh is 0.06 Yuan, then the cost to produce each MT of primary aluminum for these large-scale aluminum smelters will be 870 Yuan less than today; at a 20 percent discount the savings would be more than 1,700 Yuan/MT.[5]

SECONDARY ALUMINUM: A PATH TO GREATER SUSTAINABILITY IN THE CHINESE ALUMINUM INDUSTRY?

The reduced energy consumption and related lesser impact on the environment of the use of secondary aluminum are well documented. Producing a MT of secondary aluminum from scrap aluminum requires approximately 5 percent of the energy consumption required to produce a MT of primary aluminum.[6] In 2007, China produced a total of 2.849 million MT of secondary aluminum, a 17 percent increase over secondary aluminum output in 2006; this level of output of secondary aluminum resulted in a savings of 19.27 million MT of coal equivalents and 160 million MT of water. The level of production of secondary aluminum in 2006 also resulted in 141,000 MT less of sulfur dioxide emissions and 68 million MT of avoided solid waste emissions.[7]

In 2007 China's consumption of secondary aluminum accounted for 22.9 percent of total aluminum consumption (12.44 MT of primary aluminum was produced in 2007), which is lower than the world's average consumption of secondary aluminum of 50 percent. If by the year 2020, China is able to increase its consumption of secondary aluminum from 22.9 to 60 percent, the country could annually save 36.4 million MT of bauxite, 136.5 billion kWh of energy, and 91 million cubic meters of water (taking into consideration the growth in consumption and output of primary aluminum to 2020).

Wang Xihui—a representative to the National People's Congress, the General Manager of the Henan branch of Chinalco and the Chairman of the Non-Ferrous Metals Association of Henan Province—recently remarked that China needs to increase its utilization of secondary aluminum and that the greater use of secondary aluminum is a "green project" which will help reduce energy consumption and raw materials and cut down on pollution. In order to increase the amount of secondary aluminum output in China, it will be necessary for China to build a secondary aluminum recovery and utilization system, while increasing automation, the quality of equipment, environmental compliance, and further developing an effective network of scrap recovery, distribution and re-utilization. To accomplish these goals it will be necessary for the government to provide policy, financial and technological assistance to China's still nascent secondary aluminum industry.

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ENDNOTES

[1] One important goal for the Chinese primary aluminum industry is to put in place the technology that would enable Chinese aluminum smelters to reduce energy consumption per metric ton of primary aluminum from an average of 14,500 kWh to an average of 12,000 kWh. Technological upgrades such as these alone would reduce overall energy consumption in the primary aluminum industry by approximately 19.5 billion kWh/year or more than 10 percent of current energy consumption by the Chinese primary aluminum industry.

[2] The economic downturn in China caused by the worldwide financial crisis both has aggravated the environmental challenges posed by the primary aluminum industry (through the reinstitution of preferential power pricing policies directed at the primary aluminum industry) and ameliorated the problem by causing China's primary aluminum industry to idle a substantial amount of capacity, most of which is the least efficient of China's aluminum smelting capacity. The slowdown in output of primary aluminum in turn may result in a reduction in energy consumption of approximately 28 billion kWh by the Chinese primary aluminum industry in 2009, though an economic meltdown is not the most ideal way for the Chinese to reduce emissions and conserve energy.

[3] Compared with conditions overseas, the Chinese primary aluminum smelting industry relies to a much greater extent on the use of coal-fired power plants for the power required to smelt aluminum (by one estimate 70 percent of power used by the Chinese aluminum industry is coal-fired).

[4] With respect to its energy consumption, Chalco's overall energy consumption per unit of alumina refined has declined by 21.39 percent through the end of 2007, while its overall energy consumption per unit of primary aluminum produced declined by 3.57 percent. Taking all of its subsidiary companies as a whole, the company's rate of reuse of industrial water rose from 87.68 to 90.60 percent from 2006 to 2007 and 80 percent of its alumina refineries now are achieving zero discharges of industrial waste water, which results in a decline of wastewater discharge totaling 33.77 million tpy. In 2007 Chinalco increased its desulfurization by 98,000 MT/year and increased its rate of removal of smoke and dust from 85.1 to 99.1 percent.

[5] One estimate is that there is in excess of 2 million tons per year of aluminum smelting capacity that is produced in facilities that integrate coal production, power output and aluminum smelting.

[6] This takes into account the entire life cycle of primary aluminum production, including bauxite mining, alumina refining and primary aluminum smelting.

[7] In 2008 China produced a total of 2.7 million MT of secondary aluminum (down from 2.849 million MT of secondary aluminum produced in 2007) and in 2009 China's secondary aluminum output rose to ~2.97 million MT. Because China produced a total of 40 million MT of primary aluminum between 1990 and 2004 and the products produced and consumed in China since the 1980's have reached the end of their useful lives, it is expected that the rate of growth of scrap aluminum recovery will increase to 8 percent from ~6 percent beginning in 2010.

Developing Environmental Stewardship Through Art

By Sara Gavney Moore and Jim Harris

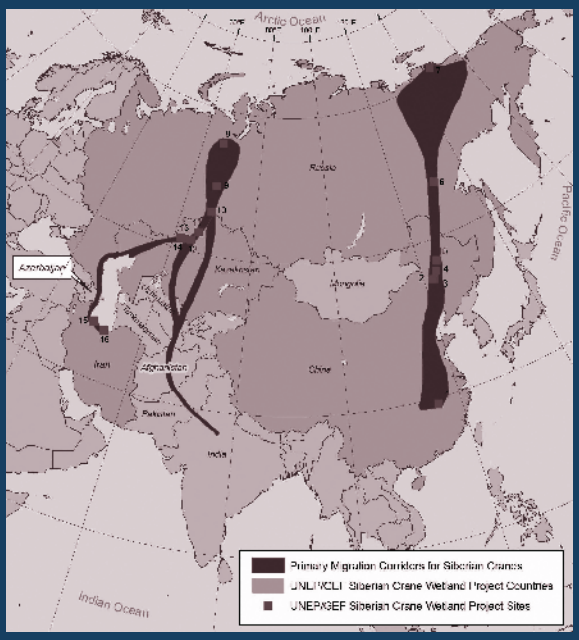
How do you paint the sky? What color are a crane's legs? Students at Xianghai Middle School in Jilin Province are asking these questions as they explore their role in educating their community about the conservation of wetlands and wildlife. With the support of two international NGOs, the International Crane Foundation (ICF) and Art in a Box, and a national NGO, Beijing Brooks Education Center (BBEC), the students and their art teacher Shi Yanqiu have designed and painted two community murals depicting the cranes, wetlands and people of Xianghai Town. The murals show the beauty of nature, the changing of the seasons, and the damages from human activities to the wetland and grassland ecosystems of western Jilin Province. Wildlife suffers, but overgrazing and groundwater depletion also threaten the livelihoods and future health of the human community. Far more than simple art projects, however, these activities are an exciting example of how students can take action to empower themselves and others through learning about their environment.

The Xianghai nature art club began working on environmental projects in 2007 after they received a donation from an elementary school in central Wisconsin. The American students had recently organized a sale of note cards depicting rare birds drawn by one of their classmates. The students donated the profits from their project to ICF which in turn gave a portion of the gift to the Xianghai Middle School art program. With $150 from the American students, the Xianghai art teacher purchased art supplies and organized field trips for the students to see wetlands and draw the cranes that migrate through or summer near the reserve, such as the endangered Red-crowned and Siberian Cranes. Inspired by the Wisconsin students, the Xianghai students designed their own set of note cards focusing on the cranes and wetlands near their home. Art in a Box, which focuses on empowering children through art, provided materials to the school for this project and developed the note cards, which are now for sale through the ICF gift shop. The funds earned support for further art and conservation activism among students at Xianghai.

The following summer, in 2008, the students once again partnered with Art in a Box and ICF to develop a mural showing the wetlands, cranes and changing seasons at Xianghai Nature Reserve. The mural was created during an annual environmental camp organized by BBEC and ICF for students and teachers living around Xianghai Nature Reserve. When asked about their art and feelings about the project, the student artists talked about working together and how they could make something as a group that none of them could do alone. This kind of attitude inspires people to work together to solve problems in their community and protect the environment.

Once the mural was complete, the students proudly marched the fully extended mural across town. A few townspeople came out to see while others ignored them. One student declared emphatically, "People don't understand art!" The students presented the mural to the Xianghai Nature Reserve and the entire student camp. They were eloquent when talking about their art and what it means to love and protect nature. The mural will be displayed in the new museum to be constructed at the nature reserve.

The students developed a new mural in the



This photo shows the countries and project activities being undertaken by the UNEP/GEF Siberian Crane Wetland Project (Described in Feature Box following this Spotlight), which includes the Xianghai Town in Jilin. The SCWP unites conservation activities at sites along the eastern and western Siberian Crane flyways, forming a network of protected wetlands that provide critical habitat for Siberian Cranes and many other waterbirds and for people who depend on these areas. Photo Credit: UNEP/GEF

fall of 2008. Painted on the side of a building on the main street of town, the mural is entitled, "Build our home, hand in hand," and shows the Xianghai Town past, present and future—with an emphasis on threats to wild resources and solutions that will allow Xianghai to be a healthy home for wildlife and future generations. In addition, ICF sponsored a video about this project entitled, "Dream on the Wall," focused on how the Xianghai students are learning about their environment and its problems, and how they are taking action through art and example to bring solutions to their community. In the video, the students and their teacher note that they are pioneers in bringing environmental awareness to their community. The students struggle with their new understanding of the impact of their village on the environment – ground water contamination from the town garbage dump or pesticide use on their crops – but the nature art club has become a tool for expressing their feelings and creating a dialogue with their community. Hundreds of people pass the mural every day.

Through personal actions and communicating with their town through art, the students have not yet solved the major the challenges in their community. Yet the problems can no longer be hidden or ignored. In fact, the example set by the children for their teachers and community leaders, and their increased ability to think critically and act according to their deepening comprehension of environmental issues may be the most significant impact of the project. They are leaders now, and will continue to contribute to the well-being of their community and environment.

ICF developed an exhibit featuring the art project, highlighting how interaction between American and Chinese students changed the way everyone involved looks at their world. The exhibit showed at ICF until October 31, 2009 before traveling to sites in Milwaukee, Wisconsin and elsewhere along the crane flyway from Wisconsin to Florida.

Support for ICF's education programs in China has been provided by the Henry Luce Foundation, the National Fish and Wildlife Foundation/ ConocoPhillips SPIRIT of Conservation Migratory Bird Program and the UNEP/GEF Siberian Crane Wetland Project. More information on ICF's China Program can be found at www.savingcranes.org/chinaprogram.html or by emailing china@savingcranes.org. To learn more about the traveling exhibit or the video, please contact Joan Garland at jgarland@savingcranes.org.

James Harris is Vice President of the International Crane Foundation (ICF) where he has worked since 1984 and in China since 1986. He now lives half time in Harbin and half time in Wisconsin. Jim had the lead role from the ICF side in organizing the 1987 International Crane Workshop in Qiqihar, the earliest significant international conservation meeting

Students in Xianghai Town, Jilin Province are using art to increase environmental awareness within their community. Their mural "Build our home, hand in hand" portrays their vision of Xianghai past, present and future, and the effects of the town on the region's environment.
Photo Credit: Jim Harris

in China. Beginning in 1991, he helped to develop a project at Cao Hai Nature Reserve in Guizhou, successfully providing opportunities for local people to improve their livelihoods while actively participating in wetland and watershed protection—a project that still continues. More recently he has worked on water management issues at Poyang Lake and for wetland nature reserves in Songnen Plain of northeast China. Water allocations to sustain ecosystem functions of Zhalong Marsh have been included in national water plans, and a long-term funding mechanism established for water releases. He can be reached at: harris@savingcranes.org.

Sara Gavney Moore is the Communications Specialist for the International Crane Foundation (ICF) since 1999. Following four years as a naturalist in ICF's Education Department, Sara worked six years with ICF's China Program to support research and community education projects conducted jointly by ICF and colleagues in East Asia. Through this work, Sara participated in education activities in Russia and China and developed and coordinated an English language website targeting teachers and students participating in Three White Cranes, Two Flyways, One World, an international education project involving students in the United States, Russia and China. She can be reached at: sgm@savingcranes.org.

金 木 水 火 土

FEATURE BOX

Linking Wetlands along the Siberian Crane Flyway in Eastern China

By Jim Harris and Sara Gavney Moore

The protection of migratory birds depends upon safeguarding key breeding areas where the birds raise their young and also the wintering grounds where the birds find food and safety. Just as important, however, is protection of sites along the species' flyways where the birds rest and refuel during their annual migrations. Ideally, conservation activities at all sites along the flyway are coordinated, to help ensure that critical habitat is protected at each stage for the journeys that millions of birds make each spring and fall. A recent project undertaken by the International Crane Foundation (ICF) with partners in China, Russia, Kazakhstan and Iran explores these concepts, focusing on the critically endangered Siberian Crane.

The UNEP/GEF Siberian Crane Wetland Project (SCWP) was initiated in 2003 to identify and protect key wetlands along the Siberian Crane flyways in Eurasia. Nearly the entire world population of Siberian Cranes winters in the Poyang Lake Basin in Jiangxi Province. Each spring the cranes migrate north through eastern China, passing through Liaoning, Jilin and Heilongjiang Provinces on their way to breeding areas in Yakutia, northeastern Russia. SCWP activities in China have focused on five wetland sites, including the Poyang Lake Basin in the southeast, Xianghai, Keerqin, Momoge and the Zhalong National Nature Reserves in northeastern China. Of critical importance to the protection of these sites is an understanding of how the cranes and other waterbirds use these wetlands and the maintenance or restoration of natural cycles of water that are vital to the ecological health and productivity of these wetlands – water resources essential for the cranes, many other wildlife species, and growing human populations.

The SCWP has supported long term research in the Poyang Lake Basin focusing on the relationship between Siberian Cranes, the wetland plants on which they feed, and water levels in the basin. Eleven years of research have found that the Siberian Cranes' winter habitat is limited primarily to areas with depths less than 30 cm, although these birds do use water as deep as 50 cm. In these areas of shallows and wet mud, the cranes can reach starchy Vallisneria tubers. This essential wetland plant feeds wintering cranes, Swan Geese, and other waterbirds that search for the tubers that develop on the plant's roots.

This research, together with related studies by others concerning hydrology, land use, and light availability for Vallisneria, is helping the Chinese Government understand what the Siberian Crane and other waterbirds need to survive during the winter months at Poyang. This knowledge is essential for evaluating the implications of developments now being considered within the lake, including a variety of water-control projects that could drastically alter the hydrology of the system. A dam proposed for the outlet to Poyang Lake, for example, would stabilize winter water levels for sake of navigation and flood control. If winter water levels were maintained significantly higher than now, most shallow waters used by Siberian Cranes and other waterbirds would be flooded

too deep for the birds to feed. Extinction could easily follow for the charismatic crane. Even if water were stabilized close to current winter water levels, the lack of fluctuation within and between years could drastically change food availability for the waterbirds and indeed, transform the ecological character of the lake. The extraordinary productivity of Poyang, which benefits waterbirds and local people, likely depends on those dramatic changes in water levels.

Further north, in Heilongjiang and Jilin Provinces, the Siberian Crane finds the midpoint of its long migration where wetlands in the Songnen Plain have long provided plentiful stopover areas. Here the birds can spend one to several weeks before continuing north or south. While many wetlands have been developed and lost to wildlife, several large nature reserves have been established, most notably Zhalong, which includes over 200,000 hectares.

In recent years, however, nearly all of these protected wetlands have been drying up. A cycle of drought may be partially responsible, especially in the west, but for the Zhalong area recent rainfall has been greater than averages recorded over the past fifty years. The lack of water arises primarily from diversions for human use in a part of China where water resources are scarce compared with growing human needs. In past years, design of these projects has not emphasized efficiency of water use or minimized impacts on wild resources. For example, a system of canals carrying water from Nenjiang (river) to Daqing and elsewhere is not designed to drain the Zhalong Marsh, but the canals entirely circle the nature reserve. Fifty-meter wide canals with associated dikes and roads prevent any overland run-off from reaching the wetlands.

Through the SCWP, ICF and Chinese colleagues under the State Forestry Administration developed collaboration with the Songliao Water Resources Commission (SWRC), a part of the Ministry of Water Resources that studies water needs and develops plans for water use in these watersheds. Our project came at a good time, for SWRC had received an expanded mandate, to consider ecological needs for water equally with economic needs as it developed water plans. Our project assisted with the ecological assessments that complemented SWRC's long-term expertise in water management.

As a result, the project studied water needs for Zhalong, Xianghai, and Keerqin Nature Reserves – we later added Momoge – and developed water management plans for each reserve based on historic records for Songnen Plain. While the natural conditions – where water often flowed in sheets across large expanses of the landscape – can never be restored, the plans do show how ecological functions of the wetlands, including nurturing globally important populations of cranes and other waterbirds, can be recreated.

At Zhalong, for example, the current system of canals and water gates makes it possible to deliver the amounts of water needed at the right times of year and in diverse places along the upper parts of the wetland. This management plan has been incorporated into regional and national plans and approved by the central government. The provincial government has added an annual appropriation to the budget to pay for water supply for Zhalong.

Nevertheless, delivery of the water needs time and experience to perfect. This past spring for example, the marsh was so dry during the April-early May breeding season that fires swept vast areas, destroying nests and young birds. Water releases started in late May – too late for the breeding birds. The other challenge for Zhalong is the large number of dikes and canals that have been built even within the reserve. These structures fragment the wetland and prevent water from spreading across large parts of the marshland. As a result, some areas remain dry while other parts are deeply flooded by water releases. Water should be released before the breeding season and from multiple locations. Further coordination involving local agencies responsible for the water releases and

Each fall Siberian Cranes migrate over 3,000 miles from their breeding areas in northeast Russia to their wintering grounds in the Poyang Lake Basin, Jiangxi Province. Through the SCWP, researchers are studying the relationship between the cranes and the dynamic wetland ecosystems within the basin. Photo Credit Ji Weitao

for wetland management are needed to solve these problems. The result should be a great increase in biological function and in the ecosystem services provided by Zhalong.

In addition to these more intensive efforts, SCWP researchers are coordinating annual surveys to monitor the population and distribution of waterbirds and identify key wetlands used by Siberian Cranes and other waterbirds along the entire crane flyway in eastern China. Over 150 sites in ten provinces are involved in the monitoring, conducted annually during the fall and spring migrations by a large number of observers trained through this project. At Huanzidong Reservoir in Liaoning, for example, hundreds of Siberian Cranes pause for weeks to feed in shallows available only because the reservoir is not full. Discovery of this new site is due to amateur bird watchers and photographers, who are making growing contributions to Chinese conservation.

Within China, the project has created much greater awareness that waterbird populations and their habitats function as integral parts of long flyways—communication and collaboration must occur among many locations and agencies for conservation to be successful. Sites such as the Poyang Lake Basin and wetlands of northeast China are connected by the migrating waterbirds that share these resources. In addition, SCWP has greatly increased interaction among Chinese and Russian researchers, so that action for northern parts of the flyway link with the Chinese effort. These interactions allow researchers and others to share information, target conservation activities and better understand the different ecologies these birds encounter along their migration.

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