Committee on Ecology and Transportation Newsletter

Transportation Research Board Committee ADC30 **Summer2011**

View from the Chair

Alex Levy, Chair Ecology and Transportation Committee

A Decade for Ecology

Have you admired yourself lately? If not, it really is time to look about us and smile at the point we find ourselves on this journey we're taking together. After all, we were – each of us – party to a year in which changing our world was suddenly made obligatory. A decade has elapsed since the amalgamation of the forums that became the International Conference on Ecology and Transportation. A decade has elapsed since a cadre of government and non-government individuals commenced an expedition to give conservation in the New World some fresh perspectives from the old one that was the FHWA/AASHTO scan tour for Wildlife Habitat Connectivity across European Highways. Oh! And then there's that decade gone-by since a few members of our common journey banded together in homage to the virtues of research and nurtured the roots of what have become this very TRB Ecology and Transportation Committee.

To our founders, members, friends as well as the researchers, liaisons, media specialists, and more than a few mentors, there is great cause for gratitude. However, in so doing, be certain to recognize yourself. Because, even if this is your first ICOET or your first time learning about the moniker, "ADC30," chances are good, you're a member of this ongoing voyage to a better New World. (And if this is your first time, welcome aboard.)

As the new chair of this Ecology and Transportation Committee, I'm honored (more-candidly, relieved) to still be on this journey with you. Although, when you consider the tenacity of the pioneers and harbor pilots who've borne us through narrow straits to open water, it's really no wonder the successes we have and will-yet achieve together. Pioneers like, Tom Linkous, the founding chair of this committee, who is truly a habitual conservationist. As a scientist, Tom may have always worked with natural resources, but as a man, he's clearly someone who builds beacons that others can follow. With engaged visionaries like you – yes you, the reader of this musing – we'll continue on our journey to a better New World.

We'll achieve even more practical results, so that - especially in times of economic austerity – the boughs of research can bear enough fruit to feed a world hungry for knowledge-based solutions. From time to time, we might even find answers when we turn an inward eye on the conservation culture within the realm of surface transportation. From agencies, organizations, institutions, oases like ICOET and the Infra Eco Network of Europe (IENE), we'll keep cultivating the unique symbiosis that sustains our quest to a better New World.

After all, whether engineer, artist, or scientist, as ecologists-all, isn't that what we're after: a New World better than the ones that we knew before; but especially better for having been in it?

ICOET Is Almost Here!

The International Conference on Ecology and Transportation begins on August 21 in Seattle WA. Many thanks to the conference organizers, who have put together a terrific mix of papers and posters geared to the conference theme " Sustainability in Motion". Three field trips (I-90 Snoqualmie Pass East Project – Ecological Connectivity: Olympic Peninsula and Puget Sound – Aquatic Ecosystems and Seattle Metropolitan Area – Sustainability in Urban Environments) are examples of how best practices are implemented. Our Committee will be meeting jointly with ADC10 Environmental Analysis from 5:00-6:00 PDT on Tuesday August 23, followed by a meeting of our Committee from 7:00-10:00 PDT. Friends are always welcome at the Committee meetings.

ICOET is an important conference as it helps generate research ideas for the Committee. For more information, please visit the conference website at http://www.icoet.net/ICOET_2011

Feature Article:

Emergence of Road Ecology in China

By Richard T. T. Forman [Harvard University, Graduate School of Design], Marcel P. Huijser [Montana State University, Western Transportation Institute], and Anthony P. Clevenger [Montana State University, Western Transportation Institute]

Expressways rapidly roll across China's land, reminiscent of the 1960s in America. For the next 5 to ten years, approximately 8,000 km is expected to be added annually to the existing 65,000 km of expressway. By then, the total amount of expressway, about 130 000 km, will rival that of the US interstate system. In addition, today the Chinese rate of increase in building cars, buying cars, and driving cars (VMT) may all be number one worldwide. Fossil fuel consumed, murky urban air, greenhouse gas emitted, bad traffic jams, mainly new drivers, and terrible accidents mushroom as well. Imagine where all this leads, even in a single decade.

Few ponder the ensuing effects on wildlife, biodiversity, vegetation, farmland, soil erosion, sedimentation, water supplies, aquatic ecosystems, and fish. The Chinese Ministry of Transport knows the history of America's multilane highways, as well as the half-century lag before major road-ecology thinking and solutions began spreading. So today, some 50 engineers, ecologists, landscape architects, planners and others in the Ministry's Chinese Academy of Transportation Sciences (CATS) are working to implement environmental solutions, essentially from the beginning of an expressway system. The group is conversant with the author's 2003 book, Road Ecology: Science and Solutions (translated into Chinese by Dr. Li Taian of Lanzhou), plus a China-focused 2008 book, Road Ecology, put together by Professor Mao Wenbi, engineer and former president of CATS.

Thus China was ready to organize its inaugural conference, Road Ecology Sub-Forum of the Transportation Development Forum, held in Beijing in May 2010. Author Richard Forman's keynote presentation provided an international perspective. High quality talks were given by: the Ministry's Environmental Protection director (Li Shubing); an expressway company manager/senior engineer (Sun Bin); CATS deputy director/professor (Chen Zongwei); Chinese Academy of Sciences landscape-ecology professor (Xiao Duning); Highway Research Institute senior engineer (Shen Yi); CATS landscape planner (Lu Xudong); provincial highway-construction professor (Lu Yayi); design-research and erosion-control engineer (Luo Junbao); Research-Design Institute director/professor (Zhang Lanjun); Peking University landscape architect (Qiao Qing); and CATS wildlife road ecologist (Yun Wang). The mix of expertise was a good representation of CATS interests. The leaders of the Jilin Provincial High Class Highway Construction Bureau introduced key projects in the Northeast (former Manchuria). We visited and discussed China's largest auto-manufacturing center (Changchun), a just-completed expressway, a scenic expressway under construction, and a ring road around the famous Changbai Mountain by the North Korea border.

In August, officials provided an equally warm welcome to authors Marcel Huijser and Tony Clevenger and their colleagues, Xianming Shi, Rob Ament and Stephen Albert, all of the Western Transportation Institute, Montana State University. Then leaders of the Yunnan Yunling Expressway Maintenance and Landscaping Engineering Co., Ltd. (approximate equivalent of a state department of transportation) and CATS introduced us to ongoing projects in Yunnan Province. We visited the Simao-Xiao Mengyang highway through the Mengyang Nature Reserve, a critical remaining Asian elephant (*Elaphas maximus*) habitat, as well as other sections of the G213 highway between the provincial capital, Kunming, and China's southern border with Thailand, Laos and Myanmar.

Both hosts and visitors wanted to learn, so discussions at numerous stops were highly informative. Wonderful hospitality included exchanging gifts and classic delicious Chinese "lazy-susan" repasts (Figure 1). At lighter times we enjoyed throwing mountaintop snowballs in the clouds, and experiencing the canopy of a rainforest from a cable car.

Figure 1. Environment-and-transportation colleagues at a traditional Chinese repast with some 24 dishes on a slowly rotating "lazy susan". Copyright Marcel Huijser.

Stated government policy for highway construction during 2010-2020 seems to be: (a) green transportation; (b) avoiding sensitive habitats; (c) recycling water and materials; and (d) low carbon use in construction and maintenance.

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Also, key problems highlighted are: (1) farmland loss; (2) lowered water table; (3) minimizing cuts and fills to reduce erosion and sedimentation; and (4) minimizing the loss of natural vegetation. Comparing these core goals and problems with those of other leading road-ecology-focused nations could be useful for all.

Highways and ecology

Especially in Jilin Province, the divided four-lane highways were commonly raised some 9 ft. in flat landscapes, thus providing views for travelers, separating highway travelers from local activities, and leaving existing farm roads crossing beneath intact. However, the raised road is more expensive than America's typical three-foot-high road, and results in terrible accidents when vehicles run off the road. Paved road shoulders often seemed to be only six feet wide, which was dangerous for vehicle breakdowns. Median strips also were about six feet wide, but quite interesting (Figure 2). Parallel 3-ridged (thrie-beam) guardrails attached together with short horizontal steel beams at frequent intervals lined the high-speed lanes, creating a very strong median structure. The four-to-five foot wide strip between guardrails was planted with dense shrubs that extended for tens of kilometers. Shrub tops were shaved off as needed at about seven feet in height. Although this is a maintenance cost, for travelers the shrubby median provides a restful green (most guardrails were also green) and blocks oncoming headlights.

Figure 2. Shrub median between connected guardrails on a new expressway. From Big Spanning by Sheng TaiLu et al., eds. 2008. Jilin Provincial High Class Highway Construction Bureau, Changchun, China.

"Soft" guardrails made of horizontal cables were occasionally present. Based on vehicle testing, accident severity was about the same as for typical guardrails but maintenance costs were higher, so the cable guardrails were no longer being installed.

In hilly country, attempts to keep the highways relatively level for traffic flow and to minimize cuts-and-fills produced three solutions uncommon in North America: (1) long gentle curves on huge amounts of fill; (2) dynamited tunnels through medium-high hills; and (3) long viaducts along a floodplain, even over its river. Figure 3 shows Richard Forman with hardhat being welcomed by a friendly head dynamiter into a tunnel being blasted (Figure 3). Tunnels (in new highways built by thousands of workers) apparently have high maintenance costs for light, air, water seepage, and falling rock. Yet tunnels provide the best wildlife overpasses by protecting natural vegetation and habitat above, and also minimize erosion and visual-aesthetic scarring of the landscape. Stormwater and pollutant runoff from the tunnels were said to be a problem.

Figure 3. Province and CATS transportation officials by expressway tunnel being blasted through low hills. Jilin Province. R. Forman photo: use of this photo prohibited without written permission

Raised viaducts along a river system met the stated transportation goals, also eliminating the need for many separate stream crossings and providing a scenic route for travelers. On the other hand, disrupting the view from hillsides and valley, some effects on floodplain biodiversity and processes, and interrupting water flows, fish movements and boating occurred, but were considered less important.

Vegetation and roadsides

Minimizing natural vegetation loss as a transportation goal is quite a contrast with American practice. The noticeably narrow expressways, tunneling rather than sideswiping a hill, and viaducts over floodplains and wetlands

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help achieve the goal. Also highways across farmland largely avoid natural vegetation.

Rare species and biodiversity were seldom mentioned. One intriguing species, the "beauty pine" (possibly related to Europe's Scots pine *Pinus sylvestris*), apparently only remains in about a hundred acres near two-lane roads in the Changbai Mountain Nature Preserve. The trees were tall and striking but seemed to be producing no seeds---not promising for survival. Although floodplains are typically hotspots of biodiversity, in China they are prime areas for rice culture.

Roadsides beyond the paved shoulders of highways were commonly some 10-15 ft wide, a nice relief from the wide swaths of largely wasted land so frequent along American highways. Roadside vegetation, as in most areas worldwide, was unexceptional except for occasional stretches of productive rapeseed-oil planting. Near cities, highway roadsides were extensively planted with regular lines of trees and shrubs, and occasionally dense flower-planting provided aesthetics. In dry areas, water running off roadways supported roadside salt-tolerant plants, as evaporation had left salty soil. Two full-size plastic cows graced one roadside.

Rest areas often offered lodging for sleeping, and highlighted cultural history transcribed onto large rocks. Some parking areas had porous pavement walkways, and a row of trees between every two parked vehicles, with grassy pavement blocks under cars. Geothermal heat is used for some rest-area facilities.

Wildlife and roads

The relatively narrow highway (small footprint) means less habitat loss. Also the shrub median provides a "stepping stone" that can facilitate crossing by some birds and other wildlife. These benefits reduce the highway barrier effect, potentially increasing population viability for certain species in the landscape.

The rather frequent viaducts permitted free wildlife movement beneath, thus further reducing barrier and fragmentation effects (Figure 4). A two-lane ring highway around the Changbai Mountain Nature Preserve included a number of short high viaducts across large-stream valleys. The viaducts crossed at about treetop level, permitting floods to pass harmlessly and wildlife to pass readily. Yun Wang, a delightful CATS highway wildlife researcher as one of our tour leaders, had used track analysis to record numerous crossings in these "underpasses" by about a dozen medium- and small-mammal species, and had also recorded roadkill of the majority of the species in other sections of the highway.

The high roadbeds in flat agricultural areas theoretically are barriers to wildlife species crossing. However, intensive long-term farming has left little natural vegetation and probably very little wildlife other than crop-related species

Figure 4. New expressway built on farmland showing narrow median, shoulder and roadside, plus characteristic erosion-control structures on fill-slopes. From Big Spanning by Sheng TaiLu et al., eds. 2008. Jilin Provincial High Class Highway Construction Bureau, Changchun, China.

such as ricebirds. Occasional farm roads crossing beneath the highway could permit some wildlife crossing, and more wildlife-crossing structures could be inserted where needed. As traffic levels grow, sensitive birds and other vertebrates in natural vegetation areas could be affected by traffic noise, though with high roadbeds and intense farming practices the problem should be minimal in farmland where such species are scarce.

No roadkills and few animal crossings were observed by the authors. Animal mortality was mentioned as an ecological problem in areas of Sichuan and Tibet, as well as Yunnan Province (frog, snake, and monkey roadkills). Significantly, very little wildlife was seen either in roadsides or in adjoining areas.

In Yunnan Province, the major north-south highway through China's Mengyang Nature Reserve, home to the largest number of Asian elephants (about 80-100 individuals) in Xishuangbanna, was upgraded in 2003 to a four-lane expressway. Sixteen viaducts and two tunnels were built in this section, and the elephants have been found to use eight of these 18 potential safe-crossing locations. Eight of the 10 unused structures are in areas where the elephants did not cross historically, whereas the eight structures used are all in known elephant movement corridors.

Despite the presence of underpasses, wild elephants still cross the road at grade in some locations, a threat to human safety and a conservation concern (Figure 5). From March to October 2006, elephants were known to cross the highway 44 times, with 94% of the crossings at night. Elephants have been observed on the highway more than 60 times from its opening on April 6, 2006 through 2008, and several elephant-vehicle collisions have occurred, causing property damage, injuries, and fatalities to both humans and elephants.

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Figure 5. Asian elephants crossing highway during a survey to identify locations for wildlife-crossing structures. World Heritage area, Yunnan Province. Photo courtesy of Yun Wang.

Standard fences and trenches are deemed ineffective to keep Asian elephants from entering the roadway, while only mixed success has been achieved using electric fences. Therefore alternative mitigation measures are being explored. In collaboration with the Western Transportation Institute, at one particularly problematic location, officials hope to install an animal detection system consisting of sensors that detect large animals as they approach a road. When detected, warning signs are activated urging drivers to slow down and be more alert, potentially resulting in fewer and less-severe accidents for both humans and elephants. Several studies indicate that newer reliably functioning animal-detection systems can reduce vehicle collisions with large mammals by 58-97%. Moreover, the benefits are likely to outweigh the costs.

Earth, soil, fill, water, erosion

In some areas concrete or stone-and-concrete troughs in road ditches channeled stormwater rapidly to the valley bottom or stream, causing noticeable scouring. The new expressways being built instead used grassy road ditches, apparently sometimes with a gravel layer beneath. At one point, the six-vehicle entourage of transportation officials including a video filmer stopped to discuss the successful new design of a grassy ditch, and the top province official and Richard Forman celebrated with a series of well-filmed "high fives".

The abundant 10 (to 30) foot- high fill-slopes along the raised highway often had a distinctive, rather aesthetic drainage mechanism to minimize erosion (Figure 6). Water running down a slope was intercepted by a thin arch, with arches in rows one over the other, and drained to somewhat vertical channels between arches. The bottom of the slope had a rock or concrete trough with evidence of scouring at the bottom of the verticals where hydraulic energy was directed. Rather than erosion control facilitating infiltration into a (presumably sandy) roadbed, this design diverted water elsewhere. Still, it allowed for steep fillslopes, narrow highway footprints, and less loss of habitat and farmland.

Cutbank slopes above highways seemed a bit steeper than in America, though slope stability depends greatly on substrate type and hydrological conditions. To control erosion on cutbanks, trees (sometimes with shrubs) were planted in a regular grid on the slope, and occasionally, trees were planted in a single row at slope bottom just above the roadside ditch. On numerous new or recent cutbanks of 10 to more than 50 feet high in hilly country, no coarse gravel or rock covering was observed on the lower portion of the slope, so presumably slumping due to hydrologic pressure from groundwater at higher level was not a problem.

Controlling wind-caused erosion and sedimentation around roads was being researched in inner Mongolia. Diverse experiments involve trees, shrubs, windbreaks, dune crests, various synthetic materials, and a range of spatial arrangements. A rather fine-scale grid of cylindrical sand-

Figure 6. Highway across valley to facilitate the movement of floodwater and wildlife. Copyright Marcel Huijser.

bags at strategic spots was reported as quite promising for minimizing wind erosion and sediment accumulation on roads. Watering plants in a dry area highlighted the familiar issues of salt accumulation and lowered water table.

Water bodies, air, and chemicals

Water pollution and transportation altering the hydrology of water-bodies presumably was of interest but did not generate much discussion. However, deicing for traffic safety was actively researched and of considerable interest. The disposition of deicing agents and associated sand affecting lakes, streams and rivers may be a problem as in most cold-weather regions.

Certain Chinese cities are reported to have some of the worst air pollution worldwide, with a familiar gray pall often cutting visibility to a few or several blocks. One city visited (Dunhua) is sometimes called the "Blue-Sky City" because on a few days every year, the blue is visible overhead. Although cities, rather than transportation, are considered largely responsible for poor urban air, trucks burning diesel fuel and tiny three-wheelers often emit black soot. Compact- and subcompact-sized cars everywhere burn

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gasoline, getting somewhat better mileage-per-gallon than the equivalent American car. Vehicle-miles-traveled grows, and growing traffic slows movement, reducing engine combustion efficiency, so air-borne transportation pollutants are increasing.

Greenhouse gas reduction was often a topic of discussion, considering that China has apparently set ambitious targets to meet by 2025 (14 yr). People look to the central government for solutions, and government tells transportation to take measures that reduce greenhouse gas emissions. Yet like most industrial nations, major solutions are scarce, especially for a hugely populous and high-economic-growth nation.

Road systems and the land

While agriculture and other human activities have eliminated extensive areas of natural vegetation in China, the remaining natural habitat may be less fragmented into pieces than in America and Western Europe. The land seems to be predominantly composed of large contiguous rice or other crop areas, extensive built areas with few wooded patches present, and somewhat-natural vegetation (doubtless with ample wood cutting) covering hilly/mountainous areas. In the agricultural and built landscapes, road systems are of secondary ecological importance to the primary land use itself. In the remaining natural landscapes, transportation-caused fragmentation effects are doubtless significant and in need of study and mitigation.

Road density and network form in landscapes or regions seemed too far off in the future to worry about. Yet bits of the big picture emerged in interesting ways. Beijing has five ring roads plus parts of a sixth and seventh. The beautiful Changbai Mountain Nature Reserve on the North Korean border has a ring road on the Chinese side. The scenic expressway being built is to be scenic for visiting travelers, not for residents. Where the goals of vegetation protection and farmland protection conflicted in highway construction, vegetation protection seemed to win.

The expressway system being built will catalyze a much more extensive secondary-road construction ahead. Relatively few two-lane highways were observed. Cars and travelers will crowd onto the expressways as they appear, but soon the novelty will give way to the desire to drive off in huge numbers to see towns, villages, parks, mountains and seashores. Could that be a catalyst for extensive habitat loss and environmental degradation? Hopefully a good avoidance solution will emerge. Nevertheless, the transformation of these valuable land areas everywhere is probably the big story from China's launching into a roads-and-cars era.

Conclusion

China's interest in highways, cars, and the environment especially focuses on the present. Wondering about where today's trends may lead in the future normally generated little discussion. Still, a viable alternative to the world's massive roads-and-vehicles approach to transportation must exist.

For today's mushrooming transportation system, China's officials and researchers seemed generally familiar with, and somewhat mimicking, current highway conditions in Western industrialized nations. Yet distinctive Chinese patterns were also evident. Also many key transportation leaders knew of road ecology and were beginning to incorporate it into highway construction. While America starts mitigating a huge existing road system, China begins incorporating ecological design into a new giant system.

The environmental protection section of the Ministry of Transport is apparently responsible for the environment adjacent to the highway. In contrast, the Ministry of the Environment is responsible for protection of large natural areas typically "far away". Apparently no one is responsible for environmental protection in the extensive agricultural and built areas. The "road effect zone", the variable-width zone where transportation planning and management are responsible for significant environmental effects extending out from a road, would be useful in China, as elsewhere.

The Chinese Academy of Transportation Sciences invited the authors to "assist us in identifying trends in China's transportation network, how that may impact our rich biodiversity, and develop road ecology research in China." Those are opportunities for many to contribute to a great nation, and our globe. With new expressways appearing and planned, this is the opportune moment. As industry reminds us, get in early and you have the greatest effect.

The key contacts for road ecology or transportation and the environment we met in the Ministry of Transport CATS include: (a) Professor Chen Jiding (Director, Research Center for Environmental Protection and Traffic Safety; engineering, vegetation); (b) Associate Professor Chen Zongwei (Vice Director; engineer, deicing agents); and (c) Dr. Yun Wang (Assistant Professor; road ecology, wildlife, landscape ecology, road engineering, physical geography).

Finally, nature protection and highway construction were mentioned as a yin-and-yang dynamic. Perhaps, as in America, a giant yang is now noticing the importance and rapid growth of tiny yin. The top Jilin Province transportation official, Li Enhui, pointed out that China's construction goals are an "ecology road, landscape road, green road, safety road." Effectively meshing conflicting goals achieves an elegant harmony.

Could China's transportation leaders provide important examples, models, and lessons in creating a new environmentally based road-and-vehicle system? Shouldn't western nations mitigating their existing systems, and developing nations rapidly expanding their transportation, learn from China, and vice versa?