Chapter 57

CHINA: BUILDING AND MANAGING A MASSIVE ROAD AND RAIL NETWORK AND PROTECTING OUR RICH BIODIVERSITY

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SUMMARY

China is experiencing rapid growth in its economy, human population and transportation network. Environmental protection (e.g. slope stabilisation, vegetation protection and establishment, storm water collection and treatment) during road construction has been a priority over the past few decades. More recently, China has begun to protect its biodiversity when planning, designing and constructing new roads and railway lines. However, China still lags behind many developed countries in some areas of road ecology. A concerted and sustained effort is required to achieve an ecologically sustainable transportation network for the future.

57.1 The rate of growth in the Chinese road and railway network is rapid and will continue to be so into the foreseeable future.

57.2 China has recently adopted road ecology principles and concepts to be used in future road projects.

57.3 Wildlife-sensitive road designs based on recent road ecology research are being implemented on new roads in China.

57.4 Further research and dissemination of findings is essential to improve the ecological sustainability of China's roads.

New roads are continuing to be built and existing roads widened across much of China to accommodate an increasingly mobile human population. To protect China's unique biodiversity, we need to (i) better understand the impact of the road network on plants, animals and ecosystem processes; (ii) initiate and complete long-term studies of the effectiveness of mitigation measures on populations; and (iii) develop systems and processes to ensure experts from relevant disciplines are involved in the planning, design, construction, operation and evaluation of the road and rail network.

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INTRODUCTION

China has the largest human population density on Earth, who drive the most vehicles along an extensive road network that includes the second largest expressway network on the planet (MOT 2011). China's economy is growing rapidly, and gross domestic product is expected to increase by approximately 7% annually over the next few years, one of the highest in the world (MOT 2011). An important component of China's growing economy is the construction of transportation infrastructure, including roads and railway. China covers almost 9,600,000 km^2 and includes tropical and subtropical forest, coniferous forest, arctic and alpine habitats, deserts and grasslands and savannah. An enormous diversity of species persists within these diverse habitats and wilderness areas, including numerous rare and threatened species.

Chinese road agencies have traditionally focused on achieving high levels of environmental protection along its major roads. The protection and restoration of vegetation is a priority, and the recently completed Qinghai–Tibet Highway and Ring Changbai Mountain Scenic Highway projects exemplify this focus (Chen et al. 2004; Wang et al. 2013b). The impact of roads on water quality and hydrology has been extensively studied, and protective measures are routinely included during highway construction (Kong & Liu 2013). Protecting landscape aesthetics and scenery has recently become a priority because of the rapid growth in China's economy and standard of living. The China Academy of Transportation Sciences (CATS) carried out the development of the first provincial-level scenic highway network with the planning of the 'Scenic Highway Network Development of Hainan Province Project' in 2011. Nationally, scenic qualities and landscape aesthetics were important in the design of the China–Pakistan Karakoram Highway, the Jilin–Yanji Expressway and the Ring Changbai Mountain Highway (Lu et al. 2010). Protecting farmland is also a very high priority in China, and road design focuses on reducing the land take for highways, thereby maximising the amount of land for agriculture (Tao et al. 2010).

While environmental protection has dominated road planning and design in China for many years, it is only relatively recently (in the last decade or so) that ecological issues have even been considered. The challenge for China in the years ahead is to identify the most cost-effective solutions from elsewhere and integrate these approaches into Chinese practice. The aims of this chapter are to highlight the rate of growth in China's surface transportation network, summarise the key achievements in ecologically sensitive road design and prioritise areas for future research and policy development.

LESSONS

57.1 The rate of growth in the Chinese road and railway network is rapid and will continue to be so into the foreseeable future

The expansion of the road and rail network in China is a high priority to facilitate economic growth and improve the standard of living for its people. By the end of 2012, the total length of roads in China had reached 4.24 million km (from 3.73 million km in 2008), including 96,200 km of expressway (up from 60,300 km in 2008) (DOCP 2012). According to China's latest transportation strategy (MOT 2011), the rapid expansion of its road and rail network is set to continue, reaching 4.5 million km of road and 108,000 km of expressway by the end of 2015.

In 2010, China had 91,000 km of railway lines, which was expected to increase to 98,000 km by the end of 2012, making it the second longest network for a single country in the world (Zhu 2013). By 2015, the length of railway is expected to reach 120,000 km (MOR 2011).

57.2 China has recently adopted road ecology principles and concepts to be used in future road projects

In 2002, the Chinese Ministry of Transport (MOT) incorporated road ecology principles and concepts into the first demonstration project, the Chuanzhusi to Jiuzhaigou Scenic Highway in Sichuan Province. This was the first scenic highway in China, and since then, numerous other projects have incorporated ecological aspects into their design. The importance of road ecology in China was further acknowledged when CATS undertook numerous road ecology research projects and implementation throughout China. The MOT continues to fund CATS to do research and provide input into the planning and design of roads and the evaluation of the use and effectiveness of mitigation measures. In 2008, the Forman (2003) classic *Road Ecology: Science and Solutions* was

translated into Chinese and published by Dr. Taian Li from Lanzhou University and Dr. Yun Wang from CATS. In 2009, CATS published their own version: *Road Ecology in China* (Mao et al. 2009; Forman et al. 2011). International exposure of Chinese road ecology research is encouraged, and researchers from CATS regularly attend and present their research findings at the International Conference on Ecology and Transportation (Chapter 60).

57.3 Wildlife-sensitive road designs based on recent road ecology research are being implemented on new roads in China

Road ecology research and mitigation began in China approximately 15 years ago and has primarily focused on quantifying the rates of roadkill, the barrier effect and the size of the road-effect zone at a number of locations across China (Fig. 57.1). The results of these

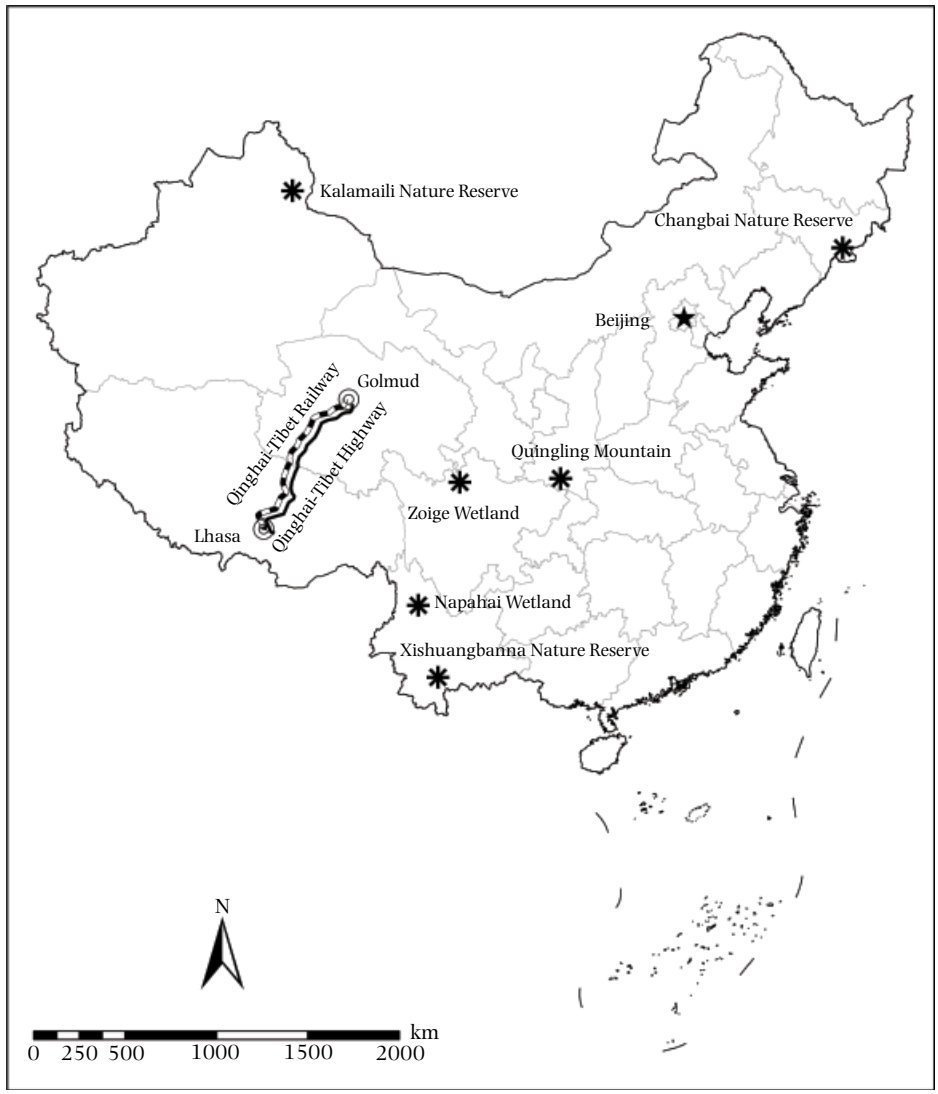

Figure 57.1 Locations of the seven road ecology research projects in China discussed in this chapter. Source: Yun Wang.

studies have shown that Chinese wildlife suffer similar effects to those in other countries. For example, mortality of wildlife has been identified as a serious problem for amphibians where a highway dissects the Zoige wetland (Gu et al. 2011) and for mammals, birds, amphibians and reptiles on the Ring Changbai Mountain Scenic Highway (Wang et al. 2013a). From August to October in 2007, five Przewalski's wild horses (out of a population of 27) were killed by vehicles on roads through the Kalamaili Nature Reserve (Zhang et al. 2008). Research has also demonstrated that many species appear to avoid highways or have lower population densities near to the highway. This avoidance zone appears to be evident for up to 5 km for the giant panda (F. Wang, Peking University, personal communication), 1 km for wild yak, 600 m for kiang, 300 m for Tibetan antelope, 200 m for Tibetan gazelle (Lian et al. 2012) and just under 150 m for black-necked crane (Wang et al. 2011). Roads have also affected the movement of wildlife, and the number of locations that Asian elephants are willing to cross the Simao to Xiaomengyang Expressway has decreased from 28 to 23 following its construction in 2006 (Pan et al. 2009).

The Chinese MOT has built multipurpose crossing structures across new roads that typically allow for the movement of wildlife and water, local residents or domestic animals. These structures include open-span bridges, culverts and tunnels, and fencing that is always included along expressways to keep animals off the road and direct them towards crossing structures. A wide range of species use these structures (e.g. Table 57.1). The Asian elephant used multipurpose crossing structures (16 open-span bridges, 2 tunnels) along the Simao to Xiaomengyang Expressway cutting through Xishuangbanna Nature Reserve, and 44% of individuals that approached or entered the structures passed through (Pan et al. 2009). More than 10 species of wildlife crossed the Ring Changbai Mountain Scenic Highway, also using multi-use crossing structures (Textbox 57.1). Dedicated wildlife crossing structures on the Qinghai–Tibet Railway were regularly used by Tibetan antelope (Textbox 57.2).

57.4 Further research and dissemination of findings is essential to improve the ecological sustainability of China's roads

In an effort to reduce its carbon footprint and protect the environment, the Chinese MOT issued a policy to accelerate the development of a 'green' and low-carbon transport system by 2020. Road ecology is recognised as a critical component of this strategy. Chinese road ecology research has mostly focused on small areas or single roads, which is out of step with the rate of growth of the overall network (Mao et al. 2009). Long-term studies are needed to properly identify the ecological impacts of roads and traffic as well as to quantify the effectiveness of mitigation measures, vegetation succession and water quality. The right of way of roads in China is typically narrower than in other countries because of the imperative to protect valuable agricultural land to feed the growing human population. Consequently, the

Table 57.1 Species observed using 84 culverts and 22 bridges under the Ring Changbai Mountain Scenic Highway, November 2008–February 2013.

Chinese species name	English species name	Conservation status in China[a]
紫貂	Sable	First class
青鼬	Yellow-throated marten	Second class
花尾榛鸡	Hazel grouse	Second class
环颈雉	Common pheasant	*
野猪	Wild boar	*
狍子	Siberian roe deer	*
黄鼬	Siberian weasel	*
松鼠	Eurasian red squirrel	*
东北兔	Manchurian hare	*
伶鼬	Least weasel	*

Source: List of beneficial or important terrestrial wildlife species in economy and science in China (http://baike.baidu.com/view/1496360.htm).

[a]The first class is the most endangered, the second class is the next most endangered, and * are threatened but also beneficial or important to the economy and/or science in China.

Textbox 57.1 Effectiveness of mitigation along the Ring Changbai Mountain Scenic Highway.

The Ring Changbai Mountain Scenic Highway (85 km in length) was constructed from 2007 to 2009, with extensive design input from wildlife ecologists to reduce the impact on biodiversity. Mitigation measures included 190 culverts and 25 extended bridges, to allow passage of wildlife, people and drainage. In 2010, traffic volume was about 200 vehicles per day. Studies on the use of the mitigation structures by wildlife have shown a high diversity of species using 84 of the culverts and 22 of the bridges, including some species listed as rare and endangered under Chinese legislation (Table 57.1 and Fig. 57.2).

Figure 57.2 Tracks of Siberian weasel through a culvert under the Ring Changbai Mountain Scenic Highway. Source: Photograph by Yun Wang.

quantification of the road-effect zone is critical in China, and multidisciplinary planning teams must cooperate to plan, design, construct and manage China's road network.

CONCLUSIONS

The rate of expansion of the road and railway network in China will continue to be rapid until at least 2015 and almost certainly for many years after that. Road ecology has recently become an important topic to the Chinese MOT, and future planning and research should focus on the improved design of multipurpose and dedicated wildlife crossing structures and fencing, the impacts of roads on endangered species and the development of national standards for the design of wildlife-friendly roads and cost-effective crossing structures.

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Textbox 57.2 Tibetan antelope use crossing structures under the Qinghai–Tibet Railway.

The Qinghai–Tibet Railway is 1142 km in length and is the highest elevation railway in the world, connecting Qinghai to Tibet (Fig. 57.1). Constructed from 2001 to 2006, the railway line includes 7 at-grade crossings, 1 tunnel, 25 bridges (similar to the Hoh Xil bridge in Fig. 57.3) and many more smaller bridges, all purpose built for wildlife. Studies conducted from 2004 to 2007 have demonstrated that the migration of the Tibetan antelope has increased over time. Of animals that approached the train line, 100% crossed underneath it in 2007, compared to only 60% during the construction phase in 2004. Furthermore, the animals that do use it have become accustomed to the noise and other disturbances, and the length of time that individuals waited before passing through has gone from 1 to 2 weeks in 2004 to several minutes in 2007 (Fig. 57.3; Li et al. 2008).

Figure 57.3 Tibetan antelopes using the Hoh Xil wildlife crossing structure in August 2006, shortly after the railway was opened. Source: Reproduced with permission of Hongfeng Zhang, Northwest Institute of Endangered Zoological Species.

FURTHER READING

Forman et al. (2011): A short review describing the state of road ecology in China for an international audience.

Li et al. (2008): Evaluated the rate of use of wildlife crossing structures by Tibetan Antelope along Qinghai–Tibet Railway.

Mao et al. (2009): The first book to summarise the state of road ecology in China, describing numerous Chinese case studies and examples.

Wang et al. (2013b): The first published comprehensive investigation of the impacts of roads (in this case the Ring Changbai Mountain Scenic Highway) and traffic in China and the effectiveness of mitigation measures.

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