

# A Study on the Challenges of and Corresponding Thoughts on Constructing the Green Transport System in the Qinba Mountains

Fu Zhihuan<sup>1</sup>, Xu Li<sup>2</sup>, Jiang Bin<sup>2</sup>, Wang Jing<sup>2</sup>, Zhao Yu<sup>2</sup>

1. Chinese Academy of Engineering, Beijing 100088, China

2. Transport Planning and Research Institute, Ministry of Transport of China, Beijing 100028, China

**Abstract:** The change of regional positioning will affect the development pattern of transport. From the perspective of the new regional positioning of the Qinba Mountains, many problems exist in the development process of transport. This study analyses main challenges in developing transport in the process of establishing national key ecological functional demonstration zones and national parks. Subsequently, based on the double requirements of economic and social development and ecological environment protection of this region in the future, the authors propose a general strategy, developing focus, and policy recommendations for the construction of the green transport system in the Qinba Mountains.

**Keywords:** Qinba Mountains; green transport

## 1 Development status of integrated transport in the Qinba Mountains

The Qinba Mountains are located in the administrative interchange of Shaanxi, Henan, Hubei, Sichuan, Chongqing, and Gansu, the core area of which includes 20 cities divided into districts from five provinces and one city such as Henan, Hubei, Sichuan, Shaanxi, Gansu, and Chongqing, and Gannan Tibetan Autonomous Prefecture; Shennongjia Forestry District; and 119 counties (district, county-level city). The total area of this region is 308 634 km<sup>2</sup>, and its total population is 61.64 million. The expansion area covers a region where the surrounding cities of Xi'an, Chengdu, Chongqing, Wuhan, Lanzhou, Zhengzhou, Luoyang, Mianyang, and Tianshui border the core area. The basic development situation of the integrated transport system is as detailed below.

### 1.1 Highways

By the end of 2014, highway mileage of the Qinba Mountains region totaled more than  $1.8 \times 10^5$  km, of which China's provincial trunk highway mileage totaled over  $1.4 \times 10^4$  km. The Qinba Mountains core area had 21 national expressways planned for it, of which sections of 11 national expressways, including the Beijing–Kunming Expressway, the Qingdao–Lanzhou Expressway, and the Lianyungang–Khorgas Expressway, within the expansion area, had almost been opened to traffic before the end of 2014. Furthermore, approximately 70% of county-level expressways in the core area have been essentially realized (Table 1): it is planned to establish 31 ordinary national highways in the core area, comprising one radial route, 11 vertical national highways, 14 horizontal national highways, and five connecting routes. Together with ordinary provincial roads, these routes essentially

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**Author information:** Fu Zhihuan, Chinese Academy of Engineering, academician. Major research direction is the railway transportation and rolling stock. E-mail: fuzhihuan138@sina.com

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cover each node at the county level: 97% of the townships within the core area are connected by asphalt roads<sup>†</sup>.

## 1.2 Railways

The railway operating mileage of the core area is 2 289 km, including double-track railways of 1 868 km (a double-track rate of 81.6%) and electric railways of 2 132 km (an electrification rate of 93.1%). The existing and under-construction railways in the core area are detailed in Table 2 and Table 3 below. The railways under construction include the Xi'an–Chengdu, Zhengzhou–Wanzhou, Wuhan–Shiyan, Lanzhou–Chongqing, and Chengdu–Lanzhou high-speed railway (Table 3). The Guangyuan–Bazhong railway is projected to be transformed into an electric railway. The Xi'an–Shiyan high-speed railway and the connecting line between Yichang and the Zhengzhou–Wanzhou high-speed railway have also been included in the plan<sup>‡</sup>.

## 1.3 Aviation

In total, 18 civil aviation airports have become operational. The core area has 11 civil aviation airports, and the aircraft movement area reference code is mostly 4D. Shiyan Wudang Mountains Airport will become operational at the end of 2016, Longnan Chengzhou Airport is expected to be open to air traffic in 2017, Ankang Wulipu Airport is being relocated, and Bazhong Enyang Airport is expected to become operational in 2020 (Table 4). Currently, the future Baoji Airport is in the early stages of planning, the prospective Shangluo Airport has progressed through site reconnaissance, and the site selection report of the forthcoming Pingdingshan Airport has been completed. The China Civil Aviation Development Plan for the 13th Five-Year Plan and the National General Airport Layout Plan also feature a number of planned civil airports in the core area of the Qinba Mountains.

**Table 1.** Construction of national expressways in the Qinba Mountains region [1].

No.	Class	Serial number	Origin	Control point (core area)	Not open to traffic
1	Main line	G5	Beijing–Kunming	Xi'an, Hanzhong, Guangyuan, Mianyang	Open to traffic
2	Main line	G55	Erliahaote–Guangzhou	Luoyang, Nanzhao, Nanyangm, Xiangyang	Open to traffic
3	Connecting line	G5515	Zhangjiajie–Nanchong	Yingshan, Nanchong	Liangping–Zhongxian
4	Main line	G59	Huhehaote–Beihai	Lingbao, Lushi, Shiyan, Fangxian, Baokang	Lushi–Yunxian, Baokang–Yidu
5	Main line	G65	Baotou–Maoming	Xi'an, Ankang, Dazhou	Open to traffic
6	Main line	G69	Yinchuan–Baise	Xi'an, Ankang, Langao, Chengkou	Ankang–Zhongxian
7	Connecting line	G6911	Ankang–Laifeng	Ankang, Pingli, Wuxi	Except for Fengjie–Wuxi, the rest are not open to traffic
8	Main line	G75	Lanzhou–Haikou	Guangyuan, Nanchong	Linzhao–Longnan
9	Main line	G85	Yinchuan–Kunming	Baoji, Liuba, Hanzhong, Bazhong	Baoji–Chaunshan, Chongqing–Bazhong
10	Connecting line	G8513	Pingliang–Mianyang	Tianshui, Chengxian, Wudu, Pingwu, Miayang	Tianshui–Chengxian, Wenxian–Mianyang
11	Main line	G22	Qingdao–Lanzhou	–	Open to traffic
12	Main line	G30	Lianyungang–Khorqas	Luoyang, Xi'an, Baoji, Tianshui	Open to traffic
13	Main line	G36	Nanjing–Luoyang	Pingdingshan, Luoyang	Open to traffic
14	Main line	G40	Shanghai–Xi'an	Nanyang, Shangzhou, Xi'an	Open to traffic
15	Main line	G42	Shanghai–Chengdu	–	Open to traffic
16	Connecting line	G4213	Macheng–Ankang	Baokang, Fangxian, Zhuxi, Pingli, Ankang	Nanzhang–Baokang, Pingli–Ankang
17	Main line	G50	Shanghai–Chongqing	–	Open to traffic
18	Connecting line	G5012	Enshi–Guangyuan	Kaixian, Dazhou, Bazhong, Guangyuan	Kaixian–Lichuan
19	Main line	G70	Fuzhou–Yinchuan	Xiangyang, Shiyan, Shangzhou, Xi'an	Open to traffic
20	Connecting line	G7011	Shiyan–Tianshui	Shiyan, Ankang, Hanzhong, Tianshui	Huixian–Tianshui
21	Main line	G93	Chengdu–Chongqing ring road	–	Open to traffic

<sup>†</sup> Date is based on the result of previous investigation on the basic situation of railway line.

<sup>‡</sup> Date is based on railway statistics.

By 2030, the number of aviation transportation airports in the core area will reach 24.

### 1.4 Water transport

The Qinba Mountains are rich in water resources, and these are more abundant in the area than the national average; water transport in the area is mainly concentrated in the upper reaches of the Yangtze River, the Han River, and the Jialing River. The

layout plan of the Yangtze River high-grade corridor in the National Inland Waterways and Port Layout Planning is “one horizontal, one network, and ten lines.” The Jialing River and the Han River constitute important parts of the “ten lines.” The total length of the Jiangnan Canal is 67 km. It was officially opened to traffic in September 2014. A 1 000-ton Yangtze River–Jiangnan Canal–Han River gold waterway circle was formed with 810 km in circumference. Jialing River is the most-inner inland waterway; with plans for the cascade development and construction

**Table 2.** Existing railways in the core area [2].

Railway	Class	Main track type	Design speed (km·h <sup>-1</sup> )	Traction	Pairs	Transport capacity (×10 <sup>4</sup> t·a <sup>-1</sup> )
Baoji–Chengdu	National railway I	Single	80	Electric locomotive	14	1 500
	National railway I	Double	120	Electric locomotive	30	5 000
Yangpingguan–Ankang	National railway I	Single	120	Electric locomotive	10	1 800
Xiangyang–Chongqing	National railway I	Double	160	Electric locomotive	50	6 000
Xi’an–Ankang	National railway I	Double	160	Electric locomotive	40	9 000
Jiaozuo–Liuzhou	National railway I	Double	120	Electric locomotive	30	10 000
Xi’an–Hefei	National railway I	Double	160	Electric locomotive	26	10 000
Bazhong–Dazhou	National railway II	Single	120	Electric locomotive	15	1 000
Guangyuan–Bazhong	Local railway I	Single	100	Internal combustion engine	5	1 000

**Table 3.** Under-construction railways in the core area.

Railway	Class	Main track type	Design speed (km·h <sup>-1</sup> )	Traction
Xi’an–Chengdu	Passenger railway	Double	250	Electric locomotive
Zhengzhou–Wanzhou	Passenger railway	Double	350	Electric locomotive
Wuhan–Shiyan	Passenger railway	Double	350	Electric locomotive
Lanzhou–Chongqing	National railway I	Double	200	Electric locomotive
Chengdu–Lanzhou	National railway I	Double	200	Electric locomotive

**Table 4.** Existing transportation airports in the core area of the Qinba Mountains [3].

No.	Airport	Location		Class	Movement area reference code	Number of air lines	2014 Passenger throughput (×10 <sup>4</sup> people)	2020 Designed passenger throughput (×10 <sup>4</sup> people)
		Province	City					
1	Hanzhong Chenggu Airport	Shaanxi	Hanzhong	Feeder airport	4C	3	3.28	30
2	Luoyang Beijiao Airport	Henan	Luoyang	Hub airport	4D	20	58.88	76
3	Nanyang Jiangying Airport	Henan	Nanyang	Feeder airport	4D	13	46.45	100
4	Xiangyang Liuji Airport	Hubei	Xiangyang	Hub airport	4D	10	67.70	150
5	Shennongjia Hongping Airport	Hubei	Shennongjia	Feeder airport	4C	1	20.85	25
6	Dazhou Heshi Airport	Sichuan	Dazhou	Feeder airport	4C	7	29.61	85 (Year 2025)
7	Guangyuan Panlong Airport	Sichuan	Guangyuan	Feeder airport	4D	5	16.85	–
8	Mianyang Nanjiao Airport	Sichuan	Mianyang	Hub airport	4D	20	108.49	200
9	Nanchong Gaoping Airport	Sichuan	Nanchong	Feeder airport	4C	10	42.94	60
10	Tianshui Maijishan Airport	Gansu	Tianshui	Feeder airport	3C	2	2.39	–
11	Gannan Xiahe Airport	Gansu	Gannanzhou	Feeder airport	4C	2	2.25	14

of 16-step aviation and electricity junction and for the river to be entirely dredged, 500-ton and 1 000-ton ships will be able to reach Shanghai along the Jialing River by entering the Yangtze River system [4].

In 2012, China issued the Transport Construction for Poverty Alleviation Planning Outline of Concentrated Destitute Areas (2011–2020) [5] and the Transport Construction for Poverty Alleviation Plan of Concentrated Destitute Areas of Qinba Mountains (2011–2020) [6]. Overall, the integrated transport system of the Qinba Mountains has played a significant role in both the economic and social development of and poverty alleviation in the Qinba Mountains.

## 2 Challenges facing the construction of the green transport system in the Qinba Mountains

From the perspective of constructing the national key ecological functional demonstration zones and national parks, the main challenges faced by the Qinba Mountains' transport system are as detailed below:

### 2.1 Traffic to cities and regions outside is not fast enough

Transport links through the Qinba Mountains' core area, linking with the Beijing–Tianjin–Hebei region, the Yangtze River Delta, the Pearl River Delta, and the Beibu Gulf economic zones, in addition to the surrounding provincial cities, are not being developed fast enough. According to the plan, nearly half of the expressways in the Qinba Mountains' core area are not yet open and a few major corridors need expansion: for example, four expressways out of Shaanxi Province in the Qinba Mountains have still not been opened. The Shaanxi provincial technical standard is low for the section of National Highway 316 that leaves the province and connects the Hubei and Gansu provinces, and the highway becomes an inter-provincial bottleneck. There is a lack of efficient railway routes connecting the core area with outside regions and cities: the existing railways are insufficient. The number of air routes is very limited and usage of the airports is low. Feeder airports lack connections with the national hub airports, which is a constraint on attracting people in major urban areas of the country to the core area of the Qinba Mountains by air. For example, Hanzhong Chenggu Airport only offers routes to Beijing, Shanghai, Shenzhen, Xi'an, and Dalian, and the airport on average has only four flights per day. The waterways of the Han River and the Jialing River have not yet been effectively used. The development of transport modes within the region is decentralized and self-contained. Links between transport modes are not smooth. The hubs of integrated passenger and freight transport are lack. The collecting and distributing systems of harbors and airports are not matched.

### 2.2 Transit traffic lacks overall planning

Around the Qinba Mountains are located the Guanzhong–Tianshui Economic Zone, the Chengdu–Chongqing Economic Zone, the Central Plains Economic Zone, and the Wuhan Metropolitan Area. Together, they form the intersecting area of North and South China, and East and West China converging transport linkages. A number of traffic trunk lines, including the Yuxinou (Chongqing–Xinjiang–Europe) International Railway, the Xi'an–Chengdu High-speed Railway, the Baotou–Maoming Expressway, and the Shanghai–Xi'an Expressway, pass through this area. Consequently, there is a significant volume of transit traffic, which further complicates matters. The infrastructure and planning are state-approved, but sometimes are also presided over by five provinces and one city respectively; although the arrangements seem reasonable for each province, city, and county, they are disorderly for the Qinba Mountains region in general.

### 2.3 Traffic into the area lacks well-surfaced roads

Traffic between secondary economic nodes is not convenient and required to transfer many times. The construction of transport leading to the major economic nodes (e.g. major resorts and industrial parks) is underdeveloped and is generally of a low grade. For example, less than 30% of the national and provincial trunk highways of Qinba Mountains within Shaanxi Province are Grade 2 and above, which is below the national requirements. The core area's internal air traffic network has not yet been formed, with the number of interconnections between the regional airports in the core area currently insufficient; moreover, tourism, emergency rescue, and other general aviation developments are underdeveloped. Most of the county and township highways within the core area are low-grade ones. The roads are in poor condition, lacking in maintenance, and there are poor connections with the surrounding trunk roads: consequently, the road network is unable to meet the development needs of cultural tourism, leisure travel, and featured agriculture. For example, Hanzhong, in the core area of the Qinba Mountains, prioritizes the building of fourth-grade highways above other types. Fourth-grade and substandard roads account for up to 88.4% of the core area roads; 1 230 km of county and township highways are still "white roads" (that is, they lack an asphalt surface). The roads leading to major scenic spots are also of a low grade. Travel difficulties for local people remain severe. For example, around Guangyuan, in the core area of the Qinba Mountains, 543 administrative villages have not yet developed well-surfaced roads. Half of the villages and towns still do not have passenger stations, and there is no bus service in 43% of the administrative villages. Rural logistics development evidently lags behind developed areas of the city<sup>†</sup>.

<sup>†</sup> Date is from the Shaanxi Provincial Transport Department and is based on the research report on transport in Hanzhong.

## 2.4 Development mode is insufficiently intensive

As it is affected by the existing administrative divisions, the area cannot be considered easily from an overall perspective, resulting in its transport development being in an extensive and fragmented state; consequently, the comparative advantages and combination efficiency of various modes of transport are difficult to realize. Due to the lack of a regional coordination mechanism, it is difficult to coordinate transport planning, construction, and management, leading to difficulties in ensuring the comprehensive utilization of transport resources. The development of inland waterways, railways, and other relatively environment-friendly transport modes is insufficient for the area. The construction of the transport infrastructure has had a big impact on the area's ecology, with much of the existing and old transport equipment and machinery characterized by high-energy consumption and high emissions. Overall, the application of clean energy transport equipment is lacking.

## 2.5 Transport management lacks safety awareness

From the perspective of transport materials, much of the traffic transiting through the mountains carries chemicals, petroleum, coal, and other bulk or dangerous goods. Heavy transport vehicles cause disturbance to tourism transport inside the core area. In addition, because of the complex mountainous terrain, transport security and safety risks to the environment may be very high. Moreover, as the five provinces and one city have each issued their own control measures, preventing vehicles transporting dangerous goods from travelling through their own areas, vehicles carrying the more dangerous loads are forced to drive along roads that are in poorer condition, posing safety risks and involving unnecessary detours. Should an explosion, leak, or other accident occur, it could have an immense environmental impact.

## 3 General strategy on the construction of the green transport system in the Qinba Mountains

Centering around the strategic vision of the national key ecological functional demonstration areas and the national parks, the future general strategy on the construction of the green transport system in the Qinba Mountains comprises implementing the five development concepts of innovation, coordination, greenness, openness, and sharing; fully harnessing the comparative superiority and combination efficiency of various modes of transport; adhering to the coordinated development of the region; adhering to green, intensive, and safe development; optimizing layout; adjusting structure; and strengthening management. The objectives are focused on building a green transport system in the Qinba Mountains that will enable external traffic to pass quickly, transit traffic to be orderly, and internal traffic to be fluid, in addition to guiding, supporting, and serving the green cycle-based development of the area.

## 3.1 Focus on fast external transit, accelerating construction, and optimizing and upgrading the main transport corridor

This objective is to implement the orderly planning of the main transport corridor of the “three horizontal, six vertical, and one ring” routes. The “three horizontals” comprise the Xi’an–Shangluo–Nanyang transport corridor, the Xiangyang–Shiyan–Hanzhong–Jiuzhaigou transport corridor, and the Wanzhou–Bazhong–Guangyuan transport corridor. The “six verticals” comprise the Luoyang–Nanzhao–Xiangyang transport corridor, the Sanmenxia–Shiyan–Enshi transport corridor, the Xi’an–Ankang–Chongqing transport corridor, the Xi’an–Hanzhong–Chengdu–Chongqing transport corridor, the Lanzhou–Guangyuan–Chengdu–Chongqing transport corridor, and the Lanzhou–Jiuzhaigou–Chengdu transport corridor. The “one ring” is formed by the Xi’an–Baoji–Longnan–Jiuzhaigou–Guangyuan–Hanzhong–Ankang–Shiyan–Sanmenxia–Xi’an cycle tours across the five provinces and one city, comprising Shaanxi, Gansu, Sichuan, Hubei, Henan, and Chongqing. The key objectives are as follows.

- (1) Increase efforts to implement the national railway planning program, accelerating construction of fast and large-capacity transport corridors linking to the surrounding cities by constructing high-standard express railways and double-line railroads alongside the existing lines. First, the construction will continue of the Xi’an–Chengdu High-speed Railway, the Zhengzhou–Wanzhou High-speed Railway, the Wuhan–Xiangyang–Shiyan High-speed Railway, the Lanzhou–Chongqing Railway, the Chengdu–Lanzhou Railway, the Neimenggu–Jiangxi Railway, the Yangpingguan–Ankang Railway added second line, and other projects, trying to form the transport capacities during the 13th Five-Year Plan. Second, there are plans to construct the Xi’an–Shiyan High-speed Railway, and then form a high-speed railway transport corridor through the northwest of the area to central China with the Wuhan–Xiangyang–Shiyan High-speed Railway. Third, the construction of related railway branch lines will be promoted, forming the external large-capacity transport corridor based on the main network of Xi’an–Chengdu, Wuhan–Xiangyang–Shiyan, Zhengzhou–Wanzhou, Xiangyang–Chongqing, Xi’an–Ankang, Baoji–Chengdu, Xi’an–Hefei, Lanzhou–Chongqing, Yangpingguan–Ankang, Neimenggu–Jiangxi, and other main line railways.
- (2) Accelerate the construction of the national expressway and important projects identified by national regional planning, and ensure the prompt commencement of construction of other local expressways with obvious regional transport corridor functions to achieve a direct expressway link between the Qinba Mountains and the surrounding provinces. The objective is to release the current bottlenecks of the important transport corridors, accelerating the construction of G65 Dazhou–Chuanshan, G75 Chuangan–Nanchong, and G7011 Hanzhong–Lueyang

routes, and other sections, and start construction of the newly added national expressways, such as the Wuxi–Zhenping, Fengjie–Jianshi, Taoyuan–Bazhong, Bazhong–Guangan–Chongqing, and Ankang–Pingli, and other sections. The Danjiangkou (Hubei Province)–Neixiang (Henan Province), Luonan–Lushi, and Lanzhou–Chengdu high-speed connecting as well as the Danfeng–Ningshan and other expressways will be included in the planning and research.

- (3) Maximize use of the water transport resources of the Han River and the Jialing River. The objective regarding dredging is to highlight the skeleton waterway construction, increase the length of waterways at level-4 and above, canalize and renovate the main tributary channels, and gradually realize nonstop transport links via the arteries and distributaries. The construction of specialized containers and automatic roll-on/roll-off freight terminals, in addition to tourism passenger terminals at the main scenic spots, are to be accelerated; also, the construction of dredging port channels and the linkages between the main ports and the main skeleton network of the cross-regional railways and highways is to be advanced.
- (4) Increase the integration and the utilization of the airport resources within the area, improving the utilization ratio of the existing airports. The hub airport flight connections in the expansion area are to be strengthened, actively opening new air routes between the hub airports in the expansion area and the feeder airports in the core area; the airlines are to improve the capacity of regional aviation; and a one-hour aviation transport passage from the hub airport of the expansion area to the feeder airport of the core area is to be created.
- (5) Construct the regional integrated transport hub of Shiyan, Hanzhong, Guangyuan, Bazhong, Longnan, Ankang, and Shangluo, improving the existing collection and distribution system, and serving the various transport demands and connections of different parts of this area.

### **3.2 Focus on fluid internal transport, eliminating the short slab on the secondary artery as soon as possible, increasing and improving the transport microcirculation**

Among the main secondary economic points, it is necessary to open up the “dead-end” highway, focusing on building a number of highways that connect important resource development areas and tourist attractions and have a prominent role in the area’s economic development, enhancing the self-development ability of the region. The area should strive to improve the proportion of highways at level two and above among the general national and provincial trunk roads, ensuring the national highways reaches the level-2 highway standard and the provincial highways reach the level-3 highway standard. The construction of highway safety and life-protection engineering shall be increased, and

the anti-disaster ability of traffic trunk line should be improved. Airlines should be encouraged to expand the cycled tourism air routes within the core area, creating the cycle with one-hour aviation tourism routes between feeder airports within the core area to promote the integrative and systematic development of tourism resources.

With the development of cultural tourism and featured agriculture, excellent traffic microcirculation becomes very important. For example, in Dashuigou Village, Wangba Township, Kangxian County, Longnan, Gansu, a pattern of diversified rural tourism was formed by greatly improving the transport microcirculation system. In accordance with the layout of the Qinba Mountains cultural tourism industry and its agriculture, and in addition to the special traffic demands of the leisure cultural tourism groups being met, the region’s traffic microcirculation system was re-designed and transformed. The area should combine policies for the overall advancement of poverty alleviation, including ones on site relocation, ecological migration, focusing on improving the towns’ and administrative villages’ asphalt roads proportion, and realizing the availability of asphalt roads in the townships, highways in the administrative villages, and a road network in all administrative villages. There should be a focus on building a number of township roads that have an inter-county outlet transport corridor function and connecting the main nodes, including important industrial parks, tourist attractions, and mineral resources development bases, thereby gradually eliminating the “dead-end” highways. A diversified general aviation service system will be constructed that meets the green cycle’s ecological requirements of the Qinba Mountains, serving the region’s scenic spots, urban agglomerations, industrial parks, and important transport hub stations, with temporary landing points for general aviation and other support facilities established, and improvements to the general airlines’ operating service infrastructure network.

### **3.3 Focus on green and intensive development, promoting the transformation of transport development in the Qinba Mountains**

It is necessary to promote a shift in the transport development mode of the Qinba Mountains from an extensive to an intensive one. The key is to harness the comparative advantages and combination efficiency of each region and various modes of transport, striving to make great advances in the layout optimization, interrelations, integrated service, and information sharing, etc. The area should seek to establish a regional cooperation mechanism for comprehensive transport system development, breaking the regional segmentation and trade barriers, and engaging in communication and consultation regarding the regional convergence of comprehensive transport system planning, the devising of policy standards, and the construction of major projects.

In the process of transport infrastructure planning, design, construction, operation, and maintenance within the Qinba Mountains, high standards of resource conservation and en-

environmental protection requirements should be implemented, encouraging the priority development of environmentally-friendly transport modes, strict conformance with eco-friendly design, and vigorous application of energy-saving and environment-protection building materials and construction techniques [7]. Transport equipment management and control measures should be introduced to the national key ecological functional demonstration areas, accelerating the elimination of old, high energy-consuming and emission-producing transport equipment and machinery, prioritizing the use of clean-energy transport equipment, and guiding the public to using public transport, cycling, walking, and availing of other green travel modes.

### **3.4 Focus on ecological environment protection, promoting Qinba Mountains transport safety risk prevention integration**

The area should pursue the orderly organization of the transiting of dangerous goods, implementing special control measures for transporting goods in the national key ecological functional demonstration areas of the Qinba Mountains, drawing a “red line” around extremely sensitive ecological areas, such as the central reservoirs, and strictly limiting the transport of dangerous chemicals within these regions. The overall planning and design of the transit transport corridors of the Qinba Mountains should be conducted, with relevant policies being formulated that should seek to avoid transit traffic entering the Qinba Mountains core area. The progress of Qinba Mountains’ transport safety risk prevention integration should be promoted, improving the monitoring network; realizing the dynamic monitoring of long-distance passenger vehicles, heavy goods vehicles, and dangerous goods transport vehicles; and ensuring that the major risk sources in the area are identifiable, preventable, and controllable. The area should establish cross-regional and cross-sectoral warning information rapid reporting and a joint response mechanism, as well as a traffic emergency rescue system with rapid response and efficient disposal, and ensure that the arrival time of emergency transport is not more than one hour after notification of an emergency. Regular emergency drills should also be organized. The construction of general aviation landing fields should be accelerated, harnessing general aviation to deal with disaster relief, combating terrorism, and safeguarding stability, along with handling emergencies; the emergency search and rescue capabilities covering the key area of water should also be upgraded.

## **4 Measures and policy recommendations concerning the construction of the green transport system in the Qinba Mountains**

### **4.1 Innovation in relation to the investment and financing policy of transport development in the Qinba Mountains**

It is necessary to research the establishment of a Qinba Moun-

tains’ development fund for green transport system, exploring resource-bundling mode and carrying out pilot demonstrations. Projects included in the national, provincial, and city-level transport construction plans should be prioritized, giving financial support to construction projects and increasing the investment proportion of central funds. The area should be allowed to conduct innovation demonstrations concerning investment and financing policies in the Qinba Mountains, exploring such mechanisms as public-private partnerships (PPPs), together with other ways to support transport development. The area should be given increasing support for rural road construction, the construction of asphalt roads for qualified villages, and the integration of road reconstruction issues in the townships with the overall arrangement of village roads. Financial support should be increased for the Han River and the Jialing River waterway projects. Additionally, it is very important to supervise and urge related national departments to accelerate the preliminary work on the Qinba Mountains’ pivotal transport infrastructure, thereby to accelerate project construction.

### **4.2 Establishing a synergetic development mechanism for Qinba Mountains region’s transport**

A cross-regional cooperation mechanism should be established, together with a regional coordination committee, in which the relevant local leaders should jointly participate in discussing major traffic issues within the region. A cross-sector coordination mechanism should also be established, strengthening the industry transverse linkages and achieving the coordinated development of industry, environmental protection, and transport. Through a cross-regional and cross-sector coordination mechanism, integrated transport planning on the area should be prepared as soon as possible, conducting a top-level design of the regional transport development. The opening of air routes among feeder airports within the Qinba Mountains’ core area and the forming of travel routes should also be supported. The low-altitude airspace management structural reform of the area should be accelerated, defining the low altitude airspace and air-routes of the Qinba Mountains to meet the needs of general aviation operations in the region.

### **4.3 Focusing attention on and guidance toward the green transport development of the Qinba Mountains**

China should actively strive to integrate the green transport development of the Qinba Mountains using relevant national pilot projects, such as the low-carbon transport city and the transit-oriented metropolis. The National Development and Reform Commission, the Ministry of Transport, and the relevant government of the Qinba Mountains shall collaborate to study and formulate ideas, approaches, and models to support the green transport development of the Qinba Mountains, formulating mod-

els of success that will be demonstrated to other impoverished mountainous areas in due course.

## References

- [1] National Development and Reform Commission. Notice of the national development and reform commission on issuing the national expressway network plan (2013–2020) [EB/OL]. [2013-05-24] [2016-07-25]. <http://whgl.cn/zwgk/fzgh/2014/04/24/52762.htm>. Chinese.
- [2] The Ministry of Railways of the People's Republic of China. National mid-long term railway network plan [Z]. Beijing: the Ministry of Railways of the People's Republic of China, 2004. Chinese.
- [3] The Civil Aviation Administration of China. National civil airport layout plan [Z]. Beijing: the Civil Aviation Administration of China, 2008. Chinese.
- [4] The Ministry of Transport of the People's Republic of China. National inland waterway and port layout plan [Z]. Beijing: the Ministry of Transport of the People's Republic of China, 2007. Chinese.
- [5] The Ministry of Transport of the People's Republic of China. Transport construction for poverty alleviation planning outline of concentrated destitute areas (2011–2020) [Z]. Beijing: the Ministry of Transport of the People's Republic of China, 2012. Chinese.
- [6] The Ministry of Transport of the People's Republic of China. Transport construction for poverty alleviation plan of concentrated destitute areas of Qinba Mountains (2011–2020) [Z]. Beijing: the Ministry of Transport of the People's Republic of China, 2012. Chinese.
- [7] The Ministry of Transport of the People's Republic of China. Guidance of the Ministry of Transport of the People's Republic of China on issuing the accelerating the development of green cycle and low-carbon transport [EB/OL]. [2013-05-22] [2016-07-25]. [http://www.gov.cn/gongbao/content/2013/content\\_2466586.htm](http://www.gov.cn/gongbao/content/2013/content_2466586.htm). Chinese.