Study on Kodari Scheme of Rikaze-Kathmandu Railway Location

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Abstract: Building Rikaze-Kathmandu Railway will change the broken road situation of Lasa-Rikaze Railway, activate the potential of Qingzang Railway, have Tibet as well as Lasa and Rikaze become the node of south Asia channel of “One Belt and One Road”, strengthen commercial trade and bilateral relations between China and Nepal. It is the shortest route for Rikaze-Kathmandu railway to go through Zhangmu port. By primary analysis, the feasible route should extend from the current Rikaze railway station, going through Qumei county, entering into the current G318 highway belt, then going through Jiding, Liuxiang and Resa, arriving Lazi. The route extends from Lazi, then goes through Jiacuola mountain by tunnel with 45km length, going through Jiacuo county and arriving Dingri. After Dingri, the route extends to west along with Pengqu river valley, going through Zhaguo, then arriving Gangga. Extending to southwest from Gangga, the route goes under Labujikang peak by a 42km tunnel, then arriving Yalai, then Nielamu and Zhangmu. The nature gradient between Nielamu and Zhangmu is 110‰, line mileage 20km, thus the rack rail technology or the linear motor driving should be considered for train to climb the steep slope more than 110‰. Another possible scheme is to build an 88km tunnel with a 28‰ gradient between Gangga and Zhangmu for going under Himalaya, so as to avoid the 110‰ steep slope between Nielamu-Zhangmu. As for Nepal section, the route extends from Kodari, going through Baharabise and Dhulikhel, finally arriving Kathmandu. The total mileage of Rikaze-Kathmandu railway is about 460km, including China section 380km and Nepal section 80km.

1 Introduction

Lasa-Rikaze Railway has been in operation since August 2014. Next step, it is necessary to go through Himalaya Mountain and extend to Kathmandu of Nepal. China-Nepal international railway, exactly Rikaze-Kathmandu Railway, is significant and should be planned, designed and constructed as early as possible.

Rikaze-Kathmandu Railway would have Rikaze as a terminal become an important mid-node on international railway, have Qinghai-Tibet Railway. Lasa-Rikaze Railway become the important constitutes of the south Asia channel of One Belt One Road strategy. It also would upgrade the potential and value of Qinghai-Tibet Railway and Lasa-Rikaze Railway. In addition, Himalaya Super Tunnel would be another engineering sign and wonder.

Rikaze-Kathmandu Railway would be great benefit for Nepal as an underdeveloped country without railway and transport tunnel, and play an important role for transportation development and economic progress of Nepal. Helping constructing Rikaze-Kathmandu Railway Nepal section, also would manifest Chinese conditional virtual giving timely help.

Buddhist scriptures are the most profoundly impressions of Chinese people from generation to generation. Chinese people accompanying with the novel “Getting Scriptures from West Heaven” and worship to West Heaven from anciencty to today, should have the mission to build the heaven road to west heaven.

There are two possible options for Rikaze-Kathmandu Railway location scheme, one is the scheme going through Zhangmu (Kodari), another one is the scheme going through Jilong (Rasuwa). This paper studies on the line selection of only Rikaze-Kathmandu Railway Zhangmu scheme.

2 Along G318 highway scheme on China section of Rikaze-Kathmandu Railway (Scheme A)

When the railway goes along existing highway, the bridge & tunnel number would be the least, and
the construction cost would be the lowest. According to this principle, Rikaze-Kathmandu Railway China section extends out from west Rikaze, deciding the route alignment along G318 highway, along Jiding-Resa-Lazi-Dingri-Zhaguo-Gangga-Nailong-Menbu-Yalai-Nielamu-Zhangmu, reaches Zhangmu port, as shown in Fig.1.

![Route alignment of Rikaze-Kathmandu Railway Zhangmu scheme.](image)

**2.1 Rikaze-Jiding railway location**  
Rikaze-Jiding linear distance is 50km, G318 highway mileage 60km. Rikaze elevation is 3860m, Jiding elevation 3910m, the elevation difference 50m. G318 highway goes over Dala hill, maximum elevation 4050m. Suggesting Rikaze-Kathmandu Railway extends from west Jiangzi Village, then extends along Ruoqu valley. By way of Qumei Village, go to Dala hill, choosing a cliff and going through the hill by a tunnel about 1km. After going through Dala hill, extends along G318 highway trend to west. Building a big bridge (>200m) near by the existing Jiding highway bridge, spanning over Buqu river, then setting Jiding station at Jiding town. Since the landform of Jiding town is narrow, suggest setting the station at the commodious place of Jiding town west 1km (elevation 3925m). In the section the landform elevation difference isn’t large, and it’s easy to decide the gradient, no need to expand line for the elevation difference. By the line situation and the existing highway mileage, estimated Rikaze-Jiding railway mileage would be 55km. The Rikaze-Gangga longitudinal alignment sketch along G318 highway scheme is as shown in Fig.2a.

![Rikaze-Gangga longitudinal alignment sketch along G318 highway scheme.](image)
2.2 Jiding-Resa railway location
Jiding-Resa linear distance is 33km, existing highway mileage 44km. Resa elevation is 4270m, Jiding-Resa elevation difference 360m and in this section G318 goes by Liuxiang country. May consider setting a station here so as to boost Liuxiang economic development and provide convenience for local people. Liuxiang elevation is 4060m, higher 135m than Jiding. Jiding-Liuxiang section is mainly in upgrade slope, and the route extends along valley, no long tunnel and big bridge. After extending out from Liuxiang country, the route goes to south to west along Requ valley. By way of Laga village the route extends to south again, then reaching Resa. Liuxiang-Resa elevation difference is 225m, the whole section in upgrade slope, mean gradient about 10‰. Jiding-Resa railway mileage is estimated 40km, the line expansion coefficient 1.21.

2.3 Resa-Lazi railway location
Resa-Lazi linear distance is 38km, highway mileage 54km. Lazi elevation is 4020m, Resa-Lazi elevation difference -250m. Suggest Rikaze-Kathmandu Railway extends from Resa station to west, passing through Cuola hill, then reaching Lazi after Gangxi village. G318 highway goes over Cuola hill, the highest altitude 4080m, thus the railway need to go through Cuola hill by tunnel mode. The tunnel entrance should be located in the west river of west Larong village. The entrance elevation is about 4350m and the tunnel exit is located on the mountainside of west Larong village valley, then the route extends to west by tunnels or bridges. The tunnel exit elevation is about 4300m, the slope gradient in tunnel is down less than 10‰, tunnel length 4-4.5km. After using bridge and tunnel, the railway going by Cuola hill and adjacent valley is shortened 3km than the existing highway mileage. After going through Cuola hill, the railway line extends west, to Gangxi village. This section is about 7km, elevation difference 220m, need setting downgrade with gradient 30‰. Suggest choose right place to set station at Gangxi village or Renda Village, station elevation 4080m. Resa-Gangxi section includes 3 big bridge, one among them with height more than 20m.

Route extends out from Gangxi village to west, along valley to Lazi, Gangxi-Lazi section route is mild and straight, no tunnel or big bridge. By estimation, Resa-Lazirailway mileage is 41km.

2.4 Lazi-Dingri railway location
Lazi-Dingri linear distance is 70km, existing highway mileage 83km, Dingri elevation 4300m, elevation difference 280m. Existing G318 highway goes over Jiacuola Hill, the highest position of highway is in Jiacuola Hill stiff with altitude 5250m. One third of the existing highway there is on the high altitude more than 5000m. The linear distance from Zhawu to Jiacuola Hill cliff is 22km, highway mileage 25.5km, Zhawu elevation 4050m, Zhawu-Jiacuola Hill elevation difference 1200m, the natural gradient 54‰, midway village such as Silong, Xintang and Jijiao.

The linear distance from Zhawu to Silong is 5.4km, highway mileage 5.6km, Silong elevation 4240m, landform natural slope 40‰. Silong-Xintang linear distance is 3km, highway mileage 3.1km, Xintang elevation 4410m, Silong-Xintang elevation difference 170m, landform natural slope 57‰, larger much than the maximum restriction gradient of the railway.
Comparing with north slope of Zhawu-Jiacuola Hill, the south slope is mild. The natural slope of the 20km section of Dingri Baiba-Bibu village is about 13.5‰.

On the special difficult section through Himalaya Mountain, the roof of the world, it’s necessary to consider super long tunnel for Rikaze-Kathmandu Railway location. Suggest Rikaze-Kathmandu Railway extend out from Lazi station, after spanning over the river, extends to northwest along G318 highway, then turn to southwest at Zhawu. Locate the Jiacuola Hill tunnel entrance at Qukuoluojiang village where is 1.5km from Zhawu, elevation 4100m. The tunnel exit is at the south of Jiacuo Country Bibu village, elevation 4570m. The tunnel length is 45km, gradient 10‰, the maximum depth 1000m. Jiacuo Country is 2km from the tunnel exit in south. Suggest to set Jiacuo station here, then set Dingri station at Baiba or Lazangwo village.

By this scheme, estimated Lazi-Dingri railway mileage is about 75km.

2.5 Dingri-Gangga railway location
Dingri-Zhaguo linear distance is 25km, G318 highway mileage 28km. Zhaguo elevation is 4310m, same that of Dingri, not spanning over high mountain or large river. Zhaguo-Gangga linear distance is 28km, G318 highway mileage 30km. Gangga elevation is 4340m, same as Dingri and Zhaguo elevation, not going over high mountains.

Dingri-Gangga natural landform is mild, valley smooth and straight, easy for railway location. Suggest Dingri-Gangga section comes out from Dingri, extending to west along Pengqu valley, reaching Zhaguo, and setting Zhaguo station at right place. The railway comes out from west Zhaguo station, extending along Pengqu valley, setting Gangga station at Gangga town.

Dingri-Gangga estimated mileage is 57km, all section along valley, maximum gradient less than 5‰, no tunnel.

2.6 Gangga-Menbu railway location
As shown in Fig.1, Gangga-Menbu is a half circle line, linear distance 49km, G318 highway mileage 69km, highway line expansion coefficient 1.4. Menbu elevation is 4500m, route goes by Nailong (elevation 4380m), the landform along highway plane, not going over high mountains.

Suggest Rikaze-Kathmandu Railway Gangga-Menbu section comes out from Gangga station, going to west and going by Didong village, then extending to northwest along Pengqu valley, setting a station at Nailong country. Gangga-Nailong elevation difference is 40m, estimated railway mileage 22km, no tunnel and no big bridge.

The railway comes out from Nailong country, then extending to west, finally reaching Menbu, setting Menbu station. Nailong-Menbu section elevation difference is 120m, estimated railway mileage 36km, no tunnel or big bridge.

By the scheme along G318 highway, Gangga-Kathmandu longitudinal alignment sketch is as shown in Fig.2b.

2.7 Menbu-Yalai railway location
Menbu-Yalai linear distance is 39km, G318 highway mileage 56km. Yalai elevation is 4380m, the section goes by Xiamude, Langnong and Tulong village. The landform elevation difference isn’t large, but undulation is big and the route spans over big river and valley. The highway goes over Laqinya hill at the south of Xiamude, maximum altitude 5010m. Going by Langnong, goes over Zhajiaxuema hill, maximum elevation 5130m. Langnong elevation is 4880m, 3.3km from Zhajiaxuema hill cliff, natural slope 76‰, so that a tunnel is necessary for going through Zhajiaxuema hill.

Suggest Rikaze-Kathmandu Railway comes out from south Menbu (elevation 4500m), extending along Pengqu valley to Xiamude (elevation 4600m) where G318 highway also goes to Jilong. Suggest setting a station at Xiamude or reserving station position. Menbu-Xiamude section is smooth and straight, no tunnel and no big bridge. Set tunnel entrance at valley mountainside of east G318 highway of Xiamude, elevation 4630m.

Langnong Village is located the south side of Laqinya hill, the lowest altitude 4850m. Xiamude-Langnong route miles is 5.5km, if the tunnel exit is located at Langnong Village, then the slope in tunnel would be 40‰, over the railway restriction slope. Therefore, suggest designing super long tunnel which goes under both Laqinya hill and Zhajiaxuema hill. Setting the tunnel exit
at the valley mountainside of north Tulong village, where the elevation is 4660m. This tunnel length is 21km, gradient less than 2‰, maximum depth 500m. After coming out from the tunnel, the route extends to southwest along valley, by Tulong reaching Yalai, setting Yalai station.

Estimated Menbu-Yalai railway mileage is 42km, including a 21km super long tunnel. Zhajiaxuema tunnel scheme have this section shorten mileage 13km than the existing G318 highway.

2.8 Yalai-Nielamu railway location
Yalai-Nielamu linear distance is 30km, G318 highway 33km, highway line expansion coefficient 1.1. Nielamu elevation is 3750m, Yalai-Nielamu elevation difference 630m, and the natural gradient 20‰, valley smooth and straight, gradient uniform, easy for railway location.

Suggest Rikaze-Kathmandu Railway Yalai-Nielamu section comes out from southwest Yalai station, extending along valley, by Rujie and Zhaxigang village, reaching Nielamu. Although the valley is straight and slope uniform, the valley is narrow and cragged, so that some sections need tunnels and bridges.

Estimated Yalai-Nielamu railway mileage is about 32km, with many mid-small tunnels and valley bridges.

2.9 Nielamu-Zhangmu railway location
Nielamu-Zhangmu linear distance is 18km, G318 highway mileage 33km, the highway line expansion coefficient 1.83. Zhangmu town elevation is 2400m, Nielamu-Zhangmu town elevation difference 1350m, natural slope 75‰, mountain valley cragged and dangerous, very difficult for railway location. Zhangmu town is located in a deep valley between Shisha Pangma(8027m) and Cho Oyu (8201m) which is on the west of Everest on Himalaya ridge line. This valley is a convenient channel from China to Nepal which is between Shisha Pangma and Everest(8848m). Anyway, it is on the roof of the world, on the top of the global, and Zhangmu town is located on the side of Cho Oyu. The elevation of the highest place of Zhangmu town is 2500m, lowest place 2180m, elevation difference 320m. China-Nepal Friend Ship elevation at Zhangmu port is 1750m, highway mileage from Zhangmu town center to Friend Ship is 9km, elevation difference 650m.

Not only Nielamu-Zhangmu natural gradient is too large and railway expansion very difficult, but also is it difficult for Zhangmu to set a station and locate. A possible method is to design overlimit slope for the railway. Then Nielamu-Zhangmu railway elevation difference is 2000m, gradient 110‰, clearly not matching with the current railway design criterion.

Another idea is that the railway comes out from Nielamu, not going through Zhangmu, taking Nielamu as port station. Then select a place in Nepal as the port station that is on the range of Rikaze-Kathmandu Railway direction, with right elevation, and not over railway limit slope. However, Nielamu-Kathmandu linear distance is 80km, Kathmandu elevation 1300m, Nielamu-Kathmandu elevation difference 2450m, natural slope 31‰. It means if not expanding the railway line by retracing, then no a place in Nepal on the range of Nielamu-Kathmandu linear range could be right for a Nepal port station.

Therefore, China-Nepal border section of Rikaze-Kathmandu Railway have to go through Zhangmu, and set special overlimit slope, using the rack rail technology to solve climb problem. According to experience of Swiss Pilatus Mount Rack Railway, the rack railway could climb slope more than 45°[1][2][3][4]. Fig.3 shows Pilatus Mount Rack Railway[5]. Fig.4 shows rack railway structure, thereinto Fig.4a shows the vertical rack railway and Fig.4b shows the plane rack railway.
In addition, the adding force traction by linear motor also could be considered for solving the problem that trains climb the steep slope more than 110‰.

According to the above analysis, China section (Rikaze-Zhangmu) of Rikaze-Kathmandu Railway along G318 highway is about 420km, 15 station, namely Jiding, Liuxiang, Resa, Gangxi, Lazi, Jiacuo, Dingri, Zhaguo, Gangga, Nailong, Menbu, Xiamude, Yalai, Nielamu, Zhangmu. About 2-3 long tunnels with length 2-10km, namely Cuola hill tunnel (4km) and some tunnels between Nielamu-Zhangmu, 2 super long tunnels with length 10km, namely Jiacuola hill tunnel (45km) and Laqinya hill tunnel (21km). Set 110‰ super overlimit slope between Nielamu-Zhangmu section so as to solve the problem that trains climb the steep slope.

3 Relatively linear scheme in some China sections (Scheme B)

It can shorten railway mileage and reduce the gradient gradient to cut curve to linear and adding bridge & tunnel proportion. Besides the above scheme to select line of Rikaze-Kathmandu Railway China section along G318 highway, it is also reasonable to use the more straight line scheme, as shown in Fig.1 (Scheme B). Fig.5 shows the relating vertical section sketch.

(1) The route in Rikaze-Dingri passes by Sajia, not by Lazi like the scheme along G318 highway. Although increasing bridge & tunnel proportion, the railway line would be more close to Rikaze-Kathmandu linear direction, and shorten the route mileage, especially, avoiding the super long Jiacuola Hill tunnel.

(2) The route in Gangga-Yalai, goes along straight line, avoiding goes around Nailong and Menbu. The total mileage of this section would be shorten 73km, and avoiding Zhajiaxuema super long tunnel.
3.1 Rikaze-Dingri railway location by Sajia in Scheme B

In this scheme the railway route goes through Sajia as control point.

3.1.1 Rikaze-Xiongma section railway location

Rikaze-Kathmandu Railway comes out from Jiangzi village of Rikaze west, expanding the line along Ruoqu valley (Fig. 1), passing through Qumei village, extending to southwest, passing through Qiebai Village (elevation 3940m), Dongguo or Daria (elevation 4270m) and Qiema (elevation 4250m). Then reaching Xiongma (elevation 3980m), set Xiongma station at Kangsa village.

The route passes through Qiebai Village, then choose place for tunnel entrance at elevation 3980m. The tunnel goes through several hills such as Zongzima, Lakeri, Quwo and Luoburi. One idea is to set tunnel exit at south side of Dariaquwa hill with elevation 4280m. It lead Quwo hill tunnel long 8km, gradient 37‰ which is over the maximum overlimit of railway. In addition, after going through Daria, the route goes through Rijiaqun hill and Qiangjiumujiari hill at once, so that Daria section which is not tunnel is less than 2km.

Thus, this tunnel exit had better be set at Qiema, selecting place with elevation 4200m as tunnel exit. In this case, tunnel length is 14km, gradient 16‰. After the route comes from tunnel at Qiema, being connected by continue bridges, and going into valley, extending to southwest. Then the route goes along plane and open area, reaching Xiongma Kangsa villag, easy for selecting line.

Qiema-Xiongma linear distance is 10km, elevation difference 220m, natural slope 22‰, so it’s easy to select line, the gradient not over the limit.

According to the above location scheme, estimated Rikaze-Xiongma railway mileage is 50km.

3.1.2 Xiongma-Sajia railway location

The route comes out from Xiongma station west, to south along Buqu river. After going by Zharong country (elevation 4020m), the route goes to west. The route can go by Qialong village (elevation 4070m), Zhaxigang (elevation 4150m), Boercuo (elevation 4230m), Secuo (elevation 4330m), Gongba (elevation 4370m), Laxiong (elevation 4530m). The route could be expanded along valley,
from Boercuo to Secuo, Gongba, then to Laxiong, but the valley natural slope is over 30‰, so after Secuo, tunnel should be set. Suggest choosing tunnel entrance position at the mountainside with elevation 4270m of Boercuo village west bank, tunnel exit at Qusang village valley north bank with elevation 4500m. This tunnel length is about 19km, longitudinal slope in tunnel 12‰. Because it goes under Dongjuema apex, so we name it Dongjuema tunnel.

After coming out from tunnel at Qusang (elevation 4500m), the route extends to west along valley, by Xiapu village (elevation 4410m), reaching Sajia (elevation 4300m). Choose right place to set Sajia station at Chama of Sajia county northwest.

Estimated Xiongma-Sajia railway mileage is 54km.

3.1.3 Sajia–Dingri railway location
Rikaze-Kathmandu Railway comes out from Sajia station south, extending to south along valley, turning to a little southwest at Yalongnuro (elevation 4450m), and choose place for tunnel entrance at the mountain foot of the river west bank with elevation 4450m, passing through Zhongla hill, deciding the tunnel exit at Quixue village with elevation 4450m, then extending to south along valley. This tunnel length is 14km, basically level, maximum depth 500m.

After coming out from tunnel at Quixue village, the route goes to southwest, then extends to south a little west along valley, by Ladong village (elevation 4330m) to Mabujia country (elevation 4270m), and set Mabujia station. There is a tunnel with length 14km between Sajia -Mabujia, route mileage about 32km.

The route comes out from Mabujia station south. Choose place for tunnel entrance at elevation 4270m, and choose place for tunnel exit at Gurong village with the elevation 4200m. This tunnel is long 30km, basically level, maximum depth 1200m.

After going out from tunnel at Gurong village, Changsuo Country station is set at Chajiang village of Changsuo Country (elevation 4180m). Estimated Mabujia-Changsuo route mileage is 34km.

Then, the route comes out from Changsuo Country west, passing through under a small hill of Changsuo Country west by a tunnel with length less than 1km; By Gesa village (elevation 4250m), extending to Qulo country (elevation 4290m). After passing through Qulo country, the route further extends to west along valley, by Jixiong village and Qialai village, finally reaching Dingri and setting Dingri station at Nazangwo village south of Baiba country (elevation 4290m). Estimated Changsuo-Dingri route mileage is 35km.

According to the above Sajia scheme, there would be 2 long tunnels on Rikaze-Kathmandu Railway Rikaze-Dingri section, namely Quwo hill tunnel (14km) and Zhongla hill tunnel (14km); 2 super long tunnel, namely Dongjuema tunnel (19km) and Mabujia tunnel (30km) as shown in Fig.5a. Estimated Rikaze-Dingri route mileage is 202km, 15km shorter than going by Lazi (Scheme A), also avoiding building Jiachuola Hill tunnel with length 45km. However, the total tunnel mileage would increase 30km.

In order to reducing engineering cost, it’s considerable after the route comes out from Mabujia station, extend to south along valley, by Sebai, Labai, Jijiao, then turn to west along another valley, reaching Luoqu. Such a retrace scheme increases mileage 8km, and avoiding Mabujia tunnel with length 30km.

3.2 Gangga-Yalai location based on the straight scheme
Gangga-Yalai linear distance is 50km, but G318 goes through Nailong and Menbu, detouring seriously, having highway mileage increase to 125km, highway line expansion coefficient 2.5.

For Rikaze-Kathmandu Railway, it is necessary to cut the circle to straight in Gangga-Yalai section. Suggest the route comes out from Gangga west, then turn to southwest, by Xibei village (elevation 4355m) and Kongmo (elevation 4375m), selecting site for tunnel entrance at Kongmo southwest (elevation 4380m). This tunnel is in northeast-southwest direction, tunnel exit should be located at Yalai north with the elevation 4380m. The tunnel length is 42km, basically level, maximum depth 1400m, making Gangga-Yalai section shorten from 125km in the detour scheme along G318 highway to 52km, net shortened mileage 73km.
3.3 Gangga-Zhangmu 88km Himalaya tunnel scheme

The most difficult section of Rikaze-Kathmandu Railway location and construction is on Nielamu-Zhangmu port, linear distance 18km, natural slope 110‰. Another possible scheme is to build the 88km Himalaya Tunnel, namely, Rikaze-Kathmandu Railway comes from Gangga station west, setting tunnel entrance at Gangga south elevation 4350m. The tunnel goes along south a little west through under Himalaya, finally reaching exit at a right spot on China side of the lower reach of Zhangmu port friendship bridge with elevation 1800m, this tunnel (Gangga-Zhangmu tunnel) length will be total 87-90km, gradient 28‰, exactly passing under Gangla apex with altitude 7000m, maximum depth 4000m, as shown in Fig. 6 and Fig. 7.

Figure 6. Himalaya tunnel scheme horizontal sketch.

Figure 7. Himalaya tunnel scheme longitudinal section sketch.

Other apexes along this tunnel includes Qiagama (elevation 6800m) and Jiangbeiyang (elevation 5600m), going through under Cuolangma lake east (elevation 5600m) as well as Cuolangma glacier.

4 Rikaze-Kathmandu Railway Nepal section location

Nepal Kodari port is located at China-Nepal friendship bridge west of Zhangmu port. Kodari-Kathmandu linear distance is 70km, total mileage of the present Nepal Kathmandu-Kodari highway (Araniko Rajmarg) is 116km, main towns includes Kodari_27km_Baharabise_54km_Dhulikhel_35km_Kathmandu. Two schemes could be considered for Kodari-Kathmandu railway, one is along the current highway, bypass Baharabise and Dhulikhel; another is goes bypass Chautara, not bypass Dhulikhel.
Nepal Kodari port station (elevation 1750m) could be built on the mild slope side at Nepal side at the lower reaching 1km from China-Nepal friendship bridge.

4.1 Kodari-Kathmandu railway location scheme along Araniko highway
The priority scheme of Kodari-Kathmandu railway location should be along the existing highway. The route comes out from Kodari station south, extending along valley or mountainside, setting Baharabise station at Baharabise elevation 1400m. Kodari-Bahirabise section gradient is 18‰, estimated mileage 20km, most of the section is continuous bridges and tunnels, bridge & tunnel ratio more than 70%.

The route comes out from Baharabise, extending to southwest along Araniko highway, spanning over Indrawati river, reaching to Dhulikhel, and setting station at Dhulikhel with elevation 1400m. The line is mainly in continuous bridges & tunnels in Baharabise-Dhulikhel section, estimated route mileage 45km. The bridge & tunnel ratio is less than 70%, no super long tunnel over 5km, but some bridge height would be over 50m, even to 200m and length more than 1000m. It's considerable to set a station at right place between Baharabise-Dhulikhel, so as to facilitating the local people’s life and boosting the local economic development.

The route comes out from Dhulikhel, extending to west a little north, reaching Kathmandu, and setting Kathmandu station at the outside of present Ring Road with elevation 1300m. Estimated Dhulikhel-Kathmandu mileage is 29km, or additionally setting Bhaktapur station.
According to this location scheme, estimated Kodari-Kathmandu railway mileage will be 84km, main mid-station includes Baharabise and Dhulikhel.

4.2 Location scheme bypass Chautara
Another possible location scheme for Kodari-Kathmandu is bypass Chautara. In this scheme, Baharabise station is located at west bank of the valley where the slope is mild and elevation 1300m. The route comes out from Baharabise station, goes to west a little south, then going through under a mountain by a 6km tunnel, exit at Phulpingkot area with elevation 1200m. After coming out from the tunnel, a super long bridge is set to span over valley. This bridge would be high over 200m, and be the controlling engineering of this scheme. Then continuously expand the line to west, reaching Chautara, and set the station at some place with elevation 1100m. Then, the route comes out from Chautara station west, spanning over a big valley by a super bridge, and going through a mountain by a tunnel with length more than km. After going out from the tunnel, the route extends to Kathmandu west, setting Kathmandu station at some place with elevation 1350m.

By the scheme, estimated Kodari-Kathmandu railway mileage will be 78km, including 2 super tunnels with length more than 5km, and 2 super bridges with length more than 1km and height to 200m.

5 Conclusions and Suggestions
There are two scheme options for Rikaze-Dingri section of Rikaze-Kathmandu Railway, namely along G318 highway scheme (Scheme A) and bypass Sajia scheme (Scheme B). The mileage of Scheme B is shortened 3.5km, avoiding the long 45km Jiachuola hill tunnel, but the total tunnel mileage increases 31km, big bridge number and total length would also increase greatly. Therefore, suggest using Scheme A along G318 highway for Rikaze-Dingri section.

There are also two scheme options for Gangga-Yalai section, namely the detour scheme (Scheme A) along G318 highway bypass Nailong and Menbu and the cutting straight scheme (Scheme B). The route mileage of Scheme B is shortened 73km than Scheme A. Although there is a 42km tunnel in Scheme B, it increases only 21km than the Zhajiaxuema tunnel with length 21km in Scheme A. Therefore, suggest using the cutting straight scheme (Scheme B) for Gangga-Yalai section.

Niealamu-Zhangmu port linear distance is 18km, natural gradient 110‰, so suggest using the rack railway technology, or using the adding force by linear motor, to solve the problem to climb slope over 110‰ for this section.

Another possible scheme is to build a super tunnel with length 88km between Gangga-Zhangmu, going through Himalaya Mountain. Not only shortening route mileage greatly, but also avoiding the overlimit gradient over 110‰ between Niealamu-Zhangmu. The slope in Himalaya Tunnel with length 88km is 28‰, matching to the present railway design standard.
Kodari-Kathmandu linear distance in Nepal section of Rikaze-Kathmandu Railway is 70km. There are two possible railway location schemes, one is along the present Araniko highway bypass Bahrabise, Dhulikhel to Kathmandu, another is bypass Bahrabise and Chautara to Kathmandu.

Nepal section of Rikaze-Kathmandu Railway is only one fifth of the total mileage, generally the elevation not over 2000m, difficulties in engineering and construction lower than that in China section.

Anyway, it is significant for Nepal economic development and China-Nepal trade to build Rikaze-Kathmandu Railway as soon as possible.

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