# Environmental Impact Assessment (Draft)

May 2018

# PRC: Yunnan Lincang Border Economic Cooperation Zone Development Project
# (Annexes: Appendix 1- Biodiversity Management Report)

Prepared by Lincang Border Economic Cooperation Zone Development Project, People's Republic of China for the Asian Development Bank.

**CURRENCY EQUIVALENTS**

(as of 15 May 2018)

| | | |
|---|---|---|
| Currency Unit | – | yuan (CNY) |
| CNY1.00 | = | $0.158 |
| $1.00 | = | CNY 6.340 |

**NOTE**

In this report, “$” refers to US dollars.

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**Appendix 1**

Project Number: TA 9373 - PRC
December 2017

People's Republic of China: Yunnan Lincang Border Economic

Cooperation Zone Development Project (P49310-002)

# Biodiversity Management Report

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Contract no: 138590-S96798

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# Contents

## Summary

Lincang Prefecture is located in a mild humid subtropical climate zone, with muddled distinction between the seasons and daytime temperatures remaining warm year-round. The average annual temperature is between 16.5 and 19.6 degree centigrade. The average annual rainfall is 1485.7 mm and the annual average relative humidity is 69～81%. The rainfall from June to September accounts for nearly 70% of the annual rainfall. Elevations within the prefecture range from 450 to 3,504 metres (1,476 to 11,496 ft). There are two international river systems running through the Prefecture, Lancang River and Nu River / Salween River. The area is the most biological diverse regions in China.

Yunan Lincang Border Economic Cooperation Zone (LBECZ) Development Project (P49310-002) covers three Chinese border cites/towns, namely Qingshuihe Border Area at the center, Zhenkang County in the north and Cangyuan County in the south, along China-Myanmar border in Lincang Prefecture of Yunnan Province, southwestern China. The project will improve the cross border trade capacity and integrated urban environment infrastructures in Qingshuihe Border Area, and social infrastructures and services in three border areas, and enhance the institutional capacity of involved agencies.

The core development area at the current stage is about 3.47 square kilometers in Qingshuihe Border Area under the management of the LBECZ. The project also includes the construction of Guomen No. 2 Elementary School in Cangyuan County and Sino-Myanmar Friendship Hospital in Zhengkang County. The project will support the border trade and regional cooperation development at Qiangshuihe Border Area of Mengding Town in Gengma County as well as Nansan Border Area of Zhenkang County and Yonghe Border Area of Cangyuan County, and will have significant impact on the local economic development and poverty alleviation.

As a national biodiversity management specialist, I am mainly responsible for documenting the biodiversity values of the project area, assessing potential impacts of the project to biodiversity, and developing mitigation measures. The working approaches include the collection and review of available data, maps and literatures, interview of local stakeholders such as the reserve management administrations, local forestry bureaus, agriculture bureaus and water resources bureaus, and three field surveys. The major results are concluded as the follows:

**A Protected areas and potential project influence**

A total of six protected areas were established outside 6 km radius from each sub-project site. Of them, four are forest type reserves including two in national level and two in provincial level, and two are national aquatic germplasm type reserves. The proposed Nanting River Bridge construction may affect the fish migration and composition for the National Aquatic Germplasm Reserve (NAGR) in the lower reach of Nanting River, which is about 6.8 kilometers in the upper reaches.

**B Current ecological status and conservation values**

**There is no plant species under the national and provincial key protected plant list in the project area.** The vegetation assemblages mainly include timberland, shrub land, grassland,

farmland with garden land, and the wetland vegetation. Generally, the terrestrial habitat and flora have low conservation values. Two patches of teak, and some teak, banyan and jackfruit mixed with the rubber plantation, have the ornamental and economic values.

129 terrestrial fauna species were identified in the project sites, including 10 orders, 24 families and 111 bird species; 3 orders, 4 families and 6 mammals; 3 families and 5 amphibian species; and 7 families and 7 reptile species. **Among them, five species are the nationally protected animals (NPAs), such as Common buzzard, Great coucal, Tiger frog, Tokay gecko and Asian water monitor. In addition, the two reptile species are recognized as the vulnerable category (VU) by IUCN RedList, such as Chinese softshell turtle and King cobra.**

Taking into account of the world population estimate and geographical distribution ranges of five NPAs and two VU reptile species, together with their population number and habitats in the project area, the two NPAs such as Tiger frog and Tokay gecko have low conservation values, and the other five species including three NPAs such as Common buzzard, Great coucal and Asian water monitor, and two VU reptile species such as Chinese softshell turtle and King cobra have medium conservation values, but not significant.

**48 fish species were identified in Nanting River system, which do not include any protected fish species in national and provincial levels. However, *Anguilla nebulosi* and *Bagarius yarrelli* are recognized as near threatened (NT) by IUCN RedList, and *Neollissochilus baoshanensis*, *Garra salweenica* and *Schiothorax nukiangensis* are recognized as data deficient (DD) category.**

Two DD fish species in IUCN RedList including *Garra salweenica* and *Schizothorax nukiangensis* mainly distribute in the middle and upper reaches of Nu River, in the northwest of Yunnan Province. Nanting River is not the concentrated distribution area of two fish species. Therefore, their conservation values are assigned as medium.

**（i） Fish species with medium conservation value**

The two NT fish species of IUCN RedList such as *Bagarius yarrelli* and *Anguilla nebulosi*, and one DD fish species *Neolissochilus baoshanensis*, in addition to *Balitora nantingensis* (was not assessed by IUCN with the lack of information) are assigned with medium conservation values. The main considerations include: (a) The four fish species are endemic to Nanting River; (b) The lower reach from Junsai to the Sino-Myanmar border area is the concentrated distribution area of the four fish species in Nanting River, including the surrounding area of proposed Nanting Bridge;(c) The four fish species were also identified as the conservation targets in the Master Plan of NAGR of lower reach of Nanting River.

**（ii） Area with relatively medium conservation value**

The river course of proposed Nanting Bridge has the relatively medium conservation value for fish migration. The river course in the vicinity is the important migration pathway of migratory fishes from Salween River and India Sea, especially for the two NT fish species under IUCN RedList and the other two fish species identified as the conservation target by the reserve authority.

The site survey was conducted in a total length of 9.6 kilometers' river course, including 1.0 kilometer in the down reach and 8.6 kilometers in the upper reach of proposed Nanting Bridge.

**The potential spawning site for fish laying floating-eggs is identified, which is located over 2.7 kilometers in upper reach of proposed Nanting Bridge. The total length of river course with potential spawning area is 5.9 kilometers.**

The river course between 1000 m in the lower reach and 700 m in the upper reach of proposed Nanting Bridge is not suitable for fish spawning. As the landform of river sides in the two sections consists of regular stones or steep land rather than staggered rocks. The water runoff becomes slow due to the small elevation difference in this section.

The landform in the location of 700 m upper reach of proposed Nanting Bridge has a significant segmentation compared with the upper and lower reaches. The river course between 700 m and 2700 m in the upper reach of proposed Nanting Bridge starts to have rocky landform, but not so staggered. Therefore, this section is still not suitable for fish spawning.

**(3) Anticipated environmental impacts and mitigation measures**

**（i） Impacts on terrestrial environment and mitigation measures**

The total project area is 123.9 hectares and its original vegetation ratio is 79.6%. The area of 98.7 hectares with vegetation comprises 51.5 hectares of rubber plantation (52.2%), 45.8 hectares of shrub (46.4%) and 1.35 hectares of grassland (1.4%). Meanwhile, 47,324 rubber trees and 5,300 shrubs will be cut. According to the current design, the area covering 24.7 hectares will be planted with the landscape plants, accounting for 25.0 % of the total vegetated area and 19.9% of the total project area. This would compensate one fourth of the loss of current vegetated land.

The rubber plantation replacement by 1:2 ratio requirement does not apply as land is scarce and cannot be provided as replacement by LBECZ/Project Management Office (PMO). According to the Forest Management Measures (1997) and Forest Management Regulation (2010) of Yunnan Province, any individuals or organizations are requested to pay the vegetation compensation fee for the local Forestry Bureau if they do not have land and capacity to implement the afforestation. The fee will be allocated as the ratio of 2: 2: 6 in provincial, municipal and county levels. The local Forestry Bureau will fulfill these responsibilities to be included in the annual afforestation plan.

The afforestation plan of Gengma County in 2018 was issued on March 17 2018. The total area of afforestation is 80,000 mu (15 mu equals to one hectare), including 50,000 mu of nut plantation, 20,000 mu of commercial forest and 10,000 mu of precious timber forest. Of them, 9,000 mu of afforestation will happen in Mengding Town, where is the location of project area of LBECZ. **This is the critical measure to compensate the carbon emission due to the cutting of rubber plantation.**

In addition, the new energy public transport facilities in LBECZ and buildings will be constructed in according to national and Yunan green building standard (GB/T50378-2006 and DBJ53/T-49-2015)). For Cangyuan and Qingshuihe Elementary Schools, and Zhenkang and Qingshuihe Hospitals, the designs also consider the energy conservation combined with solar and heat pump hot water systems. The plants in the project landscape area are recommended to plant more C4 plants than C3 plants, in order to increase the carbon sequestration, such as sedge, dicotyledon, euphorbiaceae, chenopodiaceae and amaranthaceae (all C4 plants).

The terrestrial fauna are widespread and common species, which can adapt to the new habitats very fast. The population size of Chinese softshell, Tokay gecko, Asian water monitor and King cobra are rare because the river beaches of Qingshui River and Nanpa River in the project area have been almost developed for garden fields. **The land clearance may destroy the nesting habitats of some birds, and hibernation ground of amphibians and reptiles. With the high intensive human activities in project area, these impacts would be very limited.**

The mitigation measures are proposed to minimize the impacts such as: control of construction noise to reduce disturbances, avoid of land clearance in avian breeding period and hibernation period, and education programme to workforce not hunting or harvesting wild fauna.

**（ii） Impacts on aquatic environment and mitigation measures**

During construction, noise and vibration from pilling, excavations and dredging would have temporary impacts on fish resources. The fish mainly comprises of small-sized economic species in Qingshui River, Nanpa River and Nangun River, which can be easily recovered after the project completion. The key mitigation measure is to construct the fish pass in water intake location and overflowing dyke locations.

Considering the design of proposed Nanting Bridge is three span twin cable stayed style, the construction will not happen in the river course. This will reduce the impact on fishes to a large extent. The recent survey found that the river course in over one kilometer radius of proposed Nanting Bridge is not the spawning area for fish laying floating-eggs. **The proposed Nanting Bridge will have very low impact on fish breeding if the construction avoids the breeding season from April to June.**

However, the lower reach of Nanting River is the important migration pathway for migratory fishes, especially for four conservation fish targets in according with those by the NAGR of lower reach of Nanting River. They include two NT fish species and one DD fish species under the IUCN RedList, and one newly named fish species *Balitora nantingensis* (was not assessed by IUCN with the lack of information). The mitigation measures include: (1) avoid of construction during fish breeding period from April to June and fish migration period from June to September; (2) setting up covers to prevent the solid waste falling into the river course; (3) avoid of block of river stream to prevent the fish migration due to the soil collapse of piling activities.

Accordingly, the environmental flow is recommended to avoid the pollution to the water quality in the river courses during the project construction period and after the project completion. The river slope prevention program is also recommended to prevent any large scale soil erosion. Meanwhile, the capacity building of local fishery management authority and administrative bureau of NAGR in lower reach of Nanting River would be enhanced.

**(4) Biodiversity monitoring plan**

This biodiversity monitoring plan comprises terrestrial and aquatic biodiversity monitoring plans. The potential impact, mitigation measures, monitoring mean and frequencies, locations, measurement indicators and responsibility are presented.

The terrestrial biodiversity monitoring plan is designed in three impact aspects: avifauna biodiversity, amphibians and reptiles, and timberland and habitat degradation. The total budget is

US $ 60,000. In the light of conservation values, there are not special animals or habitats needed to be conserved. This monitoring plan is a soft strategy. The majority tasks should be included in the Soil and Water Conservation Plan.

The aquatic biodiversity monitoring plan is mainly consisted of five aspects, such as impacts on fish resources, riverine habitats and water quality, sediments in riverine environment, and scientific information gaps. Even there is no nationally protected fish species found in the river systems, thirteen fish species were the endemic in Nu river system and four species were identified as the conservation targets by the NAGR of lower reach of Nanting River.

However, the biological information of four conservation targets is very limited. The capacity of local fishery staff is not qualified for the regular monitoring. With the issuance of protection and management regulation of Nanting River in Lincang Prefecture, the enforcement should be enhanced in the future. The total budget is US $ 140,000, including the cost for the construction phase $ 110,000 and the cost for the operation and maintenance phase $ 30,000.

Meanwhile, the terms of reference for two short term biodiversity survey specialists are developed for implementing both monitoring plans during the construction phase. The budget for terrestrial and aquatic monitoring survey specialists should be available for the project duration of construction.

# I. Overview

1. The project covers three Chinese border cities/towns, namely Qingshuihe, Zhenkang and Cangyuan, along the China-Myanmar border in Lincang prefecture in Yunnan Province in China (**Figure 1.1 and 1.2**). The project site is a much less developed area in comparison to other parts of the country in a remote mountainous area. Most of the populations are ethnic minorities consisted of Wa, Dai, Yi, Miao, Bai, etc. This part of the China shares a long inland border with Myanmar without very obvious physical separations, and many local residents from both countries are from the same ethnic groups with similar living styles and habits, and share the similar culture, language, habits and economy. The interactions and exchanges of merchandise as well as border trades have been existed throughout the long history of the area.The Asian Development Bank (ADB) and PRC government reached agreement to use ADB loan of $250 million with the similar amount of counterpart fund from PRC local government for implementing Yunnan Lincang Border Economic Cooperation Zone (LBECZ) Development Project (P49310-002). The proposed project will support the border trade and regional cooperation development at Mengding in Gengma County as well as Cangyuan and Zhenkang County (**Figure 1.2**) and will have significant impact on the local economic development and poverty alleviation.

## A Administrative location of Lincang Prefecture

2. Lincang Municipality is a prefecture-level city located in the southwest of Yunnan province in PRC, which covers latitude 23°05′～25°02′ N and longitude 98°40′～100°33′ E. It borders with Myanmar in southwest, Puer in the east Dali in the north, and Baoshan in the west. The distance to the provincial capital of Kunming is about 598 kilometers. It is the most southwest city in China with numbers of border ports and border routes with Myanmar and a very important gateway from China to Southeast Asia and the ocean ports to India Ocean. The area under city jurisdiction is about 24,000 square kilometers and the local resident population is about 2.52 million (2016).

3. The city shares about 290 km border line with Myanmar with many border ports and border roads, including one state level Tier 1 port (Qingshuihe Port in Mengding Township), two state level Tier 2 ports (Yonghe Port in Cangyuan County and Nansan Port in Zhenkang County), and 19 border trade passageways. The Qingshuihe Port is the nearest land port for China to access Southeast Asia and Indian Ocean seaports in Southwest of China and plays very important role in the regional cooperation and integration, especially to the border cities and towns in Myanmar.

4. Under the jurisdiction of Lincang, there are seven counties and one district, including Gengma, Cangyuan, Zhenkang, Fengqing, Yongde, Yun, Shuangjiang counties and Linxiang district (**Figure 1.2**). All eight counties and district are classified as the national poverty counties with the national poverty alleviation program supports except for Gengma County.

## B Geography and climate of Lincang

5. Lincang straddles the Tropic of Cancer in the southern part of its administrative area, or prefecture. It is situated on the middle to lower reaches of the Mekong, known as the Lancang River in China, and the Salween River, or the Nu River. Bordering prefectures are Pu'er to the southeast, and Baoshan and Dali to the northwest. It also borders Burma's Shan State. Elevations within the prefecture range from 450 to 3,504 metres (1,476 to 11,496 ft).


**Figure 1. 1 Location of project sites in Yunnan Province of southwestern China (Source: PPTA report)**


**Figure 1.2 Border Ports of Zhenkang Nansan, Mengding Qingshuihe, and Cangyuan Yonghe at Lincang Prefecture of Yunan Province**

6. Lincang has a mild humid subtropical climate, with muddled distinction between the seasons and daytime temperatures remaining warm year-round. The average annual temperature is between 16.5 and 19.6 degree centigrade. The average temperature of the warmest month is between 20.6 and 24.0 degree centigrade in June, and the average temperature of the coldest months is between 10.3 and 12.5 in January. The extreme maximum temperature is 41.4 degree in Mengding Town of Gengma County, and the extreme minimum temperature is - 4.3 degree in Daxueshan of Yongde County. There is around 317～357 non-frozen days in one year. In the different altitude areas within the Lincang Prefecture, the climate, soil and vegetation community would be different as well. The temperature would drop around 0.5～0.6 degree when the elevation rise in every 100 m. The annual average sunshine time is between 1894～2262 h. There are more calm wind days throughout the year. The average wind speed is 0.7～1.8 m/s.

7. The average annual rainfall is 1485.7 mm and the annual average relative humidity is 69～81%. The rainfall from June to September accounts for nearly 70% of the annual rainfall. During the raining season, some rainfall occurs on most days, pushing relative humidity above 80% and there is a remarkable reduction in sunshine. The rainfall from November to April only accounts for 14.6%.The rainfall has a general decrease tendency from the southwest to the northeast. The amount of rainfall is affected by the warm and humid currents from the Bengal Bay.

8. There are 10 soil types, 19 subclasses, 72 soil genera and 348 species in lincang. With the influences by terrain, climate, vegetation and human activities, the soil has a regular vertical and zonal distribution characteristic. From the low altitude to high altitude, the soils are distributed as the laterite, latosol red soil, red soil, yellow soil, yellow brown soil, and subalpine meadow soil. The laterite occurs in the elevation less than 800 m, the latosol red soil between 800 ~ 1300 m, red soil between 1300 ~ 2100 m, yellow soil between 2100 ~ 2400 m, yellow brown soil between 2400 ~ 300 m, and subalpine meadow soil between 3000 ~ 3504.

## C Hydrology and River Systems of Lincang

9. There is over 1000 rivers running through Lincang Prefecture, which belong to Nu River system in the east and Lancang River system in the west (**Figure 1.3**). The areas of two river catchments account for 51.5 % and 48.5%, respectively. Except that Zhenkang County belongs to Nu River system and Shuangjiang County belongs to Lancang River system, the other five counties and Linxiang district belong to the two river systems.

10. There is seven rivers with the catchment area over 1000 $km^2$, including Luozha River, Xiaohejiang and Mengmeng River of Lancang River system, and Nanting River, Nanpeng River, Yongkang River and Nangun River of Nu River system. There are 32 rivers with the catchment area over 200 $km^2$, and 58 rivers with the catchment area over 100 km2.

11. Lancang River is an international river, and feeds into the Pacific in Shuangjiang County of Lincang Prefecture (**Figure 1.3**). The total length is 206.6 km in Lincang Prefecture, and the catchment area is 12154.6 $km^2$. The relative large tributaries of the first grade include Luozha River and Xiaoheijiang. The average annual rainfall in the catchment is 1423.8 mm. The amount of annual precipitation is 1.73 billion $m^3$, and the amount of water resources is 7.73 billion $m^3$.

12. Nu River is also an international river, and feeds into the India Sea from Myanmar (**Figure 1.3**). The total length is 42.3 km in Lincang Prefecture, and the catchment's area is 11470.8 $km^2$.

The first grade tributary is Nanting River. The second grade tributaries with a relative larger area include Nangun River (The river is different from the Nangun river providing water supply for Qingshuihe District, which is running through Cangyuan County rather than running through Gengma County), Nanpang River and Mengmeng River. The third grade tributary with a relative large area is Yongkang River. The average annual rainfall in the catchments is 1467.2 mm. The amount of annual precipitation is 1.74 billion $m^3$, and the amount of water resources is 8.79 billion $m^3$.


**Figure 1.3 River systems with the catchment area over 20 km2in Lincang Prefecture (Red characters represent the name of county or district, and blue characters represent the river name) (Source: Lincang Runting Water Resources Scientific Services Ltd. Co., LRWRSLC)**[1]

13. According to the Lincang Water Function Zonation (LWFZ) (2016), the total number of

[1] Lincang Runting Water Resources Scientific Services Ltd. Co. is responsible for developing the water resources assessment reports for Water Intake Sub-Project from Nangun River, and two bridges across Qingshui River, respectively.

water function zones of the first grade in Lincang Prefecture is 213 zones, including 106 zones in Lancang River catchments and 107 in Nu River catchments. A total of 82 water function zones of the second grade is also allocated, including 47 zones in Lancang River catchments and 35 in Nu River catchments. For the first grade water function zone, water protection area, remaining area, and development and utilization area are classified based on the water capacity, water quality and water demands. For the second grade, the drinking water demand is only allocated one zone in Lancang River catchments. It is divided into the other four uses: ecological and landscape water demand, industry water demand, agriculture water demand, and the transition water resources.

14. In the LWFZ, the Nangun River is the unique water resources for replenishing the water for the proposed Qingshuihe Border Area. Nangun River is the first grade tributary of Nanting River. It was assigned as the water resources protection area from the waterhead to the proposed Yunjing Reservoir (**Figure 1.4**). For the downreach, it was allocated as the development and utilization zone for agriculture and industry. Nanting River is the largest river in this region (98°41′～100°14′E，23°18′～24°20′N), which originates from Boshang Town of Linxiang District, runs through Yun, Yongde, Zhenkang and Gengma Counties, and feeds into Myanmar connecting with the Nu River (**Figure 1.3**). The total length is 273 km and its catchment area is 8208 km$^2$ in Lincang Prefecture. Nanting River is the largest and first grade tributary in the left bank of Nu River. It is about 20 km down from Qingshuihe Border Area reaching Gunnong Bridge and connecting with Nu River.


**Figure 1.4 Location of proposed water supply site for Qingshuihe Border Area along Nangun River within the Nanting River Catchment (Source: Lincang Runting Water Resources Scientific Services Ltd. Co., LRWRSLC)**

15. Qingshui River is the closest river to the Qingshuihe Border Area (**Figure 1.4**). With the limits of water capacity and quality, it was allocated as the development and utilization zone from the upper Gandifangba Reservoir to the conjunction with Nanting River in the LWFZ. Nanpeng River is the largest and first grade tributary in the right bank of Nanting River, which provides approximately 38% water for Nanting River. The total length is 114 km and its catchment area reaches 2997 $km^2$. The water quality is IV grade according to the water quality monitoring by Lincang Prefecture Water Environment Monitoring and Analyses Center in 2013, even one National Aquatic Germplasm Reserve was established in 2007. The main contaminants come from the waste water from the surrounding cities and towns, and the operation of mineral industries.

## D Biological Resources of Lincang

16. According to the data from Lincang Prefecture Forestry Bureau, the area of forests is 1405 thousand hectares, accounting for 59.31% of the area of land territory. In addition to 197 thousand hectares of timber land in agriculture fields, the coverage reaches 67.8% to the total area of land territory. Of them, the area of non-commercial forest (NCF) is 475 thousand hectares (33.8 % of the total area of forests), including 348.9 thousand hectares of national level, 120.6 of provincial level and 5.12 hectares of county level.

17. The wildlife resources are abundant in Lincang. It is one of the most biologically diverse regions in China. The main vegetation communities include: tropical rain forest, tropical monsoon rain forest, evergreen broad-leaved forest, evergreen broadleaf mixed forest, evergreen broadleaf deciduous mixed forest, warm thermal coniferous forest, Yunnan hemlock forest and other vegetation types. A total of more than 4200 kinds of advanced plants (bryophyte, fern, and seed plants) is recorded. Of them, 32 plant species are included in the national protected wild fauna list.*Taxus yunnanensis*, *Alcimandra cathcardii*, *Cycas balansae*, and *Eleutharrhena macrocarpa* are the Grade I of national protected wild fauna. 28 wild plants are the Grade II, such as *Cibotium barometz* and *Alsophila spinulosa*.

18. There are more than 740 species of wild animals recorded within the scope of Lincang Prefecture, including 121 species of mammals, 413 species of birds, 55 species of reptiles, 35 species of amphibians and 85 species of fishes. Among them, 100 species are included in the national protected wild animal list. 21 wild animals are listed as the Grade I of national protected animals, such as Indochinese tiger, Asian elephant, Black gibbons, Green peacock, and 74 wild animals are listed as the Grade II, such as Macaques, Sambar and Silver pheasant. In addition, five animal species are included in the provincial protected animal list, such as Tufted deer, Wolf and so on.

19. According to the Scientific Survey Report of Nangun River National Nature Reserve (**NNR**) (2015), a total of 6 orders, 10 families, 30 genus and 45 fish species were recorded. There is no fish species under the national protected fishes list, China RedList of endangered animals, and the list of CITES appendix. Only *Anguilla nebulosa* is under the protected fish of Yunnan Province. Large economic fishes are scare, which only include *Anguilla nebulosa* and *Bagarius yarrelli*. B. *yarrelli* was recently recorded in 2003. A. *nebulosa* is an occasional species in the reserve, which mainly distributed in the main stream and tributaries of the lower reach of Nu River. This fish has the migratory habit from India Sea. There are many small and medium economic fishes, including *Neolissochilus baoshanensis*, *Scaphiodonichthys acanthopterus*, *Clarias fuscus*, *Monopterus albus*,

*Channa gachua* and *Mastacembelus armatus*. Meanwhile, four alien fish species are discovered including *Pseudorasbora parva*, *Abbottina rivularis*, *Rhodeus ocellatus* and *Gambusia affinis*, which had the negative impact on the native fish species.

20. According to Comprehensive Planning Report of National Aquatic Germplasm Reserve (**NAGR**) in the lower reach of Nanting River (2013-2033), a total of 5 orders, 9 families and 48 fish species were recorded. The main conservation targets include *Neolissochilus baoshanensis*, *Bagarius yarrelli*, *Anguilla nebulosa* and *Balitora nantingensis*. The fish composition is quite similar with that in Lancang River. The dominant fish species belong to Siluriforms, Cobitidae and Barbinae. The majority of fishes in Nanting River are adapted to the torrent, which are benthic and omnivorous fishes with except for *Channa gachua*, *Bagarius yarrelli* and *Anguilla nebulosa*.

## E Project Components

21. The project will build new border port facilities to improve the cross border trade capacity including the import and export goods handling facilities and border resident trade market, border port access roads and urban infrastructures, build new municipal service facilities to improve living condition and environment in the border town, and build new hospitals and elementary schools to improve the social service for the border area. The proposed project will have four outputs:

22. **Output 1:** Cross border trade capacity improved. This project component includes: (i) construction of a border resident trading market of 213,628.7 $m^2$; (ii) construction of an international production cooperation area of 355,266.7 $m^2$; (iii) construction of 6 urban roads witha total length of 5070.37 m; (iv) build a new bridge of 350 meters connecting two border areas.

23. **Output 2:** Integrated urban environment infrastructures in Qingshuihe border areas improved. The component includes (i) Qingshuihe water supply system of 21,000 t/d capacity, 32 km water supply pipes and 28.1 km water distribution network; (ii) Qingshuihe wastewater treatment plant of 23,000 t/d capacity and 7.26 km piping network; (iii) solid waste management system in Mengding and Qingshuihe; (iv) Qingshui River rehabilitation of 3.43 km and Nanpa River rehabilitation of 1 km; (v) 2 stations with electric charging posts and purchase of 6 new energy public transportation buses.

24. **Output 3:** Social infrastructure and services improved. This component includes (i) construction of a new Cangyuan Guomen No. 2 Elementary School with a total capacity of 1080 students in Cangyuan; (ii) construction of new Zhenkang Sino-Myanmar Friendship Hospital of 500 inpatient beds in Zhenkang; (iii) construction of Qingshuihe Hospital of 100 bed capacity in Qingshuihe; and (iv) upgrade of Qingshuihe Guomen Elementary School with new student dormitory and cafeteria of 7,691 $m^2$.

25. **Output 4:** Institutional capacity of involved agencies improved. This component include project implementation management and support, training and study tours, and technical assistance on financial management, trade and logistics improvement, teacher training, healthcare service and hospital management, etc.

26. In general, the major project components are located at Qingshuihe Border Area, with except

of Zhengkang Sino-Myanmar Hospital locating at Nansan Border Area and Cangyuan Guomen No. 2 Elemenatary School locating at Yonghe Border Area (**Figure 1.2**).

# II. Surrounding Protected Areas

## A Non-commercial Forests

27. The national non-commercial forest (NCF) is only distributed in the project area of LBECZ in Qingshuihe Border Area (**Figure 2.1**). The Zhengkang Sino-Myanmar Hospital is located in the grassland with partial farmland, and Cangyuan Guomen No. 2 Elemenatary School is located in the waste land of Baitai community of Cangyuan County.

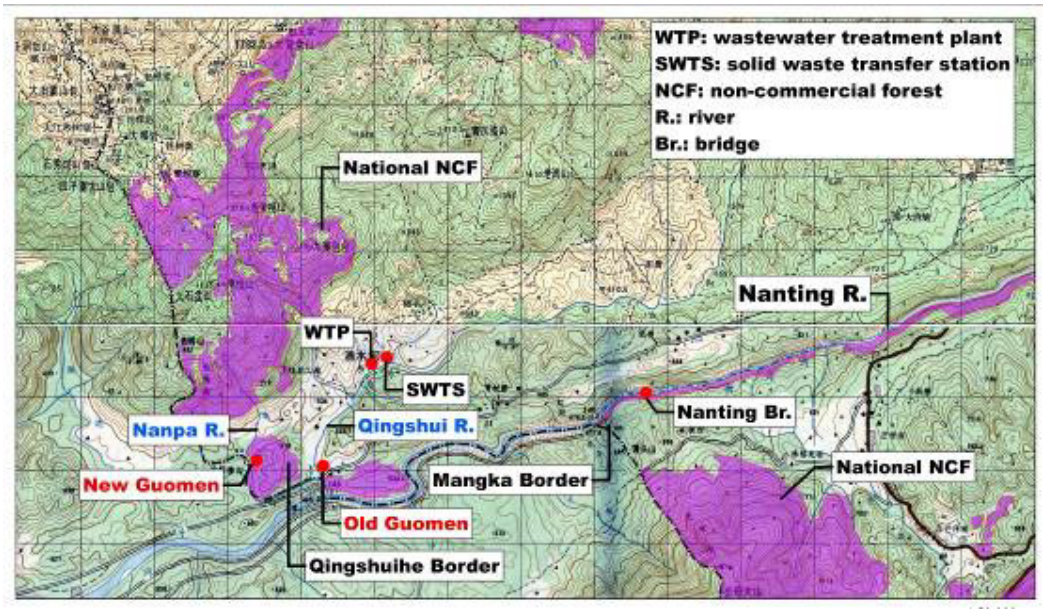



**Figure 2.1 Distribution of national non-commercial forests in Qingshuihe Border Area (Source: Lincang Forestry Bureau)**

28. In Qingshuihe Border Area, the national non-commercial forests mainly distribute in the area of New Guomen, and both banks of Nanting River (**Figure 2.2**). The proposed roads closed to the New Guomen would occupy the part of national NCF, which is mainly composed of the rubber plantation. The proposed Nanting Bridge also occupies the part of national NCF, which is mainly composed of the rubber plantation and teak (*Tectona grandis*) plantation.

**Figure 2.2 Rubber plantation and teak plantation in the project area of Qingshuihe Border Area**

29. National NCF refers to the protection forests and special use forests with extremely importance of ecological niches or extremely fragility of ecological status, playing an important role in the land ecological security, biodiversity protection, and sustainable economic and social development. The forest management aims to generate the forest ecological and social service function. **However, the NCF here is not the natural forest, which provides the low conservation values for biodiversity protection.**

30. According to the National Non-commercial Forest Management Regulation (2017), any NCFs should be strictly controlled the use for exploration, mining and construction. That stipulates the approval procedures of rubber cutting of NCF in LBECZ should follow with this regulation, which is different from the tree cutting of economic forest. The PMO has coordinated with the Lincang Forestry Bureau, and authorized the intermediary agency to develop relevant document supporting the domestic approval of FSRs.

## B Protection Areas

31. A total of six protection areas were established in Lincang Prefecture, such as Nangun River NNR, Daxueshan NNR, NAGR in lower reach of Nanting RIver, NAGR in Nanpeng River, Nanpeng River Provincial Nature Reserve (PNR) and Lancang River PNR. The proposed project area is out of these protected areas (**Figure 2.3**). The Lancang River PNR is located in the east of Lincang Prefecture, which is presented in a general direction together with Nanpeng PNR, Nangun River NNR and Daxueshan NNR in **Figure 2.4**. The basic information and spatial relationship of proposed project areas are concluded in **table 2.1**. All of these reserves are located outside 6 kilometers radius from each sub-project site.

32. Nangun River NNR was established in 1995 and expanded in 2003, which covers 27,649.5 ha in Cangyuan County and 23,237.5 in Gengma County. The total area is 50,887 hectares, including 19,923 ha core zone, 17,335.1 ha buffer zone and 13,628.9 ha experimental zone. The reserve is the second largest distribution range of Asian elephant (*Elephas maximus*) and Indochinese tiger (*Panthera tigris* ) in China after Xishuangbannan of Yunnan Province. There are 11 orders, 20 families, 87 genus and 111 mammal species, and 14 order, 36 families and 147 bird species.

33. Daxueshan NNR was established in 2006, which is located in the eastern Yongde County. The total area is 17,541 ha, including 9,276 ha core zone, 3,291 buffer zone and 4,974 ha experimental zone. The main conservation objectives include south Asian tropical mountain ecosystem represented by zhongshan moist evergreen broad-leaved forest, and 64 rare and endemic plant and animal species represented by Hog deer (*Axis porcinus*), Black gibbons (*Nomascus concolor*) (western yunnan subspecies), green peacock (*Pavo muticus*), Chinese yew (*Taxus yunnanensis*), *Alcimandra cathcartii*, etc.

34. NAGR of *Barbodes huangchuchieni* of Nanpeng River was established in 2007, which is located in Zhenkang County. The total area is 750 hectares, including 350 ha core zone and 400 ha experimental zone. Special protection period in core zone is from February 1 to next July 31, in order to protect the copulation and spawn stage of *Barbodes huangchuchieni*. The total length is 30 km including 14 km core zone and 16 km experimental zone. The main conservation objectives include *Barbodes huangchuchieni, Bagarius yarrelli*, *Mastacembelus armatus*, *Anguilla nebulosa*,

Eurasian River otter (*Lutra lutra*).

35. NAGR in the lower reach of Nanting River was established in 2013, which is located in Yongde and Gengma Counties. The total length is 150 km including the main stream and tributaries of Nanting River. The total area is 2200 hectares, including 1200 ha core zone and 1000 ha experimental zone. Special protection period is from March 1 to May 30. The main conservation objectives include *Neolissochilus baoshanensis*, *Bagarius yarrelli*, *Anguilla nebulosa* and *Balitora nantingensis*. The proposed Nanting Bridge will be constructed in the down reach of the reserve approximately 6.8 kilometer (**Figure 2.3**).

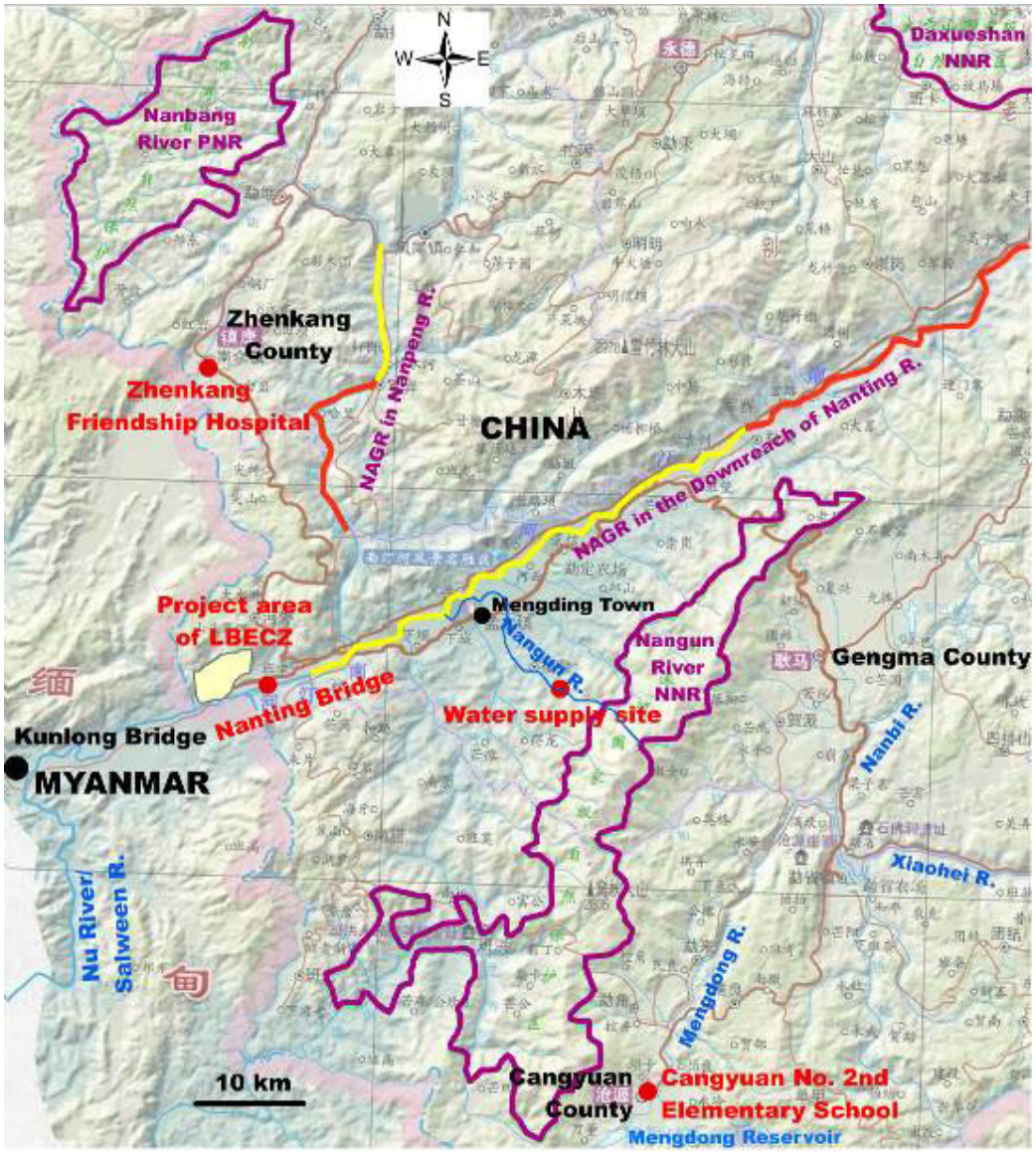



**Figure 2.3 Locations of proposed project areas (red characters) and surrounding protection areas (purple characters and polygons) (Source: NAGR in lower reach of Nanting River)**

36. Nanpeng River PNR was established in 1999, which is located in Zhenkang and Yongde Counties. This is a forest ecological type reserve in China. It aims to protect sub-tropical monsoon evergreen broadleaf forest, sub-mountain damp evergreen broadleaf forest, and rare and

endangered wildlife. The reserve is consisted of four sections: Zhuwa, Mangbinghouqing, Bodaoshan and Xuezhulin Mountain. 42 animal species and 42 plant species are included in the national protection list. 13 plant species belong to the provincial protection list. A total of 1546 species of wild seed plants were recorded, belonging to 660 genera of 155 families. In the reserve, 3 families are endemic to East Asia, and 6 genera and 451 species are endemic to China. The endemic plant species are higher than the other provincial and national nature reserves in this region, such as Nangun River NNR (Zhang et al., 2010).

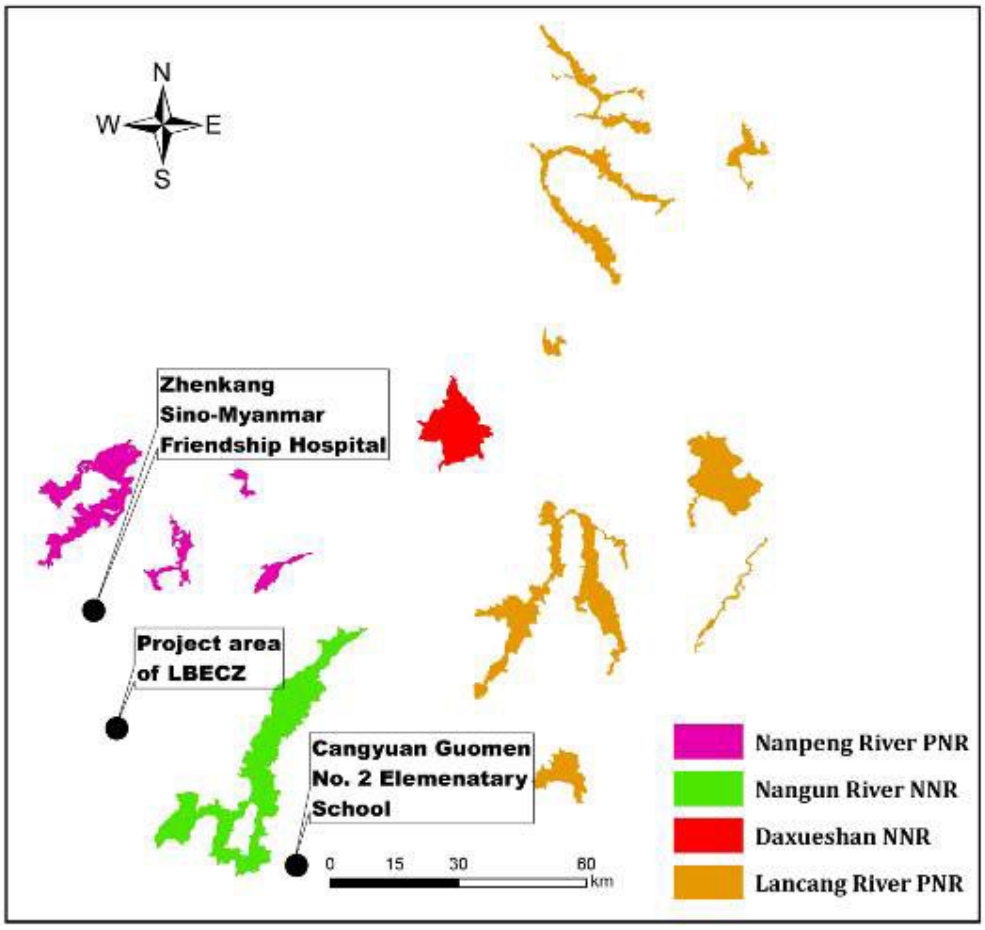



**Figure 2.4 Spatial distribution of Nanpeng River PNR, Nangun River NNR, Daxueshan NNR and Lancang River PNR, and the project areas of LBECZ, Zhenkang hospital and Cangyuan elementary school (Source: Lincang Forestry Bureau)**

37. Lancang River PNR was established in 1999, which was combined from 5 nature reserves at county/district level including Linxiang District, Fengqing County, Yun County, Shuangjiang County and Gengma County. The total area is 89,504 hectares. It is a forest ecological type reserve in China. There is 136 families, 428 genus and 1051 seed plant species, and 39 orders, 123 families and 742 vertebrate species. The main purpose is to conserve the evergreen broad-leaved forest and the monsoon evergreen broad-leaved forest ecosystems, rare and endangered wildlife such as West Black gibbons (Nomascus concolor) and *Alcimandra cathcartii*, and the wild ancient tea tree community.

**Table 2.1 Basic information of six Protection Areas in Lincang Prefecture**

| Name | Coordinates | Area (ha) | Conservation objectives | Nearest project name | Direct distance (km) |
|---|---|---|---|---|---|
| Nanguan River NNR | 98°57′32″～99°26′00″E，23°09′12″～23°40′08″N | 50,887 | Rare and endangered wildlife, and their habitats | Water supply location for Qingshui Border Area; Cangyuan Guomeng No. 2 Elementary School | 7.4km；7km |
| Daxueshan NNR | 99°41′12″～98°56′51″E，24°0′59″～23°30′41″N | 17,541 | South Asian tropical mountain ecosystem, and rare and endangered wildlife | Project area in Qingshuihe Border Area | >100 km |
| NAGR of Nanpeng River | 98°55′41″～98°59′26″E, 23°37′53″～23°51′47″N | 750 | *Barbodes huangchuchieni, Bagarius yarrelli*, *Mastacembelus armatus* , *Anguilla nebulosa*, Eurasian River otter, etc. | Banxing Tunnel; Nanting River stream | 15km; 8.5km |
| NAGR in the lower reach of Nanting River | 99°41′12″～98°56′51″E，24°0′59″～23°30′41″N | 2,200 | *Neolissochilus baoshanensis*, *Bagarius yarrelli*, *Anguilla nebulosa* and *Balitora nantingensis* | Nanting Bridge | 6.8 km |
| Nanpeng River PNR | 98°41′～99°18′E, 23°45′～24°04′N | 36,970 | Sub-tropical monsoon evergreen broadleaf forest, sub-mountain damp evergreen broadleaf forest, and rare and endangered wildlife | Zhenkang Sino-Myanmar Friendship Hospital | 20km |
| Lancang River PNR | 99°35′15″ ～ 100°09′30″E，23°11′58″～23°48′50″N | 89,504 | The evergreen broad-leaved forest and the monsoon evergreen broad-leaved forest ecosystems, rare and endangered wildlife such as West Black gibbons (Nomascus concolor) and *Alcimandra cathcartii*, and the wild ancient tea tree community. | Cangyuan Guomeng No. 2 Elementary School | > 40km |

# III. Ecological Resources in Project Sites

38. **Approach**. The baseline studies have been based on the collection and review of available data and maps, interviews of local stakeholders (namelist as the Appendix A), and field studies to observe habitats, flora and fauna in project sites. The field work was conducted four times, in December 2017, January, March and April 2018.

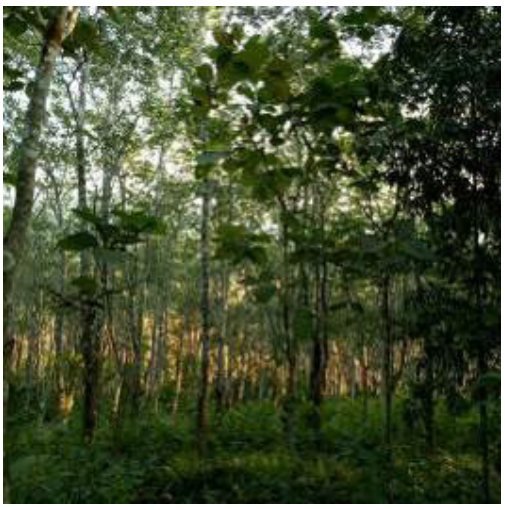
## A Flora

39. There is no plant species under the national and provincial key protected plants in the project sites.

### a Arbor species

40. The arbors mainly include *Hevea brasiliensis*, *Artocarpus heterophyllus*, *Tectona grandis*, *Ficus altissima*, *Ficus microcarpa*, *Ficus auriculata*, *Ailanthus altissima* and *Alstonia scholaris* etc.

*Artocarpus heterophyllus*



*Tectona grandis*

*Ficus altissima*

*Ficus microcarpa*

*Ficus auriculata*

*Alstonia scholaris*

*Ailanthus altissima*

*Hevea brasiliensis*

**b Textile plants**

41. Textile plants include *Boehmeris macrophylla*, *Broussonetia kazinoki*, *Thysanolaena maxima*, *Abelmoschus manihot* and so on.

**c Herbaceous plants**

42. Herbaceous plants include *Digitaria sanguinalis*, *Cynodon doctylon*, *Zoysia japonica*, *Microstegium vegans*, *Panicum notatum*, *Filipendula palmata*, *Paspalum conjugatum* and *Lonicera japonica* etc.

**d Ferns**

43. Including *Pteris nervosa*, *Matteuccia struthiopteris*, *Acrostichum aureum*, *Cyclosorus parasiticus* and so on.

**e Bryophyte**

44. Bryophyte include aquatic communities such as *Plagiomnium* spp. and *Thuidium* spp., Geophytia such as *Taxiphyllum* spp. and *Brachythecium* spp., Epixylophytia such as *Bazzania* spp.,

*Leucobryum* spp., and *Barbella* spp. and so on.

**f Medical plants**

45. *Artificial medical plant*. *Amomum villosum* is wildly planted under the rubber plantation in the project sites.

46. Wild medical herbaceous plants: *Arthraxon hispidus*, *Pleione yunnanensis*, *Ageratum conyzoides*, *Clerodendrum bungei* and *Tithonia diversifolia* etc. Medical arbor plants. *Bothrocaryum controversum* and *Alstonia scholaris*.

*Amomum villosum*

*Arthraxon hispidus*

*Pleione yunnanensis*

*Ageratum conyzoides*

*Clerodendrum bungei*

*Tithonia diversifolia*

**g Exotic invasive plant**

47. *Eupatorium odoratum* originates in Central America, which was imported in Thailand in

1920 as a spiceberry species. This was found in the south of Yunnan Province in 1934. Its reproduction capacity is very strong. The plant is recognized as a globally invasive plant with high competition.

*Eupatorium odoratum*

*Eupatorium odoratum*

## B Typical Vegetation Assemblages

48. Five vegetation assemblages were found in the project sites, including timberland, shrubland, grassland, farmland including garden land, and the wetland vegetation.

### a Timberland

49. Only two artificial forests were found in the project site of LBECZ: rubber (*Hevea brasiliensis) plantation* and *teak (Tectona grandis) plantation*. The former forest includes plantation of *Artocarpus heterophyllus*, *Coffea Arabica*, *Musa nana*, and *Amomum villosum and so* on. The herbaceous plants include *Eupatorium odoratum*, *Cyclosorus parasiticus*, *Cyrtococcum patens*, *Paspalum conjugatum*, *Pueraria lobata* and *Ageratum conyzoides* and so on.

50. *Tectona grandis* plantations only distribute in two small areas: one is located in the left bank of Qingshui River with the area less than 200 $m^2$, and the other one is located in the right hill of proposed Nanting Bridge.

*Hevea brasiliensis* plantation

*Tectona grandis* plantation

51. Natural *Dendrocalamus semiscandens* forest. This bamboo forests mainly distribute in the slope foots and valleys of hills, and the riverside areas, which generally present small patches or bands of sporadic distribution.

### b Shrubland

52. The shrubland is mainly divided into the two communities: *Psilopeganum sinense* shrubland and *Homonoia riparia* shrubland. Both of them are mainly distributed in the open areas of valley, forest edge, and river banks.

53. The *Psilopeganum sinense* shrubland has the auxiliary plant species such as *Bauhinia variegate* and *Bischofia polycarpa*, and the herbaceous plant species such as *Microstegium vegans*, *Tithonia diversifolia* and *Eupatoyium odoratum*.

54. The *Homonoia riparia* shrubland is mainly distributed along the river bank. It has the auxiliary plant species such as *Litsea lancifolia*, *Ficus pyriformis* and *Flemingia fluminalis*, and the herbaceous plant species such as *Hippochaete romosissimum*, *Saccharum spontaueum* and *Brainia insignis*.

### c Grassland

55. The grassland presents as a small patch, which is not a typical habitat in project sites. It mainly distributes in the low slops and valleys. Two grassland communities were found: *Microstegium vegans* and *M. vimineum* community, and *Eupatoyium odoratum* community.

56. The *Microstegium vegans* and *M. vimineum* community is mainly consisted of *Thysanolaena maxima* and *Pogonatherum crinitum*, and the few shrub species such as *Rhus chinensis*, *R. corchorifolius*, and *Ficus cyrtophylla*.

57. The *Eupatoyium odoratum* community is mainly consisted of *Thysanolaena maxima*, *Imperata cylindrical*, *Hedyotis hirta* and *Ageratum conyzoides*, and the shrub species such as Rhus chinensis, *Trema tomentosa* and *Vernonia volkameriaefolia*.

### d Farmland including garden land

58. Farmland only distributed in project site of proposed Zhenkang Sino-Myanmar Friendship Hospital, which mainly plants the sugar cane (*Saccharum officinarum*). The garden land mainly distributed along the Qingshui River, and the slope foots and valleys. The plant species include the common fruits and vegetables, such as pepper, kidney bean, soybean and tomato and so on.

### e Wetland vegetation

59. Wetland vegetation is found in rivers, mostly in small areas. The main communities were *Alternanthera sessilis*, *Polygonum hydropiper*, *Arundo donax*, *Arthraxon Beauv*, and *Paspalum longifolium* community.

## C Terrestrial Fauna

60. 129 terrestrial fauna species were identified in the project sites. The number of nationally protected animals is related small given the extensive human occupation. These comprise two bird species, one amphibian and two reptiles. Five of these species are Common buzzard (*Buteo buteo*), Great coucal (*Centropus sinensis*), Tiger frog (*Hoplobatrachus rugulosus*), Asian water monitor (*Varanus salvator*), and Tokay gecko (*Gekko gecko*). Only the Asian water monitor is the Grade I of national protection animals. The others are the Grade II.

### a Birds

61. Some 10 orders, 24 families and 111 bird species are believed to exist in the project sites (**Table 3.1**). According to the residential types, 84 species are residential birds, 18 winters, 6 summers and 3 migratory birds. According to the functional guilds, 85 birds are insectivores, 11 species are carnivores, 10 species are frugivores and 5 species are granivores. 30 bird species and 9 species are under the list of Sino-Japan, and Sino-Australia bilateral conservation agreement on migratory birds and their habitats, respectively.

62. The general bird species include Great Tit, Yellow-cheeked Tit, Tree Sparrow, White-rumped Munia, Chestnut-vented Nuthatch, Common Magpie, Burmese Shrike, Long-tailed Shrike, Rusty-cheeked Scimitar Babbler, Rufous-necked Scimitar Babbler, White-browed Laughing thrush, Rusty-capped Fulvetta, Grey-cheeked Fulvetta, Common Tailorbird, Franklin's Prinia, Common Tailorbird, Franklin's Prinia, Grey-headed Canary Flycatcher, White-throated Fantail and Yellow-bellied Fantail.

63. All of these birds are not recognized as critically endangered, endangered, vulnerable and near threatened categories of IUCN RedList. Only two bird species are under the national protection list: Common buzzard (*Buteo buteo*) and Great coucal (*Centropus sinensis*). The former one is also listed in appendix II of CITES, and the latter is recognized as the vulnerable species in China RedList.

**Table 3.1 The bird species list in the project sites of LBECZ of Yunnan Province**

| Number | Scientific name | NPL | SJ | SA | CITES | Residential type | Functional guild | IUCN-RedList |
|---|---|---|---|---|---|---|---|---|
| 1 | *Butorides striatus* | | √ | | | R | C | - |
| 2 | *Bubulcus ibis* | | √ | √ | III | R | I | - |
| 3 | *Egretta garzetta* | | | | III | R | I | - |
| 4 | *Nycticorax nycticorax* | | √ | | | S | C | - |
| 5 | *Tadorna ferruginea* | | √ | | | W | C | - |
| 6 | *Anas crecca* | | √ | | III | W | F | - |
| 7 | *Buteo buteo* | II | √ | | II | W | C | - |
| 8 | *Francolinus pintadeanus* | | | | | R | I | - |
| 9 | *Phasianus colchicus* | | | | | R | F | - |
| 10 | *Streptopelia orientalis* | | √ | | | R | G | - |
| 11 | *Streptopelia chinensis* | | | | | R | G | - |
| 12 | *Oenopopelia tranquebarica* | | | | | R | G | - |
| 13 | *Cuculus micropterus* | | | | | R | I | - |
| 14 | *Cuculus merulinus* | | | | | S | I | - |
| 15 | *Centropus sinensis* | II | | | | R | C | - |
| 16 | *Hirundapus caudacutus* | | √ | √ | | R | I | - |
| 17 | *Apus pacificus* | | √ | √ | | S | I | - |
| 18 | *Apus affinis* | | √ | | | R | I | - |
| 19 | *Alcedo atthis* | | √ | | | R | I | - |
| 20 | *Halcyon smyrnensis* | | | | | R | I | - |
| 21 | *Megalaima virens* | | | | | R | I | - |
| 22 | *Megalaima franklinii* | | | | | R | I | - |

| Number | Scientific name | NPL | SJ | SA | CITES | Residential type | Functional guild | IUCN-RedList |
|---|---|---|---|---|---|---|---|---|
| 23 | *Megalaima asiatica* | | | | | R | I | - |
| 24 | *Picumnus innominatus* | | | | | R | I | - |
| 25 | *Picoides major* | | | | | R | I | - |
| 26 | *Picoides canicapillus* | | | | | R | I | - |
| 27 | *Blythipicus pyrrhotis* | | | | | R | I | - |
| 28 | *Hirundo rustica* | | √ | √ | | R | I | - |
| 29 | *Hirundo daurica* | | √ | | | R | I | - |
| 30 | *Hirundo striolata* | | | √ | | R | I | - |
| 31 | *Motacilla flava* | | √ | √ | | W | I | - |
| 32 | *Motacilla cinerea* | | | √ | | W | I | - |
| 33 | *Motacilla alba* | | √ | √ | | R | I | - |
| 34 | *Anthus trivialis* | | | | | R | I | - |
| 35 | *Anthus roseatus* | | | | | R | I | - |
| 36 | *Pericrocotus divaricatus* | | √ | | | W | I | - |
| 37 | *Pericrocotus ethologus* | | | | | R | I | - |
| 38 | *Pericrocotus brevirostris* | | | | | S | I | - |
| 39 | *Pericrocotus flammeus* | | | | | R | I | - |
| 40 | *Pycnonotus jocosus* | | | | | R | F | - |
| 41 | *Pycnonotus xanthorrhous* | | | | | R | F | - |
| 42 | *Pycnonotus cafer* | | | | | R | F | - |
| 43 | *Pycnonotus aurigaster* | | | | | R | F | - |
| 44 | *Hypsipetes mcclellandii* | | | | | R | F | - |
| 45 | *Hypsipetes madagascariensis* | | | | | R | F | - |
| 46 | *Lanius cristatus* | | √ | | | W | I | - |
| 47 | *Lanius collurioides* | | | | | R | I | - |
| 48 | *Lanius schach* | | | | | R | I | - |
| 49 | *Lanius tephronotus* | | | | | R | I | - |
| 50 | *Oriolus chinensis* | | √ | | | R | I | - |
| 51 | *Dicrurus macrocercus* | | | | | R | I | - |
| 52 | *Dicrurus leucophaeus* | | | | | S | I | - |
| 53 | *Urocissa erythrorhyncha* | | | | | R | G | - |
| 54 | *Pica pica* | | | | | R | F | - |
| 55 | *Dendrocitta formosae* | | | | | R | F | - |
| 56 | *Corvus splendens* | | | | | R | I | - |
| 57 | *Corvus macrorhynchos* | | | | | R | I | - |
| 58 | *Corvus corone* | | | | | W | I | - |
| 59 | *Luscinia calliope* | | √ | | | W | I | - |
| 60 | *Luscinia svecica* | | | | | W | I | - |
| 61 | *Luscinia cyane* | | √ | | | M | I | - |
| 62 | *Tarsiger cyanurus* | | √ | | | W | I | - |
| 63 | *Copsychus saularis* | | | | | R | I | - |
| 64 | *Phoenicurus frontalis* | | | | | R | I | - |

| Number | Scientific name | NPL | SJ | SA | CITES | Residential type | Functional guild | IUCN-RedList |
|---|---|---|---|---|---|---|---|---|
| 65 | *Phoenicurus auroreus* | √ | | | | W | I | - |
| 66 | *Rhyacornis fuliginosus* | | | | | R | I | - |
| 67 | *Pomatorhinus erythrocnemis* | | | | | R | I | - |
| 68 | *Pomatorhinus ruficollis* | | | | | R | I | - |
| 69 | *Garrulax sannio* | | | | | R | I | - |
| 70 | *Alcippe dubia* | | | | | R | I | - |
| 71 | *Alcippe morrisonia* | | | | | R | I | - |
| 72 | *Tesia castaneocoronata* | | | | | R | I | - |
| 73 | *Cettia fortipes* | | | | | R | I | - |
| 74 | *Cettia robustipes* | | | | | R | I | - |
| 75 | *Phylloscopus affinis* | | | | | W | I | - |
| 76 | *Phylloscopus fuscatus* | | | | | W | I | - |
| 77 | *Phylloscopus pulcher* | | | | | R | I | - |
| 78 | *Phylloscopus inornatus* | √ | | | | M | I | - |
| 79 | *Phylloscopus proregulus* | √ | | | | W | I | - |
| 80 | *Phylloscopus borealis* | √ | √ | | | W | I | - |
| 81 | *Phylloscopus reguloides* | | | | | R | I | - |
| 82 | *Seicercus castaniceps* | | | | | R | I | - |
| 83 | *Seicercus burkii* | | | | | R | I | - |
| 84 | *Seicercus xanthoschistos* | | | | | R | I | - |
| 85 | *Abroscopus superciliaris* | | | | | R | I | - |
| 86 | *Abroscopus schisticeps* | | | | | R | I | - |
| 87 | *Orthotomus sutorius* | | | | | R | I | - |
| 88 | *Prinia hodgsonii* | | | | | R | I | - |
| 89 | *Prinia rufescens* | | | | | R | I | - |
| 90 | *Prinia polychroa* | | | | | R | I | - |
| 91 | *Prinia atrogularis* | | | | | R | I | - |
| 92 | *Ficedula parva* | √ | | | | M | I | - |
| 93 | *Ficedula strophiata* | | | | | S | I | - |
| 94 | *Muscicapa thalassina* | | | | | R | I | - |
| 95 | *Culicicapa ceylonensis* | | | | | R | I | - |
| 96 | *Rhipidura albicollis* | | | | | R | I | - |
| 97 | *Rhipidura hypoxantha* | | | | | R | I | - |
| 98 | *Parus major* | | | | | R | I | - |
| 99 | *Parus spilonotus* | | | | | R | I | - |
| 100 | *Aegithalos caudatus* | | | | | R | I | - |
| 101 | *Aegithalos iouschistos* | | | | | R | I | - |
| 102 | *Sitta nagaensis* | | | | | R | I | - |
| 103 | *Zosterops japonica* | √ | | | | R | I | - |
| 104 | *Zosterops palpebrosa* | | | | | R | I | - |
| 105 | *Passer montanus* | | | | | R | G | - |
| 106 | *Lonchura striata* | | | | | R | G | - |

| Number | Scientific name | NPL | SJ | SA | CITES | Residential type | Functional guild | IUCN-RedList |
|---|---|---|---|---|---|---|---|---|
| 107 | *Lonchura punctulata* | | | | | R | G | - |
| 108 | *Carduelis ambigua* | | | | | R | G | - |
| 109 | *Carpodacus erythrinus* | √ | | | | R | G | - |
| 110 | *Emberiza spodocephala* | √ | | | | W | G | - |
| 111 | *Emberiza pusilla* | √ | | | | W | G | - |

NPL: national protection list, SJ: Sino-Japan bilateral conservation agreement on migratory birds and their habitats, SA: Sino-Australia bilateral conservation agreement on migratory birds and their habitats.

Residential type: S = summers, W = winters, M = migratory birds, R = resident birds

Functional guild: I= insectivore; F = frugivore; G =granivore; C =carnivore.

### b Mammals

64. The mammal list was concluded from the interviews with the local managers. Six general mammal species of 3 orders and 4 families were identified in the project sites: *Mus musculus*, *Apodemus draco*, *Callosciurus erythraeus*, *Mustela sibirica*, *Arctonyx collaris*, *Scotophilus kuhlii*, and *Pipistrellus abramus* (**Table 3.2**). These six mammals are not included in the threatened category by IUCN RedList.

65. Only *Arctonyx collaris* is recognized as the vulnerable species by China RedList, which is a omnivore animal and widely distributes across the whole China. The *Scotophilus kuhlii* and *Pipistrellus abramus* are common small bats in east Asia, even they were not observed during the scientific survey period of Nangun River NNR.

**Table 3.2 The mammal list in the project sites of LBECZ of Yunnan Province**

| Scientific name | China RedList | NPL | Sources | IUCN-RedList |
|---|---|---|---|---|
| **CHIROPTERA** | | | | |
| **Vespertilionidae** | | | | |
| *Scotophilus kuhlii* | LC | - | L | _ |
| *Pipistrellus abramus* | LC | - | L | _ |
| **CARNIVORA** | | | | |
| **Mustelidae** | | | | |
| *Mustela sibirica* | NT | - | O | _ |
| *Arctonyx collaris* | VU | - | O | _ |
| **RODENTIA** | | | | |
| **Muridae** | | | | |
| *Mus musculus* | | - | O | _ |
| *Apodemus draco* | LC | - | O | _ |
| **Sciuridae** | | | | |
| *Callosciurus erythraeus* | LC | - | O | - |

Sources: L = literatures, O = observed during the scientific survey period of Nangun River NNR.

### c Amphibian and Reptiles

66. Twelve amphibian and reptile species of 10 families were identified in the project sites. Of them, three species are the nationally protected animals including Asian water monitor of Grade I,

and Tiger frog and Tokay gecko of Grade II.

67. For amphibian, 3 families and 5 species were identified (**Table 3.3**), such as *Hoplobatrachus rugulosus*, *Occidozyga martensii*, *Fejervarya limnocharis*, *Microhyla heymonsi* and *Polypedates leucomystax*. All of them generally distribute in the low hilly land, valleys, ponds, riverside and rice fields.

68. The *Hoplobatrachus rugulosus* is the Grade II of the national protected animals, which widely distributes in Middle and South China. It is an endemic species in China and also recognized as the vulnerable species by China RedList. With the illegal harvesting for food and degradation of their habitats, the population number is rapidly decreased.

69. For reptiles, 7 families and 7 reptile species were identified (**Table 3.3**), such as *Pelodiscus sinensis*, *Elaphe porphyracea*, *Sphenomorphus maculatus*, *Ophiophagus hannah* and *Trimeresurus stejnegeri*. However, the *Varanus salvator* and *Gekko gecko* may occur in the project sites.

70. According to the local records in Forestry Station of Mengding Town, the *Varanus salvator* was ever rescued in Qingshuihe Border Area. This lizard often lives in the mountain stream. It is the Grade I of national protected animals, and listed in the Appendix II of CITES.

71. The *Gekko gecko* is the Grade II of national protected animals, which mainly distribute in Southeast and South Asia. The gecko prefers inhabiting the rock crevices, caves, or tree holes in the rocks or wilderness, living in the woods, open spaces, mountains, deserts, and houses. The King cobra (*Ophiophagus hannah*) is listed in the Yunnan provincial protected animals and the appendix II of CITES, and recognized as the vulnerable species in China RedList.

**Table 3.3 The list of amphibian and reptiles from project area of LBECZ**

| Scientific name | Distribution | Elevation (m) | NPL | China-RL | CITES | IUCN-RL |
|---|---|---|---|---|---|---|
| **AMPHIBIAN** | | | | | | |
| **Dicroglossidae** | | | | | | |
| *Occidozyga martensii* | South China | 10～1000 | | NT | | LC |
| *Hoplobatraclrus rugulosus* | Middle and south China | 20～1120 | Ⅱ | VU | | LC |
| *Fejervarya limnocharis* | General | 10～1400 | | LC | | DD |
| **Rhacophoridae** | | | | | | |
| *Polypedates megacephalus* | General | 80～1600 | | LC | | LC |
| **Microhylidae** | | | | | | |
| *Microhyla heymonsi* | Middle and south China | 70～1515 | | LC | | LC |
| **REPTILES** | | | | | | |
| **Trionychidae** | | | | | | |
| *Pelodiscus sinensis* | General | ＜1000 | | VU | | VU |
| **Gekkonidae** | | | | | | |
| *Gekko gecko* | South China | 300～1300 | Ⅱ | EN | | - |
| **Varanidae** | | | | | | |
| *Varanus salvator* | South China | | Ⅰ | CR | Ⅱ | LC |
| **Scincidae** | | | | | | |
| *Sphenomorphus maculata* | Southwest China | 450～1300 | | LC | | - |
| **Colubridae** | | | | | | - |

| Scientific name | Distribution | Elevation (m) | NPL | China-RL | CITES | IUCN-RL |
|---|---|---|---|---|---|---|
| *Elaphe porphyracea* | General | 200～2400 | | LC | | - |
| **Elapidae** | | | | | | |
| *Ophiophagus hannah* | General | 300～1800 | P | EN | Ⅱ | VU |
| **Viperinae** | | | | | | |
| *Trimeresurus stejnegeri* | General | 150～2200 | | LC | | LC |

NPL: national protection list. RL: RedList

IUCN RedList and China RedList: LC = least concern, NT = near threatened, VU = vulnerable, CR = critically endangered, EN = endangered, DD = data deficiency

## D Fish resources

### a Fish Composition

72. 48 endemic fish species of four orders and 11 families were identified in project sites (**Table 3.4**), which is consistent with the fish composition in NAGR of lower reach of Nanting River. The fish list was concluded from the literatures (Zhou et al., 2016a and 2016 b) and the scientific survey reports of Nanting River NNR (Tang et al., 2015) and Lancang River PNR (Wang et al., 2010). There is no fish species under the national protected animals and the appendix of CITES. Two of them were recognized as the near-threatened species and three fish species were listed as the data deficient category. In addition, approximately four fish species were not yet assessed by IUCN RedList, such as *Balitora nantingensis*.

73. Sorted by species absolute number, Cyprinidae, Cobitidae and Sisoridae were ranked in the top 3 families. Sorted by the fauna presence value, Anguillidae, Channidae, Mastacembelidae, Cobitidae, Synbranchidae and Sisoridae were ranked in the top 5 families.

74. Four fish species were identified as the conservation objectives: *Neolissochilus baoshanensis*, *Bagarius yarrelli*, *Anguilla nebulosa* and *Balitora nantingensis* in Nanting River system. Their distribution is presented in **Figure 3.1**. The *Balitora nantingensis* and *Neonoemacheilus mengdingensis* are the two unique species only distributed in Nanting River, the *Anguilla nebulosa* is the unique species in Nanting River and Irrawaddy River, and the *Neolissochilus baoshanensis* is the unique species in Yunan Province. The *Anguilla nebulosa* is an occasional species, which can migrate from India Sea. However, the biological information of this species is quite scare.

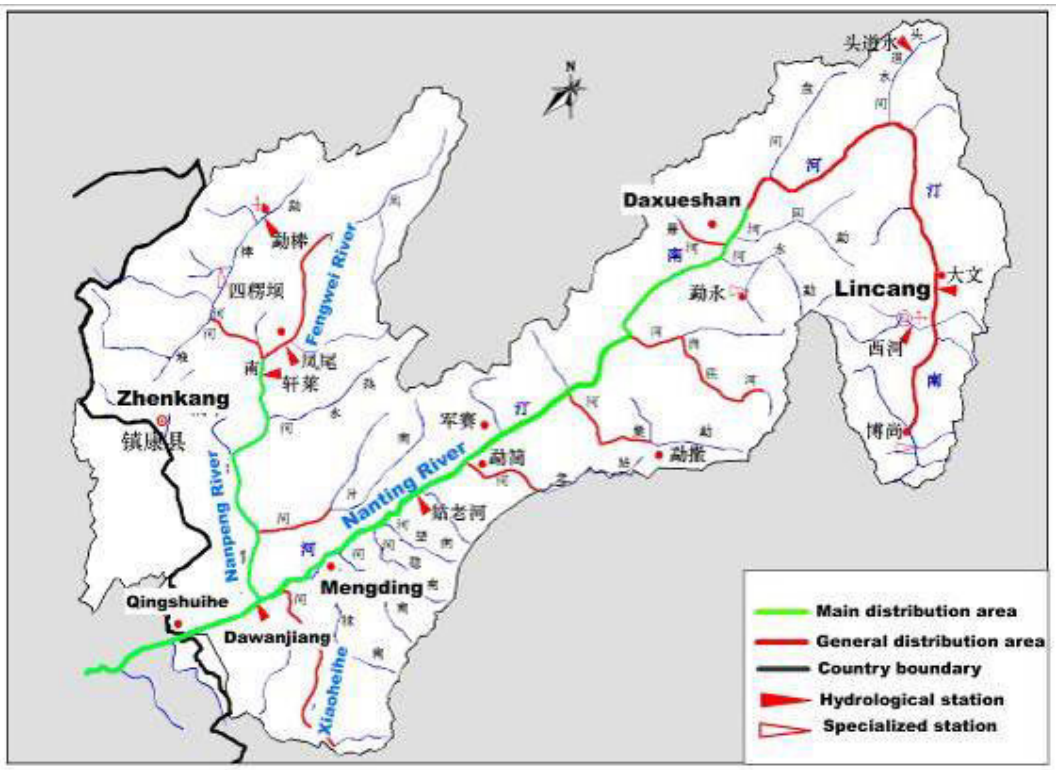



**Figure 3.1 Distribution of four conservation targets: *Neolissochilus baoshanensis*, *Bagarius yarrelli*, *Anguilla nebulosa* and *Balitora nantingensis* in Nanting River system (Source: Master plan of NAGR in lower reach of Nanting River (2013-2020))**

**Table 3.4 Fish resources in four nature reserves in Lincang Prefecture**

| Number | Scientific name | Nangun | Nanpeng | Nanting | Lancang | Endemic | IUCN-RL |
|---|---|---|---|---|---|---|---|
| Ⅰ | **ANGUILLIFORMES** | | | | | | |
| **1** | **Anguillidae** | | | | | | |
| 1) | *Anguilla nebulosa* | 1 | 1 | 1 | | | NT |
| Ⅱ | **CYPRINIFORMES** | | | | | | |
| **2** | **Botiidae** | | | | | | |
| 2) | *Botia histrionica* | | | 1 | | | - |
| 3) | *Sinibotia longiventralis* | | | | 1 | $E_L$ | - |
| 4) | *Syncrossus beauforti* | | | | 1 | | - |
| 5) | *Ambastaia nigrolineata* | | | | 1 | $E_L$ | - |
| **3** | **Cobitidae** | | | | | | |
| 6) | *Lepidocephalichthys berdmorei* | 1 | 1 | 1 | | | - |
| 7) | *Misgurnus anguillicaudatus* | 1 | 1 | 1 | 1 | | - |
| **4** | **Balitoridae** | | | | | | |
| 8) | *Vanmanenia* sp. | | | | 1 | | - |
| 9) | *Balitora lancangjiangensis* | | | | 1 | | - |
| 10) | *Balitora nantingensis* | | | 1 | | $E_2E_3$ | - |
| 11) | *Hemimyzon elongatus* | | | | 1 | $E_L$ | - |
| 12) | *Hemimyzon nujiangensis* | | 1 | 1 | | $E_N$ | - |

| Number | Scientific name | Nangun | Nanpeng | Nanting | Lancang | Endemic | IUCN-RL |
|---|---|---|---|---|---|---|---|
| 13) | *Hemimyzon pengi* | | | | 1 | $E_L$ | - |
| 14) | *Hemimyzon zhangi* | | | | 1 | $E_L$ | - |
| 15) | *Balitoropsis yunnanensis* | | | | 1 | $E_L$ | - |
| **5** | **Nemacheilidae** | | | | | | |
| 16) | *Neonoemacheilus mengdingensis* | 1 | 1 | 1 | | G | - |
| 17) | *Homatula anguillioides* | | | | 1 | | - |
| 18) | *Homatula pycnolepis* | | 1 | 1 | | $E_2$ | - |
| 19) | *Pteronemacheilus meridionalis* | 1 | 1 | 1 | | | - |
| 20) | *Physoschistura shuangjiangensis* | 1 | | | 1 | | - |
| 21) | *Schistura bucculenta* | | 1 | | 1 | | - |
| 22) | *Schistura cryptofasciata* | | | 1 | | | - |
| 23) | *Schistura disparizona* | 1 | 1 | | | $E_1E_2E_3$ | - |
| 24) | *Schistura fasciolata* | | | | 1 | | - |
| 25) | *Schistura kengtungensis* | 1 | 1 | 1 | 1 | | - |
| 26) | *Schistura latifasciata* | 1 | 1 | | 1 | | - |
| 27) | *Schistura longa* | | 1 | 1 | | $E_N$ | - |
| 28) | *Schistura nandingensis* | | 1 | | | $E_2E_3$ | - |
| 29) | *Schistura poculi* | 1 | 1 | 1 | 1 | | - |
| 30) | *Schistura prolixifasciata* | 1 | | | | $E_1$ | - |
| **6** | **Cyprindae** | | | | | | |
| | **Danioninae** | | | | | | |
| 31) | *Danio browni* | 1 | 1 | 1 | | | - |
| 32) | *Danio shanensis* | | | 1 | | | - |
| 33) | *Danio chrysotaeniatus* | | | | 1 | $E_L$ | - |
| 34) | *Raiamas guttatus* | 1 | 1 | 1 | 1 | | - |
| 35) | *Barilius caudiocellatus* | 1 | 1 | 1 | 1 | | - |
| 36) | *Barilius pulchellus* | | | | 1 | | - |
| 37) | *Aspidoparia morar* | 1 | 1 | 1 | | G | - |
| 38) | *Opsariichthys bidens* | | | | 1 | | - |
| | **Gobioninae** | | | | | | |
| 39) | *Hemibarbus maculatus* | | | | 1 | | - |
| | **Barbinae** | | | | | | |
| 40) | *Tor laterivittatus* | | | | 1 | $E_L$ | - |
| 41) | *Tor sinensis* | | | | 1 | $E_L$ | - |
| 42) | *Tor tambra* | 1 | 1 | 1 | 1 | | - |
| 43) | *Tor hemispinus* | | | 1 | | | - |
| 44) | *Puntius sophore* | | 1 | | | | - |
| 45) | *Puntius ticto* | 1 | 1 | | | | - |
| 46) | *Onychostoma gerlachi* | | | 1 | 1 | | - |
| 47) | *Scaphiodonichthys acanthopterus* | 1 | 1 | 1 | 1 | | - |
| 48) | *Poropuntius huangchuchieni* | | | | 1 | | - |
| 49) | *Poropuntius opisthopterus* | | 1 | 1 | | $E_N$ | |
| 50) | *Percocypris pingi retrodorslis* | | 1 | | 1 | | |

| Number | Scientific name | Nangun | Nanpeng | Nanting | Lancang | Endemic | IUCN-RL |
|---|---|---|---|---|---|---|---|
| 51) | *Neolissochilus baoshanensis* | 1 | 1 | 1 | | | DD |
| 52) | *Placocheilus cryptonemus* | | | 1 | | | - |
| | **Labeoninae** | | | | | | |
| 53) | *Bangana* sp. | | | | | | - |
| 54) | *Bangana lippa* | | | | 1 | $E_L$ | - |
| 55) | *Bangana yunnanensis* | | | | 1 | $E_L$ | - |
| 56) | *Bangana zhui* | | | | 1 | | - |
| 57) | *Akrokolioplax bicornis* | | | 1 | | | - |
| 58) | *Labeo pierrei* | | | | 1 | | - |
| 59) | *Crossocheilus burmanicus* | | 1 | | | | - |
| 60) | *Garra mirofronits* | | | | 1 | $E_L$ | - |
| 61) | *Garra nujiangensis* | 1 | 1 | | | $E_N$ | DD |
| 62) | *Garra salweenica* | 1 | 1 | 1 | | | DD |
| 63) | Schizothoracinae | | | | | | - |
| 64) | *Schizothorax lissolabiatus* | | | | 1 | | - |
| 65) | *Schizothorax nukiangensis* | | 1 | 1 | | $E_N$ | DD |
| 66) | *Schizothorax paoshanensis* | | | 1 | | | - |
| 67) | *Schizothorax gongshanensis* | | | 1 | | | - |
| 68) | *Schizothorax yunnanensis yunnanensis* | | | | 1 | $E_L$ | - |
| | **Cyprininae** | | | | | | |
| 69) | *Carassius auratus* | | 1 | 1 | 1 | | - |
| Ⅲ | **SILURIFORMES** | | | | | | |
| **7** | **Clariidae** | | | | | | |
| 70) | *Clarias fuscus* | 1 | 1 | 1 | 1 | | - |
| **8** | **Schilbidae** | | | | | | |
| 71) | *Clupisoma longianalis* | | | | 1 | $E_L$ | - |
| 72) | *Clupisoma sinense* | | | | 1 | $E_L$ | - |
| **9** | **Sisoridae** | | | | | | |
| 73) | *Bagarius bagarius* | | | | 1 | | NT |
| 74) | *Bagarius yarrelli* | 1 | 1 | 1 | 1 | | NT |
| 75) | *Glyptothorax burmanicus* | 1 | 1 | 1 | | $E_N$ | - |
| 76) | *Glyptothorax zanaensis* | | | 1 | | | - |
| 77) | *Creteuchiloglanis gongshanensis* | | | 1 | | | - |
| 78) | *Creteuchiloglanis macropterus* | | | 1 | | | - |
| 79) | *Glyptothorax fucatus* | 1 | 1 | | | $E_1E_3$ | - |
| 80) | *Glyptothorax fuscus* | | | | 1 | $E_L$ | - |
| 81) | *Glyptothorax laosensis* | | | | 1 | | - |
| 82) | *Glyptothorax macromaculatus* | | | | 1 | $E_L$ | - |
| 83) | *Glyptothorax ngapang* | 1 | 1 | 1 | | | - |
| 84) | *Glyptothorax trilineatus* | 1 | 1 | 1 | | | - |
| 85) | *Glyptothorax longinema* | 1 | 1 | 1 | 1 | | - |
| 86) | *Pseudecheneis paucipunctatus* | 1 | | | | $E_1$ | - |
| 87) | *Pseudecheneis longipectoralis* | | 1 | 1 | | $E_N$ | - |

| Number | Scientific name | Nangun | Nanpeng | Nanting | Lancang | Endemic | IUCN-RL |
|---|---|---|---|---|---|---|---|
| 88) | *Pseudecheneis sulcatoides* | | | | 1 | $E_L$ | - |
| 89) | *Gagata dolichnema* | | | 1 | | | - |
| 90) | *Pseudexostoma yunnanensis* | | | 1 | | | - |
| 91) | *Oreoglanis jingdongensis* | | | | 1 | $E_L$ | - |
| 92) | *Oreoglanis immaculatus* | 1 | | 1 | | $E_1$ | - |
| 93) | *Oreoglanis setiger* | | | | 1 | $E_L$ | DD |
| Ⅳ | **BELONIFORMES** | | | | | | |
| **10** | **Adrianichthyidae** | | | | | | |
| 94) | *Oryzias sinensis* | | | | 1 | | - |
| Ⅴ | **SYNBRANCHIFORMES** | | | | | | |
| **11** | **Synbranchidae** | | | | | | |
| 95) | *Monopterus albus* | 1 | 1 | 1 | 1 | | - |
| **12** | **Mastacembelidae** | | | | | | |
| 96) | *Mastacembelus armatus* | 1 | 1 | 1 | 1 | | - |
| Ⅵ | **PERCIFORMES** | | | | | | |
| **13** | **Channidae** | | | | | | |
| 97) | *Channa gachua* | 1 | 1 | 1 | 1 | | - |
| 98) | *Channa striata* | | | 1 | | | - |
| **Total** | | **33** | **41** | **48** | **54** | | |

Mg: monotypic genus, $E_I$: endemic species occurred in Lanchang River, $E_N$: endemic species occurred in Nu River, $E_1$: endemic species occurred in Nanguan River NNR, $E_2$: Endemic species occurred in National Aquatic Germplasm Reserve of Nanpeng River, $E_3$: Endemic species occurred in National Aquatic Germplasm Reserve in the lower reach of Nanting River. The lines with the light grey background indicate the conservation fish species in the NAGR of lower reach of Nanting River.

### b Fish habitats

75. The majority of fishes in Nanting River are the benthic fishes, especially preferring to live in the fast torrent. This is associated with the natural environmental conditions, such as high river bed slope, fast flowing, shallow water, and lack of opening water and still water along the stream of Nanting River. The minor fish species including *Channa gachua*, *Bagarius yarrelli* and *Anguilla nebulosa* are carnivores. The others are omnivores and their food type is relatively simple.

76. According to the anatomy of the fish gonads, the fishes that live in this area are mainly the type of disposable oviposit, and the development of germ cells in the ovary is basically synchronous. In the only few reports on the proliferation of fish in Nu River, the fish breeding season in this area is mainly concentrated from April to June. First began to breed in the basin is the small fishes of Cobitidae, Homalopteridae and Cyprinidae. With the start of the rainy season and river runoff increase, many large and medium-sized fish migrate from downreach for breeding in Nanting River.

77. There are a dozen of wetlands with variant size distributed from Daxueshan to Junsai along river course of Nanting River (**Figure 1.4**), where is approximately 15 kilometers in the upper reach of proposed Nanting Bridge. The aquatic vegetation provides good spawning habitats for

fishes producing the adhesive eggs, and also provides good foraging and shelter habitats. In addition, partial river course such as Nanpeng, Mafengcun, Mangka and Mangbing, provide the typical spawning habitats for fishes producing drifting eggs, due to the fast runoff and intensive whirlpools.

78. The river course from Banxing Village (23°30′41″N, 98°56′50″E) to the lower reach becomes narrow. The runoff is fast and the whirlpools is abundant. These provide good habitats for spawning by fish laying floating-egges. The main species include fishes of Barbinae, Cotitidae, and Botiidae and so on.

79. The fish harvest has an obvious seasonal change in Nanting River, which concentrates in April, May and June. With the rainy season going, the fishes migrate from the downreach of Nu River for spawning in Nanting River, including Barbinae, *Bagarius yarrelli* and Clarias fuscus. Through interviews with the local people along Nanting River, there are groups of fishes concentrate for spawning in the shoals in the flood season of each year.

# IV. Biodiversity assessment of the project sites

80. Evaluating the conservation value of separate habitat, the general considerations are the follows: (1) species richness and diversity; (2) species rarity and specialty; (3) geographical features, such as nesting site, hibernation site, spawning site, foraging site and migration route/passage; (4) archaeological conservation value. The final category of conservation value is defined as low, medium, high and very high.

81. Evaluating conservation value of individual species, the general considerations are the follows: (1) The cosmopolitan species with high dispersal abilities and a broad ecological niche will be given the low conservation value. (2) The specialized species such as endemic and/or stenotopic species with a narrow geographical and/or ecological niche will be given a high conservation value. Combined with the grade of the nationally protected species list and category of IUCN RedList, the conservation value is classified as: very high, high, medium.

82. In the project area, the terrestrial vegetation is dominated by the rubber plantation, with no protected plant species in national and provincial levels found. **It is well known the rubber plantation has low conservation values due to the extensive human intervention and occupation**. However, the recent researches revealed that the mistletoes in old rubber trees can provide abundant nectars and fruits for nectarivorous and frugivorous birds. In the project area, it is hard to identify whether this habitat existing due to the most of land clearance completed before the field survey.

83. Regarding the terrestrial fauna, five species are under national protected animals and two are recognized as 'Vulnerable' species by the IUCN RedList. Comparing with the world population estimate and population size in the project area, and their geographical distribution ranges, **two nationally protected animal species including Tiger frog and Gekko gecko have low conservation values, and the other five species including three protected animals such as Common buzzard, Great coucal and Asian water monitor, and two near threatened animals such as Chinese softshell turtle and King cobra have medium conservation values, but not significant** (**Table 4.1**).

84. For fishes, there is no protected species in national and provincial level found in the project area. However, there are two species recognized as near threatened by IUCN Redlist including *Anguilla nebulosi* and *Bagarius yarrelli*, and three species as data deficient such as *Neollissochilus baoshanensis*, *Garra salweenica* and *Schiothorax nukiangensis*.

85. The *Garra salweenica* and *Schizothorax nukiangensis* are mainly distributed in the middle and upper reaches of Nu River, in the northwest of Yunnan Province. Nanting River is not the concentration distribution area. Their conservation values are assigned as low. **The other three fish species including *Neolissochilus baoshanensis*, *Bagarius yarrelli* and *Anguilla nebulosi*, in addition to *Balitora nantingensis* (was not assessed by IUCN with the lack of information), have the medium conservation values** (**Table 4.1**). The location of proposed Nanting Bridge is their migratory path (**Figure 3.1**).

86. **For the river system, the relatively medium conservation value[2] is the river course of proposed Nanting Bridge**. The river course in the vicinity of proposed Nanting Bridge is the important migration pathway of migratory fishes from Salween River and India Sea, but not important spawning sites for fished laying floating-eggs. The survey report in the vicinity of proposed Nanting Bridge is presented as the **Appendix B** for reference.

**Table 4.1 Overall impact of project activities on the species with conservation values**

| Scientific name | NPL | IUCN-RL | Main distribution site of project area | Overall impact of project activities |
|---|---|---|---|---|
| **BIRDS** | | | | |
| *Buteo buteo* | Ⅱ | - | LBECZ | Medium |
| *Centropus sinensis* | Ⅱ | - | LBECZ | Medium |
| **AMPHIBIAN** | | | | |
| *Hoplobatraclrus rugulosus* | Ⅱ | - | LBECZ | Low |
| *Fejervarya limnocharis* | | DD | | Low |
| **REPTILES** | | | | |
| *Pelodiscus sinensis* | - | VU | Qingshuihe, Nanting River | Medium |
| *Gekko gecko* | Ⅱ | - | lBECZ | Low |
| *Varanus salvator* | Ⅰ | - | Qingshuihe | Medium |
| *Ophiophagus hannah* | P* | VU | LBECZ | Medium |
| **FISHES** | | | | |
| *Anguilla nebulosa* | - | NT | Nanting River | Medium |
| *Neolissochilus baoshanensis* | - | DD | Nanting River | Medium |
| *Garra salweenica* | - | DD | Nanting River | Low |
| *Schizothorax nukiangensis* | - | DD | Nanting River | Low |
| *Bagarius yarrelli* | - | NT | Nanting River | Medium |

*P: Yunnan Provincial protection animal.

EN: endangered, VU: vulnerable, NT: near-threatened, DD: data deficient.

## A Selected Species

### a Flora

87. In project sites, the plant composition mainly include the planted species, such as rubber, pineapple, coffee, banana, teak and sand benevolence in rubber plantations, and vegetables and fruits in garden fields. The native plants are cosmopolitan species, which have a general

[2] The classification of conservation value here is based on the category of IUCN RedList. According to the PCR standard, the four fish including two near-threatened (*Anguilla nebulosi* and *Bagarius yarrelli*) and the other two endemic species (*Neolissochilus baoshanensis* and *Balitora nantingensis*) were assigned as the high conservation values, The main considerations include: (1) The Nationally Protected Animal List (NPAL) was issued in 1989, which cannot reflect the actual situation of population status and distribution of partial wild animals in China with the availability of limited information. (2) The State Council of PR China established the National Aquatic Germplasm Reserve in the lower reach of Nanting River in 2013, aiming to protect these four endemic fish. That means the four fish have been given the conservation with higher priority, even they are not under the NPAL. Therefore, we defined them as the fish species with high conservation value. Considering the proposed Nanting Bridge is designed as three span twin cable staged style, the construction will have limited impact on the fish migratory path. Therefore, we defined them with the medium conservation value in this report.

distribution and high fitness to establish in new ranges. All of them have relatively low conservation values. **Therefore, we did not select any plant species as the conservation targets during this project period**.

88. The rubber plantations are close to the rotation period in the project construction area of Qingshuihe Border Area. There may have some old rubbers with mistletoes, as this is a very common phenomena in the rubber plantations in Yunnan Province. Unfortunately, almost all rubber trees have been cut before the site visit. Mistletoes, a diverse group of parasitic plants on rubber trees, providing key resources in rubber plantations through provision of abundant fruits and nectar (Watson, 2001). This indicates that the old rubber trees with mistletoes would have had relatively higher conservation values for increasing the avifauna diversity. However, this speculation is hard to be verified due to the land clearance almost done before the project construction.

89. There are the two patches of teak forests in the project construction area: One located in the left valley of Nanting Bridge, and the other located in the right side of Qingshui River and close to Shantouzhai Jiaodui. In addition, the scattered teaks and banyans were found in rubber plantations, and a few banyans in the construction area of Zhenkang Sino-Myanmar Friendship Hospital. Even they have low conservation values for biodiversity, they have higher ornamental values and economic values in comparison with the other planted trees.

**b Terrestrial fauna**

90. Even 111 bird species, 6 mammal species, 5 amphibian species, and 7 reptile species were identified in the project sites. Only two bird species, 1 amphibian and 2 reptiles are under the nationally protected animals. And two additional reptile species such as Soft-shell Turtle *Pelodiscus sinensis* and King Cobra *Opiophagus hannah*, were recognized as the vulnerable by IUCN RedList. All of these seven species have the conservation value.

91. Considering the open beaches of Qingshui River was almost developed for garden fields in both side of river rehabilitation project, the number of amphibian and reptiles is limited. **Taking into account of the distribution range, population size, and habitat extent/quality of seven conservation species, the conservation values are not significant**.

92. The basic biological information of the seven conservation species are the follow:

a) The Greater coucal (*Centropus sinensis*) is common and widespread in its range. It is resident in southern Asia, from India east to south China and Indonesia. The population trend appears to be stable, and hence the species does not approach the thresholds for Vulnerable under the population trend criterion (>30% decline over ten years or three generations). The species is evaluated as Least Concern by BirdLife International (2018).

b) Common Buzzard (*Buteo buteo*) has an extremely large range, and hence does not approach the thresholds for Vulnerable under the range size criterion. The species is evaluated as Least Concernby BirdLife International (2018).

c) The Asian water monitor (*Varanus salvator*) has been assessed as Least Concern. This species has a wide distribution throughout Southeast Asia, can be found in various

habitats, and adapts to habitats disturbed by humans. It is also abundant in parts of its range, despite large levels of harvesting (Bennett, 2010).

d) The Tiger frog (*Hoplobatraclrus rugulosus*) has not been assessed by the IUCN RedList. The species is often found in paddy fields, ditches, reservoirs, ponds, marshes, and other nearby grass. With the success of captive breeding, the wild population remains stable.

e) The Tokay gecko (*Gekko gecko*) is a nocturnal arboreal gecko in the genus Gekko, the true geckos. It is native to Asia and some Pacific Islands. Its native habitat is rainforest, where it lives on trees and cliffs, and it also frequently adapts to rural human habitations, roaming walls and ceilings at night in search of insect prey.

f) The King cobra (*Ophiophagus hannah*) has been assessed as Vulnerable (VU) by IUCN RedList (Stuart et al., 2012). This species widely distributes in South and Southeast Asia, and has experienced local population declines of over 80% over 10 years in parts of its range. Pressure on this species from both habitat loss and exploitation are high throughout this snake's range, and while no quantitative population data is available. In China, the snake is considered to have declined by over 50% over ten years in this country as a result of exploitation for both subsistence and regional trade (Wang and Xie 2009). However, it is not common in any area in which it occurs, is very rare in much of its range. Therefore, it will not be listed as the monitoring species in project sites.

g) The Chinese Softshell Turtle (*Pelodiscus sinensis*) was assessed as Vulnerable (VU) by IUCN RedList (Asian Turtle Trade Working Group, 2000). The status assessment was made with respect to the natural populations only. The taxonomic and genetic diversity of this taxon (several component species have been described or resurrected in recent years) has been confused and compromised by the mixing of animals of different origin in farms, and the escape of farmed animals into wild populations. In China, the wild population kept stable with the success of captive breeding.

**c Fish species**

93. Even 48 fish species were identified in Nanting River system, there is no any fish species found in the nationally protected animal list and IUCN RedList. Actually, 13 fish species area endemic in Nu River System in China (Zhu et al., 1990). However, there are two species recognized as near threatened by IUCN Redlist including *Anguilla nebulosi* and *Bagarius yarrelli*, and three species as data deficient such as *Neollissochilus baoshanensis*, *Garra salweenica* and *Schiothorax nukiangensis*.

94. In this report, four fish species were identified having medium conservation values: *Neolissochilus baoshanensis*, *Bagarius yarrelli*, *Anguilla nebulosa* and *Balitora nantingensis* in Nanting River system. This is consistent with the conservation targets of NAGR of lower reach of Nanting River.

95. The basic biological information of the four conservation fishes are the follows:

a) The *Neolissochilus baoshanensis* was listed as Data Deficient (Kullander, 2012). The fish has only been reported from the Nu River (Salween River) and Lancang River drainage in Yunnan, southern China (Shan et al., 2000), and might be present in lower

parts of these basins. It lays sticky demersal eggs. There is not enough information available to assess the risk of extinction of this species. **More research is needed to determine actual distribution, population trends and threats**.

b) The *Bagarius yarrelli* was assessed as the Near Threatened by IUCN RedList (Ng, 2010). Irrespective of the confusion surrounding the taxonomy of this species, the currently known populations of *Bagarius yarrelli* are harvested heavily in different parts of its range as food fish and for ornamental trade and as sport fish. Some declines reported in some studies for *B. bagarius* may refer to this species. **However, more empirical data is needed to support this claim**.

c) *Anguilla bengalensis* was assessed as the Near Threatened by IUCN RedList (Jacoby et al., 2014). It is migratory, breeding in the ocean (see Seegers *et al*., 2003) and migrating into freshwaters and estuaries, including large rivers, as juveniles (glass eels/elvers). Elvers can migrate high up rivers into streams where they inhabit pools until they mature although like many anguillid species some individuals will remain in coastal waters. There has been little or no quantitative time-series data relating to declines in the species, anecdotal evidence would indicate that both range and abundance of the species are shrinking. However, **it is essential further information is collected, as there is concern that a 'threatened' category could be more appropriate**.

d) The *Balitora nantingensis* was not assessed by IUCN RedList due to the information gaps. It mainly inhabits streams with clear and swift current, rocky bottom, seldom in the main course (Chen et al., 2005). There is almost empty about the biology of this fish species. **Further data collection and study are needed to assess this fish species**. Chen, X.-Y., G.-H. Cui and J.-X. Yang, 2005. Balitora nantingensis (Teleostei: Balitoridae), a new hillstream loach from Salween drainage in Yunnan, southwestern China. Raffles Bull. Zool. Supplement (13):21-26.

## B Selected Habitats

96. There is very little natural terrestrial habitat in the project construction area due to long history of human use and limited efforts for environment conservation. The major concern is the important migration pathway for four conservation fish targets in the vicinity of river course of proposed Nanting Bridge **(Details refer to the Appendix B**).

### a Rubber plantation

97. Rising global demand of natural rubber is expanding monoculture rubber at the expense of natural forests in the Old World Tropics. Conversion of forests into rubber plantations has a devastating impact on biodiversity. **It is well known that the rubber plantation cannot support the majority of the tropical avifauna in our study region.** The avifauna species that were solely observed in rubber were typically cosmopolitan generalists (e.g. Scaly-breasted munia (Lonchura punctulata) and Oriental Magpie Robin (Copsychus saularis), which have low conservation value. However, the recent researches showed some measures to maximize the biodiversity in rubber-dominated landscapes.

98. Wang and Zhang (2017) found that mistletoes prefer to distribute in the forests including

rubber plantations with altitude below 1500 m. Mistletoes prefer to distribute in the area with low host species diversity, which can provide nectars and fruits for foraging by nectarivorous and frugivorous birds.

99. Sceekar et al. (2016) concluded that mistletoe density increased exponentially with rubber tree diameters. A diverse group of parasitic plants provide key resources in rubber plantations through provision of abundant fruits and nectars for birds. Birds with wider habitat breadths and low conservation value had a higher probability of occurrence. Species richness and diversity increased logarithmically with surrounding forest cover, but roads had little effect.

100. Zhang et al. (2017) found that larger inter-tree gaps in rubber plantations allow more native elements to provide habitat for insects and small animals, which present attractive foraging opportunities for birds. In addition, larger planting gaps could be a win-win for biodiversity and farmers; rubber grown at a density of around 450 tree/ha will ensure more stable latex production (Huang et al., 2015). Intercropping pineapple (*Ananas comosus*), tea (*Camellia sinensis*), pepper (*Piper spp.*), and medicinal plants (e.g. *Alpinia oxyphylla*) will increase the production of latex, soil fertility and reduce soil erosion within the rubber plantation (Long, 1991; Lin et al., 1999).

**b Fish habitats**

101. Generally, the high runoff velocity with the staggered rocks provide important spawning site for fish laying floating-eggs. The slow runoff velocity with the extensive shallow river beach provide the critical spawning site for the fish laying sticky demersal eggs.

102. From Junsai to Mengding (southwards) (**Figure 1.4**), there are 27 tributaries entering into Nanting River. The number of river beaches with area of over 10 hectares exceeds 43 sites, which provide good foraging habitats and spawning habitats for fish laying sticky demersal eggs.

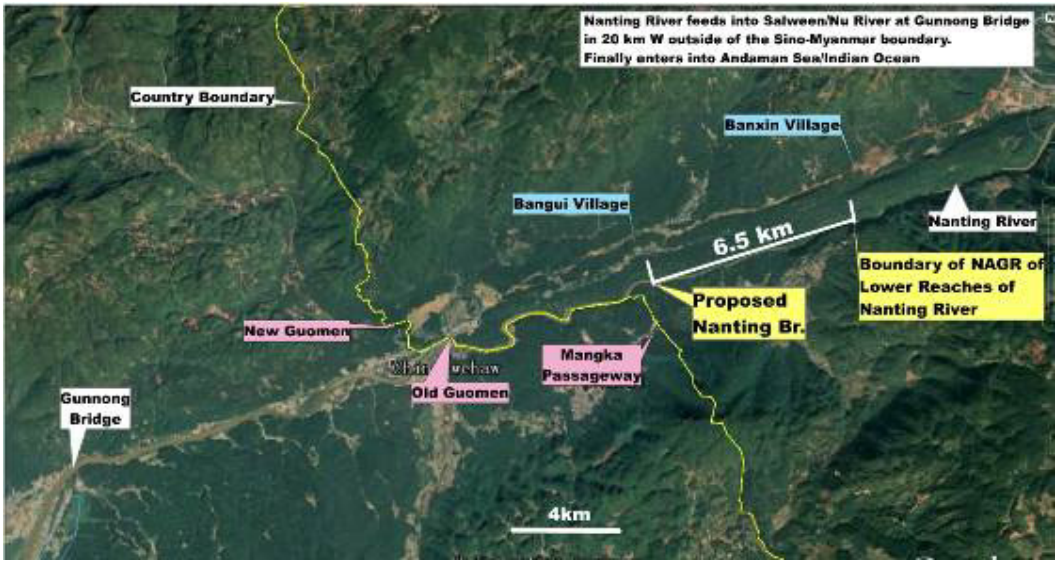



**Figure 4.1 Spatial locations of proposed Nanting Bridget and boundary of NAGR in Lower Reach of Nanting River, approximately 6.8 kilometers apart**

103. From Junsai to Daxueshan (northwards) (**Figure 1.4**), there are plenty of shallow shoals with

swift currents. These provide good spawning habitats for fished laying sticky demersal eggs. The known concentration sites include the estuaries of Hedigang River and Kaisa River. The species mainly include the small fishes of Cotitidae, Homalopteridae and Sisoridae. They are also the traditional harvesting sites of the local farmers.

104. From Mengding to the Sino-Myanmar boundary (**Figure 4.1**), the river course of Nanting River becomes narrow and spans approximately 15 km with swift current. This combining with the large stones in the river bed, create a plenty of whirlpools for fish laying floating-eggs. However, the result of site visit showed the potential spawning site is located 2.8 kilometers in the upper reach of proposed Nanting Bridge.

105. The fish laying floating-eggs mainly include Botiidae such as *Botia histrionica*, Cotitidae such as *Lepidocephalichtus berdmorei* and *Misgurnus anguillicaudatus*, Balitoridae such as ***Balitora nantingensis*** and *Hemimyzon nujiangensis*, Labeoninae such as **Garra salweenica**, and Barbinae such as *Tor tambra*, *Tor hemispinus*, *Onychostoma gerlachi*, *Scaphiodonichthys acanthopterus* and *Poropuntius opisthopterus*. Most of them are common and economic species, with exception of *Balitora nantingensis* not being assessed by IUCN with lack of information, and *Garra salweenica* as data deficient species. In fact, *Garra salweenica* is a common fish in Nu River catchment (Jiang et al., 2010).

106. The site survey was conducted in a total length of 9.6 kilometers' river course (**from Site 1 to Site 6 in Figure 4.2**), including 1.0 kilometer in the down reach and 8.6 kilometers in the upper reach of proposed Nanting Bridge. **The potential spawning site for fish laying floating-eggs is identified, which is located over 2.7 kilometers in upper reach (Site 4 in Figure 4.2) of proposed Nanting Bridge (Site 2 in Figure 4.2). The total length of river course with potential spawning area is 5.9 kilometers (from Site 4 to Site 6, Figure 4.2).**

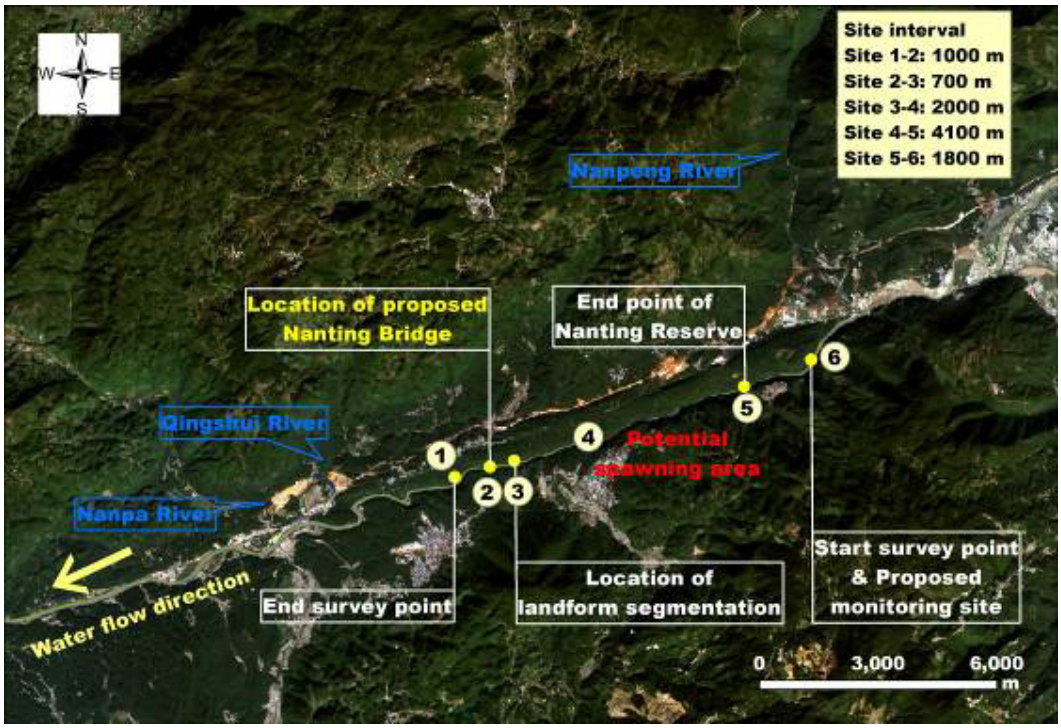


**Figure 4.2 The location of survey points in the vicinity of proposed Nanting Bridge.**

107. The river course between 1000 m in the lower reach (**Site 1 in Figure 4.2**) and 700 m in the upper reach (**Site 3 in Figure 4.2**) of proposed Nanting Bridge (**Site 2 in Figure 4.2**) is not suitable for fish spawning. As the landform of river sides in the two sections consists of regular stones or steep land rather than staggered rocks. The water runoff becomes slow due to the small elevation difference in this section.

108. The landform in the location of 700 m upper reach (**Site 3 in Figure 4.2**) of proposed Nanting Bridge has a significant segmentation compared with the upper and lower reaches. The river course between 700 m and 2700 m in the upper reach (**between Site 3 and Site 4 in Figure 4.2**) of proposed Nanting Bridge starts to have rocky landform, but not so staggered. Therefore, this section is still not suitable for fish spawning.

109. There is little information on the fish migration in Nanting River. It was reported that *Anguilla nebulosa* has the long-distance migration from India Ocean. In addition, a plenty of fishes such as Barbinae, *Bagarius yarrelli*, and *Clarias fuscus*, migrate from Salween River for breeding in Nanting River. Nanting River feeds into Salween River in the location of Gunnong Bridge of Mynamar, where is about 30 km in the west of proposed Nanting Bridge (**Figure 4.1**). In this case, **the river course in the vicinity of proposed Nanting Bridge is the important migration pathway for migratory fishes with conservation values (Table 4.2)**.

**Table 4.2 The fish species with conservation values migrate through and breed in the vicinity of proposed Nanting Bridge**

| Species | Migration period | Breeding period | Distance to Nanting Bridge |
|---|---|---|---|
| *Neolissochilus baoshanensis* | + | - | - |
| *Anguilla nebulosa* | + | - | - |
| *Bagarius yarrelli* | + | - | - |
| *Balitora nantingensis* | + | + | >2.7 kilometers in the upper reach |
| *Garra salweenica* | + | + | >2.7 kilometers in the upper reach |
| *Schizothorax nukiangensis* | - | - | - |

# V. Anticipated Environmental Impacts and Mitigation Measures

## A Terrestrial Habitats and Plants

### a Impacts on Terrestrial Habitats and Plants

110. **Construction Phase.** In the project sites, the detailed information of the current land covers and the land uses after project completion are presented as **table 1**. Most of the land currently comprises rubber plantations, shrub land, grassland and unused land. No rare plants were found in the project area, and those plants are widespread and common. The total project area is 123.9 hectares and its vegetation ratio is 79.6%. The area of 98.7 hectares with vegetation comprises 51.5 hectares of rubber plantation (52.2%), 45.8 hectares of shrub (46.4%) and 1.35 hectares of grassland (1.4%). Meanwhile, 47,324 rubber trees and 5,300 shrubs will be cut. Of them, the grassland include different types, such as clearing land for international cooperation area, unused land for Qingshuihe Guomen Elementary School and Electronic charging stations, garden field for water treatment plant, and mixed habitat types for river rehabilitation (including grassland, shrub, garden fields, river beaches and so on). The current land covers are almost artificial landscapes, which have low contribution to the biodiversity conservation. Therefore, the impact should be very limited.

111. In addition, the layout of water transmission pipes would temporarily destroy the surface vegetation, especially at the beginning section. For the later section, the layout will be consistent with the existing road network. The impact is not significant and the recovery would be very shortly.

112. **Operation Phase.** According to the current design, the area covering 24.7 hectares will be planted with the landscape plants, accounting for 25.0 % of the total vegetated area and 19.9% of the total project area (**Table 5.1**). This would compensate one fourth of the loss of current vegetated land.

113. The rubber plantation replacement by 1:2 ratio requirement does not apply as land is scarce and cannot be provided as replacement by LBECZ/Project Management Office (PMO). According to the Forest Management Measures (1997) and Forest Management Regulation (2010) of Yunnan Province, any individuals or organizations are requested to pay the vegetation compensation fee for the local Forestry Bureau if they do not have land and capacity to implement the afforestation. The fee will be allocated as the ratio of 2: 2: 6 in provincial, municipal and county levels. The local Forestry Bureau will fulfill these responsibilities to be included in the annual afforestation plan.

114. Rubber plantation is the dominated habitat in the project sites, which has low conservation values for biodiversity. However, some birds were solely found in this habitat, especially for the old rubbers with the mistletoes. Even the rubbers with the mistletoes were not identified due to the land clearance almost completed before the assignment contract period, this habitat would happen in the project area of LBECZ.

### b Prevention/mitigation measures

115. In order to compensate the biodiversity loss, it is recommended to plant the shrub producting

more nectar and fruit in green belts to attract nectarivorous and frugivorous birds. In addition, enhancing management of the rubber plantation in the outside of project area, can also increase the avian diversity. We hope the following conservation measures can be adopted in the rubber plantation by the local Forestry Bureau and local farmers.

a) Construct new roads through rubber plantations and not forest where they appear to have little effect on bird diversity;

b) Retaining a few old trees with mistletoes as much as possible during construction phase, providing a low-cost benefit to biodiversity;

c) Encourage local farmers to retain some large rubber trees ( > 25 cm diameter at breast height) with mistletoes within plantations during rotations;

d) Encourage local farmers to increase inter-tree distance, decrease the frequency of rubber tree replanting, and retain native shrubs, or intercrop some other crops, which may present low-cost methods for improving rubber plantations for avian populations and farmer wellbeing as well.

116. It is recommended to remove the banyans, devil tree and teaks of project sites (**Figure 5.1**) to be planted in the other area. Alternatively, these trees can be used as the landscape trees in the project sites.

117. The afforestation plan of Gengma County in 2018 was issued on March 17 2018 (Refer to the appendix C). The total area of afforestation is 80,000 mu (15 mu equals to one hectare), including 50,000 mu of nut plantation, 20,000 mu of commercial forest and 10,000 mu of precious timber forest. Of them, 9,000 mu of afforestation will happen in Mengding Town, where is the location of project area of LBECZ. This is the critical measure to compensate the carbon emission due to the cutting of rubber plantation.

118. In addition, the new energy public transport facilities in LBECZ and buildings will be constructed in according to national and Yunan green building standard (GB/T50378-2006 and DBJ53/T-49-2015)). For Cangyuan and Qingshuihe Elementary Schools, and Zhenkang and Qingshuihe Hospitals, the designs also consider the energy conservation combined with solar and heat pump hot water systems. The plants[3] in the project landscape area are recommended to plant more C4 plants than C3 plants, in order to increase the carbon sequestration, such as sedge, dicotyledon, euphorbiaceae, chenopodiaceae and amaranthaceae (all C4 plants).

119. During construction, the soils for land rising will be taken from vegetated hills, which will involve the removal of vegetation and soil. The spoil disposal sites would cover the vegetated valleys. It is proposed to introduce soil and water conservation measures to help the restoration of these sites. In addition, the spoil disposal sites should avoid the valleys with high proportion of natural habitats including shrubs and grass.

[3] The advantage of C4 plant is that carbon dioxide fixation efficiency is much higher than C3, which is beneficial to the growth of plants in arid environment. The starch produced by photosynthesis of C3 plants is stored in the mesophyll cells, because this is where the Calvin cycle is, and the vascular bundle sheath cells do not contain chloroplasts. The starch from the C4 plant will be stored in the vascular bundle sheath cells, because the C4 plant's Calvin cycle occurs here.

**Table 5.1 Basic land cover and construction information of different project components (unit: $m^2$)**

| Project components | Area of land occupation | Construction area | Construction base area | Area of green belt | % of greening rate | Number of trees cutting[a] | Original vegetation composition | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Rubber | Grassland | Shrub |
| **Cross-border capacity improved** | | | | | | | | | |
| Border resident trade market | 213,629 | 107,454 | 190,788 | 22,841 | 10.69% | 6,110 | 123,427 | 90,202 | |
| International cooperation area* | 355,267 | 171,633 | 284,178 | 71,089 | 20.01% | 9,124 | 184,313 | 170,954 | |
| No. 1 Road | 48,851 | 21,596 | 20,881 | 3,523 | 7.21% | 3,720 | 21,596 | | |
| No. 2 Road | 53,226 | 18,912 | 15,548 | 4,000 | 7.52% | 118 | 14,189 | | |
| No. 3 Road | 111,775 | 30,240 | 24,386 | 4,536 | 4.06% | 13,398 | 30,240 | | |
| No. 4 Road | 53,853 | 15,456 | 12,577 | 1,990 | 3.70% | 3,987 | 11,594 | | |
| No. 5 Road | 78,625 | 22,920 | 19,051 | 4,780 | 6.08% | 3,995 | 17,197 | | |
| No. 6 Road | 12,467 | 6,273 | 6,273 | 0 | 0.00% | 1,092 | 6,273 | | |
| **Social infrastructure and service improved** | | | | | | | | | |
| Cangyuan Guomen No. 2 Elementary School | 31,059 | 18,231 | 20,224 | 9,318 | 30.00% | | | 31,059 | |
| Qingshuihe Guomen Elementary School Upgrade* | | 7,691 | 1,847 | | | | | 7,691 | |
| Zhenkang Sino-Myanmar Frienship Hospital** | 60,000 | 56,009 | 37,500 | 22,500 | 37.50% | | | 60,000 | |
| Qingshuihe Hospital | 22,266 | 8,946 | 16,032 | 6,234 | 28.00% | 1,650 | 22,266 | | |
| Mengding electric charging station* | 8,000 | 8,000 | 8,000 | | | | | 8,000 | |
| Qingshuihe electric charging station* | 6,670 | 6,670 | 6,670 | | | | | 6,670 | |
| **Integrated urban environmental infrastructure improved** | | | | | | | | | |
| Water treatment plant | 24,000 | 1,290 | 3,800 | 15,000 | 62.50% | 900, 1800[b] | 12,000 | | 12,000 |
| Wastewater treatment plant*** | 24,010 | 1,422 | 5,170 | 13,600 | 56.64% | 1,030 | 18,667 | 3,333 | |
| Solid waste transfer station | 3,768 | 514 | 2,447 | 805 | 21.36% | 200 | 1,480 | | 1,480 |

| Project components | Area of land occupation | Construction area | Construction base area | Area of green belt | % of greening rate | Number of trees cutting[a] | Original vegetation composition | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Rubber | Grassland | Shrub |
| Solid waste collection station | 594 | 162 | 230 | 134 | 22.56% | | | 954 | |
| Qingshui River Rehabilitation**** | 131,298 | 0 | 13,226 | 66,568 | 50.70% | 2000, 3500[b] | 51,923 | 79,375 | |
| **Total** | **1239,358** | **503,419** | **688,828** | **246,918** | **19.92%** | **47324, 5300[b]** | **515,165** | **458,238** | **13,480** |

*grassland refers to the clearance land; ** grassland includes partial farmland; ***grassland refers to the garden field; ****grassland refers to the mixed habitats, such as timber land, garden field, shrub land and grassland. [a]: refers to the number of rubbers to be cut; [b]: refers to the number of shrubs to be cut.

Construction area refers to the area of the constructed buildings including the area of different floors, and the construction base area include the flat area of contructed buildings in addition to the area of roads and parking areas.

**Figure 5.1 Overview of the plants in the proposed Nanting Bridget. The rusty patches showed the teak trees, and the grey patches indicated the rubber plantation in the opposite hill.**

## B Terrestrial Fauna

### a Impacts on Terrestrial Fauna

120. **Construction Phase**. During the construction, the affected fauna would mainly comprise the small mammals, and amphibian and reptiles due to the loss of habitats, especially for the sites close to the valley and river beaches. The avifauna would have low impact due to the similar habitat in the surrounding area, and their movement capacity.

121. **Operation Phase**.

122. Birds. The birds found in the project area can be classified into four functional guilds (a) insectivores, (b) carnivores, (c) frugivores and (d) granivores. Insectivorous and residential birds were the dominated species in the project area, which accounted for 75.7 % of the total bird species. All of them are widespread species, which have adopted to the human dominated landscape. Construction will result in the loss of some habitats, especially for birds that nest in grasslands and shrublands in valleys and river beaches.

123. Mammals. The project may result in the loss of habitat for underground mammals such as *Mustela sibirica*, *Arctonyx collaris*, *Mus musculus* and *Apodemus draco*. But it will have low impact on flying mammals such as bats which roost during the day and feed at night. However, the *Pipistrellus abramus* prefers to nest in the old houses. The resettlement would destroy their nesting habitats to some extent.

124. Amphibians. There is only five frogs identified in the project area. Even Tiger frog is listed as the Grade II of nationally protected animals, which has good adaptive capacity to the new conditions. The improvement of river ecological environment may benefit these frogs.

125. Reptiles. Only one aquatic Soft-shell Turtle mainly live in river channel and ponds, which is recognized as the vulnerable species by IUCN RedList. The other six reptiles are ground species, including Asian water monitor of grade I national protected animals, Tokay gecko of Grade II of national protected animals, and King cobra as the vulnerable species by IUCN RedList. They are difficult to be found in the field and their population size are very small. The construction would destroy some shrublands and grasslands, which may have some impact on them.

126. Nationally protected animals. There are two bird species such as Greater coucal and Common buzzard, one amphibian such as Tiger frog, and two reptiles including Tokay gecko and Asian water monitor under the national protection animal list. The two birds and one amphibian are widespread an common species, which can adapt to the new habitats very fast. The four reptiles are believed to be rare in the project area, and unlikely to be affected by the project.

### b Prevention/Mitigation Measures

127. The contractors will be required to undertake certain actions to minimize the impact on terrestrial fauna as: the control of construction noise to avoid causing a disturbance, avoid of land clearance in avian breeding period, environmental education to workforce not hunting or harvesting wild fauna.

## C Fishery Resources

### a Impacts on Fishes

128. **Construction Phase**. During construction, noise and vibration from piling, excavations and dredging, would have temporary impacts on the fish. Considering the closure of part of the rivers of Qingshui River (river rehabilitation), Nanpa River (river rehabilitation) and Nangun River (construction of water intake infrastructure), the impacts would be more severe. In particular, the river rehabilitation project of Qingshui River will last for 24 months.

129. **Operation Phase**. The follows present the impacts of project activities in different river channels.

130. Changes in eco-environment. For the river rehabilitation project in Qingshui River and Nanpa River, dredging the channel and aligning the river course would reduce the biomass of phytoplankton, phytobenthos such as algae an diatomeae, and zoobenthos including molluscs, annelids and arthropods. These benthos can not only provide food resources for some fishes, but also affect the physical-chemical characteristics of the water body and soil. The density and composition change would affect the fish composition as well. However, there are some small fishes liking Cotitidae, Homalopteridae and Sisoridae. They are easily recovered after the project completion.

131. There is a temporary engineering construction for water intaking in Nangun River (**Figure 1.4, and Figure 5.2**). The water intake infrastructure is consisted of barrage, sand retention layer and water intake sluice. The barrage would impact on the fishes, preventing fish migrations for

reproduction, feeding and other purposes.

**Figure 5.2 The view of water intake area of Nangun River**

132. Cangyuan Guomen No. 2nd Elementary School will pass through Tangchang River, which is one of tributaries of Mengdong River (**Figure 5.3 and 5.4**). Mengdong River is the secondary tributary of Lancang River. The fishes in Tangchang River mainly comprise some small economic species, due to the narrow river channel and big fluctuation of water level. The construction will not have any impacts on the fish resources.

**Figure 5.3 View of proposed Cangyuan Guomen No. 2nd Elementary School (The middle is Tangchang River)**

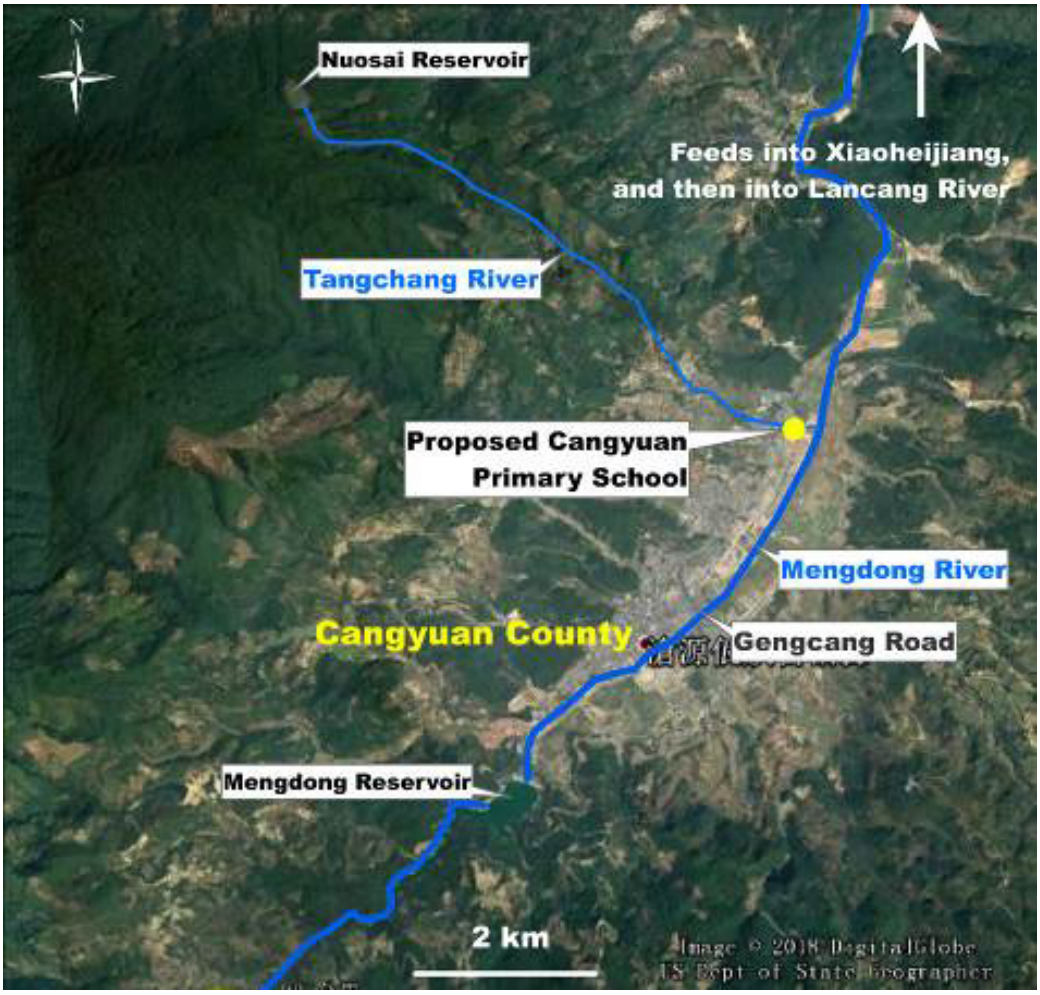



**Figure 5.2 The location of proposed Cangyuan Guomen No. 2nd Elementary School and its water systems**

133. Impacts on fish migration in Nanting River. Considering the design of Nanting Bridge is three span twin cable stayed style, the construction will not happen in the river course. This will reduce the impact on fishes to a some extent. However, the bridge vicinity is the important pathway for migratory fishes. The construction would have impact on the fish migration in the upper reach of Nanting River, such as the vibration from piling on shore as well as pollution from waste water from cavings (digging mud that would come out and seep into water). Even there is no fish species under the national protection animal list, there are four conservation fish including two NT fish species under IUCN RedList identified in the NAGR in lower reach of Nanting River.The relevant mitigation measures are needed to manage the impact of construction within an acceptable level.

### b Prevention/Mitigation Measures

134. In construction period, various measures will be implemented to protect fishes.

a) In the spawning concentration period from April to June, it is recommended to stop construction of Nanting Bridge and water intake infrastructure as well, to ensure fish free

migration and spawning.

b) In the flood season from June to September, there are many fishes swim upstream. Piling and excavation works will be forbidden as the vibrations from such operations would affect the fish, especially for the construction of Nanting Bridge.

c) Considering the potential risk of pollution from waste water from cavings (digging mud that would come out and seep into water), it is recommended to have the plan to construct the coffer dam to prevent such occurrence. The construction of side coffer dams cannot interfere with fish migratory path.

d) Avoid of construction waste water, waste residue and residual mud waste getting into the river course.

e) It is recommended to increase fish pass structure in the water intake location of Nangun River, and along water retention weirs in Qingshui River to ensure the fish movement between upper and down reaches.

f) Setting up covers to prevent the solid waste falling into the river course.

g) Avoid of block of river stream to prevent the fish migration due to the soil collapse of piling activities.

h) Employing the LID (low impact development) approach such as gabion ditch and gabion dam, to manage rainwater and reduce soil erosion.

i) Maximum use of ecological measures to protect the river slopes, to reduce the soil erosion, and increase the interaction between the water and soil.

j) The contractors will be requested to have the environment education to the workforce. All staff should comply with the Management Regulation of Nanting River, which was issued in December 2017. All illegal activities such as fish harvesting in March to May, use of certain types of capture methods, and disposal of polluted wastes into the river would need to stop.

k) Any fish caught in the construction period will be released back into the river, especially for the temporary river diversion period in Qingshui River and Nanpa River.

135. During the project operation period, the following measures are recommended:

a) Investment in scientific research programmes, to collect the fish inventory, population distribution, population trends and threats, and biological information for developing more effective management strategies.

b) Enhancement of capacity building of local Fishery Management Authority and Administrative Bureau of NAGR of lower reach of Nanting River.

c) Identification of important fish habitats by the local Fishery Management Authority, while fishing and harvesting in these areas being prohibited during the spawning season.

d) Monitoring of the fish population status and assessment of population dynamics in the vicinity of project sites in Qingshui River, Nanpa River, Nangun River and Nanting

River.

e) Collecting the waste water and oil contamination from the surface of Nanting Bridge into the urban waste water network, rather than feeding into the river course directly.

136. In addition, the monitoring will be enhanced for the releasing water from waste water treatment plant, and potential waste water from municipal solid waste transmission station. The primary purpose is to prevent contamination to the river ecosystem.

137. Table 5.2 discussed the construction timings for construction on various river sub-projects.

**Table 5.2 Timing of construction for River sub-projects**

| No. | Activity of Fish | Season | Activity to Stop/Start | Result of Action |
|---|---|---|---|---|
| 1 | Spawning Concentration period | April to June | Stop construction of river rehabilitation and water intake structure | Fish breeding succeeded. |
| 2 | Flood Migratory Season | June to September | Stop Piling and excavation works for Nanting Bridge | Free fish migration completed. |
| | | | Develop Fish pass structure at intake location at Nangun | Migration between upper and down reaches. |
| | | | Water retention weirs at Qingshui River | Migration between upper and down reaches. |

# VI. Biodiversity Monitoring Plan

138. The biodiversity assessment involves compiling inventories and providing baseline information for the selection of the elements to monitor. In the former parts of this report, the species, habitats, and communities that are important due to their rarity or those can be used as biological indicators, or those that are important to local human communities were identified. The assessment process includes field surveys, literature reviews, stakeholder consultation, and inventories to gather data relevant to the site-specific survey programme, and to identify knowledge gaps and target indicator variables.

139. In order to fill gaps of baseline knowledge and information, the scientific monitoring and research are proposed to initiate, especially in the river systems. The main purpose is to provide early warnings of conditions that require management intervention.

140. This biodiversity monitoring plan comprises two parts: terrestrial biodiversity monitoring plan (Table 6.1) and aquatic biodiversity monitoring plan (Table 6.2). The potential impact, mitigation measures, monitoring mean and frequencies, locations, measurement indicators and responsibility are presented.

## A Terrestrial Biodiversity Monitoring Plan

141. The plan (**Table 6.1**) is designed in three impact aspects: avifauna biodiversity, amphibians and reptiles, and timberland and habitat degradation. In the light of conservation values, there are not special animals or habitats needed to be conserved. As the population number of wild fauna under nationally protected animal list and IUCN RedList is small in each sub-project site, and the distribution is widespread. Therefore, the terrestrial biodiversity monitoring is a soft plan for the future implementation.

## B Aquatic Biodiversity Monitoring Plan

142. The plan (**Table 6.2**) is mainly consisted of five aspects, such as impacts on fish resources, riverine habitats and water quality, sediments in riverine environment, and scientific information gaps. Even there is no nationally protected fish species found in the river systems, thirteen fish species were the endemic in Nu river system and four species were identified as the conservation targets by the NAGR of lower reach of Nanting River. This plan is strongly recommended to initiate during the project construction and after the project completion. The major concern is to detect the impact of proposed Nanting Bridge on the fish composition in the upper and down of bridge.

143. However, the biological information of four conservation targets is very limited. The capacity of local fishery staff is not qualified for the regular monitoring. With the issuance of protection and management regulation of Nanting River in Lincang Prefecture, the enforcement should be enhanced in the future.

## C Institutional Arrangements

144. Key organizations involved in biodiversity monitoring of the project areas are as follows: Project Executing Agencies, Design Institutes, Contractors, Supervising agency, local Natural

Resources Management Bureaus (Forestry, Wildlife, Fishery), and two short team biodiversity survey implementation specialists.

145. The **terms of references of the Terrestrial Survey specialis**t are the follows:

146. The survey monitoring of terrestrial fauna and flora is recommended to be contracted to individual survey expert who will be hired by the PIU for the duration of construction impact at each of the subproject site where earthwork digging and filling of spoils is being done.–.

a) Objective of the assignment:

The specialist will carried out the due diligence that relevant mitigation measures are implemented through terrestrial biodiversity monitoring as presented in the Environmental Monitoring Plan to ensure the impacts within an acceptable level.

b) Scope of the assignment.

The specialist will conduct the biodiversity survey monitoring with emphasis of the project area of LBECZ.

c) Detailed tasks.

(1) Terrestrial fauna survey, with emphasis on the avifauna, amphibians and reptiles within the 2 kilometer radius of project area;

(2) Key habitat survey of amphibians and reptiles in hibernation period;

(3) Identification of removal of key habitats;

(4) Site survey in the afforestation area as the compensation for carbon emission due to the cutting of rubber trees, and collection of the biodiversity information;

(5) Conservation measures proposed to increase the biodiversity, especially for the species of landscape plants.

d) Minimum qualification requirements.

The specialist has the postgraduate degree with at least 8 years' experiences on inventory surveys on terrestrial fauna and flora; the ability to develop, analyze and articulate project issues; ability to diagnose problems and propose reliable solutions. The working experience in Yunan Province would be perfect. A high standard of experience of the development of technical reports in English and Chinese is required.

e) Budget and working months.

In an intermittent basis, the total working months would be three months to the maximum. The total budget estimate is US$ 60,000 including $ 30,000 for the construction phase and $ 30,000 for the operation phase.

147. The **terms of references of the Aquatic Survey specialis**t are the follows:

148. The survey monitoring of aquatic fauna is recommended to be contracted to an individual

survey expert who will be hired by the PIU for the duration of construction at the following subproject sites Nanting Bridge, water supply diversion structures, Qingshuihe river embankment rehabilitation period and construction of discharge pipe at WWTP in Quingshuihe river.

a) Objective of the assignment:

The specialist will carried out the aquatic monitoring survey that relevant mitigation measures are implemented through aquatic biodiversity monitoring as presented in the Environmental Monitoring Plan to ensure the impacts within an acceptable level.

b) Scope of the assignment.

The specialist will conduct the aquatic biodiversity monitoring survey with emphasis of the river sub-projects of LBECZ.

c) Detailed tasks.

(1) Ensure data collection when the construction works occurred in dry seasons with avoidance of the breeding season and migration season as presented in the Environmental Monitoring Plan;

(2) Ensure data collection during construction of fish pass structure, and Water and Soil Conservation Works in river sub-projects;

(3) Monitoring survey of fish catch during the construction and operation phases in suitable location of Nanting River;

(4) Survey on the fish resources in Qingshui River, Nanpa River and Nanting River in suitable locations;

(5) Fish spawning habitat survey within 5 km of upper reach of proposed Nanting Bridge;

(6) Assessment of the changes in fish composition in three rivers during the construction and operation phases;

(7) Recommend to PIU working with Environment Supervision Consultant (CSC) based on survey planting native aquatic plants to increase the capacity of water pollution and aquatic biodiversity in the river rehabilitation areas;

(8) Working with PIUs ESC, provide training to the working staff of Nanting Reserve and Fish Resources Management Stations in Gengma County and Lincang Prefecture.

d) Minimum qualification requirements.

The specialist has the postgraduate degree with at least 8 years' experiences on inventory survey on fish and their habitats; ability to develop, analyze and articulate project issues; ability to diagnose problems and propose reliable solutions; skills to train the working staff of NAGR in lower reach of Nanting River, and Aquatic resources management stations of Lincang and Gengma Agriculture Bureaus. The working experience in Yunnan Province would be prefect. A high standard of experience of the development of technical reports in English and Chinese is required.

f) Budget and working months.

In an intermittent basis, the total working months would be six months to the maximum. The total budget estimate is US$ 140,000 including $ 110,000 for the construction phase and $ 30,000 for the operation phase.

**Table 6.1 Terrestrial Environmental Monitoring Plan**

| No | Potential Impact | Proposed Mitigation measures | Monitoring Means and frequency | Location | Performance Indicator | Responsibility[4] | Approximate Cost US$ |
|---|---|---|---|---|---|---|---|
| **A Construction Phase** | | | | | | | |
| 1 | Impact on the avifauna biodiversity with generally low conservation values | Avoid of land clearance in breeding season. | Investigation in beginning and three months after the start of construction | Project area of LBECZ | Avian composition and population size | LBECZ/contractors | 15,000 |
| 2 | Impact on the amphibians and reptiles, especially for Tiger frog, Tokay gecko, and Asian water monitor. | Avoiding land clearance of key habitats of amphibians and reptiles in hibernation period | Investigation in beginning and three months after the start of construction | Project area of LBECZ | Number of key hibernation habitats | LBECZ/contractors | 5,000 |
| 3 | Removal of trees, degradation of habitats | Replanting and restoration | Once in each year during the first three years of planting | Project area of LBECZ | Number of new plants, and area of restored habitats | LBECZ/ contractors | 10,000 |
| | **Total cost for terrestrial environmental monitoring during construction phase** | | | | | | **30,000** |
| **B Operation Phase** | | | | | | | |
| 1 | Impact on terrestrial animals and vegetations due to the LBECZ operation | Monitoring | Once before, and 1st and 3rd after the project completion | Project area of LBECZ | Monitoring report including inventory, status and trend | Natural resources management agency of Lincang | 30,000 |
| | **Total cost for terrestrial environmental monitoring Survey during the operation phase** | | | | | | **30,000** |

[4] The contracted survey specialist will interact with these organizations to conduct survey.

**Table 6.2 Aquatic Environmental Monitoring Plan**

| No | Potential Impact | Proposed Mitigation measures | Monitoring Means and frequency | Location | Performance Indicator | Responsibility[5] | Approximate Cost US$ |
|---|---|---|---|---|---|---|---|
| **A Construction Phase** | | | | | | | |
| 1 | Impact on fish resources | River diversion and dredging works will occurred in dry seasons.<br>Constructions of fish pass structure together with the retention weirs. | Once before and once after construction | River rehabilitation project area | Records of assigned activities before and after construction | DIs and Contractors | 10,000 |
| | | Construction of fish pass structure in the water intake location. | Once before and once after construction | Water intake location of Nangun River | | | |
| | | Construction works, such as piling, excavation and installation, will avoid the spawning season (April to June) and flooding season (June to September); Require making channels for fish and benthic fauna and maybe cover at bridge area so no debris flows to river bed on sides | Once before and once after construction | Nanting River Bridge and water intake location of Nangun River | | | |
| | | Environmental training to workforce on importance of fisheries and prohibit illegal fishing practices | Regular monitoring | PMO | | | |
| 2 | Impact on riverine flora | Replanting the local and native plants along the river sides to compensate the loss of biodiversity.<br>Employing the ecological slope protection technique to | Once before and once after construction | River rehabilitation project area | Records of assigned activities before and after construction | DIs and Contractors | 10,000 |

[5] The contracted survey specialist will interact with these organizations to conduct survey.

| No | Potential Impact | Proposed Mitigation measures | Monitoring Means and frequency | Location | Performance Indicator | Responsibility[5] | Approximate Cost US$ |
|---|---|---|---|---|---|---|---|
| | | the maximum extent.<br>Employing the LID (low impact development) approach such as gabion ditch and gabion dam, to manage rainwater and reduce soil erosion. | | | | | |
| 3 | Scientific information gaps resulting in the poor EMP of aquatic environments | Enhancing the capacity building of fishery management staff.<br>Improving the implementation of fishery protection measures and wetland management regulation of Nanting River. | Regular training during the construction period | Fishery Management Agencies in Lincang/Gengma | Records of training and legislation | Fishery Management Agencies in Lincang/Gengma | 15,000 |
| | | Population variation understood in the project affected rivers. | Once before, regularly during and once after construction. | Project affected rivers | Fish inventory and trend, and the fish catch data | Fishery Management Agencies /contractors | 20,000 |
| | | Investigation of current and potential key spawning and foraging habitats. | One before and once after construction. | Project affected rivers | Investigation reports | Fishery Management Agencies /contractors | 10,000 |
| | | Biological study on the four conservation fish species. | Routine study | Nanting River | Study reports | Contractors | 15,000 |
| 4 | Sedimentation in riverine environments due to rehabilitation, dredging and disposal of excavated material | Any disposal of excavated material should be done outside the riverine area from fish migration or breeding grounds. Disposal should be timed to be outside of the very rough areas. | Once before, regularly during and once after construction. | Project affected areas | Siltation of riverine ecosystems due to construction activities. | Contractors | 5,000 |
| | | Soils excavated for LBECZ should be used for re-filling | Routine monitoring | Project affected areas | Physical water quality, (TSS, | Contractors | 10,000 |

| No | Potential Impact | Proposed Mitigation measures | Monitoring Means and frequency | Location | Performance Indicator | Responsibility[5] | Approximate Cost US$ |
|---|---|---|---|---|---|---|---|
| | | and should not be left exposed to wind or water for long periods. | | | soil texture) | | |
| | | Sediment control measures such as retention weirs will be used, as necessary, to minimize sediment transport offsite. Silt fencing will also be implemented to minimize erosion of soil stockpiles. | Once before, regularly during and once after construction | Project affected areas | Monitoring report of water and soil conservation | Contractors | 15,000 |
| | **Total cost for Monitoring Aquatic Environment during Construction** | | | | | | **110,000** |
| **B Operation and maintenance phase** | | | | | | | |
| 1 | Impacts of fish due to LBECZ operation | Fish catch monitoring program | Six monthly fish catch analysis from the area for three years | Upper and down of Water intake dyke, Dawanjiang, and Estuaries of Nanpa and Qingshui Rivers. | Variation in Fish species composition and catch before construction and during operation | Fishery Management Agencies /contractors | 20,000 |
| 2 | Impact on river water quality | Management of waste water and oil contamination into urban waste water network; Contractor must dispose solid wastes away from the site to an approved licensed waste disposal site instead of rivers and valleys. | Routine maintenance | Qingshui River and Nanpa River | Supervision report | Supervision company | 10,000 |
| | **Total cost for aquatic environment monitoring survey during operation and maintenance phase** | | | | | | **30,000** |

## Appendix A. Namelist of local stakeholders interviewed during the site visits

| Name | Title | Working organization |
|---|---|---|
| Yang Guangfu | Head | Division of Water Administration of Cangyuan Water Resources Bureau |
| Han Guiqing | Head | Aquatic Product Station of Cangyuan Fish Resources Management Bureau |
| Li Yongbiao | Deputy Director | Gengma Water Resources Bureau |
| Ms. Yang | Deputy Director | Gengma Agriculture Bureau |
| Mr. Zhang | Director | Gengma Management Sub-Bureau of Nanguan River NNR |
| Ms. Chen Juan | Head | Mengding Agriculture Administrative Management Office |
| Huo Haijun | Head | Mengding Water Resources Administrative Management Office |
| Guo Linda | Head | Mengding Forestry Administrative Management Office |
| Zhao Xuechuang | Head | Division of Water Administration of Lincang Water Resources Bureau |
| He Chaonen | Head | Division of Countryside Water Resources, Lincang Water Resources Bureau |
| Liang Yunan | Head | Aquatic Product Station of Lincang Agriculture Bureau; National Aquatic Germplasm Reserve in lower reach of Nanting River; National Aquatic Germplasm Reserve in Nanpeng River |
| Zhou Yourong | Manager | Lincang Runting Water Resources Science and Technology Services Ltd. Co. |
| Li Qiang | Staff | Lincang Wildlife Protection and Management Bureau |
| Mr. Zhang | Deputy Director | Lincang Forestry Bureau |
| Ms. Li | Head | Administrative Bureau of Lancang River Provincial Bureau |

## Appendix B. Survey report in the vicinity of proposed Nanting Bridge

On April 24, the site survey was conducted to check the location of potential spawning sites and the landform in the vicinity of proposed Nanting Bridge. The total length of river course survey is 9.6 kilometers, including 1.0 kilometer in the down reach and 8.6 kilometers in the upper reach of proposed Nanting Bridge. In general, the river course survey can be divided into five sections (**Figure B.1 and Table B.1**).

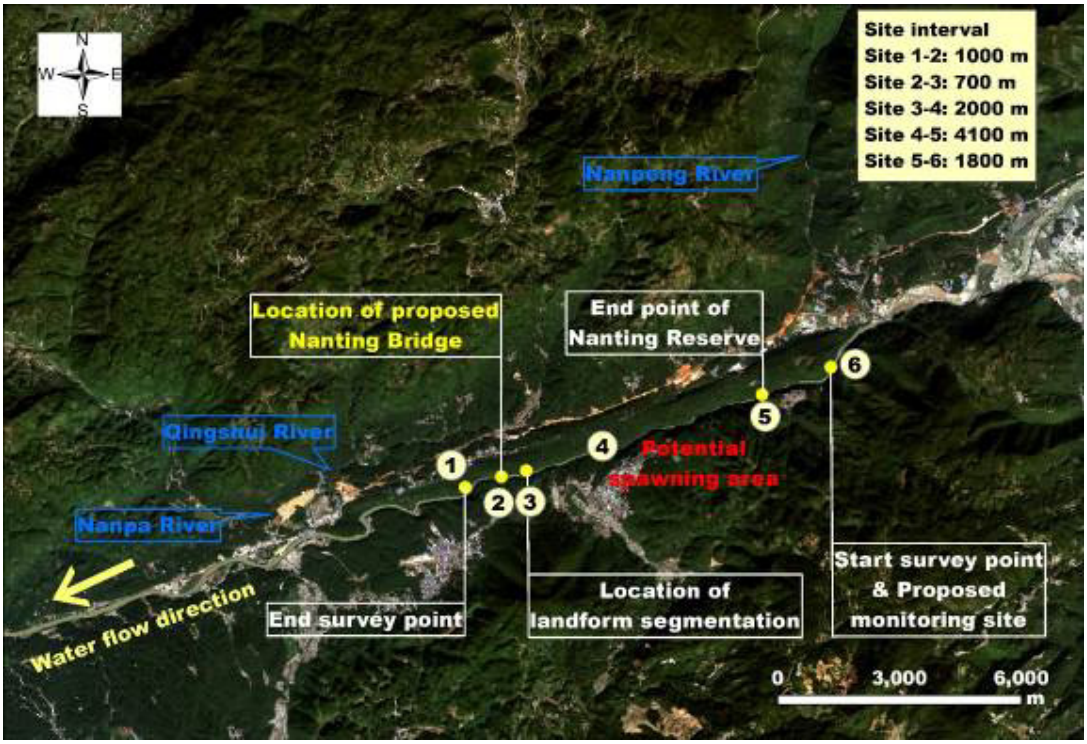



**Figure B.1 Key locations in the vicinity of proposed Nanting Bridge**

There are two connected sections (from Site 4 to Site 5, and from Site 5 to Site 6 in Figure ?) as the potential spawning area for fish laying floating-eggs, which is located in the far upper reach exceeding 2.7 kilometers of proposed Nanting Bridge. The total length of river course with potential spawning area is 5.9 kilometers (from Site 4 to Site 6). The major considerations are the follows:

(1) The river course between 1000 m (Photo 1) in the lower reach and 700 m (photo 3) in the upper reach of proposed Nanting Bridge (Photo 2) is not suitable for fish spawning. As the landform of river sides in the two sections are steep, and consist of regular stones or soil rather than staggered rocks.

(2) The river course between 700 m and 2700 m (Photo 4) (section between Site 3 and Site 4) in the upper reach of proposed Nanting Bridge become more staggered rocks than the river sides in the lower reaches (section from Site 1 to Site 3). The Site 3 is the location of landform segmentation.

(3) The river course between Site 4 and Site 6 consists of staggered rocks (Photo 5 and Photo 6), which would be the potential spawning area for fish laying floating-eggs. In this section, the Site 5 is the end point of National Aquatic Germplasm Reserve in the lower reach of Nanting River.

**Based on these observations, the construction of proposed Nanting River would have some impact on the fish migration, rather than fish breeding**. Considering the design of Nanting Bridge is three span twin cable stayed style, the construction will not happen in the river course. This will reduce the impact on fish migration to a large extent.

However, the river course is the concentration distribution area of four conservation fish, identified in the master plan of NAGR of lower reach of Nanting River, which include two near-threatened species

*Anguilla nebulosa* and *Bagarius yarrelli* under the IUCN RedList. **The drilling of piles in the river sides will disturb the fish migration due to increasing noise and water turbidity. In addition, the solid waste and potential pollution from the engineering operation would also affect the water quality and increase the risk of fish migration**. Relevant mitigation measures are proposed in next section.

**Table B.1 Basic information of key locations in the vicinity of proposed Nanting Bridge**

| Location | Coordinates | Site/Photo code | Elevation (m) | Interval* (m) | Remarks |
|---|---|---|---|---|---|
| End survey point | 23°29′23″N; 98°52′25″E | 1 | 448 | 1000 | In this river course between site 1 and site 2, both river sides are pretty smooth, which are not suitable for spawning by fish. |
| Location of proposed Nanting Bridge | 23°29′29″N; 98°52′57″E | 2 | 445 | 700 | In this river course between site 2 and site 3, both river sides are pretty smooth, which are not suitable for spawning by fish. The water runoff is relatively slow and water level becomes shallow due to the small land elevation difference. |
| Location of landform segmentation | 23°29′35″N; 98°53′20″E | 3 | 444 | 2000 | The landform has significant difference in the upper and down reaches of site 3. Both river sides become irregular rocks in the upper reach of this location. The water runoff is higher than the down reach due to the high elevation difference. |
| Location of distinctive large and irregular rocks in the upper reach | 23°29′55″N; 98°54′23″E | 4 | 451 | 4100 | The landform of both sides consist of large and staggered rocks between site 4 and 5, which provides potential spawning area for fish laying floating-eggs. |
| End point of NAGR of Lower Reach of Nanting River | 23°30′41″N; 98°56′51″E | 5 | 464 | 1800 | The end point is 6.8 km from the location of proposed Nanting Bridge. |
| Stare survey point | 23°31′2″N; 98°57′40″E | 6 | 473 | | The site is recommended to be the monitoring site during the project implementation period, which is easily reachable and approximately 50 m in the upper reach of swift current. |

**Note: The interval indicates the distance of the point to the nearest point in the upper reach of Nanting River**

**Photo 1**

**Photo 2**

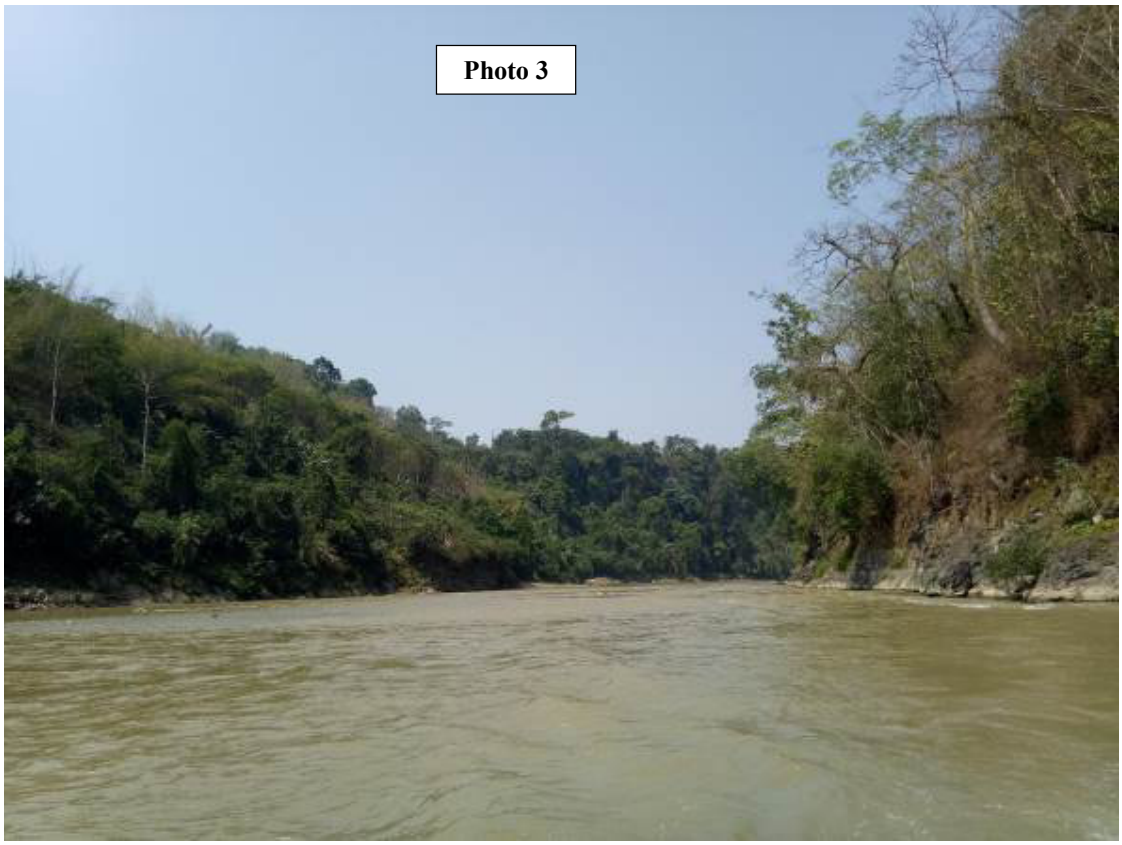


**Photo 3**

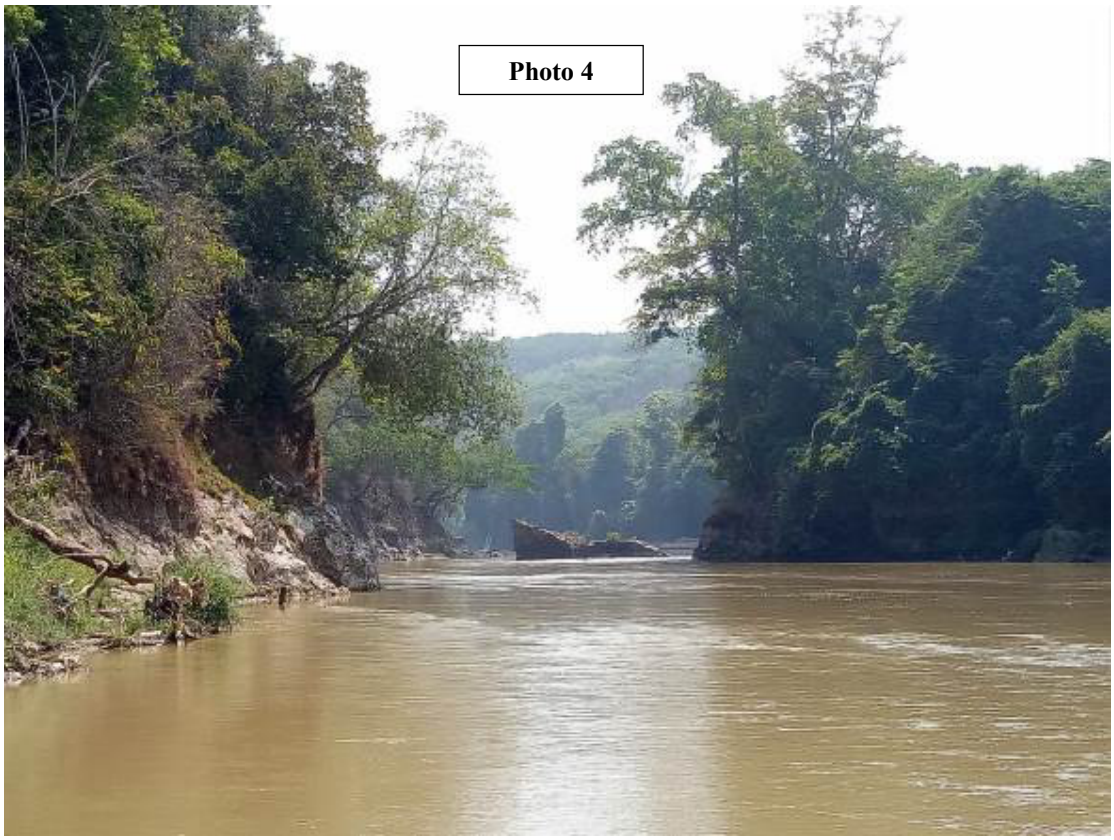


**Photo 4**


Photo 5


Photo 6