An empirical analysis of the influence of typical highways in the Sanjiangyuan Protected Area on wetlands

Haixiu Sun¹, Yuanpeng Zhao¹, Zhengyun Wang¹ and Tianli Zheng², *

¹ Qinghai Provincial Administration Bureau for Highway Construction, Xi’ning Qinghai 810000, China
² Tianjin Research Institute for Water Transport Engineering, M.O.T, Tianjin 300000, China

*Corresponding author e-mail: zhengtlpku@163.com

Abstract. Wetlands play an important role in water conservation and biodiversity accumulation. The crossing highways may cut off the water flow relationship between wetland patches, and further influence wetland ecosystems. In this study, we investigated the situation of wetlands based on field survey, aerial photographic and remote sensing image interpretation along two roads (Gongyu Expressway and S308 road) in the Sanjiangyuan Part. We found that there were only two places exhibits a different wetland image at the either side of the road. Road construction basically did not obstruct wetlands. It was also noted that by improving existing culverts, measures could be taken to avoid or alleviate such phenomena.

1. Introduction
The average elevation of the Sanjiangyuan Protected Area is about 4400m. There are large areas of alpine wetland in this region, which play an important role in water conservation and biodiversity accumulation [1]. Highways are vital infrastructure of the national economy, but the construction and operation of highways may cause the effects of connectivity and water quality of wetland structures and functions [2]. It is important to make clear the influence of the highway on the wetland, to ensure that highways construction does not destroy the original hydraulic connectivity system and to maintain the normal hydrological process of the wetland. However, most of the existing studies are based on the description of experience, and lack of field-based empirical analysis, especially the case studies on the impact of highway construction on wetlands in the Sanjiangyuan Protected Area are still scarce.

In this project, we use the Gongyu Expressway and S308 road as the target areas in Sanjiangyuan Protected Area, adopts the technical means of combining ground, aerial photographic and remote sensing image interpretation, obtain the characteristics of remote sensing image before and after highway construction, and carry out an empirical analysis on whether the highway construction has separation effect on the alpine wetland in Sanjiangyuan Protected Area, with a view to providing scientific basis and research foundation for highway construction in Sanjiangyuan Protected Area in the future.
2. Materials and Methods

2.1. Overview of Study Area
In this study, we use the Gongyu Expressway and S308 road as the target areas in the Sanjiangyuan Protected Area. The average elevation of the Gongyu Expressway (Gonghe to Yushu (Jiegu) Expressway) is 4500m, and the plateau wetland ecosystem is the main one along the route. The S308 road (Yushujiegu Town to Budongquan section of the expressway, Line S308) along the alpine hypoxia, mainly for the alpine meadow grassland ecosystem.

2.2. Research Methods
This project adopts the technical means of field survey, aerial photographic and remote sensing image interpretation, to obtain the present situation and its evolution process of wetland around the highway. Survey of Wetland Status: combined with satellite remote sensing images, we carried out investigations of Gongyu Expressway and S308 road along the route. Using aerial photographic technology to investigate the current situation of wetland, found two wetland separation areas, located at K355 of Gongyu Expressway (35° 20'3.24" N, 99° 4'12.03" E) and S308 road (33° 30'54.14" N, 96° 5'2.24" E), respectively. In addition, K520 of Gongyu Expressway (34° 40'36.80" N, 98° 3'3.11" E) was selected as a typical case of the highway crossing through wetland without separation.

Wetland change analysis: Based on a comparative analysis of satellite imagery from 1990-2017 and aerial imagery from 2018, satellite images are from the QuickBird Satellite Sensor, with a resolution of 0.6 m; drone aerial imagery image source type is DJI phantom4pro, with a resolution of 0.05-0.1 m.

3. Results and Analysis

3.1. Cases Where Highway did not Cause Wetland Separation
The investigation on the whole line of Gongyu Expressway and S308 road shows that the construction of the highway has no separation effect on the wetland in most areas. Taking K520 in the Gongyu Expressway as an example, the Gongyu Old Road (G214) without the culvert and the Gongyu Expressway passed by the bridge have not been degraded before and after the completion of the wetland. Presumably the reason is that the terrain is flat, the surrounding mountains can collect runoff, the groundwater level is high, the year-round formation of blisters in low-lying areas, these water bubbles have a lower horizontal hydraulic connection, and the surface runoff cut off by the road has less effect on its overall hydraulic connectivity.
Figure 1. K520 subgrade on Gongyu Expressway (Figure a, b, c and d are satellite images for 2004, 2007, 2010 and aerial photographic images for 2018, respectively).

3.2. Cases where Highway Caused Wetland Separation
Only the wetland at K355 of Gongyu Expressway was found blocked by the highway. Satellite remote sensing images show that the construction of the earlier Gongyu Old Road (G214) has resulted in a water system separation, and the wetlands along the north and south of the road have been separated, with only the finer channels formed by culverts connecting the north and south through the road. Images of 2015 and 2017(e, f in Figure 2) show that the north side of Gongyu Expressway has formed a lake due to severe water accumulation, while the south side vegetation presents degradation, and the 2018 aerial photographic images (g in Figure 2) show the same result. Because it is difficult to form a floodplain wetland on one side and a narrow channel on the other side under natural conditions [3]. It is inferred that the reason for the wetland separation is that the direction of runoff is from north to south, but the culvert has insufficient water area, which leads to the formation of water in the road north, which cannot be fully discharged through the culvert, and is tightened into a narrow river by the culvert on the south side.
Figure 2. K355 subgrade on Gongyu Expressway (Figure a, b, c, d, e, f and g are satellite images for 1990, 2000, 2010, 2013, 2015, 2017 and aerial photographic images for 2018, respectively).

A section along the S308 road has been found with intermittent separations to wetlands. Aerial photographic images with different flight heights (Figure 3) show that intermittent separations at the site cannot flow through the culvert when the water is less due to the high location of the culvert, forming water on the northeast side of the highway, resulting in the death of vegetation at the water accumulation. Related studies have also found that sand movement will cause water accumulation and sand accumulation on one side of culverts when culverts are overbuilt [4].

Figure 3. Case of water system separation in S308 road section (Figure a and b are aerial photographic images in 2018 respectively).

4. Conclusions and Recommendations
Surveys along the ground, aerial photographic and remote sensing image interpretation results show that the construction of Gongyu Expressway and S308 road basically did not separate the wetland in the Sanjiangyuan Protected Area. There are only two viable possible wetland degradation caused by road construction, which can be slowed down by applying measures such as increasing and improving culverts.

The impact of highways on wetlands is long-term and cumulative [5]. In the future, it is necessary to strengthen the dynamic monitoring of the evolution of alpine wetland along the highway in the Sanjiangyuan Protected Area, and seek a new balance between construction and ecological protection.
on the basis of quantifying the impact of highway construction and operation on the ecological environment along the Sanjiangyuan Protected Area.

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References
[1] W. J. Mitsch and J. G. Gosselink, The value of wetlands: importance of scale and landscape setting, J. Ecological Economics. 35 (2000) 25-33.
[2] Y H Zhou and Y He, Impact of Highway Construction on Wetland, J. Anhui Agricultural Science Bulletin. 23 (2017) 83-85.
[3] X S Song, W Deng, X S Song, et al., Mathematical model for continuous diffusion flow on wetland surface, J. Journal of Hydraulic Engineering. 38 (2007) 1166-1171.
[4] R. J. Barnard, J. Johnson, P. Brooks, et al., Water Crossings Design Guidelines, Washington:Department of Fish and Wildlife, Olympia, Washington, 2013.
[5] Y Zhou, On the Monitoring of Wetland Vegetation Based on UAV Remote Sensing, J. Cultural Geography. 2(2017) 01.