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IMPACT OF ROAD CONSTRUCTION ON VEGETATION ALONGSIDE QINGHAI–XIZANG HIGHWAY AND RAILWAY

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ABSTRACT: Based on the field investigation in August 2001 and August 2002, digital China Vegetation Map in 2001 and Qinghai-Xizang(Tibet) Plateau Vegetation Regionalization Map in 1996, vegetation characteristics along two sides of Qinghai–Xizang highway and railway are studied in this paper. Meanwhile, the impact of Qinghai–Xizang highway and railway constructions on the vegetation types are analyzed using ARCVIEW, ARC/INFO and PATCH ANALYSIS. It was found that: 1) Qinghai–Xizang highway and railway span 9 latitudes, 12 longitudes and 6 physical geographic regions (East Qinghai and Qilian mountain steppe region, Qaidam mountain desert region, South Qinghai-Xizang alpine meadow steppe region, Qiangtang alpine steppe region, Golog-Nagqu alpine shrub meadow region and South Xizang mountain shrub steppe region); 2) the construction of Qinghai–Xizang highway and railway destroyed natural vegetation and landscape, especially in 50m-wide buffer regions along both sides of the roads, it was estimated that the net primary productivity deceased by about 30 504.62t/a and the gross biomass deceased by 432 919.25–1 436 104.3t. The losing primary productivity accounted for 5.70% of the annual primary productivity within 1km-wide buffer regions (535 005.07–535 740.11t/a), and only 0.80%–0.89% of that within 10km-wide buffer regions (3 408 950.45–3 810 480.92t/a). The losing gross biomass was about 9.47%–17.06% of the gross biomass within 1km-wide buffer regions (7 502 971.85–25 488 342.71t), and only 1.47%–2.94% of that within 10km-wide buffer regions (43 615 065.35–164 150 665.37t).

KEY WORDS: Qinghai–Xizang highway and railway; vegetation types; landscape index; fragmentation; net primary productivity; biomass

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1 INTRODUCTION

The railway and highway, as the unnatural corridors, were studied on their impact as following: 1) economic effects (KANG *et al.*, 2000): railway, highway and canal have direct economic benefits; 2) destruction of the habitat of wildlife and effect on the spread and transfer of species (FORMAN and LEXANDER, 1998; THIERRY, 2000; TIKKA *et al.*, 2001); 3) the studies on pollution and disasters (ZHANG and CHEN, 2000); 4) the studies on landscape fragmentation and edge effects (BOHEMEN, 1998; BORREGO *et al.*, 2000; DANIEL and DENNIS, 2001). These studies focus on the edges of forest-steppe (LUIZ and GILBERTO, 1997) abroad, and forest window effects and edge effects on wildlife were studied intensively in China (XI *et al.*, 1993; MA, 1990). Lately, ZHANG Yi-li *et al.* (2002) studied the changes of land cover and land use of the buffer regions of Qinghai–Xizang highway systematically. These studies were mainly on the area nearby traffic lines and traffic lines themselves, but the studies of impact of road construction on vegetation are rare. Qinghai–Xizang highway and railway lie in high-cold eco-frailty region, and the physical conditions are complicated (SUN and ZHENG, 1993). The constructed section (Xining to Golmud) and the constructing section (Golmud to Lhasa) of Qinghai–Xizang railway run parallel

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to Qinghai–Xizang highway approximately①. The studies on the effect of Qinghai–Xizang highway were mainly on permafrost (WU *et al*., 2000; ROY and CHOPPING, 1996) and land use changes.

2 STUDY AREA

The constructed section of Qinghai –Xizang railway (Xining to Golmud) lies in Qinghai Province, passing Xining City, Huangzhong County, Huangyuan County, Haiyan County, Gangcha County, Tianjun County, Wulan County, Delingha City and Golmud City. The constructing section lies in central Qinghai-Xizang Plateau, across Golmud City, Zhiduo County of Qinghai Province and Amdo County, Nagqu County, Damxung County, Doilungdêqên County, Lhasa Proper of Xizang Autonomous Region. The constructing section Qinghai–Xizang railway goes south by Qinghai–Xizang highway from Golmud City (Fig. 1). Total length of Qinghai –Xizang railway is 1142km, including the constructed 29.75km and the constructing 1112.25km, and 594.23km in Qinghai Province and 547.77km in Xizang Region. When the constructing section is finished, the total railway will cross 9 latitudes and 12 longitudes, with an altitude from 2200m to 5200m. Vegetation types alongside the railway comprise meadow steppes, deserts, alpine meadow steppes and high-mountain shrubs; precipitation is 40mm to 500mm; the lowest temperature is −33.6℃ and the highest is 35.5℃. The constructing section of Qinghai–Xizang railway lies in Qinghai-Xizang Plateau except that the section from Golmud to Nanshan Pass lies in the southern edge of Qaidam Basin①②③.

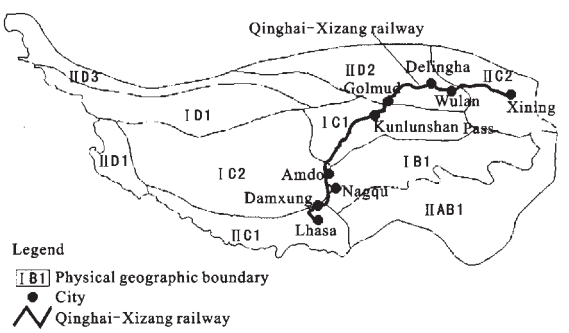
3 METHOD AND DATA

The study data include: the 1∶1 000 000 digital China Vegetation Map in 2001, the 1∶4 000 000 Qinghai-Xizang Plateau Vegetation Regionalization Map in 1996, the 1∶2 000 000 Map of Distribution of Natural Reserves and Function Regions Boundary Adjusting alongside Qinghai–Xizang railway. We have investigated the vegetation types alongside the railway from Aug.1 to 20, 2001 and Jul.29 to Aug.23, 2002. The digital and analysis work adopts R2V, ARCVIEW3.2 and ARCGIS8.1.

Data sources of biomass and net primary productivity in Qinghai-Xizang Plateau: major biomass of Qinghai-Xizang Plateau adopted the research results of LUO Tian-xiang *et al*. (1999), whose data came from sample investigating; the net primary productivity came from PIAO Shi-long and FANG Jing-yun (2002), who got the data from remote sensing imagines using NPP-CASE model; Other data came from WHITTAKER (1977).

The study object is the vegetation type along Qinghai–Xizang highway and railway, using the name of vegetation types and adjusting properly: Marsh and Water are combined to Marsh and the Cultivated vegetation was included in Farmland. There are 11 vegetation types: Ⅰ. Needle-leaved Forest; Ⅱ. Broad-leaved Forest; Ⅲ. Shrub; Ⅳ. Desert; Ⅴ. Steppe; Ⅵ. Grassland; Ⅶ. Meadow; Ⅷ. Wetland; Ⅸ. Alpine Vegetation; Ⅹ. Farmland; and Ⅺ. Land Without Vegetation.

The study includes structure analysis of vegetation types, the impacts of road constructing on vegetation types and the loss of biomass and the net primary pro-



ⅠB1 Golog-Nagqu Alpine Shrub Meadow Region
ⅠC1 South Qinghai-Xizang Alpine Meadow Steppe Region
ⅠC2 Qiangtang Alpine Steppe Region
ⅠD1 Kunlun Alpine Desert Region
ⅡAB1 West Sichuan and East Xizang Mountain Needle-leaved Forest Region
ⅡC1 South Xizang Mountain Shrub Steppe Region
ⅡC2 East Qinghai and Qilian Mountain Steppe Region
ⅡD1 Ali Mountain Semi-desert and desert region
ⅡD2 Qaidam Mountain Desert Region
ⅡD3 North Kunlun Mountain Desert Region

Qinghai–Xizang highway is parallel to Qinghai–Xizang railway approximately

Fig.1 Location of Qinghai–Xizang Railway

① Institute of Exploration and Designing, Railway Ministry. Report of environmental topic on constructing Qinghai –Xizang railway Golmud to Lhasa (Tanggula mountain pass to Lhasa). February 2001. Lanzhou.
② Institute of Exploration and Designing, Railway Ministry. Evaluation conspectus of environment effects on constructing Qinghai–Xizang railway Golmud to Lhasa (Golmud to Tanggula mountain pass). April 2001. Lanzhou.
③ Institute of Exploration and Designing, Railway Ministry. Evaluation conspectus of environment effects on constructing Qinghai–Xizang railway Golmud to Lhasa (Tanggula mountain pass to Lhasa). April 2001. Lanzhou.

ductivity. 1) The analysis of structure of vegetation types adopts percentage of vegetation types and some landscape indexes, comparing among 1km-wide, 10km-wide and 30km-wide buffer regions and different regions. 2) The effect of road constructing on landscape adopt Number of Patches (*NP*), Mean Patch Size (*MPS*), Mean Shapes Index (*MSI*), Patch Size Standard Deviation (*PSSD*), Edge Density (*ED*) and Shannon's Diversity Index (*SDI*). 3) The road constructing also affects the biomass and net primary productivity.

4 RESULTS

4.1 Analysis of Integrated Ecosystem Structure

The analysis of 1km-wide, 10km-wide and 30km-wide buffer regions of Qinghai–Xizang railway (including the constructed section and the constructing section) shows that the distribution tendencies of vegetation types are similar in 1km-wide, 10km-wide and 30km-wide buffer regions (Table 1): the supreme vegetation type is Meadow, the second is Steppe and both of them occupy more than 60% of total area; the third is Desert, which is about 16% of total area; next are Land Without Vegetation, Shrub, Alpine Vegetation, Farmland, Needle-leaved Forest, Broad-leaved Forest and Wetland. It is notable that in the vegetation types alongside the railway, Farmland is more than 6% and as the increasing of distance to railway the percentage of Farmland decreases.

Table 1 Area percentage of vegetation types alongside Qinghai–Xizang highway and railway (%)

Vegetation type	1km-wide buffer region	10km-wide buffer region	30km-wide buffer region
Ⅰ Needle-leaved Forest	0.02	0.29	0.40
Ⅱ Broad-leaved Forest	0.00	0.06	0.04
Ⅲ Shrub	5.23	4.52	5.19
Ⅳ Desert	16.07	16.95	14.81
Ⅴ Steppe	26.30	23.02	21.67
Ⅵ Grassland	0.00	0.00	0.00
Ⅶ Meadow	38.78	40.39	43.24
Ⅷ Wetland	0.40	2.72	0.00
Ⅸ Alpine Vegetation	1.79	4.50	6.26
Ⅹ Farmland	7.71	2.48	1.29
Ⅺ Land Without Vegetation	3.70	5.07	7.11

It should be pointed out in particular that Wetland is the important and sensitive ecosystem, which spread around Qinghai–Xizang highway and railway and mainly in Amdo County, Nagqu County and Doilungdêqên County, and the famous Agong Wetland and Lalu Wetland are distributed there. The constructing railway will traverse 38.8km of wetland. Road constructing will destroy vegetation, surface water and animal habitats, therefore the impacts of road constructing on wetland should not be not ignored.

4.2 Analysis of Regional Vegetation Types Structure

The Qinghai–Xizang highway and railway is about 2000km and cross 9 latitudes and 12 longitudes. The vegetation types change greatly alongside the road, which means that there are different environmental problems.

4.2.1 Comparison of areas in different regions

By overlaying the natural regionalization map on 1km-wide, 10km-wide and 30km-wide buffer regions of railway in vegetation type map, the vegetation type map was divided into 6 regions (Fig. 2) and the areas of vegetation types in different regions are shown in Table 2.

Region 1: In this region Steppe is dominant ecosystem, next are Meadow and Farmland; in 30km-wide buffer region, Shrub and Wetland occupy a certain percentage. This region displays steppe landscape. The percentage of Farmland decrease from 20% to 4%, which shows that there is a certain percentage of farmland and as the increasing of distance to railway Farmland decreases greatly because of environmental compatibility and closing to cities.

Region 2: Desert occupies about 50% of the total area, next are Land Without Vegetation, Meadow, Steppe and Shrub. This region crosses Qaidam Basin and displays desert landscape. Farmland has the same features as region 1.

Region 3: Meadow and Steppe have high area percentage and the percentages of other vegetation types are small and the region shows alpine meadow steppe landscape. Confined by natural condition, there is only small percentage of farmland in this region.

Region 4: Meadow occupies about 80% in 1km-wide and 10km-wide buffer regions and 50% in 30km-wide buffer region, next are Steppe and Alpine Vegetation; the other vegetation types have little or no percentage.

Region 5: Meadow area is about 96% in 1km-wide buffer region and 90% in 10km-wide and 30km-wide buffer regions; Alpine Vegetation is 6.1% in 30km-wide buffer region; it is typical alpine meadows landscape.

Region 6: Meadow is more than 46%, next are Shrub and Steppe. The features of the Farmland are similar as Region 1 and Region 2.

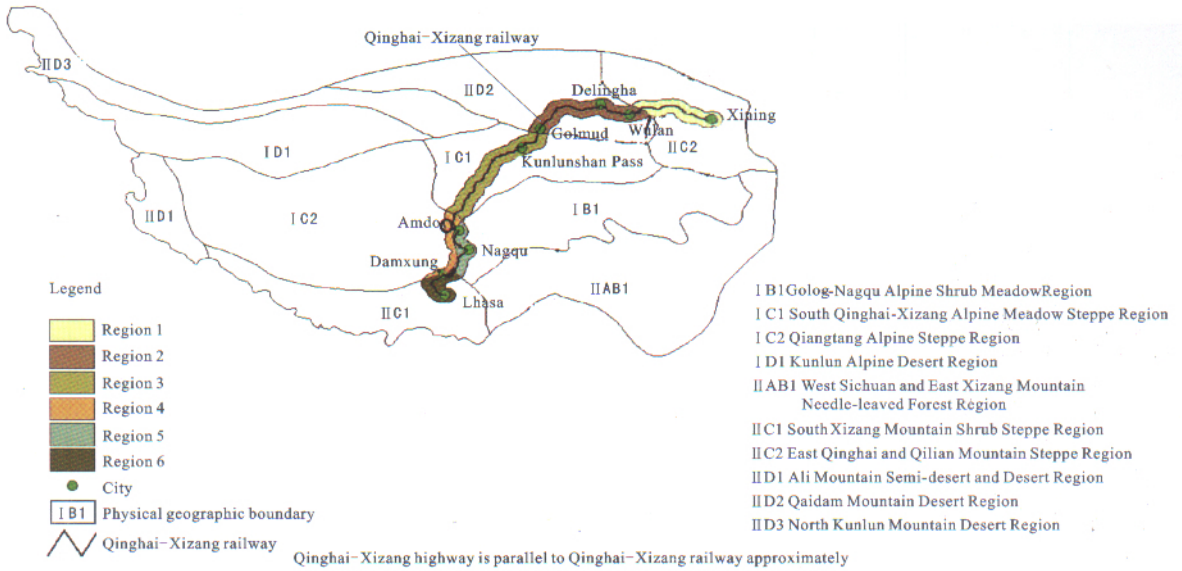


Fig. 2 Vegetation type regions alongside Qinghai-Xizang highway and railway

Table 2 Area percetages of different vegetation type regions(%)

Vegetation type region	Buffer region	Ⅰ	Ⅱ	Ⅲ	Ⅳ	Ⅴ	Ⅵ	Ⅶ	Ⅷ	Ⅸ	Ⅹ	Ⅺ
Region 1	1km	0	0	6.62	2.79	50.81	0	18.65	0.15	0	20.99	0
	10km	0	0.36	8.76	3.61	47.96	0	21.8	9.47	0.1	7.9	0.03
	30km	0.18	0.23	11.99	1.82	33.07	0	33.4	15.01	0.13	4.02	0.12
Region 2	1km	0	0	5.12	53.44	8.75	0	11.93	0.09	0	10.25	10.42
	10km	1.13	0	5.23	54.91	4.35	0	14.9	2.55	0.07	3.16	13.68
	30km	0.61	0	5.35	49.76	6.61	0	16.05	2.98	0.7	1.56	16.38
Region 3	1km	0	0	0.54	4.95	46.06	0	38.25	0.15	5.49	1.47	3.09
	10km	0	0	0.25	7.46	38.26	0	39.01	0.27	10.35	0	4.39
	30km	0	0	0.19	6.15	35.16	0	40.01	0.51	10.7	0	7.29
Region 4	1km	0	0	0	0	12.43	0	84.86	0	2.7	0	0
	10km	0	0	0.05	0	14.3	0	80.64	1	3.42	0	0.59
	30km	0	0	0.29	0	26.30	0	55.33	2.62	10.81	0	4.82
Region 5	1km	0	0	1.41	0	0	0	96.3	2.29	0	0	0
	10km	0	0	1.09	0	0	0	90.75	3.11	3.84	0	1.19
	30km	0	0	1.5	0	0.27	0	89.94	1.31	6.15	0	0.82
Region 6	1km	0	0	14.96	0	24.94	0	47.51	0	0	12.59	0
	10km	0	0	14.87	0	18.03	0	56.49	0	6.45	3.67	0.49
	30km	0	0	16.11	0	18.75	0	46.2	0	13.9	2.25	2.76

Note: Ⅰ. Needle-leaved Forest; Ⅱ. Broad-leaved Forest ; Ⅲ. Shrub; Ⅳ. Desert; Ⅴ. Steppe; Ⅵ. Grassland; Ⅶ. Meadow; Ⅷ. Wetland; Ⅸ. Alpine Vegetation; Ⅹ.Farmland; Ⅺ. Land Without Vegetation

4.2.1 Comparison of other diagnostic values in 30km-wide buffer regions

Other diagnostic values are listed in Table 3.

Total Area (*TA*): the largest is 30 239.77km^2 in Region 3, the second is 26 048.703km^2 in Region 2, next is 17 050.98km^2 in Region 1, 10 220.47km^2 in Region 5, 10 077.11km^2 in Region 6 and 8517.06km^2 in Region 4. Number of Patches (*NP*): the largest is in Region 2, the smallest is in Region 4. Mean Patch Size (*MPS*): the largest is 148.12km^2 in Region 5, next is 139.99km^2 in Region 3, and 119.96km^2 in Region 4. Patch Size Standard Deviation (*PSSD*) and Patch Size Coefficient of Variance (*PSCV*) reflect the fragmentation of area: the biggest fragmentation is Region 5, next are in Region 6 and Region 1. Edge Density (*ED*) expresses fragmentation: the biggest is 0.69km/ km^2 in Region 6, next are in Region 2 and Region 3. Mean Edge Length (*ME*): the largest is in Region 3, next are region 6 and 2. Mean Patch Fractal Dimension (*MPFD*) indicates regularity: the most irregular region is Region 4, next are Region 2 and Region 1. Shannon's Diversity Index (*SDI*): the biggest is in Region 2 and the smallest is in Region 5.

4.3 Impact of Road Constructing on Landscape

The constructed sections (Xining–Golmud) and the constructing section (Golmud–Lhasa) of Qinghai–

Table 3 Diagnostic values of landscape within 30km-wide buffer region in each region

Region	*TA*(km²)	*NP*	*MPS*(km²)	*PSCV*	*PSSD*	*ED*(km/km²)	*ME*(km)	*MPFD*	*SDI*
Region 1	17050.98	158	107.92	270.46	0.03	0.55	59.16	0.15	1.57
Region 2	26048.70	256	101.75	223.19	0.03	0.62	63.39	0.17	1.60
Region 3	30239.77	216	139.99	199.20	0.03	0.60	84.03	0.00	1.56
Region 4	8517.06	71	119.96	267.94	0.04	0.43	51.29	0.20	1.40
Region 5	10220.47	69	148.12	642.00	0.12	0.38	56.61	−1.26	0.85
Region 6	10077.11	99	101.79	313.48	0.04	0.69	71.12	0.06	1.57

Xizang railway collocate with Qinghai−Xizang highway (TIKKA *et al*., 2001). Basing on cutting off effect of highway on vegetation types, the railway aggravates the fragmentation.

4.3.1 Impact of road constructing on integrate vegetation types

By comparing 1km-wide, 10km-wide and 30km-wide buffer regions (Table 4), it was found that Number of Patches increased, Mean Patch Size decreased and Edge Density increased, which shows that the vegetation types were cut off by Qinghai −Xizang highway and railway, and made landscape more fragmental. Shannon's Diversity Index decreased, which means that landscape diversity decreased. The other landscape indices reflect the different impact of road constructing on vegetation types.

4.3.2 Changes of other diagnostic values of vegetation types in 20km-wide buffer region of Qinghai−Xizang highway and railway

Due to the construction of Qinghai−Xizang highway and railway, vegetation types were differently changed (Table 5): the greatest change of *NP* was in Meadow, next were Steppe, Desert, Shrub, Land Without Vegetation, Farmland, Alpine Vegetation and Wetland; Meadow's *ED* raised most, next were Steppe, Desert, Farmland, Land Without Vegetation, Shrub and Alpine Vegetation, other vegetation types did not change; *MPS* changed most in Steppe, next were Meadow, Desert, Farmland, Shrub, Land Without Vegetation and Alpine Vegetation, which means that landscape became more fragmental; *PSCV*'s decrease means the area of patches' scatter reduced(Needle-leaved Forest, Broad-leaved Forest and Wetland did not change.); *MPFD* raised in Shrub, Alpine Vegetation and Farmland, which means the shape of the patches became more regular; reduction of *MPFD* is in Desert, Steppe, Meadow and Wetland, which means that the shape of the patches become more irregular; other vegetation types did not change.

Table 4 Diagnostic values of vegetation types in the buffer regions incised by Qinghai−Xizang highway and railway

Buffer region	*NP*	*MPS*(km²)	*ED*(km/km²)	*PSCV*	*MPFD*	*SDI*
1km-wide buffer region	251	14.28	1.55	155.65	0.24	1.650
Highway incising 1km-wide buffer region	344	10.25	1.75	176.14	0.21	1.630
Highway and railway incising 1km-wide buffer region	647	5.06	2.98	175.09	0.15	1.620
10km-wide buffer region	435	80.02	0.63	357.73	0.17	1.840
Highway incising 10km-wide buffer region	511	68.12	0.67	371.32	0.18	1.820
Highway and railway incising 10km-wide buffer region	830	41.77	0.81	233.07	0.54	1.780
30km-wide buffer region	787	129.80	0.56	528.40	0.14	1.841
Highway incising 30km-wide buffer region	880	116.07	0.58	520.06	0.15	1.836
Highway and railway incising 30km-wide buffer region	1205	84.60	0.63	337.27	0.10	1.836

Table 5 Changes of other diagnostic values of vegetation types in the buffer regions of Qinghai−Xizang highway and railway

Vegetation type	*NP*	*MPS*(km²)	*PSCV*	*ED*(km/km²)	*PSSD*	*MPFD*
Ⅰ Needle-leaved Forest	0	0	0	0	0	0
Ⅱ Broad-leaved Forest	0	0	0	0	0	0
Ⅲ Shrub	32	−0.002	52.448	0.527	−0.001	−0.026
Ⅳ Desert	64	−0.005	14.689	2.364	−0.007	0.040
Ⅴ Steppe	114	−0.012	5.506	5.292	−0.018	0.116
Ⅵ Grassland	0	0	0	0	0	0
Ⅶ Meadow	133	−0.008	−156.897	6.720	−0.043	0.105
Ⅷ Wetland	0	0	0	0	0	0
Ⅸ Alpine Vegetation	14	−0.001	9.870	0.223	−0.001	−0.001
Ⅹ Farmland	17	−0.002	23.675	0.788	−0.002	−0.002
Ⅺ Land Without Vegetation	18	−0.002	−41.925	0.776	−0.006	−0.006

4.4 Impact of Qinghai–Xizang Highway and Railway on Biomass and Net Primary Productivity

The impact of Qinghai–Xizang highway and railway on vegetation types include the permanent and the temporary. The permanent came from permanent land use and some temporary land use. Permanent land use refers to the land used by embankments, stations, bridges and tunnels. Temporary impacts came from temporary land use, which refers to road of auto transportation, material spots, bases, work roads and work spots. The temporary impacts can be reduced to least by effective management, while permanent impacts are not reversible. The pollution of environment caused by road constructing focused on 1km-wide buffer region and the impacts of road construction on vegetation types were in 50m-wide buffer region, which was the permanent land use.

By creating 50m-wide buffer regions alongside Qinghai–Xizang highway and railway (including the constructed and the constructing sections) and basing on biomasses and net primary productivities of different vegetation types, the total loss of biomass (*TLB*) and net primary productivity (*NPP*) is calculated (Table 6). The permanent land use was 288.83km^2, involving 8 vegetation types, among which Meadow was 102.71km^2, next were Steppe (76.62km^2) and Desert (62.48km^2). Annual loss of net primary productivity was 30 504.6t/a, including Meadow (18 076.22t/a), Farmland (3055.83t/a), Shrub (1135.56t/a) and others. Loss of biomass was 432 919.25–1 436 104.3t, of which Meadow was 205 411.6–616 234.8t, next were 153 248.8–459 746.4t in Steppe and 45 400.94–52 385.7t in Farmland. The losing Net Primary Productivity accounted for 5.70% of the annual Net Primary Productivity within 1km-wide buffer regions (535 005.07–535 740.11t/a), and only 0.80%–0.89% of that within 10km-wide buffer regions (3 408 950.45–3 810 480.92t/a). The losing gross biomass was about 9.47%–17.06% of the gross biomass within 1km-wide buffer regions (7 502 971.85–25 488 342.71t), and only 1.47%–2.94% of that within 10km-wide buffer regions (43 615 065.35–164 150 665.37t).

Table 6 Net primary productivity and biomass within 50m-wide buffer region along two sides of Qinghai–Xizang highway and railway

Vegetation type	Total area(km^2)	Average Net Primary Productivity (g/m^2·a)	Biomass(kg/m^2)	Total Net Primary Productivity(t/a)	Total Biomass(t)
Ⅲ Shrub	11.13	102.00	2–4	1135.56	22265.8–44531.6
Ⅳ Desert	62.48	24.00	0.1–4	1499.50	6247.93–249917.2
Ⅴ Steppe	76.62	80.00	2–6	6129.95	153248.8–459746.4
Ⅶ Meadow	102.71	176.00	2–6	18076.22	205411.6–616234.8
Ⅷ Wetland	0.33	250.00	0–0.1	81.75	0–32.7
Ⅸ Alpine Vegetation	3.44	140.00	0.1–3	481.85	344.18–10325.4
Ⅹ Farmland	17.46	175.00	2.6–3	3055.83	45400.94–52385.7
Ⅺ Land Without Vegetation	14.65	3.00	0–0.2	43.96	0–2930.5
Total	288.83			30504.62	432919.25–1436104.3

5 CONCLUSIONS AND QUESTIONS

5.1 Conclusions

(1) Buffer regions are divided by regionalization line into 6 regions and each presented different landscapes: Region 1 is steppe landscape, Region 2 is desert landscape, Region 3 is meadow steppe landscape, Region 4 and Region 5 are alpine meadow landscape and Region 6 is shrub meadow landscape.

(2) Qinghai–Xizang highway and railway span 9 latitudes,12 longitudes and 6 physical geographic regions (East Qinghai and Qilian mountain steppe region, Qaidam mountain desert region, South Qinghai alpine meadow steppe region, Qiangtang alpine steppe region, Golog-Nagqu alpine shrub meadow region and South Xizang mountain shrub steppe region).

(3) Natural landscapes are predominant. Human landscapes (Farmland) are secondly and diminished with the increase of distance to road. The tendencies are similar in Region 1, Region 2 and Region 4, there is no human landscapes in Region 3. Farming is limited by latitude and road constructing promotes human activities, such as cultivation. The direct impacts of road constructing are cutting habitats and made habitats more fragmental. The fragment degrees of vegetation types are different. The most fragmental is Meadow, next were Steppe and Desert.

(4) The Patch Size Coefficient of Variance and Mean Patch Fractal Dimension have no apparent regularity in 1km-wide, 10km-wide, or 30km-wide buffer regions.

(5) The vegetation within 50m-wide buffer regions are destroyed entirely, it is estimated that the Net Primary Productivity deceases by about 30 504.62 t/a and the gross biomass deceases by 432 919.25–1 436 104.3t. The losing Net Primary Productivity accountes for 5.70% of the annual Primary Productivity within 1km-wide buffer regions (535 005.07–535 740.11t/a), and only 0.80%–0.89% of that within 10km-wide buffer region (3 408 950.45–3 810 480.92t/a). The losing gross biomass is about 9.47%–17.06% of the gross biomass within 1km-wide buffer region (7 502 971.85–25 488 342.71t), and only 1.47%–2.94% of that within 10km-wide buffer regions (43 615 065.35–164 150 665.37t).

(6) The impact of Qinghai–Xizang highway and railway on vegetation types include the permanent and the temporary. The temporary impacts can be reduced to least by effective management, while permanent impacts are not reversible. So, on the basis of choosing road lines scientifically, the emphasis of ecological restoration is temporary land use.

5.2 Questions

(1) The studied area is so large and the roads are so long, considering the time of the data, we can not find more detailed maps. In order to make up for the defect of the precision, we conducted two outdoor investigations. The modified data fit for analysis.

(2) This paper discusses the direct and permanent destruction of vegetation by road constructing, but the impacts of road constructing on vegetation means more, especially on the fragile Qinghai-Xizang Plateau.

(3) Wetland is an important ecosystem, but for the limit of data, the impact of road constructing on it were not embodied commendably.

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