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SYNOPSIS

# Effects of Pipeline Construction on Wetland Ecosystems: Russia–China Oil Pipeline Project (Mohe-Daqing Section)

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Although the multiple roles of wetland ecosystems and their value to humanity have been increasingly understood and documented in recent years (Getzner 2002; Hoehn et al. 2003), the efforts to conserve and restore wetlands are not in harmony with the press for high speed of economy growth. The degradation of wetlands is proceeding, especially in China (Cyranoski 2009). Russia–China Oil Pipeline Project (Mohe-Daqing Section) has already begun in May, 2009, and is ongoing. The pipeline runs through four riverine wetlands and two marshlands of Heilongjiang Province, Northeast China. Although the project has vital significance of mitigating the energy crisis as well as guaranteeing the energy security of China, it will bring a series of ecological and environmental problems, especially for wetland ecosystems.

The excavated spot of the Russia–China Oil Pipeline Project (Mohe-Daqing Section) is located at the south side of Amur-Heilong River, the Russia–China boundary river. The pipeline passes Heilongjiang Province and Inner Mongolia Autonomous Region of China, and ends at Daqing City of Heilongjiang Province (Fig. 1). The whole line spans 972.6 km.

Riverine wetlands and marshlands are the two main types of wetlands where the pipeline passes through. The pipeline runs through four riverine wetlands (Huma River National Nature Reserve, Pangu River National Nature Reserve, Nemoer River Provincial Reserve, and Wuyuer River–Shuangyang River Provincial Nature Reserve) and two marshlands (Ta River Marshland and Duobukuer River Marshland) (Fig. 1). The total crossing length of Ta River Marshland and Duobukuer River Marshland is 50 km, which are permafrost marshlands (Fig. 1). The total crossing length of the riverine wetlands (nature reserves) is 204.79 km. The specific information of these nature reserves is shown in Table 1.

The pipeline construction occupies 1.56 ha open water and 96.83 ha the unutilized lands (mainly for freshwater marshlands) (PetroChina Planning & Engineering Institute 2007). The directly occupied wetland area is up to 4.77% of the entire construction area. The construction will alter the existing hydrologic regime of these wetland areas in two ways. It will block the surface water flows or change the flow directions because of the soil or spoil deposition, and block the shallow groundwater flows directly.

The monitoring data of the groundwater from the Greater Khingan Range (Chen 2007) suggests that along the pipeline, there are four sections (24th Forest Farm-23rd Hydrologic Station, 22nd Forest Farm-Walagan, Walagan-Xiufeng, Taiyanggou Workshop-Guyuan Forest Farm). Up to 152 km pipeline passes through river valleys, with the groundwater depth ranging from 1 to 3 m. The pipeline trench is excavated deep into 2.5 m approximately. Therefore, almost all the groundwater of the riverine wetlands can be affected by the pipeline. And the negative effect on groundwater cannot be mitigated through either natural or artificial restoration.

The entire pipeline runs through three large-scale rivers (Amur-Heilong River, Huma River, and Nenjiang River, total length 3.4 km) using the tunnel method, and cross eight moderate-scale rivers (Pangu River, Daxiergenqi River, Xilinixi River, Ta River, Duobukuer River (two times), Nemoer River, and Wuyuer River, total length 9.9 km) using open-cut method. For the groundwater depth of river beds usually shallow, the pipeline will cut off the hydraulic connection between the surface water and the

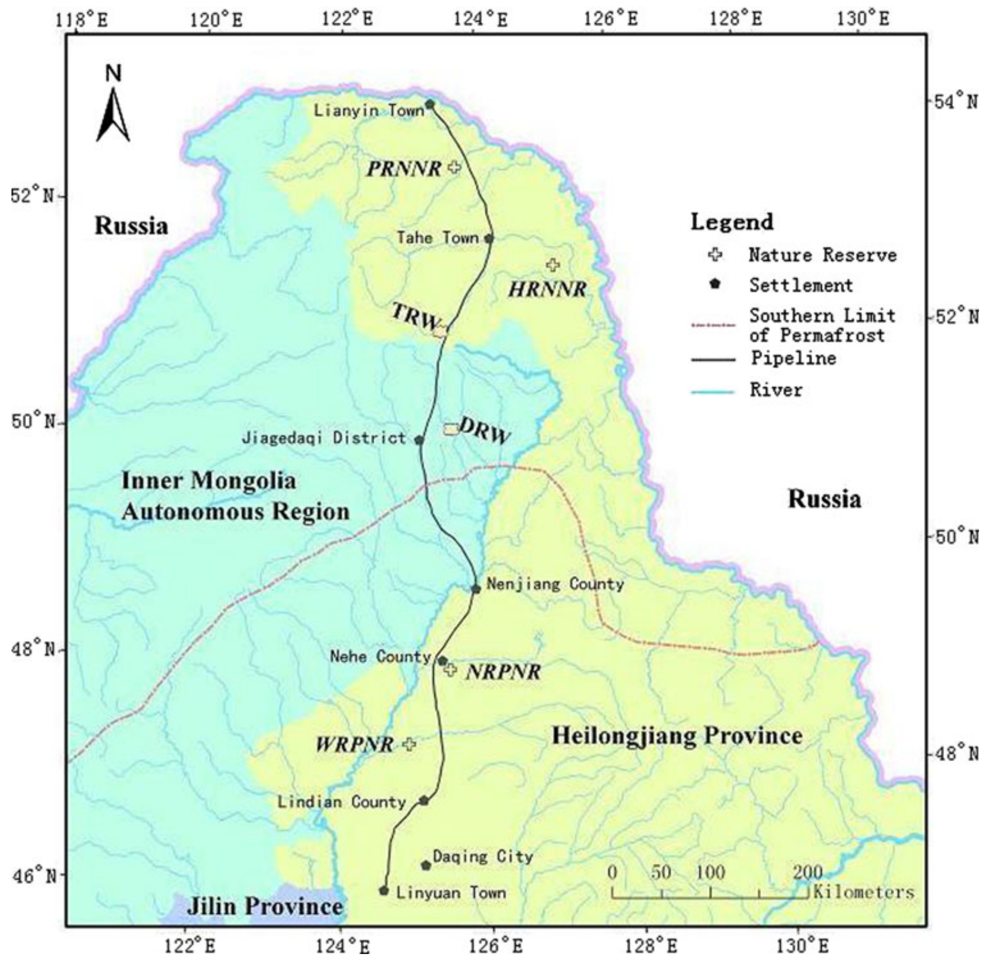


**Fig. 1** Distribution of wetlands along Russia–China oil pipeline. *PRNNR* Pangu River National Nature Reserve; *HRNNR* Huma River National Nature Reserve; *NRPNR* Nemoer River Provincial Nature Reserve; *WRPNR* Wuyuer River–Shuangyang River Provincial Nature Reserve; *TRW* Ta River Wetland; *DRW* Duobukuer River Wetland

groundwater to a certain extent, and block the subsurface flows aside.

The pipeline right-of-way can be divided into three areas: a work area used for vehicle traffic, a trench area for burying a pipeline, and a pile area where soil was stockpiled during excavation. Compaction of soil profiles occurs in the work area which has experienced heavy traffic during construction, which will result in the increased soil bulk density, reduced porosity, and hydraulic conductivity (Landsburg 1989). And soil pH, organic matter content, and nitrogen content of the trench area will be altered because of the inversed soil profiles. Particularly, the pipeline passes through many valleys with steep slopes. Once the native vegetation and river banks are destroyed without adequate protection, soil erosion should take place in the related riverine wetlands. The aggravation of soil erosion might bring the diminution of wetland area, which can directly reduce ecological function of wetlands.

Besides changes in hydrology and soils, there will be ecological changes during and after the pipeline construction. Lots of species of plants distribute in the wetland areas crossed by the pipeline. Plants belonging to 49 families, 300 species distribute in Nemoer River Nature Reserve, including 4 species of national rare and endangered plants (*Astragalus membranaceus*, *Glycine soja*, *Radix Glycyrrhizae*, *Sagittaria natans*). The grassland area of Wuyuer River–Shuangyang River Nature Reserve occupied by the construction is 1.43 ha. The turf height is 45–70 cm and vegetation coverage is 60–70%. The most common plants are *Calamagrostis angustifolia*, *Phragmites australis*, and *Chloris gayana*. Some rare and precious wild plants, for example *G. soja*, *A. membranaceus*, and *R. Glycyrrhizae*, also distribute in Wuyuer River–Shuangyang River Nature Reserve. However, these wetland plants are destroyed significantly by the pipeline construction. In the trench area, the shoots and roots of the involved plants are eradicated, and the surrounding plants' roots are affected as well. The other plants of the work area and pile area are destroyed by the soil or spoil stacking and human trampling, and with the shoots destroyed but the roots survived. The clearance and disturbance of these wetland plants will result in the loss of plant species richness and community composition. A more serious consequence is the total extinction of rare species or loss of local genotypes. In

**Table 1** Information of the crossing nature reserves

| Name of wetlands | Huma River National Nature Reserve | Nemoer River Provincial Nature Reserve | Wuyuer River–Shuangyang River Provincial Nature Reserve | Pangu River National Nature Reserve |
|---|---|---|---|---|
| Location | 48°50′–49°36′ N, 123°30′–126°40′ E | 48°18′–48°33′ N, 124°31′–125°35′ E | 47°18′–47°53′ N, 124°59′–125°34′ E | 52°09′–53°22′ N, 123°19′–124°49′ E |
| Main protection objects | Cold water fish | Riverine wetland ecosystem and rare waterfowl | Wetland ecosystem and rare wildlife | *Brachymystax lenok*; *Lota lota* |
| Function of crossing area | Core zone; Buffer zone | Buffer zone, Experiment zone | Experiment zone | Experiment zone |
| Surface area | Total area 52,050 ha | Total area 61,385 ha; Core zone 18792 ha; Buffer zone 22,516 ha; Experiment zone 20,077 ha | Total area 22,934 ha; Core zone 9,260 ha; Buffer zone 5,265 ha; Experiment zone 8409 ha | Total area 6,500 ha; Core zone 4,850 ha; Experiment zone 1650 ha |
| Crossing length (m) | 168,000 | 6,390 | 900 | 29,500 |
| Crossing method | Tunneling; open-cut | Open-cut | Open-cut | Open-cut |

addition, the disturbed habitat will permit the establishment and spread of exotic species which may displace native species (Findlay and Bourdages 2001). The integrity and background of the wetland ecosystems may be destroyed.

Moreover, pipeline crossing construction is shown to not only compromise with the integrity of the physical and chemical nature of fish habitat, but also to affect biological habitat and fish behavior and physiology (Lévesque and Dubé 2007), which will result in the avoidance movement of fish, altered distribution of populations (Newcombe and Jensen 1996) and reduce population size and species. *Acipenser schrencki*, *Huso dauricus* and *Brachymystax lenok* are national key protected animals (level II), which are facing extinction. They distribute in Huma River National Protection Reserve, which is the only high latitude and cold temperate zone provincial nature reserve of aquatic wildlife in China. *B. lenok* and *Lota lota* are main protection objectives of Pangu River Nature Reserve, which is the national fish genetic resources reserve in the high latitude cold zone. The disturbance or damage of pipeline construction or operation on these fish species are significant loss of geography and ichthyology. Moreover, Huma River is an important breeding site of *Oncorhynchus keta*, which is the endemic species of Amur-Heilong River basin. The altered water quality may cause the reduced yield of *O. keta*. Although the disturbances of pipeline construction are not long-term, the altered fish population distribution and movement cannot be recovered in short-term.

Furthermore, the crossing wetland areas are rich in bird species. There are 147 species of birds, which occupied 52.31% of the total bird species in Nemoer River Nature Reserve. And 265 species of birds distribute in Wuyuer River–Shuangyang River Nature Reserve. And *Ciconia boyciana*, *Grus japonensis*, *Aquila chrysaetos* are national key protected birds (level I). The clearance of wetland vegetation may reduce the food source of birds and destroyed the food chain (vegetation–insect–bird). The construction is conducted in the spring, which can also scare birds, especially migratory birds. The lack of food or other construction disturbance may cause the death of migratory birds and altered migratory route. This will decrease the bird diversity of the nature reserve, which cannot easily be recovered.

In addition, the northeast region is the second greatest permafrost area in China. During the past 40 years, the degradation of permafrost, as evidenced by deepening active layer, thinning of permafrost, rising ground temperatures, expansion of taliks, and disappearance of permafrost islands, has been accelerating due to the rapid environmental changes, marked climate warming and ever increasing human activities (Jin et al. 2006). Considering that the projected climate warming of this area is 1.0–1.5°C (Pan et al. 2004), this degradation trend would be continued during the next 40–50 years.

Since the permafrost and marshland environments are symbiotic and interdependent (Sun et al. 2008), the degradation of permafrost will cause the degradation of the existed marshlands, and form new marshlands in the thaw settlement sites along the pipeline. As a result, the pipeline would be subjected to seasonal freeze–thaw cycles. According to the Sino-Russia Oil Pipeline Project Plan, the designed life of this pipeline is 50 years (PetroChina Planning & Engineering Institute 2007). The protection and restoration measures are designed based on the current geological investigation at present, which cannot meet the need of wetland change along the pipeline under the climatic change in the future. Thus, there is potential risk of thaw settlement events with no protection engineering facilities. As a result, the groundwater flows may be blocked by the pipeline settlement.

At last, the pipeline project also presents tremendous challenges from an environmental perspective during the operation period. It is difficult to guarantee from accidents of spills and leakages, which will actually cause serious pollution of wetlands.

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