

The current status, threats and protection way of Sanjiang Plain wetland, Northeast China

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Abstract: The Sanjiang Plain is a vast area of alluvial floodplains and low hills in northeast Heilongjiang Province. It is the largest tract of wetlands in China and East Asia outside of Siberia. 28 wetland nature reserves exist on the Sanjiang Plain, and three of them have been listed as wetlands of international importance to water bird conservation by the Ramsar Convention Bureau. The wetlands of Sanjiang Plain are noteworthy for its rich biodiversity, but they continue to decline in area and deteriorate in quality currently. The main threats or constraints, immediate cause, root cause and required response are analyzed in this paper, and the four aspects opinion such as improvement of watershed management, enhancement of protection and restoration of habitats and biodiversity, alternative livelihoods of rural residents living in and near natural wetland reserve, and reinforcement of capacity building of natural reserves are brought forward as the effective measures for the Sanjiang Plain wetland protection.

Keywords: Sanjiang Plain; Wetland Protection, Wetland nature reserves; Threat factors, Deterioration; Northeast China

CLC number: X37

Document code: B

Article ID: 1007-662X(2005)02-0148-05

Instruction of Sanjiang Plain

Definition of Sanjiang Plain

The Sanjiang Plain is a vast area of alluvial floodplains and low hills in northeast Heilongjiang Province, China (Fig. 1). It is characterized by the confluence of three major rivers, the Heilong River (Amur in Russia), the Wusuli River (Ussuri in Russia), and the Songhua River. The Heilong River forms the international boundary with Russia to the north, and the Wusuli River forms another border with Russia to the east. In the south and west the terrain climbs into low hills and then mountains of interior Heilongjiang Province.

Sanjiang Plain is a general topographic region, not a political unit, usually defined as 18 rural counties and 7 cities (urban counties), with a total area of approximately 108 900 km² (Liu, 2002) (Table 1). The total population of the Sanjiang Plain is approximately 9 million, with approximately 4.5 million of those living in the 18 rural counties. Population density is approximately 74 persons per square kilometer, which is low for eastern China.

Development history of Sanjiang Plain

The original vegetation of the Sanjiang Plain was a vast tract of wetlands, meadows and forests. Until recently it involved China's largest area of wetlands, but these wetlands have been dramatically reduced by agricultural development during the last 50 years. The Sanjiang Plain's high-quality soils and favorable climate for grain production attracted major attention from government agricultural development programs beginning in the early 1950s. Since that time the central government of China strongly encouraged settlement and reclamation of wetlands, and development of large-scale farming in Sanjiang Plain. Enormous state agricultural farms were established with Korean War veter-

ans or groups of youths recruited from cities. Investments from multi-lateral and bi-lateral international sources equipped many of the large state farms. These State farms, now largely mechanized, have turned the Sanjiang Plain into one of the eight national bases for grain production in China. Over 5 000 000 hm², or 47% land of the Sanjiang Plain, has been converted to farmland, mostly for corn, soybean, and rice production. Most of this farmland was reclaimed from various types of original wetland by massive drainage projects (Table 2).

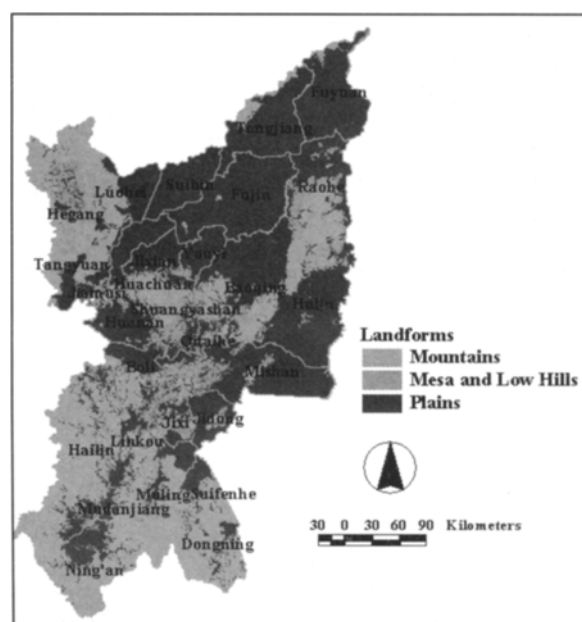


Fig. 1 The location and geographic status of Sanjiang Plain

Agricultural drainage schemes, including huge networks of drainage canals and major groundwater pumping schemes combined with paddy irrigation, continue to be an integral part of State farms' agricultural production. Remaining wetlands in Sanjiang Plain exist within a primarily agricultural environment.

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Received date: 2004-11-19

Responsible editor: Chai Ruihai

Forest cover in the uplands of the Sanjiang Plain was greatly reduced from historical levels by agricultural expansion, but is now stabilizing, as many uplands are now in State forest farms. Approximately 1.1 million hm^2 of forest exist in the 18 Sanjiang Plain counties, with 0.7 million hm^2 being natural forest and 0.4 million hm^2 of plantations.

Table 1. Summary of Cities and counties of Sanjiang Plain (Heilongjiang Statistical Bureau, 2003)

County or City	Area (km ²)	Population (1000)	Per Capita GDP(RMB)
Baoqing County	10000	4.240	4743
Shuangyashan City	1767	5.067	10133
Fujin County	4872	4.380	7477
Fuyuan County	6262	0.810	7766
Hegang City	4551	6.912	6076
Muling City	6663	3.210	9942
Huanan County	4451	4.450	4086
Hulin City	9330	3.020	9062
Tongjiang City	6252	1.620	8336
Jidong County	3234	2.990	10583
Jixi City	2300	9.187	6401
Jixian County	2257	3.120	4083
Linkou County	7180	4.410	5191
Luobei County	6762	2.320	9449
Mishan City	7843	4.400	7088
Huachuan County	2268	2.180	2933
Qitaihe City	1767	4.895	10707
Raohe County	6765	1.410	3321
Suibin County	3335	1.860	7415
Boli County	4455	3.740	4572
Tangyuan County	3460	2.680	4853
Jiamusi City	1875	8.230	11022
Yilan County	4616	3.830	4836
Yuyi County	1742	1.250	6227

Table 2. Change in land use on Sanjiang Plain

Year	Wetland Area (hm ²)	Percent	Farmland Area (hm ²)	Percent
1949	5,340,000	49.0%	786,000	7.2%
1983	2,275,700	20.9%	3,778,300	34.7%
1994	1,481,600	13.6%	4,572,400	42.0%
2000	889,786	8.2%	5,164,214	47.4%

Brief description of natural resources in Sanjiang Plain

General geographical character, climate and soil

The Sanjiang Plain includes three major topographic areas: a) low mountains; b) slopes, low hills and terraces; and c) alluvial plains, including extensive floodplains. The mountainous areas occupy 34% of the area, with elevations ranging up to 1 000 m above sea level (Fig. 1). Slopes, low and terraces occupy 9% of the area in the transition between mountains and plains, and the alluvial plains occupy 57% of the area, with elevations between 80 to 34 m above sea level in the Fuyuan delta (Heilong River/Wusuli River confluence). The Wanda Mountains traverse the Sanjiang Plain from southwest to the northeast, dissecting the area into two major alluvial plains. The northern area is larger, and is known simply as the "Sanjiang Plain," while the plain to south of the Wanda Mountains is known as the Muling-Xingkai Plain, for the major river and the enormous Lake Xingkai (known as Lake Khanka in Russian) on the border with Russia,

which dominate that part of the landscape. The Wusuli River corridor connects the two plains. Rivers such as the Beilalong, Naoli, Abuqin, Qihuli, Woken and Muling drain the Wanda Mountains and other highlands, discharging onto the alluvial plains, providing water to the wetlands located there.

The soils of Sanjiang Plain are mainly wet black clays, and generally more than 20 cm thick. Black-soil is characterized by high concentrations of organic matter and nutrients that lead to high ecological and agricultural productivity. The Plain's peat mires developed from the rich supply of organic matter to the lowland wetlands. There are 130–145 frost-free days, with annual precipitation fluctuates between 450 and 700 mm of rainfall, 60–70% of which falls in the growing season. These conditions mean that agricultural productivity of Sanjiang Plain is high.

Overview of vegetation in Sanjiang Plain

The original vegetation of the Sanjiang Plain was a vast tract of wetlands, meadows and forests. It was locally known as the "Beidahuang" (the northern wilderness) (Yi *et al.* 1982). The natural vegetation of the upland areas was characterized by dense and mixed coniferous forests in the higher mountains (e.g., *Pinus koraiensis*, *Larix* spp., *Picea* spp., *Abies* spp.), and by broad-leaf forests (e.g., *Quercus mongolica*, *Tilia* spp., *Betula* spp., *Populus* spp., *Ulmus* spp.) on the hills, secondary terraces, undulating uplands, and on the former natural levees along old river courses. The river floodplains and lowlands included an immense expanse of freshwater wetlands--reed marshes, wet sedge meadows, grass meadows, lakes, and riparian willows and other wet forests. Much of this original vegetation has been transformed into agricultural land in the later half of the 20th century.

Wetland resources and biodiversity of Sanjiang Plain

China's natural inland wetlands cover some 25 million hm^2 —roughly 11 million hm^2 are marsh, and some 12 million hm^2 are shallow lakes. The remaining 2 million hm^2 are rivers and streams. Heilongjiang Province supports 4.34 million hm^2 of wetlands (Liu 1995; Heilongjiang Environmental Protection Bureau 1998). By 2001 Heilongjiang Province had established 58 wetland nature reserves to protect 1 949 000 hm^2 freshwater wetlands and aquatic areas, an area equal to 4.3 % of the total area of the Province (454 800 km^2). Approximately 28 wetland nature reserves exist on the Sanjiang Plain. Three of them (Xingkai Lake, Honghe, and Sanjiang NNRs) have been listed as wetlands of international importance to water bird conservation by the Ramsar Convention Bureau. The Sanjiang Plain Ramsar sites represent 14% of the 21 Ramsar sites in China, and 16% of the total Ramsar site area in China.

The majority of the significant remaining wetlands are in the lower floodplains of rivers, especially tributaries to the Wusuli River (Naoli, Abuqin-Qihuli, Muling, Song'acha) and along the Wusuli River itself, with shallow lakes, ox-bow lakes, riparian willow woodlands, and muskeg and shrub wetlands as less important wetland types. These wetlands are hydrologically dependent on the runoff from forested uplands in the watersheds of the Wanda Mountains and upper Muling River. Maintaining sound hydrologic cycles in forest and agricultural land within these watersheds is critical to maintaining long-term wetland health and ecosystem functions.

Sanjiang Plain is noteworthy for its rich biodiversity. Sanjiang Plain wetlands are ranked as globally important in the *Directory of Asian Wetlands*. There are about 1000 species of plants, 37 ecosystem types and 528 species of vertebrate fauna in this area

(Ni *et al.* 1999) (Table 3). The Sanjiang Plain also supports 37 species that are listed in the World Conservation Union IUCN Red List as globally threatened species (Han *et al.* 2003, Zhao *et al.* 2003, Liu *et al.* 2004). One of these is “critically endangered”, 10 species are “endangered”, and 16 species are “vulnerable.” Larger wild mammals have been virtually eliminated, but a diversity of smaller mammals, birds, amphibians, reptiles, fish, and invertebrates are present. The Sanjiang Plain is world-renowned for its water birds, most notable of which are the cranes. Of the 15 species of cranes in the world, eight regularly visit or occupy China wetlands; six have been recorded in the Songhua basin, and four species nest there (Ma 1987). Red-crowned and White-naped Cranes nest on the Sanjiang Plain. Additionally, the Heilong and Wusuli Rivers support the Huso (Kaluga) Sturgeon *Huso dauricus* and Amur Sturgeon *Acipenser schrenckii*, both of which are globally endangered.

Table 3. Estimates of Species Richness for Heilongjiang Province and Sites in the Sanjiang Plain

Plants and animals	Heilongjiang Province		Sanjiang Plain
	Provincial Protection Bureau (1998) ¹	Liu Xingtu (2002)	UNDP/GEF (2002)
Vascular plants	2114	>1230	
Mammals	87	71	75
Birds	358	325	339
Reptiles		13	14
Amphibians		11	11
Fish	105	82	89

The current core problem and threats to Sanjiang Plain wetlands

A core problem and detailed threats analysis for the wetland biodiversity of Sanjiang Plain is necessary in order to structure efficient biodiversity conservation (Liu *et al.* 2001). After the analysis of background information, interviews with conservation officials and management departments, and field observations from experience in Sanjiang Plain the core problem is that “the wetlands of the Sanjiang Plain continue to decline in area and deteriorate in quality, threatening the continued survival of wetland-dependent wildlife.” Thirty-seven vertebrate wildlife species ranked by the World Conservation Union (IUCN) as globally threatened are found in these wetlands, of which 20 are wetland birds. For some of these wetland birds, the Sanjiang Plain includes a key part of their remaining habitat at a global level. Although the Government of China has established nature reserves to protect a part of the Sanjiang Plain wetlands, the deterioration of wetland habitat continues, even within the nature reserves, and the populations of wetland wildlife remain severely depressed. Closely associated natural resource problems include the long-term decline in groundwater levels, surface water quality, and forest cover in the watersheds.

An adequate response to the core problem of loss of wetland area and deterioration in wetland habitat quality requires an analysis of specific threats. The mainly threats, immediate cause, root cause and required response analysis for this core problem is presented in Table 4.

Table 4. The threats analysis for the core problem of Sanjiang Plain

Threats/constraints	Immediate Cause	Root Cause	Required Response
Wetland dehydration	1) Surface water drainage, diversion and/or storage systems; 2) Groundwater over-pumping; 3) Deforestation changing water balance	1) Prior government crop production policy; 2) Flood management; 3) Current irrigation expansion; 4) Agricultural use of forest farms	1) Improved basin-level water resource management 2) Forestry investments in watershed
Wetland conversion	1) State farm cropland expansion 2) Expansion of road, rail transport corridors 3) Leasing of farmland within nature reserves	1) Pressure to increase incomes by expanding crop production and trade 2) Farmland existed prior to natural reserve establishment 3) Insufficient natural reserve funds--need for lease income for NR operations	1) Farmland to wetland restoration with compensation 2) Policy, regulation & enforcement to prohibit wetland conversion 3) Increased financial allocation to natural reserves 4) Integrated transport development planning & engineering
Overexploitation of wildlife & plants	1) Over fishing 2) Over hunting 3) Excessive vegetable harvest 4) Excessive medicinal herb harvest 5) Excessive reed harvest 6) Excessive timber harvest	1) Increase household food supply 2) Income generation for poor 3) Raw materials use (fuel, paper, etc.) unregulated 4) Few economic alternatives	1) Alternative income sources 2) Improved enforcement of existing regulations and training 3) Development of sustainable harvest programs 4) Education of natural reserve staff in enforcement, 5) management and wildlife conservation
Human disturbance of wildlife during sensitive periods (nesting, rearing, migration)	1) Households in wetlands 2) Farms in wetlands 3) Fishermen in wetlands 4) Hunters in wetlands 5) Tourists in wetlands	1) Pre-existing villages within natural reserve 2) Economic activities in natural reserve conflict with conservation policy 3) Low awareness of wildlife's biological needs	1) Enforcement of existing regulations on use of natural reserve zones 2) Resettlement of households from natural reserves 3) Development of tourism management plans 4) Conservation education among villagers 5) Education of natural reserve staff
Habitat degradation	1) Anthropogenic fire 2) Overgrazing	1) Desire for forage improvement 2) Livestock industry development 3) “Controlled burns” asprecaution against catastrophic fire 4) Untrained natural reserve personnel	1) Relocation & compensation of grazers 2) Husbandry programs for grazing, hay, fire 3) Education of natural reserve staff
Water pollution	1) Agricultural fertilizers & pesticides 2) Sedimentation 3) Sewage	1) Economic pressure to increase crop production 2) Excessive use of agro-chemicals due to poor user practice	1) Confirmation and quantification of the problem 2) Promote mitigation 3) Water resource planning for water quality 4) Development of best management practices

The effective measures for Sanjiang Plain Wetland protection

Improvement of watershed management

The long-term health of wetlands depends on an adequate supply of good quality water. The problem of fluctuating and in many instances inadequate water supply to the Sanjiang Plain has been caused by forest conversion to agriculture in the headwaters and hilly lands of the catchment areas and over-cutting, especially in the natural forests (Ma *et al.* 2003). This has led to increased erosion, siltation, and flooding in the summer rainy season and scarcity of water in other seasons. And the inter-institutional water management at a watershed scale of Sanjiang Plain wetland is extremely challenging, there are precedents in Heilongjiang (e.g., the Song-Liao Water Resources Commission, Ministry of Water Resources and Environment Protection Bureau). Therefore alteration of the hydrologic regime is the driving force in wetland loss in the Sanjiang Plain. Agricultural drainage schemes are the leading threat causing loss and degradation of wetlands. However, deforestation, flood control projects, irrigation storage and diversion schemes, groundwater irrigation pumping, construction of highways and contamination from agricultural and urban runoff also damage or destroy wetlands by altering their critical water supplies. A watershed management approach to improving the hydrologic regime is necessary if wetlands are to be effectively protected.

Watershed management is land management to accomplish specific water resource goals. In the Sanjiang Plain, watershed management is necessary to regulate water supplies and water quality in the downstream wetlands, and avoid future threats to their hydrologic integrity. In this way the following two major issues in watershed management will benefit the wetlands: a). reforestation and improved management of upland watersheds which drain to key wetland sites. Watersheds in the Sanjiang Plain were once a matrix of forested uplands and wetlands on the lowland sites. Agriculture has replaced many of the wetlands, and also replaced a substantial amount of forest on low hills in the middle and upper watersheds. Reforestation of these agricultural lands in the middle and upper watershed can have important positive effects on the water cycle—increasing infiltration, while reducing rapid rainfall runoff, flood peaks, erosion and sedimentation and improving water quality, and provides income and employment for rural families to enhance the economic well-being of local communities; b). improved water resource management at a watershed level is critical in resolving the water supply and water quality problems in wetlands. The key stakeholders in watershed issues in the Sanjiang Plain, including the Ministry of Water Resources, State Farms, and Environmental Protection Department should be brought together to coordinate and provide an excellent opportunity to build awareness and resolve specific problems related to water resource management in wetlands.

Enhancement of protection and restoration of habitats and biodiversity

Although the states and provincial government have made outstanding progress in establishment of wetland protected areas in the Sanjiang Plain, the agricultural production of Sanjiang Plain became a policy priority before the importance of wetland and biodiversity conservation was recognized. This precluded

effective conservation and led to loss or degradation of much of the important wetland and associated biodiversity resource base. Enhanced protection and/or restoration of degraded or lost wetlands and biodiversity are necessary if these resources are to be sustainably managed.

Protection and restoration of habitats and biodiversity are disciplines included in the science of wildlife management. They are closely related in all types of ecosystems, and in the case of wetland ecosystems, they are also directly linked to the hydrological performance of watersheds. To undertake the following three initiatives will be helpful: a). development of scientific approaches to integrating management of water and habitats with the requirements of wildlife; b). farmland restoration to wetland habitats at pilot sites in nature reserves; and c). design and implementation of wildlife species recovery projects for target umbrella species (e.g. Oriental Stork, Red-crowned Crane, White-naped Crane, Scaly-sided Merganser, Swan Goose, Greater White-fronted Goose, Lesser White-fronted Goose, Bean Goose, and Menzbier's Pipit) of waterbirds.

Alternative livelihoods of rural residents living in and near natural wetland reserve

Most traditional activities of rural residents like forest harvest in upper-stream, farmland expansion, reed cutting, marsh hay-cutting, fishing, collecting wild herbs and vegetables are subsistence-oriented and negative for the sustainable development of the wetlands. Alternative livelihoods will be pressing for wetland protection in Sanjiang Plain. It includes three components: a). develop agro-forestry (e.g. intercrop of tree and soybean or clover) and non-timber forest products (e.g. plantation of fungi, medicinal and herbal plant, fruit-bearing shrubs; bee products) in or near forest area on upland or hilly sites; b). sustainable resource use of wetland. This method will target traditional activities to develop strict guidelines for the natural resources utilization in wetland; c) eco-tourism approach. The eco-tourism activities will support conservation efforts and will seek to provide economic benefits to local inhabitants. It is critical that tourism planning for the Sanjiang Plain incorporate a wide range of ecotourism attractions. This will help to provide a stable base for long-term sustainable development. The proposals should be formulated through partnership mechanisms. Thus, the local communities, non-governmental organizations, the public sector, and the private sector travel trade should all play a role in the decision-making process during the formulation and implementation of tourism proposals.

Reinforcement of capacity building of natural reserves

The first nature reserve in Heilongjiang Province was established in 1958, with 141 new reserves established since then. The rapid pace of establishing protected areas has exceeded the capacity of communities to adapt to new expectations and the capacity of the education system to train new managers. Most people living near nature reserves are unaware of the location of the nature reserve, and are unfamiliar with the objectives and operations of the reserve. Most Heilongjiang nature reserves cannot employ qualified natural resource professionals. This situation leads to have great difficulty in processing the protection of wetland. Therefore, conservation education and public awareness will benefit both watershed and biodiversity management through increased public understanding of the community role of the protected area.

The conservation education should include curricula in formal

education systems, and technical and professional training programs. The conservation education in formal education systems will focus on local schools and school systems in communities surrounding nature reserves, and giving the knowledge such as wetlands ecological processes and benefits for humans, proper use of agricultural chemicals and disposal of wastes. In this way, the stakeholder will understand the benefits of conservation and sustainable use of wetlands resources. The technical and professional training address themselves to the needs for delivery of different educational materials in different formats to the technical and managerial personnel in nature reserves. The short term and long term training have proven to be efficient mechanisms in many aspects of nature conservation for quickly upgrading the detailed knowledge of underlying scientific disciplines of natural reserve staffs.

Enhanced public awareness will help villagers to make the transition from depletion to sustainable use of natural resources. The methods include use of the mass media and exhibits to let villagers know the wetland functions such as storage of surface water, replenishment of groundwater, water purification, and reduction of drought impacts. Public awareness will also be enhanced by increased employment of local villagers as patrol wardens, boat guides, and other part-time or permanent employees. This will involve villagers directly in nature reserve operations and management.

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