

Ecological significance and classification of Chinese wetlands

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Abstract

China supports a great variety of wetlands, including some of the most important in the world. However, an appropriate classification system applicable to all wetlands is not available. Based on a preliminary inventory, a new classification system for Chinese wetlands is proposed. This system classifies natural wetlands into three categories on the basis of their natural features and distribution: peatlands, coastal and estuarine wetlands, and riverine and lacustrine wetlands. Each category is divided into several sub-classes. The areal extent of wetlands in each Province has been estimated and their ecological importance assessed.

Introduction

During the past ten years several national studies on the conservation and management and natural functions of wetlands have been made in China (Lu 1988; Lu 1990). Most of these studies require a clear definition of what constitutes a wetland in China. As more and more people become involved in wetland studies the need for an appropriate classification system becomes more essential. However, up to now it has not been possible to agree on a classification system that is acceptable to all Chinese wetland scientists. Traditionally, peatlands have received the most attention (Long *et al.* 1983; Niu & Ma 1985) and these have been classified into three categories (Table 1) according to their peat content and pH value, and 15 sub-types according to floral features. During the 1986–89 wetland inventory the system utilised by Scott (1989) for an Asian wide inventory was adopted. In this inventory 22 categories of wetlands were recognised (Table 2).

Based on a nationwide investigation of the coastlines and offshore islands, several comprehensive scientific surveys of remote areas, such as Tibet, Xinjiang and Inner Mongolia, and other general surveys made by the author and colleagues, a preliminary inventory of wetlands in China was completed in 1990 (Lu 1990). During this inventory, the different types of wetlands in 26 of the 30 provinces in the country were

surveyed. Individuals and institutions with information on particular sites were contacted or interviewed directly and a new classification of Chinese wetlands proposed (Table 3). This system considers the natural features of the wetlands and their distribution. The system is described in this paper and the ecological significance of wetlands discussed.

Results and discussion

In total, over 62 million ha of wetlands were surveyed; amongst these 25 million ha were natural wetlands and about 36 million ha artificial. The natural wetlands include about 11 million ha of peatland, more than 2 million ha of coastal wetlands, and more than 12 million ha of riverine and lacustrine wetlands. The artificial wetlands include 34 million ha of paddy fields (rice, sugar cane, and areas of aquatic vegetation), more than 2 million ha of aquacultural ponds, and salt-pans. The extent of natural wetland in each Province is shown in Table 4.

Peatlands

Peatlands are distributed widely across China. However, three quarters of the total area is found in Eastern China. The Qinghai-Tibetan Plateau has about 20%

Table 1. Classification of peatlands in China (long *et al.* 1983).

Type 1:	Eutrophic mire (Peat Content > 7.0%, pH: 5.6–7.7)
Subtype 1:	floatated grassy mire <i>Carex lasiocarpa/Carex pseudocuraica</i>
Subtype 2:	clumped grassy mire <i>Deyeuxia angustifolia, Carex schmidtii/ Carex meyeriana/Carex muliensis/ Juncus sp., Carex argyi/Carex japonica</i>
Subtype 3:	<i>Cladium</i> mire <i>Cladium chinense</i>
Subtype 4:	<i>Scirpus</i> mire <i>Scirpus/Scirpus tabernaemontani</i>
Subtype 5:	<i>Phragmites</i> mire <i>Phragmites communis</i>
Subtype 6:	<i>Kobresia – Carex</i> mire <i>Kobresia littledalie, Carex moorcroftii/ Kobresia tibetica, Carex muliensis</i>
Subtype 7:	<i>Bueckea</i> mire <i>Bueckea tvutescens</i>
Subtype 8:	<i>Alnus</i> mire <i>Alnus sibirica, Alnus hirsuta/ Alnus trobeculosa</i>
Subtype 9:	<i>Betula</i> mire <i>Betula fruticosa, Betula ovalifolia</i>
Subtype 10:	larch – grassy mire <i>Larix olgensis/Larix gmelinii, Betula ovalifolia/Betula fruticosa, Carex sp.</i>
Type 2:	Mesotrophic mire (Peat Content 5.1–7.0%, pH: 4.6–5.5)
Subtype 11:	clumped grassy – moss mire <i>Carex sp. Sphagnum apiculatum</i>
Subtype 12:	floatated grassy – moss mire <i>Carex sp. Sphagnum oligoporum</i>
Subtype 13:	larch – moss mire <i>Larix sp. Sphagnum sp. Polytrichum sp.</i>
Type 3:	Oligotrophic mire (Peat Content < 5.0%, pH: 3.5–4.5)
Subtype 14:	<i>Sphagnum</i> mire <i>Sphagnum sp.</i>
Subtype 15:	<i>Rhynchospora – Sphagnum</i> mire <i>Rhynchospora chinensis, Sphagnum sp.</i>

of the peatlands with another 5% in the remote highlands of the Tian Shan and Altai Shan. Small areas of peatland are scattered all across the country with the largest amounts being found in the mountains and plateaux, with very small amounts on the plains. For example, peatlands are well developed in Da Hinggan Ling, Xiao Hinggan Ling and Changbai Mountains in north-east China, Tian Shan, Altai Shan, Qilian Moun-

tains in north-west China, Yan Taihang Mountains in north China, Xi Shan, Lu Shan, Huang Shan, Jing-gang Shan, Wugong Shan, Qin Ling and Shennongjia Mountains in central China, and Daliang Shan and Xiaoliang Shan in south-west China. Mountain peatlands account for about 60% of the total area compared to 23% in the plateaux. Two thirds of the peatlands on

Table 2. Classification of wetlands in China used in 1986–1989 inventory (Scott 1989).

1.	shallow sea bays and straits (under six metres at low tide)
2.	estuaries, deltas
3.	small offshore islands, islets
4.	rocky sea coasts, sea cliffs
5.	sea beaches (sand, pebbles)
6.	intertidal mudflats, sand flats
7.	mangrove swamps, mangrove forest
8.	coastal brackish and saline lagoons and marshes
9.	salt pans (artificial)
10.	shrimp ponds, fish ponds
11.	river, streams – slow-flowing (lower perennial)
12.	river, streams – fast-flowing (upper perennial)
13.	oxbow lakes, rivering marshes
14.	freshwater lakes and associated marshes (lacustrine)
15.	freshwater ponds (under 8 hectares), marshes, swamps (palustrine)
16.	salt lakes, saline marshes (inland drainage systems)
17.	water storage reservoirs, dams
18.	seasonally flooded grassland, savanna, palm savanna
19.	rice paddies
20.	flooded arable land, irrigated land
21.	swamp forest, temporarily flooded forest
22.	peat bogs

the plains are on the Shan Jiang Plain (Three Rivers Plain) in north-east China.

In eastern China there is a greater variety of peatlands than occurred in western China. Forested, grassy or moss dominated mires with eutrophic, mesotrophic or oligotrophic conditions are common in the eastern mountains. Only grassy or reed dominated mires with eutrophic conditions are found in the western regions.

Peatlands not only provide rich natural materials, such as peat, reed, medicinal herbs etc., but also improve the local climate. Recently, the ability of peatlands to ameliorate waste waters has received some attention.

Coastal and estuarine wetlands

The coastline of China extends for about 18 000 km along the shores of the Yellow Sea, East China Sea and South China Sea, and includes some 5000 offshore islands (Chen *et al.* 1989). Seven major types of wetlands are included in this broad category: deltas and bays, tidal mudflats, grassy and reed-bed salt marsh-

es, mangrove swamps, sand beaches, rocky sea coasts, and offshore islets. It is difficult to estimate the total area of wetland under the criteria used by Scott (1989) which includes all areas down to 6 m depth at low tide. An estimated 2 million ha of wetland occur down to the low tide mark. These wetlands vary with those north of Hangzhou Bay being sandy or muddy, except for the Liaodong and Shandong Peninsulas which are rocky. About 1.6 million ha of coastal marshes and mudflats occur in this region: in the estuaries of the rivers along the coastline of Liaoning Province, around the estuary of the Yellow River in Bohai Gulf (Tianjin Municipality, Hebei Province and Shandong Province), and in the estuary of the Yangtze River and along the adjacent coast of Jiangsu Province.

Most of the rivers flowing into the Yellow Sea carry large amounts of sediment, resulting in rapid accretion of deltas and the continuous creation of new wetlands. In some areas (e.g. the coast at Dongtai County, Jiangsu Province) the rate of coastal accretion exceeds 400 mm y^{-1} . Mudflats in this area support a variety of molluscs and are highly productive. Besides providing wintering areas for large numbers of waterfowl (swans, geese and ducks), the coastal marshes and mudflats are extremely important as staging areas for shorebirds during the migration season, and as breeding habitat for a variety of species, including the rare Saunders's Gull *Larus saundersi*. The coastal marshes also produce a large amount of reed and grass that is used as stock feed and the raw material for paper-pulp manufacture. Recent studies have indicated that *Spartina* can be planted in this biome and provide protection for the coastline and promote siltation (Zhong 1985).

The coast to the south of Hangzhou Bay is mainly rocky, with extensive wetlands confined to the mouths of the larger rivers, e.g. in the estuaries of the Pearl River in Guangdong Province, and the Min River in Fujian Province. Mangroves (with 30 species, Table 5) occur patchily along the coast as far north as central Fujian Province and around islands in the South China Sea. The total area of mangroves has declined from 67 000 ha in the 1970s to less than 15 000 ha in 1990, and much of that in a very degraded condition (Lin 1984, 1990). Some of the best remaining stands are found on Hainan Island, e.g. in Dongzaigang Natural Reserve which has now been designated as internationally important under the Ramsar Convention. The whole region is very important for fisheries production. Locally, the mangroves, fish ponds and rice paddies support large numbers of herons and egrets (e.g. in the Pearl River delta), while coastal mudflats are

Table 3. A proposed classification system of wetlands in China.

1. Natural wetlands	
System 1:	coastal and estuarine wetlands
Type 1:	deltas and bays
Type 2:	tidal mud and sand flats
Type 3:	grassy and reed-bed salt marshes
Type 4:	mangrove swamps
Type 5:	sea beaches (sand, pebbles)
Type 6:	rocky sea coasts, sea cliffs
Type 7:	small offshore islands, islets
System 2:	riverine and lacustrine wetlands
Type 8:	lake and river islets
Type 9:	shallow freshwater lakes
Type 10:	shallow brackish and saltwater lakes
Type 11:	flood plain
Type 12:	seasonal lakes and riverbeds
Type 13:	wet meadows
Type 14:	temporarily flooded forest
Type 15:	silted reservoirs
System 3:	peat bogs
Type 16:	floated grassy bogs
Type 17:	clumped grassy bogs
Type 18:	stretched grassy bogs
Type 19:	reed bogs
Type 20:	shrub bogs
Type 21:	wood bogs
Type 22:	moss bogs
2. Artificial wetlands	
Type 1:	paddy fields (rice, surgegane, aquatic vegetable)
Type 2:	aquatic culture ponds (shrimp, fish and clam ponds)
Type 3:	water storage reservoirs
Type 4:	salt pans

important as staging and wintering areas for migratory shorebirds, gulls and terns.

Riverine and lacustrine wetlands

China has more than 50 000 rivers with a catchment basins in excess of 100 km², and over 1500 with a basin area of more than 1000 km². Wetlands along these rivers can be subdivided into two types. First are those in peripheral drainage regions, and second, those in endorheic regions (Fig. 1). Both include river and lake islets, shallow lakes (freshwater, brackish or saltwater), flood plains, seasonal rivers and lakes,

wet meadows, temporarily flooded forests, and silted reservoirs.

Wetlands in peripheral drainage basins

Peripheral drainage basins cover 6.12 million km², about 64% of the total territory of China. This encompasses 23 major rivers; 18 of these are part of the hydrographical network of the Pacific Ocean, 4 of the Indian Ocean and 1 of the Arctic Ocean. The hydrographical net of the Pacific Ocean includes the Nenjiang-Songhuajiang-Heilongjiang Basin in north-western China and the Yangtze-Yellow-Huaihe Basin. The largest freshwater marshes in China are found in the former basin, in the Provinces of Heilongjiang,

Table 4. Estimate of wetland area in each province of China.

Province	TOTAL AREA (1,000 ha.)	WETLAND AREA (1,000 ha.)	%
1. Anhui	13,900	400 – 500	3.0
2. Beijing	1,700	30 – 40	2.1
3. Fujian	12,100	100 – 120	0.9
4. Gansu	45,100	20 – 25	0.05
5. Guangdong	19,000	500 – 550	2.7
6. Guangxi	23,600	150 – 200	0.7
7. Guizhou	17,000	15 – 20	0.1
8. Hainan	3,200	10 – 15	0.4
9. Hebei	19,000	200 – 250	1.2
10. Heilongjiang	46,900	5,800 – 6,100	12.8
11. Henan	16,700	250 – 300	1.6
12. Hubei	18,000	300 – 350	1.9
13. Hunan	21,000	600 – 650	3.0
14. Inner Mongolia	120,000	1,100 – 1,250	1.0
15. Jiangsu	10,300	1,500 – 1,700	14.6
16. Jiangxi	16,700	550 – 600	3.4
17. Jilin	18,700	600 – 650	3.2
18. Liaoning	14,600	350 – 400	2.4
19. Ningxia	6,600	40 – 50	0.6
20. Qinghai	72,400	1,000 – 1,150	1.4
21. Shaanxi	19,500	40 – 50	0.2
22. Shandong	15,300	800 – 900	5.2
23. Shanghai	600	25 – 30	4.5
24. Shanxi	15,600	50 – 60	0.3
25. Sichuan	56,700	400 – 450	0.7
26. Taiwan	3,600	10 – 10	0.3
27. Tianjin	1,100	70 – 80	6.8
28. Xinjiang	160,000	3,800 – 4,000	2.4
29. Xizang	120,000	3,800 – 4,200	3.3
30. Yunnan	39,400	150 – 200	0.4
31. Zhejiang	10,200	150 – 200	1.6
Total	958,500	22,810 – 25,100	2.5

Jilin, and north-eastern Inner Mongolia. There are about 2 million ha of wetlands on the Sanjiang (Three Rivers) Plain alone. This region of north-eastern Heilongjiang consists of a vast complex of shallow freshwater lakes, reed marshes and peat bogs in the lowlands near the confluence of the Heilong (Amur), Sungari and Wusuli (Ussuri) Rivers. Other extensive systems of freshwater lakes and marshes occur near Qiqihar in south-western Heilongjiang, around Tongyu and

Baicheng in western Jilin. There are two very large lakes in this region: Hulun Nur in north-eastern Inner Mongolia and Xingkai Hu (Lake Khaka) straddling the border between Heilongjiang and Russia. Other important wetlands include the mountain bogs of the Changbai Shan on the Korean border. The wetlands of the north-east are extremely important as breeding habitat for waterfowl, notably ducks, geese and cranes,

Table 5. Species of mangrove in China (Lin 1990). Thirty species of mangrove belonging to 20 genera in 16 families occur in Guangxi (GX), Hainan (HN), Guangdong (GD), Fujian (FJ), and Taiwan (TW) provinces.

	GX	HN	GD	FJ	TW
<i>Acanthus ebracteatus</i>	-	+	-	-	-
<i>Acanthus ilicifolius</i>	+	+	+	+	-
<i>Acrostichum aureum</i>	+	+	+	-	-
<i>Acrostichum speciosum</i>	-	+	-	-	-
<i>Aegicera corniculatum</i>	+	+	+	+	-
<i>Avicennia marina</i>	+	+	+	+	+
<i>Barringtonia racemosa</i>	-	+	+	-	+
<i>Bruguiera cylindrica</i>	-	+	-	-	-
<i>Bruguiera gymnorhiza</i>	+	+	+	+	+
<i>Bruguiera sexangula</i>	-	+	-	-	-
<i>Cerbera manghas</i>	+	+	+	-	+
<i>Ceriops tagal</i>	+	+	+	-	+
<i>Excoecaria agallocha</i>	+	+	+	+	+
<i>Heritiera littoralis</i>	-	+	-	-	+
<i>Hibiscus tiliaceus</i>	+	+	+	+	+
<i>Kandelia candel</i>	+	+	+	+	+
<i>Lumnitzera littorea</i>	-	+	-	-	-
<i>Lumnitzera racemosa</i>	+	+	+	-	+
<i>Nypa fruticans</i>	-	+	-	-	-
<i>Pemphis acidula</i>	-	-	+	-	+
<i>Rhizophora apiculata</i>	-	+	-	-	-
<i>Rhizophora mucronata</i>	-	-	-	-	+
<i>Rhizophora stylosa</i>	+	+	+	-	+
<i>Scyphiphora hydrophyllacea</i>	-	+	-	-	-
<i>Sonneratia alba</i>	-	+	-	-	-
<i>Sonneratia caseolaris</i>	-	+	-	-	-
<i>Sonneratia hainanensis</i>	-	+	-	-	-
<i>Sonneratia ovata</i>	-	+	-	-	-
<i>Thespesia populnea</i>	-	+	+	-	+
<i>Xylocarpus granatum</i>	-	+	-	-	-

and are also very important for their fisheries and reed production.

The great plains of the Yangtze-Yellow-Huaihe Basin in eastern China contain some of the largest wetlands in China, and the greatest concentration of freshwater lakes. The total area of lacustrine wetlands in this region is estimated at over 4 million ha. The Yangtze Basin, in particular, is famous for its lakes; these include the Dongting Lakes in Hunan Province, the Wuhan Lakes in Hubei Province, Poyang Lake in Jiangxi Province, and a chain of large lakes, including Shengjin, in south-western Anhui Province. Cao Lake in central Anhui Province, and Tai Lake, Hongze

Lake and Gaoyou Lake in Jiangsu Province. Many of the lakes are fringed with marshes, and there are also extensive marshes in the dried out beds of ancient lakes, in old river channels (particularly along the Yellow River), and in seasonally flooded areas.

The wetlands in the Yangtze-Yellow-Huaihe Basin are of great importance for wintering waterfowl, particularly herons and egrets, storks, ducks, geese and coots. Several species of cranes winter in large numbers, including the rare Siberian Crane *Grus leucogeranus*, White-naped Crane *Grus vipio* and the Hooded Crane *Grus monacha* (Ma 1986). A small population of the endangered Baiji or Chinese River Dolphin *Lipotes*

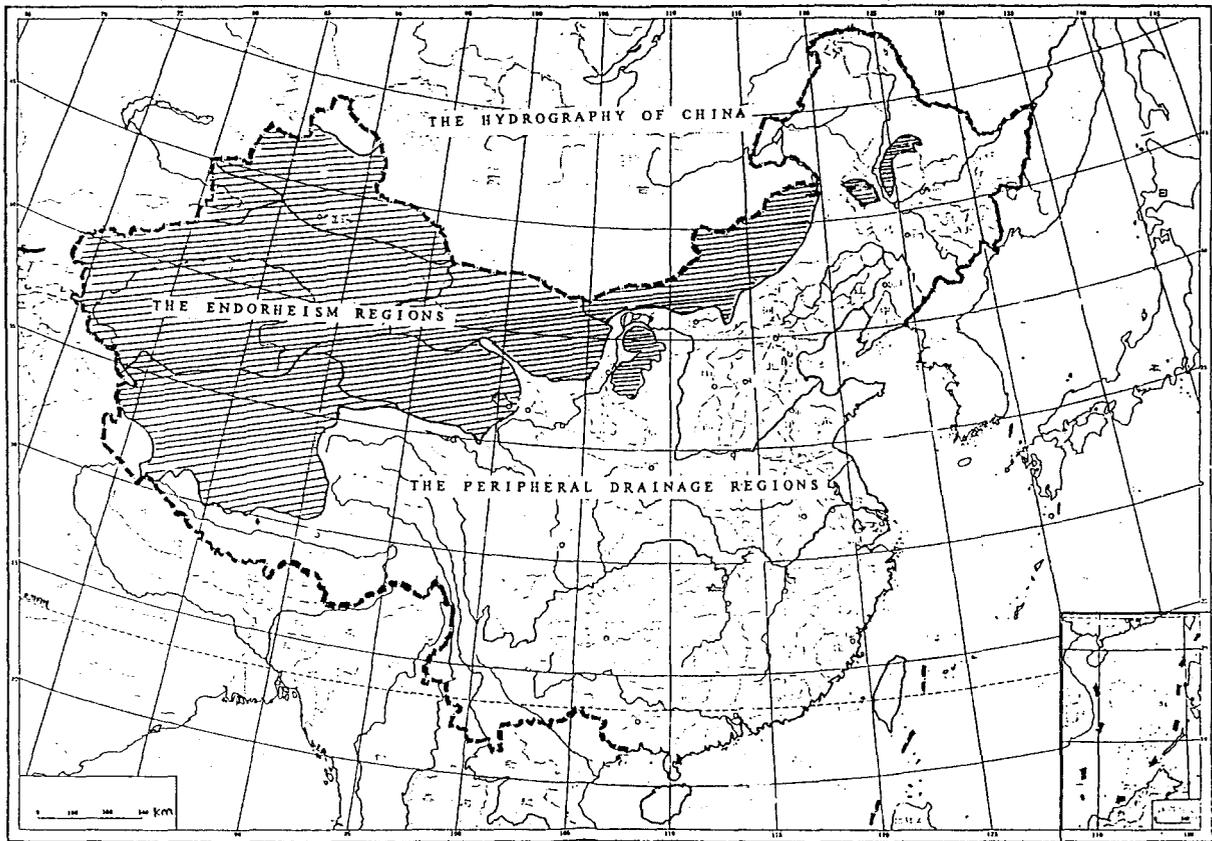


Fig. 1. Regions in China with endorheic and peripheral drainage.

vexillifer still survives along the lower-middle reaches of the Yangtze River. Recent estimates suggest that as few as 100 individuals remain (Zhou 1987). The lower Yangtze valley in Anhui Province is also the last stronghold of the endangered Chinese Alligator *Alligator sinensis*. The region includes some of the country's major freshwater fish producing areas; the lower Yangtze Basin, with its many large and small lakes, is the most important and includes the provinces with the highest fish production, Jiangsu and Hubei (Wang *et al.* 1989; Wang 1987).

A chain of freshwater lakes and marshes in the headwaters of the Brahmaputra (Yarlung Zangbo Jiang Basin), Ganges and Indus Rivers in the main Himalayan ranges in south-eastern Tibet, is part of the Indian Ocean hydrographic net (Gua *et al.* 1984). These wetlands are known to be of considerable importance for breeding waterfowl, notably Bar-headed Geese *Anser indicus* and Black-necked Cranes *Grus nigricollis* (Zhen 1983). A recent survey showed that there are also a considerable number of wintering waterfowl in these areas (Lu 1990). The wet meadows

also support the main pastoral area in Tibet (Zheng 1985).

There are a few large lakes and extensive marshes in the highlands of the Altai Shan. Chianassu Hu in the central Altai and a group of small lakes at the southern end of the Altai lie in the upper drainage of the Ertix He (Irtys River), and are thus part of the Arctic Ocean hydrographic net. A nature reserve has been established around some of the Altai lakes in order to protect the beaver *Castor fiber* (Liang 1986).

Wetlands in endorheic drainage regions

The endorheic regions in China cover 3.5 million km², about 36% of the country. They are spread over 12 regions with all except the Wuyur He and Baicheng in north-eastern China being located in the western part of the country. Wetland information has been received from two of these regions: the Qinghai-Tibetan Plateau and Tian Shan Mountains and desert areas in Xinjiang. The Qinghai-Tibetan Plateau is the largest high altitude plateau in the world, most of it being between 4000–5500 m above sea level and bounded to the north by the

Kun Lun Shan and Nan Shan, and to the south by the great Himalayan Range. The entire plateau is dotted with innumerable lakes, ponds and bogs, and includes the sources of a number of great rivers: the Yellow, Yangtze, Mekong and Salween in the east; and the Indus, Ganges and Brahmaputra in the south (Zhang 1982). However, much of the plateau consists of inland drainage systems and most of lakes are saline. Qinghai Lake covers 495 200 ha and is the largest saline lake in China. The total area of wetlands exceeds 5 million ha. The wetlands fall into two major groups: i) the hundreds of large, mostly saline lakes in the north plain of Tibet (Qiangtang area); and ii) a chain of large saline lakes in the Zaidan Basin, north of Kun Lun Shan. Some of the wetlands are very important for breeding waterfowl, notably bar-headed Geese and Black-necked Cranes (Lu 1990).

The great inland drainage systems of the Xinjiang deserts in north-western China include several large freshwater and saline lakes with associated brackish marshes surrounded by sandy desert. The largest of the freshwater lakes is the 100 000 ha Bosten Hu near the northern edge of the Tarim Basin. The Bo Hu marshes to the south-west of Bosten Hu cover some 30 000 ha, and include many small lakes and ponds, and the extensive reed beds support a major paper industry. Other major wetlands include the Tarim Liuchang Lakes in the Tarim Basin, Aiding Hu in the Turpan Depression, Manasi Hu in the Junggar basin, and numerous intermittent rivers and streams rising in the surrounding mountains along the edges of the Tarim and Junggar Basins. Recent surveys show that the marshes along the Tarim River support one of the largest breeding populations of Black Stork *Ciconia nigra*. There are also many small lakes, marshes and streams in the Tian Shan. The Bayinbuluke complex of small lakes and marshes along the Kaidu River at more than 2400 m in the Tian Shan is known to be an important breeding area for waterfowl, notably Whooper Swans *Cygnus cygnus*. The areal extent of wetlands in Xinjiang Region exceed 5 million ha.

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