

Bulletin on the Ecological and Environmental Monitoring Results of the Three Gorges Project 2018

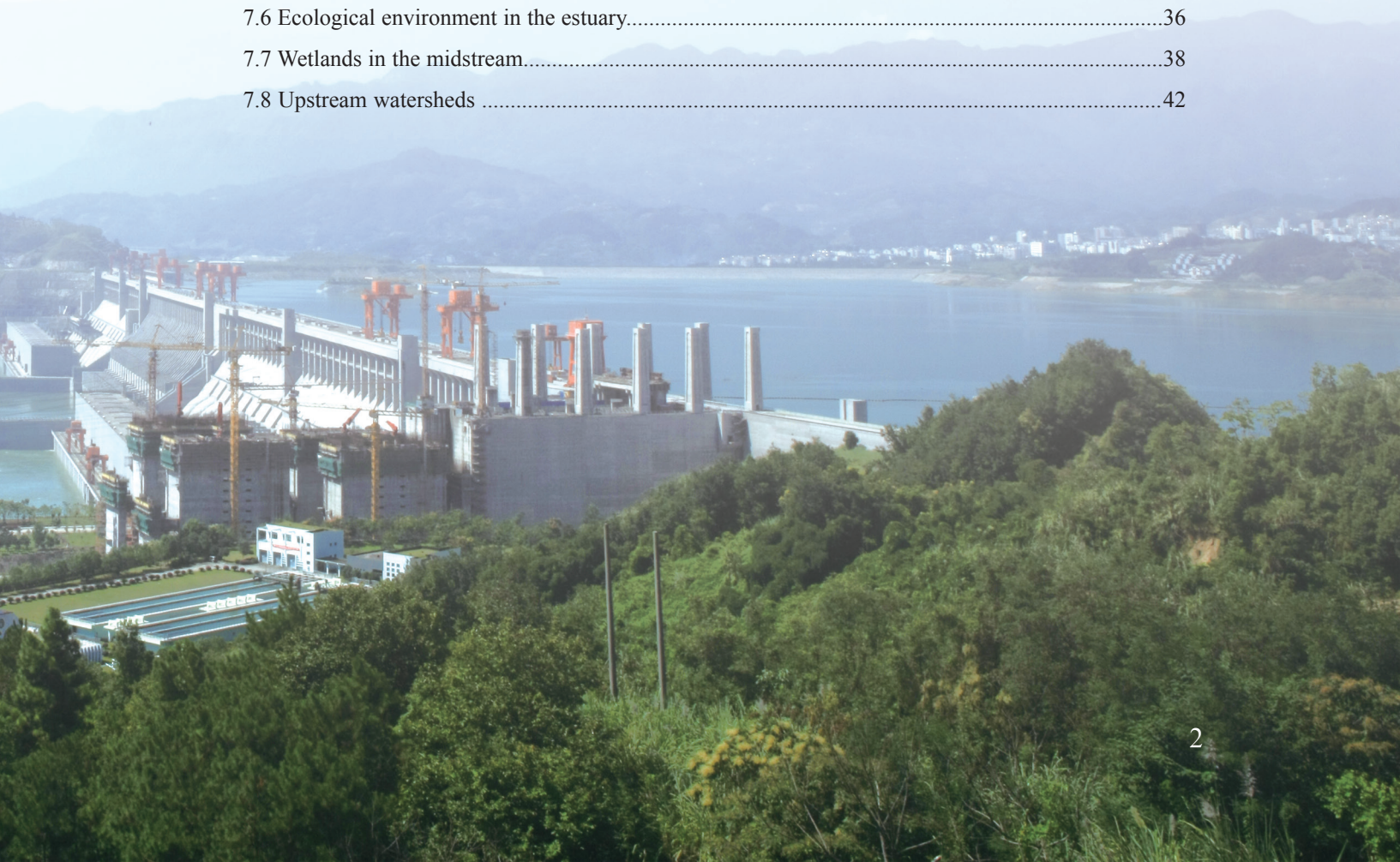


**Ministry of Ecology and Environment of the People's
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Overview

In 2017, the Three Gorges Water Project maintained good operation, and the 175 m trial impoundment was achieved in success for the eighth consecutive time, giving full play to the comprehensive role of flood control, power generation, navigation, and water resources utilization. A total of 10.36 bn. m³ floodwater was impounded during the flood season. The Three Gorges power plant generated about 97.6 bn. kWh electricity throughout the year. The navigation lock had been operated safely and efficiently with annual freight volume exceeding 100 mil. t again. The project replenished the lower reaches with 23.3 bn. m³ water during the dry season.

The mean annual temperature of the Project area posted 18.1°C, 0.2°C higher compared with the average year. The area experienced 1,386.3 mm annual precipitation, 24% higher than that of the average year. The mean relative humidity was 77%, in line with that of the average year, while the mean wind speed posted 1.6 m/s, 0.3 m/s higher than that of the historical average.

The forest area reached 2.8637 mil. ha., the forest

coverage registered 49.66%, and the living wood growing stock totaled 171.5763 mil. m³ in the Project area, including 169.8230 mil. m³ of the forest growing stock. The area of arable land of the Project area stood at 415,406 ha., up by 1.5% compared with last year. The planted acreage was 636,282 ha., up by 5.2% compared with last year. The multiple cropping index of was 189.3%, a slight drop from last year. Grain crops still dominated agricultural production.

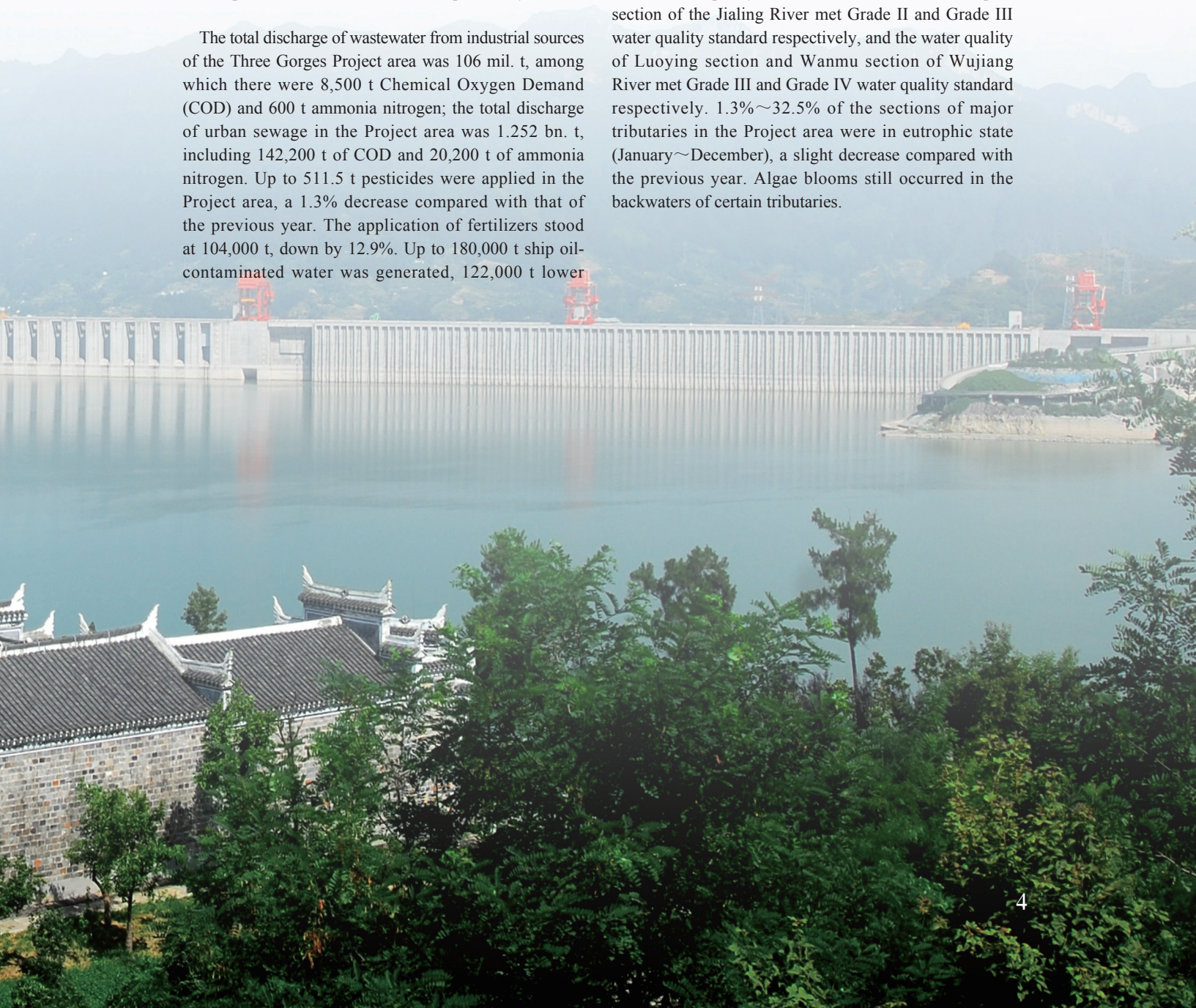
The natural fishery catches in the Project area, downstream the dam, and in the Dongting Lake and Poyang Lake totaled 70,800 t, a 6.8% increase than that of last year. The fish fry amount of the four major Chinese carps was about 280 mil. at Jianli section downstream the Dam, a dramatic decrease compared with that of the same period last year. The survey at the upstream of the Yangtze River found 25 endemic and 8 alien fish species. Samples of juvenile *Aclpenser Sinensis* Grdy were monitored in the downstream of the Yangtze River and estuary area and one bycatch adult *Aclpenser Sinensis* Grdy was investigated in the estuary area.

The Three Gorges Project area observed 776 earthquakes at $M \geq 0.0$, 295 times more than the previous year, mainly including microearthquakes, ultra-micro earthquakes, and some individual earthquakes reaching the intensity of small and moderate earthquakes. The quakes were mainly distributed along the riverside at Badong County-Zigui County of Hubei Province, and the riverside at Wushan County-Wuxi County-Fengjie County of Chongqing Municipality. The potential hazard sites of geological disasters in the Three Gorges Project area experienced an increase from the previous year.

The total discharge of wastewater from industrial sources of the Three Gorges Project area was 106 mil. t, among which there were 8,500 t Chemical Oxygen Demand (COD) and 600 t ammonia nitrogen; the total discharge of urban sewage in the Project area was 1.252 bn. t, including 142,200 t of COD and 20,200 t of ammonia nitrogen. Up to 511.5 t pesticides were applied in the Project area, a 1.3% decrease compared with that of the previous year. The application of fertilizers stood at 104,000 t, down by 12.9%. Up to 180,000 t ship oil-contaminated water was generated, 122,000 t lower

than that of the previous year. The standard-meeting discharge was 167,000 t. Shipboard domestic sewage totaled around 2.387 mil. t, a decrease of 386,000 t from the previous year.

The amplitude of flow variation of the mainstream of Yangtze River in the Project area was 2,900~20,800 m^3/s , and the mean amplitude of velocity was 0.09~2.36 m/s. The annual average water quality of the mainstream of Yangtze River in the Project area was good, the annual overall water quality of the Jinzi section and Beiwenquan section of the Jialing River met Grade II and Grade III water quality standard respectively, and the water quality of Luoying section and Wanmu section of Wujiang River met Grade III and Grade IV water quality standard respectively. 1.3%~32.5% of the sections of major tributaries in the Project area were in eutrophic state (January~December), a slight decrease compared with the previous year. Algae blooms still occurred in the backwaters of certain tributaries.



Chapter 1

Operation of the Three Gorges Project

In 2017, the Three Gorges Water Project maintained good operation, the electricity generating units of the Three Gorges Power Station were operated safely and steadily, and the shiplift project has entered into trial operation phase, generating remarkable overall benefits such as flood control, electricity generation, navigation, and water resources utilization.

● Comprehensive regulation

In 2017, the Three Gorges Reservoir accepted a total of 421.4 bn. m³ incoming waters, down by 6.6% from the preliminary designed value. The Three Gorges Water Project safely experienced the flood season, the 175 m trial impoundment was achieved successfully and the level of comprehensive utilization of water resources continued to increase; the maximum inflow of the Three Gorges Reservoir was 38,000 m³/s during the flood season and a total of 10.36 bn. m³ floodwater was impounded, exerting a remarkable effect on flood control. During the drawdown period, the Three Gorges Reservoir replenished the lower reaches for 177 days in total, with an amount of 23.3 bn. m³ in replenishment.

● Operation of the power station

In 2017, by overcoming the influence of incoming water decline, actively regulating of a group of reservoirs and optimizing the small and medium floods, the Three Gorges Power Station generated 97.6 bn. kWh electricity throughout the year and successfully completed the annual generation and operation targets.

● Navigation management

In 2017, the navigation lock of the Three Gorges maintained safe and efficient operation for the fourteenth consecutive year, enabling the total freight volume exceeding 100 mil. t once again.

● Project progress

In 2017, the shiplift project in the Three Gorges Project area entered into trial operation phase smoothly. The ecological environment of the Three Gorges Dam area was pleasant, and the planning project was also under steady progress. Major projects like Yangtze River Rare Fish Conservation Center and Museum of the Three Gorges Project proceeded in an orderly way.



Chapter 2

Economic and Social Development

2.1 Climate

In 2017, the main characteristics of the climate conditions in the Three Gorges Project area could be demonstrated as below: the temperature was abnormally warm in winter and close to normal in spring, and the temperature in summer was on the high side while that in autumn was on the low side; the days with high temperature were more than ever in general; the precipitation in winter, spring and autumn were significantly more than that of the average year,

especially in autumn, with the precipitation in October registering a historical high since 1961; days of heavy rain throughout the year was more than that of the average year; the mean annual wind speed was higher than that of normal years and the mean annual relative humidity was the same as that of the normal years. The main meteorological disasters that struck the Project area and adjacent areas were continuous rain in autumn, high temperature and droughts, and rainstorms and floods.

Table 2-1 Monitoring results of meteorological elements of each station in the Three Gorges Project area in 2017

Station	Mean temperature (°C)	Precipitation (mm)	Mean Relative humidity (%)	Evaporation (mm)	Mean wind speed (m/s)	Sunshine hours (h)	Foggy days (d)
Chongqing	19.4	1245.5	75	1090.2	1.3	1154.4	22
Changshou	18.4	1158.0	79	743.8	1.4	1114.7	38
Fuling	18.1	1036.4	81	-	1.7	1201.0	172
Fengdu	19.0	1223.4	77	796.7	1.5	1143.2	33
Zhongxian	18.1	1550.2	81	-	1.4	1041.2	165
Wanzhou	19.0	1717.6	78	1140.2	1.2	1238.9	14
Yunyang	18.5	1541.3	78	-	1.5	1244.7	47
Fengjie	18.6	1542.7	73	1056.7	1.8	1226.7	29
Wushan	16.5	1516.4	75	-	2.5	1513.0	132
Badong	17.6	1450.7	74	1272.0	1.8	1448.1	37
Zigui	17.1	1535.4	77	810.0	1.1	1271.0	8
Yichang	16.8	1117.6	78	1139.6	1.8	1414.1	70

Note: “-” means unavailable. According to meteorological observation regulation, if data is not measured for more than three days in a month, the data for this month will be recorded as unavailable. If data of over 10% of the months is missing, the data for this year will be recorded as unavailable. The evaporation data of Chongqing, Wanzhou, Fengjie, Badong and Yichang were those of small evaporation dish corrected from those measured in big evaporation dishes.

2.1.1 Meteorological elements

In 2017, the mean annual temperature of the Project area recorded 18.1°C, 0.2°C higher than that of the average year (17.9°C), and 0.3°C lower than last year. The mean annual temperature in the Three Gorges Project area ranged from 16.0°C to 19.0°C, of which the western and northern regions ranged from 17.5°C

to 19.0°C, and the eastern and southern regions ranged from 16.0°C to 17.5°C generally. The mean annual temperature of the northwest regions was 1.0~2.0 °C higher than that of the southeast regions. Compared with the normal years, the mean annual temperature in most of the Three Gorges Project area in 2017 was higher or close to normal, especially in the central regions

with 0.2°C higher and some regions were 0.6~1.0°C higher. In terms of time distribution, the monthly mean temperatures within the year varied greatly, with the monthly mean temperatures in January, February, April, July, August and December being warmer and those of May, June, September and October being colder; the

monthly mean temperatures in March and November were close to normal, and the temperature in January and August underwent an obvious warmth, with 2.0°C and 1.2°C above the normal respectively, and the monthly mean temperature in January registered a historical high since 1961.

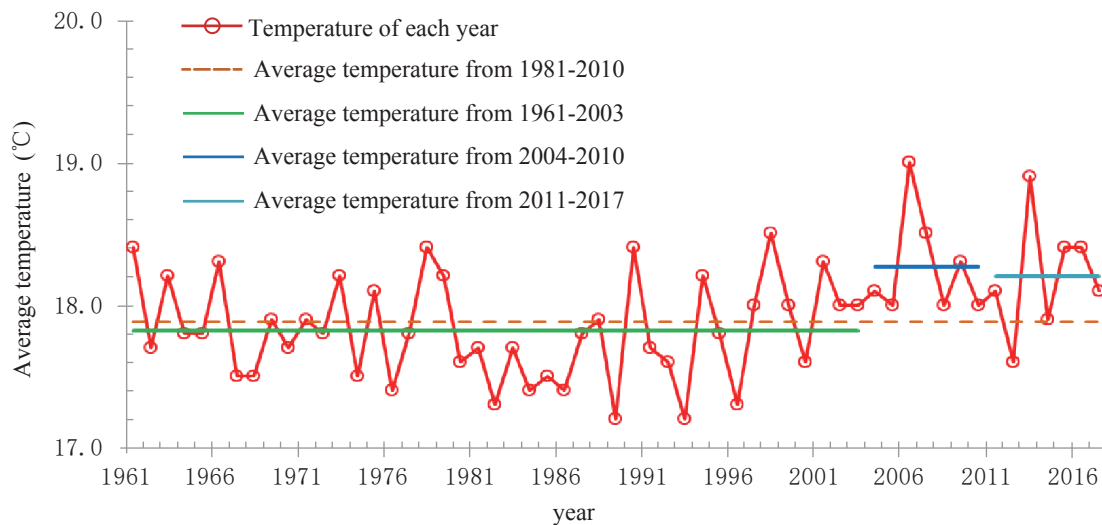


Figure 2-1 Mean annual temperature of the Three Gorges Project area between 1961 and 2017

The annual precipitation was 1,386.3 mm in the Project area in 2017, 24% more than the historical average (1,114.9 mm). The annual precipitation in the Three Gorges Project area was 1,359.9 mm, 15% more than the average year. In terms of spatial distribution, the annual precipitation of most parts of the Project area was above 1,100 mm, and the annual precipitation of the central parts of the area was generally above 1,400 mm, among which the annual precipitation in locations such as Wuxi, Wanzhou and Enshi was over 1,600 mm, and Hefeng posted the largest volume with 1,936.9 mm. Compared with normal years, the annual volume of precipitation in the Three Gorges Project area was more

than the average years in general. According to the time distribution, the precipitation in the first half of year was more while the precipitation in the second half of the year showed “less-more-less” features. Precipitation from February to June and that from September to October were more than the same period of the average years, among which the precipitation in September and October more than doubled compared with the same period of the previous year. The precipitation in October registered a historical high; the precipitation in January, July, August, November and December was less than normal, especially in November and December with 56% and 74% less than the average year respectively.

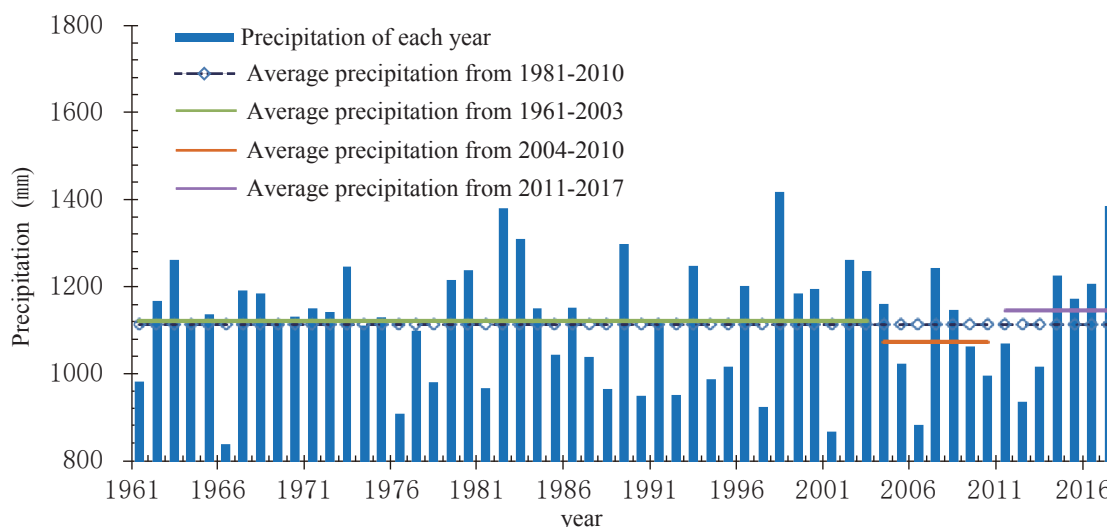


Figure 2-2 Mean annual precipitation of the Three Gorges Project area during 1961–2017

The mean relative humidity of the Project area was 77%, close to that of historical average (76%). The relative humidity of all monitoring stations in the Three Gorges Project area ranged from 72% to 86%. Compared with the average year, the relative humidity in most parts of the Project area was close to historical average, except only some parts of the northeastern area were 2%~4% higher than average year. The relative humidity in Fengjie was 6% higher, and that of Chongqing 4% lower. Seasonal analysis indicated that the relative humidity was higher in winter and autumn while lower in spring and summer. The relative humidity (historical average) was 79% (77%), 75% (74%), 75% (76%) and 83% (79%) in winter, spring, summer and autumn respectively, all close to that of the same period of the average year.

The mean wind speed was 1.6 m/s in the Project area, 0.3 m/s higher than that of historical average (1.3 m/s). The overall wind speed in the Project area has not changed much. The mean monthly wind speed hit the maximum in August, being 1.8 m/s, while the minimum was observed in January, June, September and December at 1.5 m/s. The wind speed was 0.5 m/s higher in October and 0.2~0.3 m/s higher than historic average in all rest months. Wushan station recorded the maximum mean wind speed at 2.5 m/s, and other places all experienced wind speed between 1.1 m/s and 1.8 m/s.

The number of foggy days showed an obvious local characteristics in the Project area. The foggy days in

Fuling, Zhongxian, and Wushan were 172, 165 and 132 days respectively, while there was only 8 foggy days in Zigui. In terms of yearly variation, February, May, June and September had the highest number of fog days with 7 days, followed by April, October and December with 6 days; the foggy days in January, March, July and November were 4~5 days respectively; August experienced the least with 2 days.

2.1.2 Meteorological hazards

In 2017, the Project area was hit by such main meteorological hazards as continuous rain in autumn, high temperatures and droughts and the rainstorms and floods. In specific, there were heavy autumn floods causing rainstorms and floods in some parts of the Project area; strong heat wave leading to periodic summer droughts; frequent heavy rainstorms hitting some parts of the Project area.

● Heavy autumn floods causing rainstorms and floods in some parts of the Project area

Affected by the continuous autumn rains, the precipitation in all parts of the Three Gorges Project area were more than normal, among which, the mean precipitation in Chongqing in autumn was 60% much than the same period of the average year, registering the largest volume since 1961. However, the precipitation in different seasons was unevenly distributed. Nearly 90% more than average year in September and October, reporting the highest in the same period since 1951,

while 50% less in November. The period of heavy precipitation in Chongqing is mainly from early September to mid-October. In 2017, the total amount of precipitation in autumn flood season in Hubei Province nearly doubled compared with the normal years, recording the second highest since 1961, second only to 1983. In terms of spatial distribution, the precipitation in most parts of the western region of Hubei Province was more than doubled compared with the average year. The autumn rain began on August 24th and ended on October 19th, with two distinct periods of precipitation mainly occurring from August 24th to September 11th and September 18th to October 19th.

Affected by a large scale of autumn rains, a total of 82 rivers distributed in Hubei, Chongqing, Shanxi, Sichuan and other provinces have raised the flooding alarm, 15 rivers have surpassed the safety water level, and the heavy rainstorms also triggered some secondary disasters such as torrential floods and mudslides in parts of the Three Gorges Project area. In addition, some parts of the Project area were struck by floods, and the continuous rainy weather also adversely affected crop autumn harvest and sowing.

● Strong heat wave leading to periodic summer droughts

In 2017, days with high temperature in the Three Gorges Project area (the daily maximum temperature above 35°C) mostly appeared in July, 5~30 days later than normal. In the summer of 2017, the high temperature period in summer was concentrated with strong intensity. All 34 districts and counties in Chongqing experienced high temperature above or equal to 35°C. The districts and counties like Shapingba, Beibei, Yubei, Jiangjin, Qijiang, Wansheng, Changshou, Fuling, Fengdu, Dianjiang, Zhongxian, Wanzhou, Yunyang, Kaizhou, Fengjie and Wuxi all experienced the hot weather above or equal to 40°C. Extreme maximum temperature in places like Fengdu (43.9, August 25th), Kaizhou (43.4°C, August 18th, 19th, 25th), Fengjie (42.2°C August 24th) Wuxi (43.5°C, August 25th) all broke the local historical record. Affected by this, summer in the Three Gorges Project area featured high temperature and droughts in the region, but the drought was slight in general.

● Frequent heavy rainstorms hitting some parts of the Project area

In April 2017, the central part of the Three Gorges area of the Yangtze River experienced torrential rain and precipitation process successively, mainly distributed in Wanzhou, Yunyang, Wushan, Kaizhou, Wuxi, Fengjie and other places. The onset of heavy rains started 1~2 months earlier than usual. During the year, there were 10 regional rainstorms in the Three Gorges area of the Yangtze River, more frequently than average year, among which, the frequency of rainstorms in Wanzhou was the highest on record.

2.1.3 Acid Rain

In 2017, the annual precipitation pH value of the six monitoring stations in Shapingba, Fuling, Wanzhou, Fengjie, Badong and Yichang were 5.92, 5.41, 5.74, 5.93, 5.96 and 5.53 respectively. In terms of annual average acidity, the pH values of rainfall in Shapingba, Wanzhou, Fengjie and Badong were normal, and the pH values of rainfall in Fuling and Yichang were in general acidic.

In 2017, the intensity of acid rain was low from May to October in reservoir area, and that of the other months reached a general acidity. February witnessed the strongest intensity with the precipitation pH value being 5.53. From the perspective of spatial distribution, the pH value of the monthly precipitation of Shapingba ranged from 5.63 to 6.19, with the monthly acidity level being normal; except in April and July, the pH value of monthly precipitation in Fuling ranged from 5.13 to 5.70, reaching the level of general acid intensity, and the most severe one occurred in January; the pH value of monthly precipitation in Wanzhou ranged from 5.38 to 6.08, reaching the level of general acid intensity in March, April, July and December; there was no acid rain throughout the year in Fengjie. In January and February of 2017, Badong underwent general acid rains, especially in January with the pH value of the precipitation reaching 5.23; the pH value of the precipitation in Yichang ranged from 4.92 to 6.10, and the acid rain occurred in February, March, and from September to November.

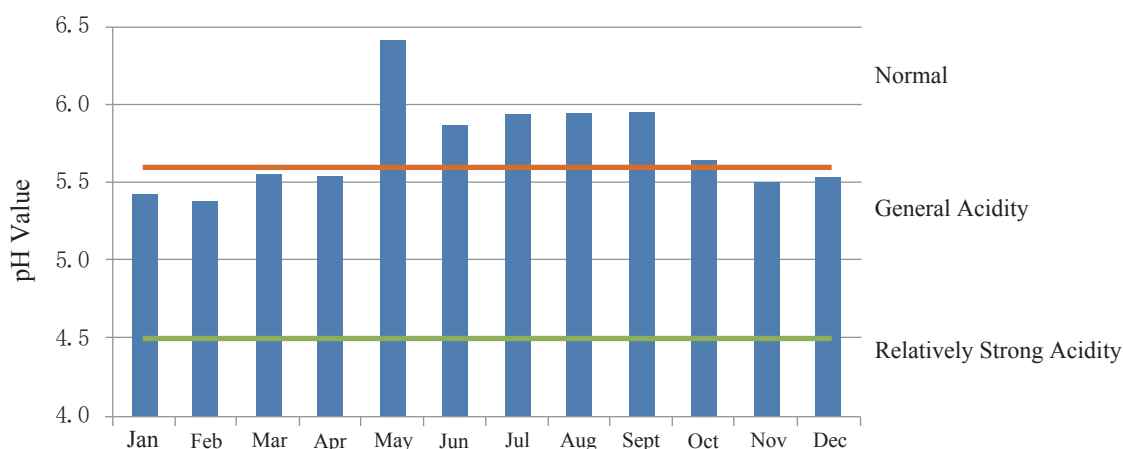


Figure 2-3 Mean pH Value of Monthly Precipitation in the Three Gorges Project area in 2017

2.2 Forest resources

In 2017, the forest area of the Project area occupied 2.8637 mil. ha. with the coverage of 49.66%. Specifically, there were 2.6386 mil. ha. closed forest land, accounting for 92.14% of the total and 225,100 ha. special shrub land defined by the state, which took up 7.86% of the total. The living wood growing stock totaled 171.5763 mil. m³, which included 169.8230 mil. m³ forest growing stock, and 1.7533 mil. m³ scattered wood land, scattered trees and trees on the sides of villages, homesteads, roads and rivers, which accounted for 98.98% and 1.02% respectively.

There were 1.7897 mil. ha. natural forests and 848,900 ha. planted forests. The growing stock for natural forests stood at 123.1407 mil. m³ and that for planted forests was 46.6823 mil. m³. Natural forests were the main forest resources in the Project area, from the perspective of the sources of forests.

There were 1.7122 mil. ha. shelter forests and 106.6792 mil. m³ shelter forest stock, accounting for 64.89% of the total forest area and 62.82% of the forest stock respectively. The area of special-purpose forests stood at 183,900 ha. and that of special-purpose forest stock was 17.6339 mil. m³, taking up 6.97% and 10.38% of their respective total. There were 701,800 ha. timber forests and 45.0852 mil. m³ timber forest stock, taking up 26.60% and 26.55% of their respective total. The area of firewood forests stood at 2,400 ha. and the stock was 138,600 m³, registering 0.09% and 0.08% of their

respective total. Economic forests covered an area of 38,200 ha., taking up 1.45% of the total, with growing stock of 286,100 ha., accounting for 0.17%. From the perspective of the variety of forests in the Project area, the shelter forests whose main purposes were to generate ecological benefits was the dominant variety.

Sapling forests of the Three Gorges Project area covered 1.0755 mil. ha., and the stock was 44.7406 mil. m³, accounting for 42.52% of the total area and 26.35% of the total growing stock of arboreal forest. There were 1.0268 mil. ha. half-mature forests with 79.6811 mil. m³ growing stock, taking up 40.59% and 46.91% respectively. The area and growing stock of near-mature forests were 298,600 ha. and 28.8552 mil. m³, constituting 11.80% and 16.99% respectively. Mature forests covered 113,200 ha. and the growing stock stood at 14.0029 mil. m³, accounting for 4.48% and 8.25% respectively. There were 15,400 ha. over-mature forests with 2.5432 mil. m³ growing stock, taking up 0.61% and 1.50% of the total respectively. Sapling and half-mature forests dominated the arboreal forests with the coverage and growing stock accounting for 83.11% and 73.26% of the total respectively.

The planted forest covered 76,500 ha. in the Project area, and 75,400 ha. was preserved with the survival rate of 98.55%. Specifically, the planted forests amounted to 11,100 ha. in Hubei and 11,100 ha. was preserved with the survival rate of 100%. The planted forests reached 65,400 ha. in Chongqing and 64,300 ha. was preserved with the survival rate of 98.30%.

A total of 109,817 ha. forests suffered from forest hazards, accounting for 3.83% of the total forest area in the Project area, including 103,322 ha., or 94.09%, damaged by forest diseases and insect pests, and 6,495 ha., or 5.91%, ruined by forest fires and other hazards.

2.3 Terrestrial plants

In 2017, the plant communities in the Project area fell into 110 formation types in 34 formation groups under 7 vegetation types of 5 vegetation type groups. Specifically, there were 61 types of forest formations, 25 types of shrub formations and 24 types of grass formations. The wild higher plants in the Project area could be divided into 4,797 species of 1674 genera under 299 families, accounting for 14.9% of the total number of plant species in the country. Specifically, 463 were moss species, 371 were pteridophytes and 3,963 were seed plant species.

In 2017, the dynamic characteristics of the terrestrial plant communities in 2005, 2010 and 2017 were compared and analyzed through a survey of 360 fixed plot communities in the Project area. The results showed that 18% of the forest formations in the Project area have changed, of which 9.31% changes occurred in broad-leaved forests, 8.32% occurred in coniferous forests, and no formation changes occurred in bamboo forests.

The forests in the Project area had a relatively high biodiversity, and the species diversity of the tree layer first decreased and then increased. The changes of species diversity of different types of forest trees varied slightly. The biomass of forest tree layer increased by 12.8% in general. The biomass of bamboo tree layer decreased significantly which showed a trend of degradation. 75% shrub formations in the Project area changed, which in general was in the stage of forest succession. 89.47% grass formations in the Project area changed, showing a tendency for the positive succession to the shrubs.

As for *Thuja sutchuenensis*, the typical rare and endangered plant in the Project area, the absolute growth of the diameter at breast height (DBH) was significantly lower than that of other tree species in the community, and its value of importance in the community gradually decreased. Through dynamic monitoring, it was found that the interference of human activities (such as severe logging unlawfully) and the invasion of other species were two major factors that restricted the survival and



Coniferous forest– *Pinus armandii* forest

and persistence of its population.

2.4 Terrestrial animal species

In 2017, land-bird monitoring was conducted in 12 districts and counties in the Three Gorges Project area where natural vegetation were large and adjacent. A total of 14,668 birds of 178 species were detected from April 18th to May 11th (spring) and from October 9th to November 12th (autumn), among which, there were 23 new species that have not been detected in the past three years. 7,764 birds were recorded in spring and 6,904 in autumn. Both the type and number of the above birds were dominated by local species. From the perspective of ecological type, the most suitable canopy omnivorous birds accounted for the largest proportion, especially the various pycnonotidae species; the proportion of birds in the forest was also large, indicating that the hierarchy of forest vegetation in the Three Gorges Project area was in a good preservation state; the number of birds feeding on the trunks like woodpecker and nuthatch was very small, indicating that there were fewer large trees and aged forests. The number of predatory birds was very small, which might be related to the high intensity of human activities in the monitoring area. There were more birds in cities and villages, reflecting that human activities in the Project area had a large impact on environment. Compared with the previous year, bird density did not change much. However, the percentage of shrub birds decreased and the percentage of birds in the forest increased, resulting in a smaller percentage of canopy omnivorous birds such as pycnonotids.

Three lakes and eleven tributaries in the Project area were selected for monitoring in the winter because of

their better water quality, better preserved vegetation and less human disturbance. In winter 2017, a total of 4,801 species were recorded, among which, cormorant (863), *anas falcata* (768), mallard (757) and *tachybaptus* (532) were the largest birds in number. Moreover, 13 Chinese merganser listed as Category I State Protect species in China were also detected, which was slightly higher than that of last year's winter; and 248 mandarin duck-listed as Category II State Protect species in China were also detected with little population fluctuations. The density of water bird in lakes was significantly higher than that of in rivers. The number of cormorants and *laridae* increased, while that of duck, *podicedidae*, *ardeidae*, shorebirds and *osteoclasts* all decreased. Among the three lake-type wetlands surveyed, Hanfeng Lake had the largest number of birds, reaching 1,222, while the number of birds in Changshou Lake declined. Among the 11 tributaries, the number of wintering water birds in Pengxi River reached the largest of 708, followed by Wujiang River (334) and Tangxi River (189), and the water birds in Jiuwanxi declined dramatically.

From August 9th to August 24th, 2017, the amphibians and reptile species were monitored. 16 reptiles of 11 species, 160 amphibians of 11 species, 16 beasts of 5 species and one species of owls were monitored in 13 sample night patrols lines. The density of amphibians in land sample line was 1.02/km, and that in stream sample line was 36.45/km; the density of reptiles was much lower than that of amphibians and had no record in waterways. The density of reptiles in land sample line was 0.31/km.

2.5 Rare and endemic aquatic animals

2.5.1 Endemic fish species

In 2017, 116 fish species were identified totally in the upstream reaches of the Yangtze River including Yibin, Hejiang, Mudong, the part of Chishui municipality along the Chishui River, and Yichang reach in the midstream. Specifically, there were 25 endemic fish species and 8 alien fish species in the upstream of the Yangtze River. The endemic fish species in upstream reaches such as Yibin and Hejiang did not exhibit significant variations after impoundment. The number of endemic fish species in the reservoir area was downsized compared with that before impoundment.

A total of 2433.79 kg fish was collected in catch investigation, totaling 39,955 ones. There were 8,457 endemic fishes with total weight at 363.75 kg, which

accounted for 14.9% of the total weight of the catch and 21.2% of total amount. The percent of endemic fish went up 35.5% by weight, and 130.4% by number. There was a significant change in the population of endemic fish species in the upper reaches of the Yangtze River after impoundment of the Three Gorges Reservoir. There was a certain amount of endemic fish species in Yibin, Hejiang reaches, Mudong reach in the tail region and tributary Chishui River.

In 2017, experiment was carried out on artificial propagation of *Sauyage et Dabry* in Cage Ship Base in Luzhou, Sichuan province, which produced 5 batches of fertilized eggs and fries, with fertilization rate at 95% and 835 fries out of films.

2.5.2 Rare aquatic animals

In 2017, surveys were conducted in the known spawning sites in Yichang section of the lower reaches of Gezhouba Project during the propagation season of Chinese sturgeon. Based on the results of hydroacoustical navigation detection, the number of breeding populations of Chinese sturgeon was estimated to be over 20. After 2003, the number of breeding populations of Chinese sturgeon remained at a low level and showed a gradual decline tendency.

The survey on egg predatory fish was conducted from November 2017 to January 2018, and no breeding activities of Chinese sturgeon were found.

In 2017, 1 juvenile Chinese sturgeon sample was monitored in Yangzhou section of the lower reaches of the Yangtze River and 888 juvenile Chinese sturgeons



Chishui River



Acipenser dabryanus

were monitored in estuary area. The bycatch of 1 Chinese sturgeon was investigated in estuary area and there was no report of bycatch of paddlefish. The bycatch of 4 *Acipenser dabryanus* was found out in Chishui River. The bycatch of 14 mullets was found out in the Hejiang, Mudong, Yichang reach and the part of Chishui municipality along the tributary Chishui River. In the upper and middle reach of the Yangtze River, no paddlefish has been found for years, and the population of *Acipenser dabryanus* was very small. There was still a certain population of mullets.

In November and December 2017, by using visual transversal sampling and towed passive acoustic survey method, 529 finless porpoises were observed in the main stream of Yangtze River from Yichang to Shanghai reach. 1,042 finless porpoises were observed in 299 times in Poyang Lake. The number of finless porpoises did not change significantly compared with previous years, and the population was relatively stable. 181 finless porpoises were observed in Dongting Lake in 77 times. Compared with the year of 2012, the population of finless porpoise in Dongting Lake has increased significantly.

There still was no report of white-flag dolphin (*Lipotes vexillifer*) in the investigation of 2017.

2.6 Fishery resources and environment

2.6.1 Fishery resources

In 2017, the catch of natural fishes in the Project area, downstream the Dam, and in the Dongting Lake and Poyang Lake totaled 70,800 t, was up by 6.8% with last year. The fish fry amount of the four major Chinese carps at Jianli section downstream the Dam was 280 mil., a sharp decrease over last year. The total catch of eel in the estuary waters in fishing season was 1.13 t,

up by 72.68% compared with last year. The total catch of *Coilia ectenes* in the downstream of Yangtze River and in the estuary waters in fishing season was 63.34 t, up by 1.90% compared with last year. The total catch of long-tail anchovy (*Coilia mystus*) in fishing season was 18.4 t, down by 16.36% compared with last year. The total catch of Chinese mitten crab in the downstream of Yangtze River and in the estuary waters in fishing season was 84.6 t, up by 43.15% compared with last year.

● Three Gorges Project area

In 2017, the total catch of natural fish of the Project area was 7,641 t, up by 18.37% compared with last year. The total catch of the four major Chinese carps was 1,850 t. Among the important economic fish in the Project area, there were 294 t catfish, 334 t *Coreius heterodon* and 479 t *Pelteobagrus fulvidraco*. Compared with the same period of last year, total catch of the Project area was up by 18.37%, among which, the four major Chinese carps were up by 17.51%, catfish up by 32.43%, *Coreius heterodon* up by 53.92%, but that of *Pelteobagrus fulvidraco* was down by 27.97%.

● Downstream the dam

In 2017, the catch of natural fish downstream the Dam totaled 1,996 t, down by 7.8% compared with last year. It was estimated from the composition of the catch that there were 443 t carp, 393 t silver carp, 179 t grass carp, 159 t bighead carp, 139 t southern catfish and 120 t bream, the combined weight of which accounted for 71.8% of the total catch. They were the main commercial fish species downstream the Three Gorges Dam.

● Dongting Lake

In 2017, the catch of natural fish of the Dongting



Wharf in Jingzhou

Lake reached 31,800 t, up by 7.8% compared with last year. Specifically, 14,400 t were from eastern part of the Dongting Lake, 9,300 t were from southern part and 8,100 t were from western part, accounting for 45.3%, 29.2% and 25.5% respectively of the total. In the catch, settled fish species such as carp, crucian, catfish and *Pelteobagrus fulvidraco* as well as the “four major Chinese carps” took up 70.1% of the total weight of the sampled catch and were the major commercial fish species in Dongting Lake.

● Poyang Lake

In 2017, the catch of natural fish in the Poyang Lake was 29,400 t, up by 4.3% compared with last year. The settled fish species such as carp, crucian carp, catfish, *Pelteobagrus fulvidraco* and mandarin fish as well as the “four major Chinese carps” took up 79.1% of the sampled total catch and were major commercial fish species in the Poyang Lake.

● Yangtze River estuary

In 2017, the catch of *Coilia mystus* (tapertail anchovy) per ship and the output value per ship during the fishing season of the Yangtze River estuary were 0.597 t, 67,538 yuan, up by 41.08% and 154.62% respectively, and the total catch of them was 18.4 t, down by 16.36% compared with that of the same period from last year. The average length and weight of tapertail anchovy in the estuaries of Yangtze River in 2017 were 145.16 mm and 10.33 g, up by 5.19% and 13.52% respectively compared with last year.

The elver (*Anguilla Japonica*) catch per ship and output value per ship were 37,636 and 376,855 yuan, up by 216.38% and 217.78% compared with last year; the total catch during the fishing season was 1.13 t, up by 72.68% last year.

In 2017, 124 and 30 fishing licenses for eel and long-tail anchovy (*Coilia mystus*) were issued in estuary waters respectively, 54 and 22 less than previous year; 1,487 and 178 fishing licenses for *Coilia ectenes* and *Chinese mitten* crab were issued in the lower reaches and estuary of the Yangtze River respectively, among which 53 less for *Coilia ectenes* and 5 more for *Chinese mitten* crab than previous year

● Early resources of fish

In 2017, the fish fry amount in Sanzhou section of Jianli County in the midstream of the Yangtze River was 48.54 bn., among which, the fish fry amount of “the four

major Chinese carps” was 280 mil., marking a significant decline compared with last year. Among the fish fry of “the four major Chinese carps”, silver carp took up 76.4% and grass carp 15.9%. The percent of black carp and bighead carp was small, taking up 7.7%. Compared with the period before the impoundment, the spawning scale of “the four major Chinese carps” in the Project area was generally in a steady rise from 2010 to 2017.

2.6.2 Fishery waters

In 2017, 13 monitoring sites (Yibin, Banan, Fuling, Wanzhou, Wushan, Zigui, Yichang (spawning site of Chinese sturgeon), Jingzhou, Yueyang, Hukou, Dongting Lake, Poyang Lake and estuary) were established to monitor the water quality of the important fishing waters in the mainstream of the Yangtze River. The assessment of water quality complied with the *Water Quality Standard for Fisheries* (GB11607-89). For the unspecified indicators, the assessment complied with Grade III water quality standard of the *Environment Quality Standard for Surface Water* (GB3838-2002). The monitoring data showed that in 2017, the overall water quality of important fishery waters of the Yangtze River basin was good in fish wintering, propagation and finishing periods, basically meeting the requirements for fish growth and propagation. However, some waters were polluted to certain extents, with TN, volatile phenol, petroleum and COD_{Mn} as the main pollutant.

● Upstream Yangtze River

The waters of Yibin and Banan could basically meet the requirements of fish growth and reproduction. The monitoring indicators of pH value, dissolved oxygen, total phosphorus (TP) and heavy metals such as copper, zinc, lead, cadmium and arsenic in different periods were in line with fishery water quality standards. Permanganate index, hexavalent chromium and ammonia nitrogen met the Grade III water quality standard for surface water. Copper and volatile phenol in Fuling, Wanzhou, Wushan and Zigui sections of the Three Gorges Project area failed to meet the standard sometimes, and other monitoring items met the standards.

● Midstream of the Yangtze River

66.67% monitoring indicator of TP of Jingzhou waters failed to meet the standard, and all other indicators met water quality standard. There was no obvious change in the concentrations of monitoring indicators compared with last year.

The non-attainment rate of TN concentration in

Yueyang waters during fish wintering and finishing periods was 33.3% and 66.7%; other indicators met water quality standard. There was no obvious change in the concentrations of monitoring indicators compared with last year.

The non-attainment rate of TN concentration in Hukou waters in fish wintering, propagation and finishing periods was 100%, 100% and 66.7% respectively, and that of TP in fish wintering, propagation and finishing periods was 100%, 100% and 100% respectively. Hexavalent chromium and chlorophyll a were far above the monitoring values of waters in fish wintering period, but other indicators met water quality standard. Compared with last year, the TP was far beyond the standard and there was no obvious change in the concentrations of monitoring indicators.

● Spawning sites of the Chinese sturgeon

The non-attainment rate of ammonia nitrogen and non-ionic ammonia in the waters of the spawning sites of the Chinese sturgeon in Yichang was 20%. All monitoring indicators met water quality standard, and there was no obvious change in the concentrations of monitoring indicators compared with last year.

● Dongting Lake

The non-attainment rate of TN concentration in Dongting Lake waters in fish wintering, propagation and finishing periods were 22.22%, 66.67% and 33.33% respectively. The non-attainment rate of COD_{Mn} in propagation period was 11.11%; the non-attainment rate of non-ionic ammonia in fish wintering and propagation period was both at 22.22%; all other monitoring indicators met water quality standard. Compared with last year, the TN concentration in propagation period was higher than last year, and there was no obvious change in the concentration of other monitoring indicators.

● Poyang Lake

The non-attainment rate of TN concentration in Poyang Lake in fish wintering, propagation and finishing periods was 91.67%, 75.00% and 41.67% respectively. The non-attainment rate of TP concentration in fish wintering, propagation and finishing periods was 100%, 100% and 83.33% respectively. All other monitoring indicators met water quality standard. Compared with last year, the concentration of TP was relatively high and far beyond the standard.

● Yangtze River estuary

All the non-attainment rate of TN concentration in the Yangtze River estuary waters during the fishing seasons of eel, *Coilia mystus* and Chinese mitten crab was 100%. All other monitoring indicators met the water quality standard. Compared with last year, the concentration of petroleum, non-ionic ammonia and mercury decreased to a certain extent, that of lead went down remarkably, and that of other monitoring indicators did not change notably compared with last year.

2.7 Agroecology

2.7.1 Ecological environment of farmlands

In 2017, the total area of agricultural lands in 153 villages and towns in 19 districts (cities, counties) of the Three Gorges Project area was 415,406 ha., up by 1.5% compared with last year. Specifically, 105,875 ha. was paddy fields, 172,362 ha. was dry croplands, 93,219 ha. was citrus orchards, 15,582 ha. was tea gardens, 5,423 ha. was traditional Chinese herb medicine gardens and 22,545 ha. was for planting of other crops. Arable lands accounted for 67.0% of total agricultural lands, 25.5% of which was paddy lands and 41.5% dry croplands. The total area of gardens took up 33.0% of the total agricultural lands, 22.4% of which was for citrus, 3.8% for tea, 1.3% for traditional Chinese herbal medicines and 5.5% for others. There was a slight increase of agricultural land area compared with last year.

Analysis of tillage system showed 52,488 ha. of dry croplands practiced triple-cropping system, 94,641 ha. double-cropping system, and 29,176 ha. one-cropping system, which accounted for 29.8%, 53.7% and 16.5% respectively of total dry cropland area. In paddy fields, 9,046 ha. practiced triple-cropping system, 57,381 ha. double-cropping system, and 40,687 ha. one-cropping system; taking up 8.4%, 53.6% and 38.0% respectively of total paddy fields.

The analysis of slope gradient of agricultural lands (excluding paddy fields) showed that the area of agricultural lands with slope gradient below 10° was 67,104 ha., of those with slope ranging between 10°~15° 97,761 ha., of those with slope ranging between 15°~25° 113,633 ha., and of those with slope over 25° 45,223 ha. The area of agricultural lands with slope gradient over 15° was in a slight increase, and those with slope below 15° decreased slightly.

The analysis of agricultural land altitude indicated that

the area of agricultural lands with altitude less than 500 m was 216,966 ha., of those with altitude at 500~800 m 121,601 ha., of those with altitude at 800~1,200 m 48,758 ha., and of those with altitude higher than 1,200 m 10,473 ha. The area of agricultural land with high altitude increased slightly, while that of low altitude was in a slight decrease.

The sown area of crops in the Three Gorges Project area totaled 636,282 ha. in 2017, a 5.2% increase compared with last year. A total of 392,259 ha. of them was planted with grain crops, and 236,669 ha. with cash crops, taking up 62.4% and 37.6% respectively. The multiple cropping index was 189.3%, decreased slightly compared with last year.

2.7.2 Rural energy

In 2017, 2.0158 mil. t firewood was consumed in the Three Gorges Project area, 1.92 t per household on average. There was a 64.4% decrease of firewood consumption, 1.98 t reduction per household compared with last year. There were 271,612 household biogas pools in rural areas, down by 3.0% from last year. There were 261 large joint household biogas pools, down by 29 from last year. The annual output of biogas was 117.3230mil. m³, down by 3.34% over last year. There were 23.6 biogas pools (excluding joint household biogas pools) for every 100 households. In the energy mix of the Project area, there were 1.9122 mil. t straw, 195.1888 mil. kW electricity from small hydropower stations and 448,200 t coals from small coal mines.

2.7.3 Crop diseases and insect pests

In 2017, investigations found 23 kinds of crop diseases and insect pests including rice planthopper. The findings indicated that crop diseases and insect pests struck the Project area by a total of 394,789 ha.·times, and the prevention and control measures were taken for 403,511 ha.·times. A total of 234,694 t grains were saved, and 66,306 t were lost, together with 175.0053 mil. yuan economic losses. The overall occurrence of crop diseases and insect pests was level II. Compared with

the previous year, crop loss decreased by 3.6% and economic losses decreased by 4.5%.

In all types of plant diseases and insect pests, rat plague for crops, other pests and diseases of vegetables and *Pieris rapae* and *Plutella xylostella* in vegetables wreaked fairly large havoc. In terms of the severity in all counties and urban districts, counties such as Kaizhou, Yunyang in the Project area had relatively serious crop diseases and insect pests, which needs more prevention and treatment efforts. In terms of the crop types that caused pests and diseases, the occurrence of pests and diseases of vegetables was the most serious in recent years.

2.8 Earthquakes and geological disasters

2.8.1 Earthquakes

There were 776 recorded earthquakes ($M \geq 0.0$) in the Three Gorges Project area in 2017, 295 more than that of last year. Specifically, 618 earthquakes were measured at $0.0 \leq M < 1.0$, up by 275 compared with last year; 138 earthquakes at $1.0 \leq M < 2.0$, up by 11; 14 earthquakes at $2.0 \leq M < 3.0$, up by 4 compared with last year; and 3 earthquakes at $3.0 \leq M < 4.0$, up by 2 compared with last year; and 3 earthquakes at $4.0 \leq M < 5.0$, up by 3 compared with last year. The strongest earthquake was the M5.0 earthquake occurring in Wulong district of Chongqing at 17:43 on November 23th, 2017. Most were micro and ultra-micro earthquakes, some reaching the intensity of small and moderate earthquakes. In 2017, the annual frequency and intensity of earthquakes in the Three Gorges Project area were both higher than those in 2016, mainly in the form of micro and ultra-micro earthquakes. The earthquakes were mainly distributed along the Yangtze River in Badong County-Zigui County of Hubei Province, and Wushan County-Wuxi County-Fengjie County of Chongqing municipality. The earthquake frequency was relatively high in the period of reservoir-preparing stage for impoundment and the high water-level operation period.

Table 2-2 Statistics of earthquake frequency of the Three Gorges Project area in 2016-2017

Year Magnitude	2016		2017	
	Annual frequency	Monthly average frequency	Annual frequency	Monthly average frequency
0.0~0.9	343	28.58	618	51.50
1.0~1.9	127	10.58	138	11.50
2.0~2.9	10	0.83	14	1.17
3.0~3.9	1	0.08	3	0.25
4.0~4.9	0	0	2	0.17
5.0~5.9	0	0	1	0.08
Total	481		776	
Max. M	3.5		5.0	

2.8.2 Geological disasters

In 2017, a total of 4,787 potential geological hazard sites (collapses, landslides and unstable banks) were monitored in the Three Gorges Project area. All the sites were monitored through mass prevention and monitoring program, including 220 professional monitoring sites. A total of 5,758 technicians worked on monitoring and early warning, they released 323,000 publicity materials and collected 8.544 mil. pieces of monitoring data.

There were 174 deformation sites with the risk of

geological disasters in 2017, up by 54.0% compared with last year; 48 of which had severe deformation, up by 11.6% compared with last year. A total of 48 sites reached dangerous (disaster) level, up by 116.7% compared with last year.

In 2017, the prediction and early warning of such disasters in the Three Gorges Project were in a timely fashion, together with effective emergency response measures. Local authority organized emergency evacuation and relocation of 1,906 people throughout the year.

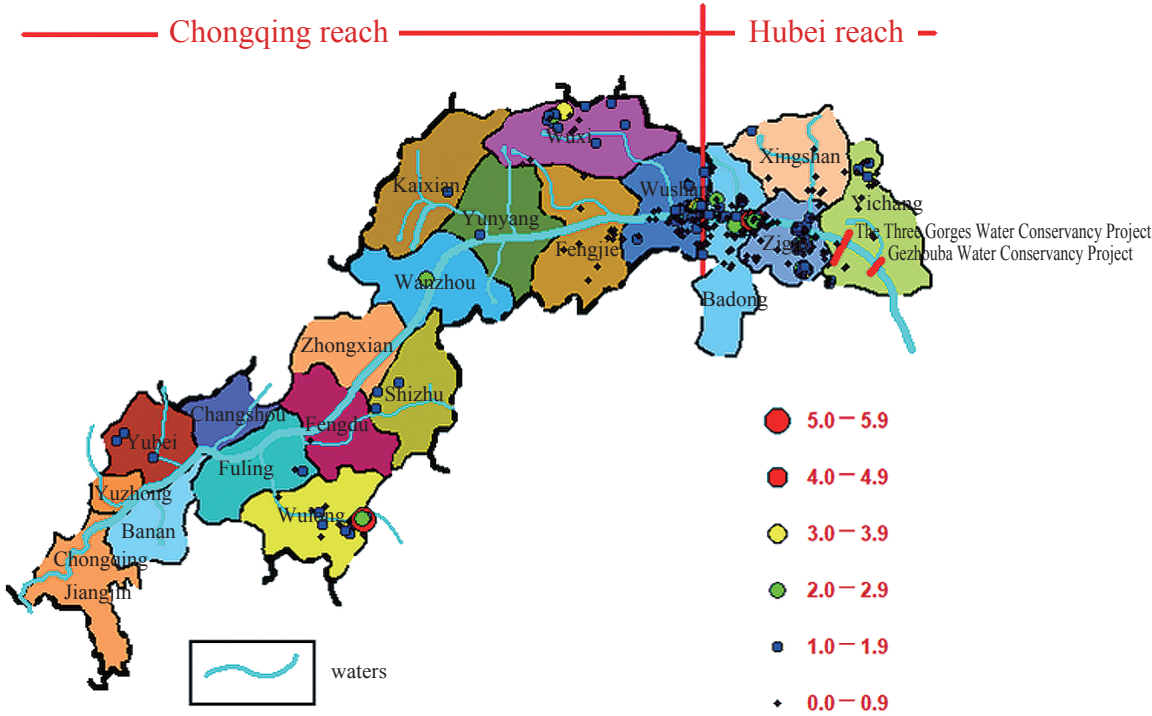
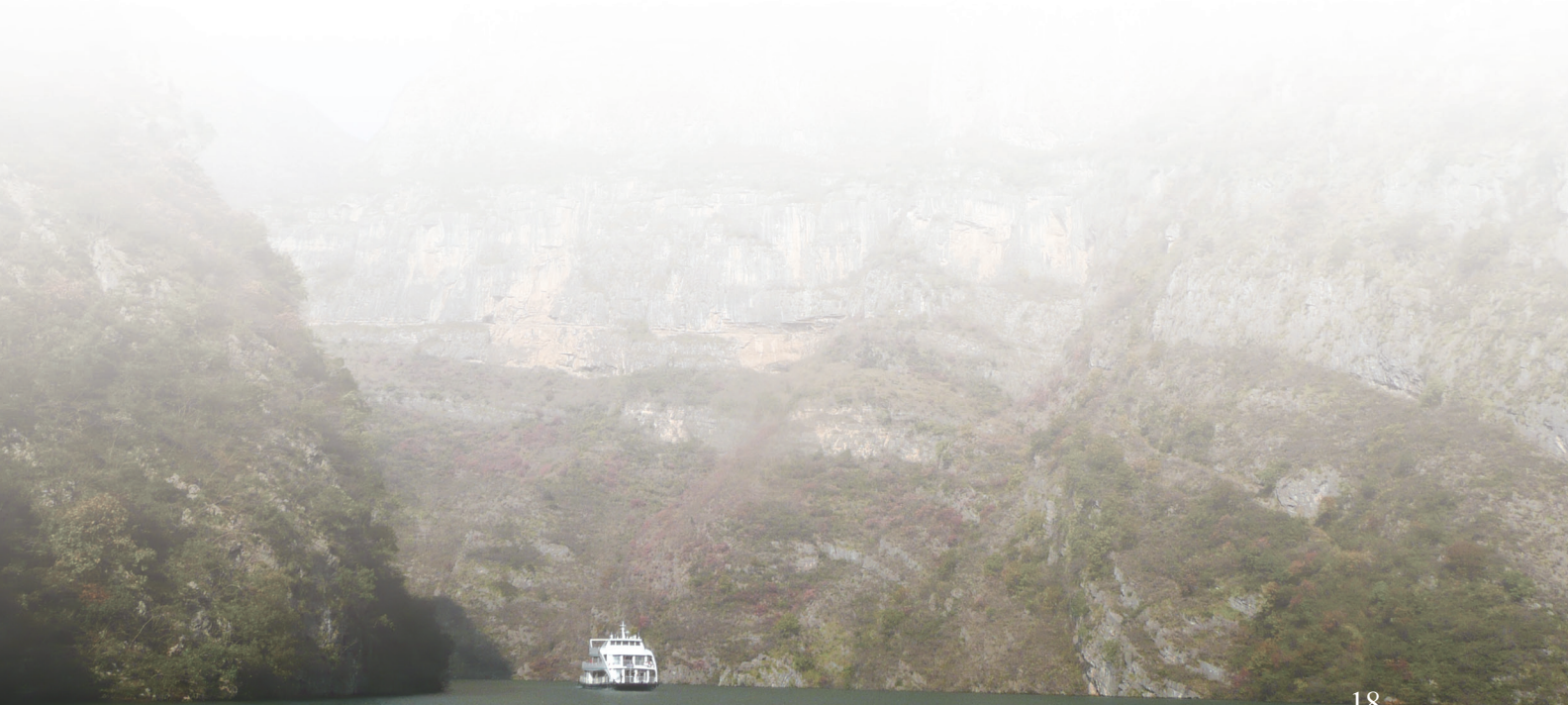


Figure 2-4 Map of epicenters of the Three Gorges Project area in 2017



Chapter 3

Discharge of Pollution Sources

3.1 Discharge of Industrial Effluent

National environmental statistics have optimized and adjusted statistical methods to meet the demands of situation. The new method statistics showed that in 2017, the total discharge of wastewater from industrial sources of the Three Gorges Project area was 106 mil. t, 30 mil. t less than the previous year. Specifically, 89 mil. t was discharged

in the Chongqing-based Project area and 17 mil. t was discharged in the Hubei-based Project area, accounting for 84.2% and 15.8% respectively of the total. In the discharged industrial effluent, there were 8,500 t COD and 600 t ammonia nitrogen, down by 2,300 t and 200 t respectively compared with last year.

Table 3-1 Discharge of industrial effluent in the Three Gorges Project area in 2017

Region		Wastewater (100 million t)	COD (10,000 t)	Ammonia nitrogen (10,000 t)
Hubei-based project area		0.1675	0.0831	0.0018
Chongqing-based project area		0.8938	0.7713	0.0605
Total		1.0614	0.8544	0.0623
Specifically,	Chongqing city proper	0.2742	0.1904	0.0180
	Changshou Dist.	0.2335	0.1156	0.0067
	Fuling Dist.	0.1203	0.1354	0.0109
	Wanzhou Dist.	0.0484	0.0652	0.0041

Note: Districts and counties of Chongqing in the Three Gorges Project area includes: Wanzhou District, Fuling District, Yuzhong District, Dadukou District, Jiangbei District, Shapingba District, Jiulongpo District, Nan'an District, Beibei District, Yubei District, Banan District, Changshou District, Jiangjin District, Kaizhou District, Fengdu County, Wulong County, Zhongxian County, Yunyang County, Fengjie County, Wushan County, Wuxi County, Shizhu Tujia Autonomous County; the city proper includes: Yuzhong District, Dadukou District, Jiangbei District, Shapingba District, Jiulongpo District, Nan'an District, Beibei District, Yubei District, Banan District.

3.2 Discharge of urban pollutants

3.2.1 Urban sewage

In 2017, the total discharge of urban sewage in the Project area was 1.252 bn. t, increasing by 40 mil. t from the previous year. Specifically, 1.203 bn. t was from the Project area in Chongqing Municipality and 49 mil. t from the Project area in Hubei Province, taking up 96.1% and 3.9% respectively of the total urban sewage. In the discharged urban sewage, there were 142,200 t COD and 20,200 t ammonia nitrogen. Compared with the previous

year, the discharge of COD increased by 1,800 t, while that of ammonia nitrogen decreased by 1,600 t.

In 2017, there were a total of 245 sewage treatment plants in cities and towns of the Project area; 218 of them were in the Project area in Chongqing Municipality and 27 were in the Project area in Hubei Province. The designed daily sewage treatment capacity of the Three Gorges Project area was 2.987 mil. t.

Table 3-2 Discharge of urban sewage of the Three Gorges Reservoir area in 2017

Region		Wastewater (100 mil. t)	COD (10,000 t)	Ammonia nitrogen (10,000 t)
Hubei-based project area		0.49	0.75	0.11
Chongqing-based project area		12.03	13.48	1.92
Total		12.52	14.22	2.02
Specific- cally	Chongqing city proper	6.74	5.21	0.70
	Changshou Dist.	0.50	0.53	0.10
	Fuling Dist.	0.72	0.93	0.15
	Wanzhou Dist.	0.98	1.64	0.24

Table 3-3 Urban domestic garbage in direct discharged areas of the Three Gorges Project area in 2017

Region	Urban permanent population (10,000)	Generated amount (10,000 t)	Disposal amount (10,000 t)	Directly discharged (10,000 t)
Jiangjin	37.2	14.32	13.03	1.29
Chongqing city proper	663.2	255.13	247.47	7.65
Changshou	33.5	12.87	12.61	0.26
Fuling	63.8	24.55	23.82	0.74
Wulong	10.1	3.89	3.77	0.12
Fengdu	18.1	6.94	6.81	0.14
Shizhu	3.0	1.14	1.03	0.11
Zhongxian	20.4	7.85	7.14	0.71
Wanzhou	89.1	34.26	32.55	1.71
Yunyang	25.2	9.71	8.84	0.87
Kaizhou	35.8	13.77	13.50	0.28
Fengjie	22.7	8.72	7.94	0.78
Wushan	15.7	6.05	5.51	0.54
Wuxi	0.5	0.19	0.17	0.02
Badong	7.6	2.91	2.71	0.20
Xingshan	1.5	0.59	0.52	0.07
Zigui	9.6	3.69	3.35	0.33
Yiling	1.4	0.53	0.48	0.05
Total	1058.2	407.12	391.23	15.88

3.2.2 Domestic garbage

In 2017, the generated amount of garbage in 26 urban districts (counties) of the Three Gorges Project area totaled 4.0712 mil. t; 3.9123 mil. t of which were disposed, taking up 96.1%, 158,800 t of which were discharged, taking up 3.9%.

3.3 Agricultural non-point pollution

3.3.1 Application and loss of pesticides

In 2017, 19 districts (counties) in the Project area applied 511.5 t pesticides (pesticide equivalent), down by 1.3% compared with last year. Specifically, 205.4 t were organophosphorus pesticides, 69.8 t were herbicides, 38.2 t were carbamates, 88.0 t were pyrethroid pesticides and 110.1 t were others. The application amount per unit area was 1.23 kg/ha.

It was estimated from cropland plot monitoring data that the total loss of pesticides was 33.5 t in the Project area in 2017, with no obvious change when compared with that of the previous year. Specifically, 16.4 t were organophosphorus pesticides, 3.6 t were herbicides, 1.9 t were carbamates, 4.5 t were pyrethroid pesticides and 7.1 t were others.

3.3.2 Application and loss of fertilizers

In 2017, 104,000 t fertilizers (fertilizer equivalent) were applied in the Three Gorges Project area, down by 12.9% compared with last year. Specifically, 72,000 t were nitrogen fertilizers, 25,000 t were phosphorus fertilizers and 7,000 t were potassium fertilizers. The application amount per unit area was 0.25 t/ha.

It was estimated from cropland plot monitoring data that the total loss of fertilizers was 9,200 t in the Three Gorges Project area in 2017, down by 1,400 t compared with last year. Specifically, 6,600 t were nitrogen fertilizers, 1,400 t were phosphorus fertilizers and 1,200 t were potassium fertilizers.

3.4 Discharge of ship pollutants

In 2017, there were 6,600 registered ships in the Three Gorges Project area. The number of registered ships went up by 738, the total tonnage up by 1.3521 mil. t, and the passenger numbers dropped by 13.7% compared with the previous year. There was no ship pollution accident in the Three Gorges Project area in 2017.

3.4.1 Oil-containing wastewater

In 2017, among the 457 surveyed ships in the Project area, the attainment rate of oil-containing wastewater discharged by ship engine rooms was 92.1%. In all types of ships, the attainment rate of wastewater was 100% for passenger ships, 92.6% for non-transport ships and 89.4% for cargo ships. Compared with the previous year, the attainment rate for oil-containing wastewater of all types of ships went up slightly, with 1.7%, 1.0% and 3.0% increase for passenger ships, non-transport ships and cargo ships respectively.

In 2017, the generated amount of oil-containing wastewater totaled 180,000 t in the Project area with treatment rate at 99.5%. A total of 167,000 t oil-containing wastewater met discharge standard after treatment, with attainment rate at 93.6%. In all types of ships, the generated amount of oil-containing wastewater was 94,000 t for cargo ships, 59,000 t for passenger ships, 27,000 t for non-transport ships. Compared with the previous year, the generated amount of ship oil-containing wastewater was down by 122,000 t and the attainment rate increased by 5.1 percentage points. In all discharged oil-containing wastewater, 1.40 t were petroleum, down by 25.03 t compared with last year.

3.4.2 Ship sewage

In 2017, the investigation on sewage discharge of 50 ships was carried out. Specifically, 49 ships treated their sewage before discharge, with attainment rate of 92.9% for suspended solid, 88.1% for COD, 92.9% for BOD₅, 71.1% for TP, 88.3% for TN and 95.9% for E-coli. The treatment rate of sewage discharge of ships basically leveled off with the previous year.



Passenger Ship

Table 3–4 Discharge of oil-containing wastewater from ships in the Three Gorges Project area in 2017

Ship		Oil-containing wastewater						Petroleum	
Type	Amount	Generated amount (10,000 t)	Percent (%)	Treated amount (10,000 t)	Treatment rate (%)	Attainment amount (10,000 t)	Attainment rate (%)	Discharge (t)	Percent (%)
Passenger ship	1470	5.9	32.8	5.8	99.1	5.8	100.0	0.41	29.3
Cargo ship	2881	9.4	52.2	9.4	99.7	8.4	89.4	0.76	54.3
Non-transport ship	2160	2.7	15.0	2.7	100.0	2.5	92.6	0.23	16.4
Total	6511	18.0	100.0	17.9	99.5	16.7	93.3	1.40	100.0

Based on factors such as the amount of various ships, generated amount of sewage, passenger amount, crew number, ship annual operation time and percentage of ships with different tonnages, the estimated results showed that the generated sewage amount from ships in the Project area in 2017 was about 2.387 mil. t, down by 386,000 t compared with last year. In all ship sewage, there were 220.2 t for COD, 206.9 t for suspended solid, 89.1 t for BOD₅, 50.1 t for TN and 4.5 t for TP.

3.4.3 Ship garbage

In 2017, sample investigation was conducted on the generation and collection of domestic garbage of 62 ships and it was estimated that the total generated amount of ship garbage was about 28,100 t in the Project area in the whole year. The port garbage collection center and garbage collection ships within the jurisdiction collected and disposed such garbage.

Chapter 4

Status of Water Environment Quality

In 2017, the monitoring of water environment quality of the Three Gorges Project area included the monitoring of hydrology and water quality of both mainstream and tributaries of the Yangtze River as well as the comprehensive trophic states and algal blooms of major tributaries. The assessment of overall water quality and comprehensive trophic state complied with the *Measures on Assessment of Environment Quality of Surface Water (Trial)* (Huanban No. (2011) 22) released by Ministry of Environmental Protection.

4.1 Streamflow

In 2017, there were 9 hydrological monitoring sections at the mainstream of the Yangtze River in the Project area, and they were Zhutuo section in Yongchuan, Tongguanyi and Cuntan sections in Chongqing, Qingxichang section in Fuling, Tuokou section in Wanzhou, Guandukou section in Badong, Beibei section of Jialing River, Linmen River and Wulong section of Wujiang River. The flow of the mainstream in the Project area ranged between 2,900 m³/s and 20,800 m³/s, and the mean flow rate varied between 0.09 m/s and 2.36 m/s; the flow of Jialing River ranged between 260 m³/s and 4,560 m³/s; and the flow of Wujiang River ranged between 472 m³/s and 2,300 m³/s, and the mean flow rate varied between 0.11 m/s and 1.92 m/s. The flow rate of the mainstream reach from Tuokou section to the Dam evidently became smaller compared with that of the upper reaches due to impoundment of the Reservoir. The average flow rate of each section was 1.48 m/s at Zhutuo, 1.40 m/s at Cuntan, 0.28 m/s at Tuokou, and 0.22 m/s at Guandukou. The maximum flow rate of each section was 2.11 m/s at Zhutuo, 2.36 m/s at Cuntan, 0.46 m/s at Tuokou and 0.38 m/s at Guandukou.

4.2 Water quality

In 2017, 9 water quality monitoring sections were established in the mainstream of the Yangtze River in the Project area. They were Zhutuo section in Yongchuan, Tongguanyi and Cuntan sections in Chongqing, Jiangjin Bridge section, Qingxichang section in Fuling, Shaiwangba and Tuokou sections in Wanzhou, Guandukou section in Badong and Nanjinguan section in Yiling. Jinzi section and Beiwenquan section for

monitoring of water quality were established in the Jialing River. Wanmu section and Luoying section were established in the Wujiang River.

The monitoring results showed that in 2017, among the 9 sections above-mentioned in the mainstream of the Yangtze River in the Project area, the water quality of 7 sections met Grade II with that of Guandukou and Nanjinguan sections meeting Grade III. The overall water quality was basically good.

The annual overall water quality of Jinzi section and Beiwenquan section of the Jialing River met Grade II and Grade III standard respectively. The water quality of Luoying section and Wanmu section of Wujiang River met Grade III and Grade IV standard respectively. The major pollutant of Wanmu section was TP.

4.3 Trophic state and algal blooms of main tributaries

4.3.1 Trophic state

A total of 77 trophic state monitoring sections were established in 38 main tributaries subject to backwater effect of the mainstream of the Yangtze River as well as the bay waters upstream the Dam with similar hydrological conditions. Specifically, 42 sections were in backwater areas and 35 sections were in non-backwater areas. Five indicators such as chlorophyll a, TP, TN, COD_{Mn} and SD were employed to calculate the trophic state index and assess comprehensive trophic state of the water bodies. The findings showed that from January to December of 2017, 1.3%~32.5% of the sections of 38 main tributaries of the Project area were in eutrophic state, 62.3%~96.1% were in mesotrophic state, and 0%~9.1% were in oligotrophic state. Specifically, 2.4%~47.6% sections in backwater areas were in eutrophic state, so were 5.7%~45.7% sections in non-backwater areas.

The main tributaries of the Project area that were in eutrophic state witnessed a slight decrease compared with the previous year. Specifically, there was a 5.8 decrease of percentage points of eutrophic sections,

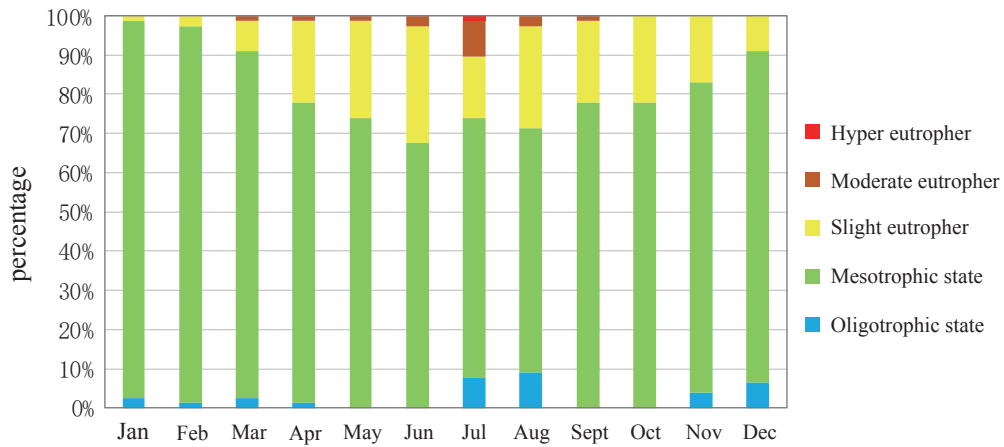


Figure 4-1 Trophic state of main tributaries of the Yangtze River in the Project area in 2017

and a 5.1 and 0.7 increase of percentage points of mesotrophic and oligotrophic sections respectively. The overall eutrophication level of backwater areas decreased slightly compared with that of last year. Specifically, there was a drop of 11.8, 10.0, 12.5, 10.0, 5.0, 2.5, 17.5 and 2.5 percentage points of eutrophic sections from January to August respectively, and an increase of 0.6, 2.5, 2.5 and 5.0 percentage points from September to December compared with that of the same period last year. The eutrophication level of non-backwater areas decreased slightly compared with that of the previous year. Compared with the same period last year, there was a decrease of 21.2, 18.9, 2.7, 5.4, 27.0, 10.8 and 8.1 percentage points of eutrophic sections in January, February, March, May, June, July and August respectively, and an increase of 2.7, 5.4, 5.4 and 5.4 percentage points in April, October, November and December; the percentage of eutrophic sections in September was the same as that of last year.

4.3.2 Algal blooms

The patrol investigation results of 2017 showed that there were water color anomalies in 38 major tributaries of the Yangtze River in the Three Gorges Project area, among which, the frequency of occurrence from May to October was relatively high, and no abnormalities in water color were observed in the remaining months.

Rivers with water color anomalies mainly include Meixi River, Daning River, Shennv Stream, Pengxi River, Zhuxi River, Taohua Stream and Long River. The dominant algae species in spring were Cyclotella of Bacillariophyta, Cryptomonas of Cryptophyta and Peridineeaceae of Pyrrophyta. In autumn, the dominant algae species of algal bloom included Cyclotella and Melosira of Bacillariophyta, as well as Cryptomonas of Cryptophyta.



In situ sampling

Chapter 5

Status of Public Health

5.1 Basic Situation

In 2017, the monitoring range of public health of the Three Gorges Project area included 19 townships, towns and urban sub-districts of 5 monitoring sites such as Chongqing city proper (Yubei, Jiangbei, Banan, and Changshou), Fengdu County, Wanzhou District and Fengjie County in Chongqing as well as Yichang City in Hubei Province. The total population under monitoring this year was 820,043, up by 37,402 compared with last year. Specifically, 417,351 were male and 402,692 were female with gender ratio at 1.04:1; 463,192 lived in cities and towns and the rest 356,851 lived in rural areas.

5.2 Life statistics

In 2017, a total of 6,850 babies were born in the monitoring sites. 3,632 were male, and 3,218 were female with gender ratio at 1.13:1. The birthrate was 8.35‰, down by 4.46% compared with last year. In 2017, a total of 5,350 people died, with a mortality of 6.52 ‰, down by 1.36% from the previous year; 3,126 were male, with the mortality of 7.49 ‰; and 2,224 were female, with a mortality of 5.52‰.

The birthrate was 8.84‰ for Chongqing, 6.90‰ for Fengdu, 6.77‰ for Wanzhou, 13.57‰ for Fengjie and 6.74‰ for Yichang. The mortality was 6.77‰ for Chongqing, 6.27‰ for Fengdu, 6.03‰ for Wanzhou, 5.62‰ for Fengjie and 9.19‰ for Yichang. Except for in Yichang the birthrate was lower than the mortality, in other monitoring sites the birthrate was higher than mortality. For birthrate, it rose by 8.68%, 4.70% and 1.94% in Fengjie, Yichang and Wanzhou respectively compared with last year; the birthrate in Fengdu and Chongqing dropped by 16.00% and 14.57% respectively. For mortality, it rose 3.61% and 3.35% in Chongqing and Fengdu; and that in Wanzhou, Yichang and Fengjie declined by 5.66%, 5.35% and 0.36% respectively.

All monitoring sites reported 17 cases of infant death including 8 baby boys and 9 baby girls, with mortality at 2.48‰, down by 0.40% compared with last year.

According to ICD-10 disease classification standard, the top five diseases with the highest mortality of the people in all monitoring sites in 2017 were circulatory system diseases, tumors, respiratory system diseases, damage & poisoning and endocrine system diseases with mortality at 244.62/100,000, 168.65/100,000, 106.21/100,000, 44.88/100,000 and 18.78/100,000 respectively, leading to 37.50%, 25.85%, 16.28%, 6.88% and 2.88% respectively (combined 89.38%) of the total deaths. The ranking of the top 5 killer diseases remained the same as last year. The rise of the mortality of damage & poisoning was 10.45% and that of respiratory system diseases was 6.16%; and the mortality of endocrine system diseases, tumors and circulatory system disease declined by 9.84%, 4.42% and 3.06% respectively. The ranking of the top five causes of death changed little.

5.3 Monitoring of diseases

5.3.1 Monitoring of infectious diseases

In 2017, all monitoring sites reported 4,937 cases of legal infectious diseases with morbidity at 602.04/100,000, up by 2.61% compared with last year. There were 5 deaths with mortality at 0.61/100,000. There was no report of Category A infectious disease. The morbidity from high to low was 1,042.97/100,000 in Chongqing, 666.68/100,000 in Fengdu, 555.07/100,000 in Yichang, 408.59/100,000 in Fengjie and 393.73/100,000 in Wanzhou. There was 18.26% and 2.81% increase of morbidity in Chongqing and Fengdu, but 7.49%, 7.06% and 2.86% reduction in Yichang, Wanzhou and Fengjie respectively compared with last year. The reported cases of Category B infectious diseases reached the most in June but least in January and were in the range of 189~251 cases in the rest months. There were two epidemic outbreaks of Category C infectious diseases in summer (June~July) and in winter (January~February and December). Specifically, the outbreak from January to February was caused by other infectious diarrhea, while that in December was caused by influenza cases.

All monitoring sites reported 2,619 cases of 10 types

of Category B infectious diseases (excluding HIV) with morbidity at 319.37/100,000, up by 12.90% compared with last year. In all monitoring sites, Chongqing (572.17/100,000) had the highest morbidity, followed by Yichang (396.1/100,000), Fengdu (338.00/100,000) and Fengjie (294.44/100,000); Wanzhou had the lowest (132.96/100,000). There was 69.91%, 2.58% and 2.23% increase of the morbidity in Chongqing, Wanzhou and Fengjie respectively, but 11.50% and 2.47% reduction in Yichang and Fengdu compared with last year. The top five infectious diseases with the highest morbidity were viral hepatitis (139.75/100,000), TB (78.04/100,000), syphilis (48.53/100,000), dysentery (25.24/100,000) and gonorrhea (21.58/100,000). The combined morbidity of the top 5 diseases accounted for 98.05% of the total. In all types of Category B infectious diseases, there was an increase of morbidity for hepatitis A, C and E, dysentery, typhus fever, gonorrhea, syphilis, scarlet fever and TB compared with last year. There was some reduction of the morbidity of other Category B infectious diseases. The amount of HIV infected patients went up by 21.14% compared with last year.

All monitoring sites reported 2,318 cases of 8 types of Category C infectious diseases with morbidity at 282.67/100,000, down by 6.97% compared with the same period last year. The morbidity was 470.80/100,000 for Chongqing, 328.68/100,000 for Fengdu, 260.76/100,000 for Wanzhou, 158.90/100,000 for Yichang and 114.14/100,000 for Fengjie. The morbidity went up by 8.88% in Fengdu and 6.22% in Yichang, but decreased by 13.92%, 13.64% and 11.91% in Fengjie, Chongqing and Wanzhou monitoring sites respectively. Among the Category C infectious diseases, the number of reported cases of other infectious diarrhea, hand-foot-and-mouth disease, influenza and mumps was more than others, accounting for 96.20% of the total. Compared with the previous year, the morbidity of influenza, mumps, conjunctivitis and other infectious diarrhea has increased, and that of other diseases declined.

5.3.2 Monitoring of endemic diseases

In 2017, the monitoring sites carried out monitoring on iodine deficiency. B-ultrasound method was employed to investigate a total of 590 children with age at 8~12, and 6 of them had I^o thyroid enlargement, taking up 1.02% and suggesting a slight endemic. The ratios of thyroid enlargement in Fengdu, Wanzhou and Yichang were 1.67%, 0.87% and 0.0% respectively. A total of 1,164 households were investigated on their salt consumption, and 1,144 households consumed iodine added salt,

taking up 98.28%; 1,093 households consumed qualified iodine added salt. The qualification rate of iodine added salt was 95.54% and consumption rate of qualified iodine added salt was 93.90%. There was 0.27 percentage points reduction of the consumption rate of iodine added salt, 2.02 and 1.73 percentage points increase of qualification rate of iodine added salt and consumption rate of qualified iodine added salt respectively compared with last year.

5.3.3 Public health emergencies

There was no report of public health emergencies in all monitoring sites.

5.4 Monitoring of biological media

5.4.1 Monitoring of rats

In 2017, the average indoor rat density of all monitoring sites in the Three Gorges Project area was 2.12%, and the outdoor rat density was 1.66%, both being higher than that of last year and lower than the average value of that of five years (1999-2003) before Stage II impoundment (indoor density at 3.94% and outdoor density at 4.22%). The outdoor and indoor rat density in autumn was slightly higher than that of spring, same as that of last year. In spring and autumn, the indoor rat density was higher than outdoor rat density, contrary to that of last year. The ranking of indoor rat density of all monitoring sites from high to low was Fengdu (5.52%), Yichang (3.67%), Fengjie (1.44%), Wanzhou (1.07%) and Chongqing (0.82%). The ranking of outdoor rat density from high to low was Fengdu (3.81%), Wanzhou (3.24%), Chongqing (1.60%), Fengjie (0.72%) and Yichang (0.65%). The monitoring data in 20 years showed that both the indoor and outdoor rat density in the Project area presented a downward trend in general.

In indoor environment, *Mus musculus* was the dominant rat species, taking up 41.86%, followed by *Rattus norvegicus*, taking up 30.23%; *Rattus flavipectus* ranked the third, taking up 27.91%. The Top 3 rat species kept the same as the previous year, and *Mus musculus* leaped from the third place to the first place in 2017. In outdoor environment, *Rattus flavipectus* was in dominance, accounting for 30.91%; *Rattus norvegicus* and other rats together ranked the second place, taking up 20.00%; *Apodemus agraius* ranked the fourth, taking up 12.73%. *Apodemus agraius* had been downgraded from the third place last year to the fourth. Compared with last year, for indoor environment, the percentage

of *Mus musculus* went up; no *Apodemus agraius* or insectivore was caught; and the percentage of other rat species had a slight decrease. For outdoor environment, the catch of small insectivores dropped dramatically, but the percentage of *Rattus flavipectus*, *Apodemus agraius* and other rat species had an obvious increase compared with last year.

5.4.2 Monitoring of mosquitoes

In 2017, the adult mosquito density was 141.64/pen•man hour for livestock pens and 24.74/room•man hour for human dwellings. The density of adult mosquito of livestock pens was higher than that of the previous year (133.96/pen•man hour) and lower than the five-year average (198.57/pen•man hour) before Stage II impoundment (1999-2003). The density of adult mosquito of human dwellings was lower than that of the previous year (29.74/room•man hour) and lower than the five-year average (63.97/room•man hour) before Stage II impoundment. In all monitoring sites, the ranking of adult mosquito density of human dwellings from high to low was Wanzhou (60.80/room•man hour), Chongqing (37.80/room•man hour), Fengjie (12.40/room•man hour), Fengdu (9.60/room•man hour), and Yichang (8.40/room•man hour). The ranking of adult mosquito density of livestock pens from high to low was Fengdu (249.70/pen•man hour), Yichang (172.80/pen•man hour), Wanzhou (112.30/pen•man hour), Chongqing (88.0/pen•man hour) and Fengjie (64.0/pen•man hour). There was some increase of adult mosquito density of human dwellings in Fengjie, and some reduction in Chongqing, Fengdu, Wanzhou and Yichang compared with last year. There was some increase of adult mosquito density of livestock pens in Fengdu, Wanzhou and Yichang, and some reduction in Chongqing and Fengjie.

The 10-day change trend of adult mosquito density of both human dwellings and livestock pens was basically the same during May-September but with different peak time of such densities in different monitoring sites. The earliest peak of adult mosquito density of human dwellings occurred in Fengdu in early July, followed by Wanzhou and Yichang in late July, Chongqing in late August and the latest peak in Fengjie in early September, while the earliest peak of adult mosquito density of livestock pens occurred in Wanzhou in late June, followed by Chongqing and Yichang in late July, Fengjie in early September and the latest peak in Fengdu in late September.

Armigeres subalbatus ranked the first in both human dwellings and livestock pens, taking up 79.30% and 90.12% respectively of the total. In human dwellings, *Culex pipiens fatigans* ranked the second, taking up 12.30%, followed by *Culex pipiens pallens*, *Culex tritaeniorhynchus* and *Anopheles sinensis* at the third, fourth and fifth place respectively. In livestock pens, *Culex pipiens fatigans* ranked the second, taking up 4.44%, followed by *Culex pipiens pallens*, *Culex tritaeniorhynchus* and *Anopheles sinensis* at the third, fourth and fifth place respectively, the same as in human dwellings. The percentage of *Armigeres subalbatus*, *Culex pipiens pallens* and *Anopheles sinensis* went up, and that of other mosquito species decreased in human dwellings compared with last year. In livestock pens, there was some rise of percentage of *Armigeres subalbatus* and *Culex pipiens pallens*; the percentage of *Anopheles sinensis* remained the same; and the percentage of other mosquito species decreased somewhat compared with the previous year.



Chapter 6

Environmental Quality of the Dam Area

6.1 Hydrology and Meteorology

6.1.1 Streamflow

In 2017, the statistical analysis of measurement data of Huanglingmiao Hydrological Station downstream the Three Gorges Project showed that the annual average flow was 13,800 m³/s. The maximum flow was 29,400 m³/s occurring on July 12th and minimum flow 5,810 m³/s occurring on

January 27th. The annual average sediment discharge rate was 0.102 t/s with average sediment concentration at 0.007 kg/m³. The maximum average sediment concentration of the monitoring sections was 0.059 kg/m³ occurring on September 6th and minimum average sediment concentration was 0.002 kg/m³ occurring on January 1st.

Table 6–1 Monthly flow at Huanglingmiao Hydrological Station in 2017

Unit: m³/s

Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
Avg.	6600	6910	7980	10900	15300	19200	22200	19200	19000	21000	10100	7340	13800
Max.	7810	8530	9700	14800	20200	26800	29400	29000	28900	29300	17400	9930	29400
Min.	5810	6240	6820	8180	11100	12100	7630	12800	14800	14100	7590	6230	5810

Table 6–2 Monthly sediment concentration at Huanglingmiao Hydrological Station in 2017

Unit: kg/m³

Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
Avg.	0.002	0.002	0.002	0.002	0.003	0.008	0.014	0.009	0.016	0.006	0.003	0.002	0.007
Max.	0.002	0.003	0.003	0.003	0.003	0.015	0.023	0.014	0.059	0.011	0.006	0.002	0.059
Min.	0.002	0.002	0.002	0.002	0.003	0.003	0.008	0.006	0.007	0.004	0.002	0.002	0.002

6.1.2 Climate

In 2017, the annual average air temperature of the Three Gorges Dam area was slightly on the high side, the precipitation was slightly on the high side, and the monthly distribution of precipitation was uneven.

● Air temperature

The annual average air temperature of the Three Gorges Project area was 17.6°C, up by 0.4°C compared with the historical average. The annual extreme high temperature was 41.0°C on July 27th and annual extreme low temperature was -0.1°C occurring on January 16th.

● Precipitation

The annual precipitation of the Three Gorges Project area was 1,287.0 mm, up by 12% compared with that of historical average. The monthly distribution of precipitation was very uneven, mainly concentrated on April-October with daily maximum precipitation of 75.6 mm on June 4th. The longest continuous precipitation period in the year was 10 days occurring in October. The longest continuous non-precipitation period of the year was 14 days in June, October and December respectively.

● Wind speed

The annual average wind speed of the Three Gorges

Dam area was 1.4 m/s. The maximum wind speed reached 19.5 m/s on July 29th. The wind direction was ever-changing in the whole year. The northwest by north

wind was the dominant wind, which accounted for 22% in the whole year.

Table 6–3 Meteorological indicators of the Three Gorges Dam area in 2017

Month		1	2	3	4	5	6	7	8	9	10	11	12	Year
Air temperature	Temperature (°C)	7.9	8.7	12.1	17.6	22	24.6	28.6	27.8	23	17.2	13.1	8.6	17.6
	Departure (°C)	2.3	0.8	0.1	0	0.3	-0.6	1.1	1	-0.1	-0.8	0.4	0.8	0.4
Precipitation	Precipitation (mm)	9.6	48.2	83.2	183.8	109.4	168	151.1	175.3	161.1	182.5	14.2	0.6	1287
	Departure (%)	-50.3	49.2	69.5	105.6	-21.8	13.0	-31.0	-6.5	47.9	118.6	-69.5	-96.5	10.7
Wind speed	Mean (m/s)	1.5	1.9	1.5	1.3	1.4	1.4	1.2	1.3	1	1.2	1.4	1.8	1.4
	Max. (m/s)	6.8	8.4	7.9	6.9	7.6	6.5	11.5	10.5	4.3	5.5	5.6	7.4	11.5
	Extreme (m/s)	10.5	14.6	12.4	11.7	11.6	12.1	19.5	15.7	6.8	9.2	10.1	13.1	19.5

6.2 Water quality

The assessment of water quality was in accordance with *Measures on Assessment of Environment Quality of Surface Water (Trial)* (Huanban No. [2011]22).

In 2017, the water quality of Taipingxi and Letianxi sections of the mainstream of Yangtze River continued to be good by meeting Grade II standard, with no change on a year-on-year basis. The annual average value of TP in

both sections of Taipingxi and Letianxi was 0.10 mg/L, 0.03 mg/L lower with a 30% drop compared with the previous year; the annual average value of fecal coliform of Taipingxi and Letianxi was 7,200/L and 8,700/L respectively, down by 15.1% and 11.8% on a year-on-year basis. Other parameters in the two sections were relatively stable and showed no significant changes.

Table 6–4 Water quality of the mainstream sections of the Yangtze River in the Three Gorges Dam area in 2017

Section	Q1	Q2	Q3	Q4	Year
Taipingxi	II	II	II	II	II
Letianxi	II	II	II	II	II

Table 6–5 Water quality of near–bank waters of the Yangtze River in the Three Gorges Dam area in 2017

Sampling site		Q1	Q2	Q3	Q4	Year
Left bank (30 m to the bank)	Upstream approach	II	II	II	II	II
	Downstream approach	II	II	II	II	II
Right bank (30 m to the bank)	Auxiliary dam	II	II	II	II	II

Chapter 7

Monitoring and Studies on Ecological Environment

7.1 Wanzhou Model Zone

Wanzhou Model Zone conducted experiments on efficient eco-agricultural models and technologies that focus on the compound ridge tillage of grain crops, cash crops and fruit trees on slope farmland and the hedgerow farming technologies, in an effort to address certain issues as the rational use and protection of slope farmlands, and control of water and soil loss and non-point source pollution.

7.1.1 Experiment on the compound ridge tillage of grain crops, cash crops and fruit trees on slope farmland

The monitoring data in 2017 indicated the compound ridge tillage of grain crops, cash crops and fruit trees on slope farmland (hereinafter referred to as Model I) could notably improve the physical and chemical properties of soils. From the conventional flat tillage of grain and cash

crops up and down the slope (hereinafter referred to as Model II), the content of organic matters, Total Nitrogen (TN), Total Potassium (TK), Kjeldahl Nitrogen (KN), Available Phosphorous (AP), and Available Potassium (AK) of Model I went up by 17.52%, 24.61%, 5.18%, 17.99%, 15.85% and 26.79% respectively, and that of Total Phosphorous (TP) went down by 4.48%. Compared with the previous year, the content of KN, AP and AK of Model I rose by 6.51%, 11.54% and 28.91% respectively and that of organic matters, TN, TP and TK descended by 25.29%, 19.00%, 14.67% and 15.40% respectively.

From the perspective of water and soil conservation, the mean soil moisture of Model I registered a 12.28% increase in 2 days after rain, 9.32% increase in 4 days after rain, and 6.79% increase in 8 days after rain respectively compared with that of Model II. Under the circumstance of continued droughts, the loss of soil moisture of Model I was lower than that of Model II. The surface runoff and soil erosion of Model I posted 42,295 m³/km² and 45.47 t/km² respectively, down by 41.60% and 62.71% from Model II. The runoff modulus and soil erosion modulus went up by 120% and 140% respectively.

From the perspective of controlling non-point source pollution, the nitrogen loss of Model I amounted to 285.52 kg/km², 44.10% lower than that of Model II. The phosphorous loss load of Model I registered 65.64 kg/km², 47.65% lower than that of Model II. Specifically, the nitrogen loss of surface runoff and sediments in Model I reached 151.84 kg/km² and 133.68 kg/km² respectively. The phosphorous loss was mainly carried by sediments, with its loss load being 43.65 kg/km², while the phosphorous loss carried by the surface runoff was only 21.98 kg/km². The nitrogen and phosphorous loss load in Model I went up by 201.24% and 177.55% respectively from last year.

From the perspective of economic benefits, by adopting the compounded interplanting mode of planting crude medicine (*Houttuynia cordata*) below



Survey on rural household

Honey Pomelo and of sowing leguminous crop (peanut) between the field, the net income of Model I was higher, amounting to 2,113 *yuan/mu*.

7.1.2 Experiment on steep slope with hedgerow model

The 2017 monitoring data suggested the steep slope with hedgerow model was more efficient in improving nutrient content of soils. Compared with the bare steep slope (control model), the hedgerow model increased the content of soil organic matter, TN, TK and AP by 14.47%, 2.11%, 2.37% and 20.20% respectively; TP, KN and AK down by 2.24%, 3.06% and 0.13% respectively. The TP and AP content in soil of hedgerow model went up by 2.34% and 82.34%, and that of soil organic matter, TN, TK, KN and AK went down by 12.83%, 23.68%, 7.92%, 16.25% and 2.50% respectively compared with the previous year.

There was a significant difference in soil erosion on different slopes in different planting patterns on steep slopes. The surface runoff and soil erosion capacity of hedgerow model were higher than that of 4-year bare steep slope, with the runoff modulus and soil erosion modulus of the former being 32,110 m^3/km^2 and 27.77 t/km^2 respectively, and the latter being 27,000 m^3/km^2 and 17.21 t/km^2 respectively. Compared with the hedgerow model, the runoff modulus and soil erosion modulus of the bare steep slope decreased by 15.89 % and 38.03% respectively. With the increase of the number of years left uncultivated, vegetation coverage increased on the bare land, root system composition and aboveground biomass increased, and surface runoff and soil erosion decreased significantly. Compared with the previous year, the surface runoff and soil erosion modulus of the hedgerow model increased by 47.97% and 51.42%, respectively, and that of bare slope increased by 55.46% and 23.89% respectively.

In terms of controlling non-point source pollution, the nitrogen loss load of hedgerow model registered 182.52 kg/km^2 , 40.14% more than that of bare slope. The phosphorous loss load of the hedgerow model totaled 46.60 kg/km^2 , 40.0% more than the bare slope. Specifically, the nitrogen loss of the surface runoff and the sediments of hedgerow model posted 95.04 kg/km^2 and 87.47 kg/km^2 respectively; the phosphorous loss was mainly carried by sediments, with its loss load being 30.54 kg/km^2 , while the phosphorous loss carried by the surface runoff was only 16.05 kg/km^2 . The nitrogen and phosphorous loss load of the hedgerow model increased



Soil sampling

by 62.4% and 68.5% compared with the previous year.

Though the ecological and environmental benefits of the honey pomelo-hedgerow model on 25 degrees' steep slope was lower than that of bare slope, they made some economic achievements, with 726 *yuan/mu* of its honey pomelo-hedgerow model in 2017.

7.2 Zigui Model Zone

7.2.1 Monitoring soil erosion and water and nutrient loss of slope farmland

In 2017, the slope farmlands and navel orange orchards taken with protection measures remarkably reduced soil and water erosion and nitrogen and phosphorus loss. The three types of ecological plantation models, that is, ryegrass-soybean plot, wheat-peanut plot with toon interplanted as hedgerow, and wheat-peanut plot with alfalfa interplanted as hedgerow cut down slope runoff by 18.2%, 24.4% and 28.0% respectively compared with that of the conventional wheat-peanut plot. They also reduced slope sediment yield by 38.1%, 76.8%, and 70.4% respectively; the nitrogen loss of surface runoff decreased by 21.1%, 22.6% and 22.9% respectively; the nitrogen loss of sediments decreased by 22.6%, 76.4% and 44.9% respectively; the phosphorous loss of sediments decreased by 45.1%, 89.9% and 77.1% respectively.

Relative to the conventional navel orange orchard, the slope farmlands that had taken such four measures as intercropping perennial White Clover as hedgerow, straw coverage, intercropping day lily as hedgerow, and burying contour impermeable membrane reduced the runoff yield by 23.2%, 23.6%, 32.7% and 29.3%; and reduced the sediments yield by 73.5%, 55.0%, 58.1% and 49.5%; the loss of nitrogen in sediment was cut down by 70.2%, 57.9%, 61.2% and 60.1%. Different



Rapid soil test on site

from nitrogen loss, the loss of phosphorous was dominated by granules. Relative to the conventional navel orange orchard, the loss of phosphorous in sediment was cut down by 78.6%, 68.3%, 75.2% and 66.1% respectively.

7.2.2 Studies and demonstration on eco-agricultural models on the slope farmland

Land use and management approaches have significant impact on the fertility of mountain soils. The findings of 2017 survey suggested the content of the sand with diameter ranging from 2mm to 0.05 mm accounted for 26.69%~44.35% in the soils of the monitoring sites, that of silty sand with diameter ranging from 0.05 mm to 0.002 mm occupied 34.34%~48.04%; and that of clay with diameter under 0.002 mm took up 17.15%~26.76%. The content of soil nutrients was 10.70~33.79 g/kg for organic matter; 0.56~1.78 g/kg for TN; 0.25~2.19 g/kg for TP; 9.89~29.37 g/kg for TK; 56.20~224.81 mg/kg for KN; 0.30~133.58 mg/kg for AP and 60.20~559.00 mg/kg for AK.

Most slopes with altitudes above 700 meters in the monitoring area were converted into terraced fields. The planted crops mainly included crops such as sweet potato, corn, wheat, peanut and rice, and cash crops

such as chestnuts, pears and tea, but the latter was at a small scale. For the steep slopes with severe ecological degradation, policies like returning cultivated land to forests had been implemented. Compared with the previous years, the pH data indicated that the pH value of soils in the monitoring area showed a slow decline, but no statistical difference was observed.

7.3 Water-level-fluctuating Zones

The surveys were conducted on soil physical and chemical properties and vegetation restoration in 22 monitoring sites in the water-level-fluctuating zones of Banan, Changshou, Fuling, Fengdu, Zhongxian, Wanzhou, Kaixian, Yunyang, Fengjie, Wushan, Badong, Zigui, and Xingshan in the Three Gorges Project area after water drawdown (June) and before the impoundment (September) in 2017.

7.3.1 Soil physical and chemical properties

In 2017, the monitoring data on the composition of soil particles in the water-level-fluctuating-zones of the Project area showed the soil in the area had loose texture, with relatively more particles with diameter less than 0.05 mm.

The monitoring data showed the contents of almost all heavy metals were below Grade I limit set by *Environmental Quality Standard for Soils (GB15618-1995)* in most soils except cadmium, lead and copper, which were below Grade II limit.

The monitoring data suggested relatively high content of soil nutrients in the central part of the Project area (the reach from Fengdu to Zhuyi River in Fengjie) and relatively low content in the head and tail regions of Project area. After water recession, the content of AP and Ammonium Nitrogen went up by 1.17 mg/kg and 0.67 mg/kg, and that of organic matters, TN, TP, TK, AK and Nitrate-N in soils went down by 0.39 g/kg, 0.17 g/kg, 0.13 g/kg, 2.52 g/kg, 0.75 mg/kg and 0.21 mg/kg respectively compared with that of the same period last year. Before the impoundment, the contents of organic matters, TK, Ammonium Nitrogen and Nitrate-N went down by 0.28 g/kg, 4.77 g/kg, 0.15 mg/kg and 0.22 mg/kg respectively, while that of TN, TP, AP and AK went up by 0.10 g/kg, 0.02 g/kg, 3.61 mg/kg and 19.28 mg/kg respectively.

7.3.2 Vegetation restoration

In 2017, the post-recession plant community survey identified 57 species of vascular plants in 48 genera of 19

families. There were a large amount of monotypic genus and minor genus species, accounting for 85.4% and 14.6% of the total species respectively. Herbaceous plant species dominated the vegetation and the percentages of arbor, shrub and vine species were relatively low. Before the impoundment, there were 52 species of vascular plants in 45 genera of 21 families. There were a large amount of monotypic genus and minor genus species, accounting for 86.7% and 13.3% of the total species respectively.

7.3.3 Monitoring of bio-vectors

In 2017, a total of 2,608 rat traps were placed in the monitoring sites of the water-level-fluctuating zones, as a result of which 14 rat-shape animals were caught with average rat density at 0.69%, a slight decrease from last year. *Rattus norvegicus* accounted for 42.86%, *Anourosorex squamipes* 35.71% and *Apodemus agrarius* 21.43%; other rat species were not caught. In specific, 6 rat-shape animals were caught with average rat density at 0.53% in the post-recession period, 39.8% lower than that of the same period last year (0.88%). 8 rat-shape animals were caught with average rat density at 0.91% in the pre-impoundment period, 4.21% lower than that of the same period last year (0.95%). There was no dominant rat species and the rat density before impoundment was slightly higher than that of the post-recession period.

In 2017, zapper lamps were placed in the monitoring sites of water-level-fluctuating zones for 87 zapper lamp-times with catch of 249 mosquitoes. The mosquito density was 2.86/zapper lamp-times, lower than that of the same period last year (3.93/zapper lamp-times). The main mosquito species were *Culex pipiens fatigans* (49.80%), *Armigeres subalbatus* (37.35%), *Anopheles sinensis* (6.43%), *Aedes ingbopictus* (3.61%) and *Culex tritaeniorhynchus* (2.81%).

In 2017, flytraps were placed in monitoring sites of water-level-fluctuating zones for 87 trap-times, catching 225 flies with average fly density at 2.59/flytrap, higher than that of the same period last year (2.10/flytrap). The main fly species were *Boettcherisca peregrina* (68.44%), *Musca sorbens* (13.33%), *Musca domestica* (7.11%) and *Aldrichina grahami* (4.89%).

7.4 Groundwater dynamics and soil gleization

7.4.1 Groundwater dynamics

The groundwater monitoring sections were distributed

along the reach between Shimatou Village and Xiaogang Farm of Honghu City in the four-lake region downstream the Dam. In 2017, the mean annual groundwater table of the observation wells ranged between 21.76 m and 22.60 m and varied between 0.88 m and 1.72 m across the year. The confined water table ranged between 21.28 m and 23.30 m, with variation spanning 2.02 m. The phreatic water table ranged between 21.27 m and 23.35 m, with variation spanning 2.08 m. In general, the groundwater table moved up and down within the scope of 0.05 meters in 2017, with 0.01 meters increase on average.

The mean monthly water table curve showed for the majority of the observation wells, the groundwater table kept at a low level from January to March, ascended obviously in April, maintained ascending tendency from May to June, kept a high level from June to August, began to descend in September, kept a relatively high level in October, descended dramatically in November, and kept at a fairly low level in December. Compared with the previous year, the groundwater table ascended late and descended late as well in 2017.

7.4.2 Soil gleization

The soil gleization conditions of 25 soil profiles were monitored in the four-lake region in the summer and winter in 2017, and the measuring indicators included the soil moisture, oxidation reduction potential, the total amount of reductive substances, the content of active reductive substances, and the content of ferrous iron. The monitoring data showed that within the year, the total amount of reductive substances ranged between 0.31 and 8.44 centimol/kg, and averaged out at 1.76 centimol/kg, down by 0.45 centimol/kg from last year; the mean annual content of active reductive substances ranged between 0.10 and 6.62 centimol/kg, and averaged out at 1.03 centimol/kg, down by 0.31 centimol/kg from last year; the mean annual content of ferrous iron ranged between 0.00 and 1.81 centimol/kg, and averaged out at 0.42 centimol/kg, 0.09 centimol/kg more than last year. The soil gleization in summer was lagging and was not notably alleviated in winter compared with the previous year.

7.5 Water-salt dynamics and soil salinization in the estuary

7.5.1 Water-salt dynamics

The water-salt dynamics and soil salinization was monitored in the estuary (land-sea interface) of Yangtze River in 2017. There were three monitoring sections



Profile of gleization sampling in winter

(Yinyang section, Daxing section, and Xinglongsha section) at the north branch of the Yangtze River, about 4 km, 22 km and 35 km away from the north estuary, all stretching from the north to the south and perpendicular to the river bank. There were three monitoring sites at each section with varied distances from the bank. The main monitoring indicators included the conductivity of the Yangtze River waters, conductivity of inland river waters, soil conductivity, groundwater conductivity and groundwater depth.

● Conductivity of the Yangtze River waters

In 2017, monitoring data at the three sections showed the conductivity of the Yangtze River waters was high in spring, autumn and winter, and low in the summer. The mean annual conductivity of river water in each section was lower than that of the previous year, and the sea water invasion process was weakened. The conductivity of Yinyang section was 18.9 mS/cm, with a drop of 2.0% from last year. Specifically, it rose by 4.7% and 13.6% in January-March and May-July respectively, declined by 9.0% in September-November compared with last year. The mean annual conductivity of Yinyang section dropped by 20.4% compared with 2013 (dry year). The mean annual conductivity of Daxing section was 12.3 mS/cm, a drop of 23.1% from last year. In specific, it escalated by 33.4%, 227.3%, 81.1% and 19.5% in January-February, May-June, August and November respectively compared with last year; and was lower in the remaining months than in the same period of 2016. The mean annual conductivity of Daxing section dropped by 48.8% compared with 2013. In 2017, the mean annual conductivity of Xinglongsha section in January rose by 51.8% and kept a relatively low level in the remaining months

compared with the same period last year. The mean annual data for Xinglongsha section dropped by 73.0% compared with that of 2013.

● Conductivity of inland river waters

In 2017, the conductivity of inland river waters was lower near the north bank and higher near the south bank of the north branch than the previous year. The mean annual conductivity of inland waters of Yinyang section was 2.31 mS/cm, down by 3.5% from last year; in specific, it rose by 15.7% and 46.7% in January-February and October-November respectively compared with the previous year; the mean annual conductivity of inland waters of Yinyang section went up by 14.2% compared with that of 2013. The mean annual conductivity of inland waters of Daxing section was 1.82 mS/cm, down by 6.9% from last year and down by 27.7% compared with that of 2013. The mean annual conductivity of inland waters of Xinglongsha section rose by 3.7% compared with the same period last year. In specific, the first half year(January-August) had a basically increase than the same period last year, and there was a decrease of 29.6% from September to December. The mean annual conductivity of inland waters of Xinglongsha section dropped by 30.2% compared with that of 2013. There was very significantly positive correlation between the conductivity of inland river waters and that of the Yangtze River waters at the three monitoring sections in the estuary.

● Groundwater depth

In 2017, the groundwater depth in the north bank of the estuary was basically less than 1.0 m, while that of the south bank was higher with the mean groundwater depth being 1.2 m, due to the effects of the upstream runoff variations and water level fluctuations of the Yangtze River.

The mean annual groundwater depth of Yinyang section was 67.8 cm, up by 6.0% from last year but the same as that of 2013. Compared with the previous year, the buried depth in August-September decreased by 18.5%, while those in the remaining months were higher than the previous year. Compared with 2013, the buried depth in February-July increased by 20.0% on average, and decreased by 10.6% in August-November.

The mean annual groundwater depth of Daxing section was 80.2 cm, up by 4.9% and 16.5% from last year and 2013 respectively. Compared with the previous year, the groundwater depth in June-July and October-

December increased by 29.7% and 9.2% on average, and decreased by 12.7% in August-September on average. Compared with 2013, the buried depth in all months increased somewhat except from August to September when there was a decrease of 35.5%. In specific, the average increase from January to July was 57.0% and that from October to December was 15.0%. The mean annual groundwater depth of Xinglongsha section was 154.6 cm, up by 32.5% and 23.3% from last year and 2013 respectively. During the year, the deepest period of time was March-May and July-August, and the average buried depth was 178.3 cm and 193.0 cm respectively, reaching a historical high. Compared with the previous year, the depth in April-May, July-August and November-December increased by 62.3%, 35.2% and 59.0% respectively; compared with 2013, the buried depth in the above months increased by 73.5%, 34.0% and 20.7% respectively. The deepening of the buried depth reduces the risk of soil salinity, but there is still a risk of salinization in the soil with a water level in the critical depth.

● Groundwater conductivity

In 2017, affected by the conductivity of groundwater and inland waters, the groundwater conductivity of all sections decreased somewhat. The mean annual conductivity of groundwater of Yinyang section was 6.95 mS/cm, down by 5.4% from last year and the same as 2013; compared with the previous year, the conductivity of groundwater from January to June basically remained the same, and that from July to December decreased by 11.7% on average; the decline was most significant in August-October; compared with that of 2013, the conductivity in the first half of the year was 7.16 mS/cm, which was relatively high, and that of August-December decreased by 4.6%. The groundwater conductivity of the Daxing section was 1.37 mS/cm, which was basically the same as that of the previous year and an increase of 17.3% compared with that of 2013. Compared with the previous year, the conductivity of groundwater decreased by 8.6% from January to July and increased by 15.8% from August to December on average. Compared with that of 2013, the average conductivity in January-June and September-December increased by 25.5% and 22.0% respectively and decreased by 15.0% from July to August. The groundwater conductivity of the Xinglongsha section was 3.19 mS/cm, 44.4% and 57.6% lower than that of the previous year and that in 2013 respectively. Compared with the previous year, the average conductivity from November to December increased by 64.6%, and that from January to October

decreased by 51.7%.

7.5.2 Soil salinization

In 2017, the mean annual soil conductivity of estuary area was slightly lower than that of last year. The soil conductivity of Yinyang section was 6.04 mS/cm, basically the same as the previous year, and decreased by 13.5% than that of 2013. Compared with the previous year, the soil conductivity in January-May decreased by 14.9%, and that in June-December underwent an increase by 16.4% on average. Compared with 2013, the soil conductivity was at a low level in all 12 months. The soil salinity content of the stationary sampling points in autumn increased a little, but the deep soil conductivity decreased slightly compared with the previous year. The soil conductivity of Daxing section was 4.1 mS/cm, down by 4.7% and increased by 48.5% respectively compared with the previous year and that of 2013. In specific, the conductivity in January-June and November-December decreased by 16.0% and 18.27%, and that in July-October increased by 9.2% compared with the same period last year. The soil conductivity of Xinglongsha section was 6.89 mS/cm, up by 3.6% from last year and basically the same as that in 2013. In autumn of 2017 (October), the area of lightly salinized soil near the estuary increased slightly. The non-salted soil has a tendency of becoming mildly salinized, which was consistent with the results of fixed-point monitoring.

7.6 Ecological environment in the estuary

7.6.1 Environmental elements in waters

● Physical environmental elements

In spring, the temperature was high in the surface layer and low in the bottom layer of monitored waters, and high near the coastline and low in the infralittoral waters in the estuary. The temperature ranged between 13.7°C and 18.7°C in the surface layer, and between 13.5°C and 18.7°C in the bottom layer. In autumn, the temperature was low near the coastline and high in the infralittoral waters, as opposed to the case in spring. Compared with last year, the highest and lowest temperature in spring was 0.10°C higher and 0.10°C lower respectively; and the highest and lowest temperature in autumn was 0.07°C and 0.88°C lower respectively.

In spring, the diluted waters in the estuary started to extend eastwards along with growing runoff flowed into the sea. In the surface layer, the salinity was below 18.00 near the coastline, and above 28.00 in the infralittoral waters, reaching the maximum at 32.37. In the bottom

layer, the extend force of diluted waters beyond the estuary mouth were weak, and the salinity was low near the coastline and high in the infralittoral waters. In autumn, the salinity was low near the coastline and high in the infralittoral waters, affected by the diluted waters of the Yangtze River and the surface waters of Taiwan warm currents. Specifically, the salinity was below 20.00 in the surface layer, and under 26.00 in the bottom layer near the coastline; and above 30.00 in the surface layer and above 32.00 in the bottom layer in the infralittoral waters. The distribution of salinity resembled that of the same period last year. However, the maximum of salinity was 1.22 higher in spring and 0.07 higher in autumn.

● Hydrochemical elements

The content of dissolved oxygen in the surface of layer river waters in the estuary averaged out at 8.27 mg/L in spring and 8.29 mg/L in autumn. The figure in the surface layer seawaters in the estuary was 9.64 mg/L in spring and 7.43 mg/L in autumn. Compared with the same period of last year, the figure in the surface and bottom layers of the river waters was lower in spring and higher in autumn; the figure in the surface layer of seawaters was lower than that of last year, while the figure in the bottom layer of seawaters was slightly higher.

The pH value averaged out at 7.99 in spring and 7.80 in autumn in the surface layer river waters, and 8.00 in spring and 8.04 in autumn in the bottom layer river waters in the estuary. The pH value averaged out at 8.31 in spring and 8.52 in autumn in the surface layer seawaters in the estuary and 8.16 in spring and 8.82 in autumn in the bottom layer seawaters. In spring, the pH value of river waters in the estuary was on a rising trend from the estuary mouth and the coastline to the northeast, and high pH value was recorded in the northern part of the surveyed waters. Compared with last year, the pH values were on the high side in spring; in autumn, the figure in the surface layer river waters was lower and that in bottom layer was higher; the figure in both surface and bottom layer of seawaters were on the high side.

The content of phosphate, silicate, nitrate, TN, and TP was all in a steep downward trend from the estuary towards the open sea. The laws of distribution of $\text{NH}_3\text{-N}$ and nitrite were more complicated.

● Sediment elements

In 2017, the content of suspended matters averaged out at 90.61 mg/L in the estuary seawaters in spring and

106.79 mg/L in autumn. Compared with the previous year, the content of suspended matters was obviously on the high side.

7.6.2 Biological elements in waters

● Chlorophyll-a

In the spring of 2017, the concentration of Chlorophyll-a ranged between 0.30 $\mu\text{g/L}$ and 28.20 $\mu\text{g/L}$ and averaged out at 5.16 $\mu\text{g/L}$ in the surface layer seawaters, higher than those of the same period last year. The patch of waters with high Chlorophyll-a readings was mainly distributed in the mid-and-eastern part of the monitored seawaters. In autumn, the concentration of Chlorophyll-a ranged between 0.48 $\mu\text{g/L}$ and 4.09 $\mu\text{g/L}$ and averaged out at 1.09 $\mu\text{g/L}$ in the surface layer seawaters, higher than those of the same period last year. The patch of waters with high Chlorophyll-a readings was obviously moving westward, and mainly distributed near the mouths of the Yangtze River.

● Fish zooplankton

In 2017, a total of 54 fish zooplankton were caught in spring, which fell into 11 species in 7 families. *Salanx ariakensis*, *Japanese anchovy*, *Chelidonichthys spinosus*, and *Harpodon nehereus* became dominant species. A total of 39 fish zooplankton spawns and larvae were caught in autumn, which fell into 5 species in 4 families. Compared with the previous year, the dominant species of fish plankton changed, in that tapertail anchovy and *Allanetta bleekeri* were no longer the dominant species, giving way to *Japanese anchovy*.



Cygnus columbianus

7.7 Wetlands in the midstream

7.7.1 Dongting Lake

● Streamflow

Dongting Lake embraces four inflow rivers (Xiangjiang River, Zishui River, Yuanjiang River, and Lishui River) in the south and empties into Yangtze River in the north (Hubei Province). The contributing inflows of the lake includes the aforementioned four inflow rivers, three bleeders of Yangtze River (Songzi Bleeder, Taiping Bleeder, and Ouchi Bleeder), and interval inflows. The waters converge in the lake and feed to Yangtze River at Chenglingji (Qili Mountain). Dongting Lake is the most important buffering lake of the Yangtze River.

In 2017, the annual precipitation of Chenglingji Station at Dongting Lake outlet was 1,747.0 mm, up by 22.0% from last year. The water level maximized at 34.63 m, minimized at 19.95 m, and averaged out at 25.30 m this year. The annual runoff was 2.5% less than historical average and 11.0% less than last year. The annual sediment discharge amounted to 16.10 mil. t, 55.0% less than historical average, and 35.0% less than last year. From the interannual perspective, the majority of the runoff and sediment discharge at Chenglingji Station happened between March and August, with runoff during this period accounting for 72.4%, and the sediment discharge during this period accounting for 83.6% of the whole year. The sediment discharge peaked on March 24th, with the maximum discharge at 0.392 kg/m³.

In 2017, the incoming water in the Yangtze River was slightly larger in general. In specific, the incoming water was abundant in January-April, small in May and abundant in June-July. In July, there was a heavy flood in the middle reaches of the Yangtze River. The incoming water was large and small repeatedly in August-October; and that of November-December was large in general. The incoming water of the four inflow rivers in Dongting Lake was 10% more than the mean annual amount in April-October. Specifically, 30%-40% more in June-July; normal in April and September; 30% less in May and August; and 10% less in October. Affected by continuous heavy rainfalls, the Dongting Lake water system and other tributaries of the Xiang River, Zishui River and Yuanjiang experienced a heavy flood at the same time; the four inflow rivers underwent rapid water intensification in many times. Affected by the multi-tributary floods, Dongting Lake witnessed both inflow and outflow heavy floods, with the water level surpassing

the alert level and registering a historical high. During the flooding process of the lake, the total inflow of the Dongting Lake system ("four waters" plus "interval") had a maximum of 7 days and 15 days of floods of 28.6 bn. m³ and 46.4 bn. m³ respectively, both of which registered No.1 since 1951.

Statistics on the 60-day flood volume showed the total inflow of the lake was 99.31 bn. m³ and the total outflow 104.50 bn. m³. Analysis data of the flood sources at Chenglingji Station (Qili Mountain) showed the four inflow rivers dominated the total inflow, accounting for more than 74.7%; followed by the interval inflows of Dongting Lake (except the maximum amount of 60-day flood), which took up the portion between 11.2% and 12.6%. Analysis data of the contributors to monthly runoff at Chenglingji Station showed 73.4% of the Dongting Lake inflow came from the four inflow rivers between June and October, and 22.3% in the remaining months. Over 58.2% of the incoming flow observed at Luoshan Station was contributed by Yangtze River.

● Water quality

In 2017, among the 9 inflow river sections of Dongting Lake, 8 attained or exceeded Grade III water quality standard with the exception of Liuzhenzha section meeting Grade IV, which was slightly better over last year. In the 12 monitoring sections across the lake area, the annual mean water quality of all sections attained Grade IV and failed to meet the water quality target of the water function zone, and the water body was slightly polluted. The pollution caused by TN and TP was severe, with the concentration of 1.73 mg/L and 0.075 mg/L respectively. Compared with the previous year, the water quality in general turned better, and the percentage of sections of Grade V decreased by 25%; the concentration of both TN and TP declined slightly.

The concentration of Chlorophyll-a in Dongting Lake averaged out at 4.33 mg/m³, a slight decrease over last year (5.16 mg/m³). The lake as a whole was in minor eutropher. The Tropical Level Index (TLI) of Dongting Lake ranged somewhere between 45.3 and 57.9 this year, a slight decrease over last year. Specifically, the maximum TLI was recorded at the monitoring section of Major and Minor West Lakes. The section at eastern Dongting Lake (except for Lujiao) and the section at the lake outlet were in minor eutropher, and other sections were in mesotrophic state. In terms of temporal distribution, the TLI was above 50 in January, March, June-July and September-October, which reached minor

eutropher; and below 50 in the remaining months, which suggested minor eutropher; and that in the other 6 months were in mesotrophic state.

A total of 50 genera of phytoplankton species from 6 phyla were identified in Dongting Lake. Specifically, the *Bacillariophyta* and *Chlorophyta* species had the most abundant phytoplankton species, with 20 and 17 genera respectively; followed by *Cyanophyta* species in 5 genera, *Euglenophyta* species in 4 genera, *Pyrrophyta* species in 3 genera and *Cryptophyta* species in 1 genus. The biomass density of phytoplankton species was 280,000 pcs/L on an annual average, and the maximum biomass density of phytoplankton species was recorded in September, and the minimum density was observed in March. In terms of geographical distribution, the eastern Dongting Lake recorded the highest. Compared with last year, both the number of species and density decreased a little.

28 genera of zooplankton species were identified in Dongting Lake, including 9 genera of *Rotifera* species, 10 genera of *Cladocera* species, and 9 genera of *Copepods*. The mean annual biomass density of zooplankton was 122 pcs/L, with the highest in March and the lowest in December. In terms of geographical distribution, the eastern Dongting Lake recorded the highest. Compared with last year, both the number of species and mean density increased slightly.

● Vegetation

In 2017, the stationary observation data on 6 typical islets and shoals (Liumen Gate, Lu Lake, Tuanzhou, Junshan, Chunfeng, and Jianxing Farm) showed each of the three indicators—the number of species, the species richness index, and species diversity index of the *Triarrherca sacchariflora* community was more than that of *Polygonum flaccidum* and *Carex tristachya* communities. For the *Triarrherca sacchariflora* community, the number of species identified each month ranged between 18 and 31; both of the species richness index and the species diversity index were the highest in April prior to the flood season (9.3 and 0.47 respectively) and at the minimum in November after the flood season (3.3 and 0.20); the community coverage hit the lowest in January (43.0%) and reached the highest in April (100%); the biomass was the lowest in January (28.1 g/m³), then rose fast, and peaked in April (1,694.4 g/m³). Compared with last year, the species diversity index and the biomass of the *Triarrherca sacchariflora* community saw some decrease. As for the

Carex tristachya community, the mix of the species was simpler and the number was somewhere between 5 and 14; the species richness index was fairly low, somewhere between 1.3 and 3.5 per quadrat; the species diversity index was at the maximum in December (0.07) and at the minimum in April (0.0); the community coverage was relatively low in November (87%), and that in January and April was 100%; the biomass was at the maximum in April (414.7 g/m²) and declined after flood season in November (197.7 g/m²). Compared with last year, the biomass of the *Carex tristachya* community was slightly increased, but the species diversity index decreased notably. As for the *Polygonum flaccidum* community, the number of species identified each month ranged between 0 and 10; the species richness index was relatively low and between 0 and 4.8 per quadrat; the species biodiversity index was fairly high after the flood season, ranging between 0.2 and 0.4, and fairly low prior to the flood (0.0); the community coverage was 0 in January-April, and rose fast after floods. In November, the figure was 83.0%, and then dropped to 4.8% in December; the biomass hit the highest in December (597.8 g/m²) and became 0 in January-April. Compared with last year, the species richness index, the species diversity index, the community coverage and the biomass of the *Polygonum flaccidum* community increased dramatically after flood.

● Biodiversity

In 2017, 139 species of summer migrant birds were identified in eastern Dongting Lake and they fell into 45 families under 14 orders, with an increase of 8 species compared with the previous year, and 2 new records, that is, *Plegadis falcinellus* and *Cuculus sparverioides*, were monitored in eastern Dongting Lake. A total of 470,604 overwinter water birds were identified, which fell into 63 species in 13 families under 6 orders, up by 148% from last year in three monitoring records. The three species of birds that increased dramatically in number in winter season were *Cygnus columbianus*, *Vanellus Brisson* and Great Cormorant, which increased by 3,405, 1,582 and 4,657 respectively, with an increase of 1,007%, 590% and 418%. The birds that reduced greatly compared with the previous year were *Anaschypeata* and *Tringa erythropus*, which decreased by 6,591 and 10,567, with a reduction of 5,358% and 649%. *Anseriformes* species and *Charadriiformes* species were the dominant species of overwinter bird species in the eastern Dongting Lake, which accounted for 70% and 18% of the total respectively. Compared with last year, the number of *Anseriformes* species increased by 199%, while that

of *Charadriiformes* species up by 82%. In terms of geological distribution, the most popular habitats were eastern Dongting Lake, where the winter birds accounted for 82% of the total throughout the region.

In 2017, 91 *Elaphurus davidianus* were identified in the eastern Dongting Lake in 2017, down by 20.17% compared with the previous year. In specific, there were 27 males, 43 females, 16 larvae, and the population birth rate was 37.20%. *Elaphurus davidianus* was mainly distributed in Zhuzi River with the population of 80~100 and Hongqi Lake with the population of 70~80. In flooding season (June-September), the *Elaphurus davidianus* in Dongting Lake showed an out-spread trend due to or motivated by flooding.

7.7.2 Poyang Lake

● Streamflow

As the largest freshwater lake in China, Poyang Lake is located to the south of Yangtze River in the northern part of Jiangxi Province. The lake embraces five major rivers (Ganjiang River, Fuhe River, Xinjiang River, Raohe River, and Xiuhe River) as well as Boyang River, Zhangtian River, Qingfengshan Stream, and Tongjin River as inflow rivers. After convergence in and buffering by Poyang Lake, the river waters empty into Yangtze River through the lake outlet.

The annual precipitation of Poyang Lake registered 1,727.2 mm in 2017, 20.0% more than the historic average. The precipitation fell mainly from June through August, which accounted for nearly 52% of the total precipitation in the year. The water level maximized at 20.88 m and minimized at 7.76 m this year, as observed at Xingzi Station. The mean water level was at 13.05 m. Affected by the incoming water from the upper reaches of the Yangtze River and the five major rivers, together with the rainfall in the lake area, the water level of the Xingzi Station in the Poyang Lake area began to increase rapidly from late June. It peaked at 20.88 meters on July 6th, with 1.88 meters over the alarming level, ranking No.9 since the record of flood crest.

In terms of the amount of the annual runoff and sediment, there was less precipitation and fewer sediments in 2017 in Poyang Lake area. The combined runoff contributed by the aforementioned five-major inflow rivers to the lake reached 120.7 bn. m³, up by 35% from last year and 9% less than the historical average. The influx of sediments amounted to 6.173 mil. t, down by 30% from a year earlier and 40% less than the historical



Night testing of the inflow at Chenglingji Station

average. The runoff discharge of the lake through outlet to Yangtze River totaled 156.3 bn. m³ this year, down by 30% from last year and 4% less than historical average. The sediment discharge of the lake amounted to 4.652 mil. t, 61% less than a year earlier, and 58% less than historical average.

The 60-day flood volume recorded from May to July indicated the total inflow of the lake reached 38.872 bn. m³, down by 58% from last year; and the total outflow 33.91 bn. m³, down by 61%; rendering the buffering balance at 4.960 bn. m³ this year, 21% more than that of last year. In 2017, the main contributing runoffs of Poyang Lake included the five major inflow rivers (Ganjiang, Fuhe, Xinjiang, Raohe, and Xiuhe) and interval waters. Specifically, Ganjiang River had always been the dominant inflow river of the lake and contributed 54.6% of the total inflow, followed by Xinjiang River which contributed 13.8%.

● Water quality

The inflow rivers of Poyang Lake enjoyed good water quality in 2017. The percentage of the contributing river waters that had attained Grade I~III standard ranged between 93.4% and 100.0% and averaged out at 98.4%, up by 2.3 percentage from last year. Specifically, Le'an

River was the main river which failed to attain water quality standard, and the main pollutants were $\text{NH}_3\text{-N}$ and TP. The monitoring section at the lake outlet attained Grade II standard in the first quarter; and Grade III standard in the second and third quarters; and Grade IV standard in the fourth quarter, with TP as the main pollutants. According to the data from the 15 monitoring sections across the lake area, the number of the sections that attained Grade I~III standard ranged between 5 and 15, which took up 33.3%~100% of the total and averaged out at 84.4%, up by 6.1 percentage points from last year. The main pollutants were TP and $\text{NH}_3\text{-N}$.

● Vegetation

In 2017, the features of vegetation distributed in zonation belts on the islets and shoals such as *Artemisia selengensis*, *Carex cinerascens*, and *Phalaris arundinacea* as well as the mudflats were monitored. The observation data of the recent years suggested that the interannual variations of the dominant species in the above three vegetation belts varied little from year to year, indicating that the representative vegetation communities in the islets and shoals of the lake area did not undergo any notable changes or any replacement of communities.

In 2017, analysis data of biomass indicated the surface biomass of *Artemisia selengensis* belt averaged out at 3,017.4 g/m^2 in spring, slightly lower than that of last spring (3,235.6 g/m^2), and 3,215.7 g/m^2 in autumn, slightly higher than that of last autumn (2,804.3 g/m^2). The surface biomass of *Carex cinerascens* belt in spring was 2,154.9 g/m^2 , lower than the same period last year (2,433.9 g/m^2); and that of autumn 2,409.6 g/m^2 , lower over the previous year (2,517.4 g/m^2). The surface biomass of *Phalaris arundinacea* was 1,347.9 g/m^2 in spring, lower than the data of last spring (1,531.7 g/m^2); and 1,531.7 g/m^2 in autumn, lower than the data of last autumn (1,663.5 g/m^2). The surface biomass on the mudflat belt averaged out at 726.6 g/m^2 in spring, lower than that of last spring (920.4 g/m^2); and 845.3 g/m^2 in autumn, lower than the data in the same period last year (872.6 g/m^2).

In 2017, analysis data of community biodiversity (the Shannon-Wiener index) showed mudflat belt recorded the maximum values, which was, 1.56 in spring and 1.95 in autumn, both higher than the data from the previous year (1.42 and 1.68 respectively). The community biodiversity of *Artemisia selengensis* belt posted 0.57 in spring and 1.34 in autumn, both higher than the data



Migratory birds in Poyang Lake

from the previous year (0.38 and 1.16 respectively). The community biodiversity of *Carex cinerascens* belt was the lowest, at 0.23 in spring, similar with last spring, and 0.20 in autumn, lower than the data of last autumn.

● Census on water birds

Over 565,000 overwinter water birds of 66 species (12 families under 6 orders) were recorded in the census conducted on December 18th, 2017 on overwinter water birds across the lake. The biodiversity index (the Shannon-Wiener index) of water birds was 2.66, and its evenness index was 0.64. The number of bird species on the record was 5 less than last year, and the population was 30,000 more than the previous year. Both the Shannon-Wiener index and evenness index of water birds across the lake saw somewhat increase (2.59 and 0.61). As for the population of key species, there were 3,786 *Grus leucogeranus*, 435 *Grus monacha*, 762 *Grus vipio*, 4,970 *Grus grus*, 8,324 *Ciconia boyciana*, 15,520 *Platalea leucorodia*, 34,567 *Cygnus columbianus*, 81,777 *Anser cygnoides*, 134,536 *Anser fabalis*, and 77,086 *Anser albifrons*. A total of 60 species of water birds were identified in the census on reproductive water birds in summer, which fell into 15 families under 6 orders. In specific, there were 24 species of summer migratory birds, 8 species of resident birds, 24 species of winter migratory birds and 4 species of traveler birds. The number of *Charadriiformes* species (27 species) was the highest among the identified species, followed by *Ciconiiformes* species (15 species). The biodiversity index (the Shannon-Wiener index) of water birds was 2.37, slightly lower than the same period last year (2.49). G index was 3.50, F index was 8.92, and G-F 0.61, basically the same as the previous year (3.52, 8.95 and 0.61).

7.8 Upstream watersheds

7.8.1 Yangjichong Watershed, Wujiang River Basin

Yangjichong Watershed in Longli County, Guizhou Province, is an integral part of the Wujiang Waters in the Yangtze River Basin. The watershed sits on the karst plateau, and is somewhere between 1,112 m and 1,630 m above sea level. The local vegetation is humid, sub-tropical evergreen broadleaf forests. A total of 3.37 km² catchment area is monitored by the monitoring station at the outlet of the watershed. The soils in the watershed are dominated by yellow soil, paddy soil, and calcareous soil. The land uses are mainly woodlands and farmlands. A total of 1,323 residents live there. The industrial structure is dominated by agricultural farming.

In 2017, the annual precipitation registered 1,131.40 mm, up by 9.33% against last year. The monitoring data on slope runoff plots suggested the sediment yield and runoff yield went up 9.22% and 7.44% respectively in cropland runoff plots, up by 32.10% and 18.50% in bare land plots, down by 9.50% and 10.01% in grassland runoff plots, down by 8.92% and 9.80% in cash tree runoff plots from last year, and no results were monitored in woodland runoff plots.

In 2017, the monitoring data on soil nutrient outputs showed the output of TN, nitrate nitrogen, and TP was 4,993.39 mg, 2,709.26 mg, and 456.37 mg respectively in cropland runoff plots; 700.36 mg, 518.96 mg, and 11.62 mg in bare land plots; 36.08 mg, 26.65 mg, and 1.81 mg in woodland runoff plots; 37.23 mg, 28.27 mg, and 0.38 mg in cash tree runoff plots; and no output of N, nitrate nitrogen, and TP was monitored in woodland runoff plots. The total TN output monitored at the station at the outlet of the watershed amounted to 796.18 kg, and the total TP output registered 92.93 kg.

In 2017, the soil erosion intensity was dominated by minor and moderate erosion, the area of which accounted for 35.73% and 23.52% respectively of the total area of the watershed. The runoff monitored at the station at the outlet of the watershed totaled 1.0969 mil. m³, up by 7.67% over last year; the annual sediment yield amounted to 75.34 t, and the sediment delivery modulus was 22.42 t/(km²·y).

7.8.2 Maojiawan Watershed, Chishui River Basin

Maojiawan Watershed in Qixinguan District, Bijie Municipality of Guizhou Province, is an integral part of the Chishui River Basin in the upstream of Yangtze

River. The watershed sits between 620 m and 1,340 m above sea level, and the local landforms are karst high mountains and gorges. The local vegetation is dominated by sub-tropical evergreen broad-leaved forests. The monitoring station at the outlet of the watershed monitors an area of 3.98 km². The main categories of the soils are yellow soil and calcareous soil. The land use patterns include closed woodland, shrub land, orchard, dry land, rural residential quarters, and land for transportation. The watershed supports a population of 1,257 residents, and the main industry is agricultural farming, in addition to small-scale livestock and poultry breeding.

In 2017, the precipitation in the watershed registered 709.5 mm across the year, down by 15.6% compared with last year. Analysis data of the runoff yields of runoff plots with varied slope gradients indicated the runoff yield was zero in 5° plots, 15.72 m³ in 15° plots, and 24.11 m³ in 25° plots. Analysis data of sediment yield of different runoff plots indicated the sediment yield was zero in 5° plots, 24.66 kg in 15° plots, and 46.56 kg in 25° plots. In 2017, the monitoring data on soil nutrient outputs in those plots showed, there was zero runoff in 5° plots. The annual output of TN totaled 13,947 mg, of NH₃-N 804 mg, of nitrate nitrogen 4,495 mg, and of TP 102 mg from 15° plots. The annual output of TN totaled 32,423 mg, of NH₃-N 712 mg, of nitrate nitrogen 20,473 mg, and of TP 159 mg from 25° plots.

In 2017, the soil erosion intensity was dominated by moderate and intensive erosion, being 1.67 km² and 1.30 km² respectively, the area of which accounted for 42.0% and 32.8% respectively of the total area of the watershed. The runoff monitored at the station at the outlet of the watershed totaled 748,700 m³, the annual sediment yield amounted to 229.7 t, and the sediment delivery modulus was 57.72 t/(km²·y).

7.8.3 Dawan Stream Watershed, Minjiang River Basin

Dawan Stream Watershed in Cuiping District, Yibin Municipality of Sichuan Province in southwest China is an integral part of Minjiang River Basin upstream Yangtze River. The watershed sits 425~540 m above the sea level. The landform is middle and lower mountain with purple soils. The local vegetation is dominated by sub-tropical evergreen broad-leaved forests. A total of 1.43 km² catchment area is monitored by the monitoring station at the outlet of the watershed. The soils are principally purple soils and paddy soils. The land uses are mainly woodlands and farmlands. The watershed

provides for a population of 465 residents, and its main industry is agricultural farming.

In 2017, the annual precipitation registered 861.5 mm, down by 25% from last year. The monitoring data on soil erosion of runoff plots suggested that the sediment yield was 2.4~12.5 kg, and the runoff yields was 1.25~2.20 m³. For the 5° runoff plot, the sediment yield order was bare land > cropland > woodland. The runoff yield of bare land was the highest, and that of intercropping model of corn-sweet potato-rapeseed was the lowest; for the 15° runoff plot, the sediment yield order was cropland > woodland > shrub land. The runoff yield of artificial shrub land was the lowest, and that of intercropping model of corn-sweet potato-rapeseed was the highest; the runoff yield and sediment yield of 15° runoff plot produces were higher than that of the 5° runoff plot.

In 2017, according to the monitoring data on soil nutrient outputs, the loss of TN in all planting modes ranged between 2,900~30,700 mg, that of TP ranged between 580~6,900 mg, of organic matters between 12~515 g. The mean annual concentration of TN and TP posted 1.40 mg/L and 0.138 mg/L respectively at the station at the outlet of the watershed.

In 2017, the soil erosion intensity was dominated by minor and moderate erosion, the area of which accounted for 34% and 55% respectively of the total area of the watershed. The runoff monitored at the station at the outlet of the watershed totaled 59,800 m³, the annual sediment yield amounted to 1,072.5 t, and the sediment delivery modulus was 353.7 t/(km²·y).

7.8.4 Xiejiawan Watershed, Jialing River Basin

Xiejiawan Watershed is located in Anju District of Suining Municipality, Sichuan Province, and

the landform is typical hills with purple soils. It sits on 280~332 m above the sea level, with mean longitudinal river slope at 2.9%. The historical average temperature registered 18.2°C, and the historical average precipitation 895.5 mm. The catchment area monitored by the monitoring station at the outlet of Xiejiawan Watershed covered 0.0689 km². There is 1 mother flow plot, 5 runoff plots with varied gradients, and 6 runoff plots in different planting modes. In 2017, the mean annual temperature across the watershed was 20.14°C. The maximum daily temperature was 37.0°C, and the minimum daily temperature was 5.6°C. The annual precipitation totaled 746.2 mm, 149.3 mm less than the average year. There were 216 rainy days throughout the year. The maximum daily precipitation was 62.5 mm, and the maximum monthly precipitation 148.5 mm. The annual water surface evaporation on land totaled 773.6 mm, with the maximum and minimum daily evaporation at 10.0 mm and 0.0 mm respectively.

Among runoff plots with varied gradients, the runoff yield of 5°, 10°, 15°, 20°, and 25° plots was 0.71 m³, 1.18 m³, 1.43 m³, 1.85 m³, and 2.35 m³ respectively, and their sediment yield posted 0.97 kg, 1.94 kg, 3.42 kg, 7.31 kg, and 13.72 kg respectively. As the slope gradients increased, the runoff and sediment yield increased significantly. As for the six runoff plots with different planting modes, their runoff yield was 1.95 m³, 1.30 m³, 1.70 m³, 1.19 m³, 2.34 m³, and 1.61 m³ respectively, and the sediment yield was 7.02 kg, 2.39 kg, 4.88 kg, 1.56 kg, 8.93 kg and 2.87 kg respectively.

The annual runoff monitored by the monitoring station at the outlet of Xiejiawan Watershed totaled 2,880.63 m³, and the sediment discharge totaled 1,007.03 kg. The mean annual concentration of TN and TP in waters was 3.99 mg/L and 0.30 mg/L respectively.

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