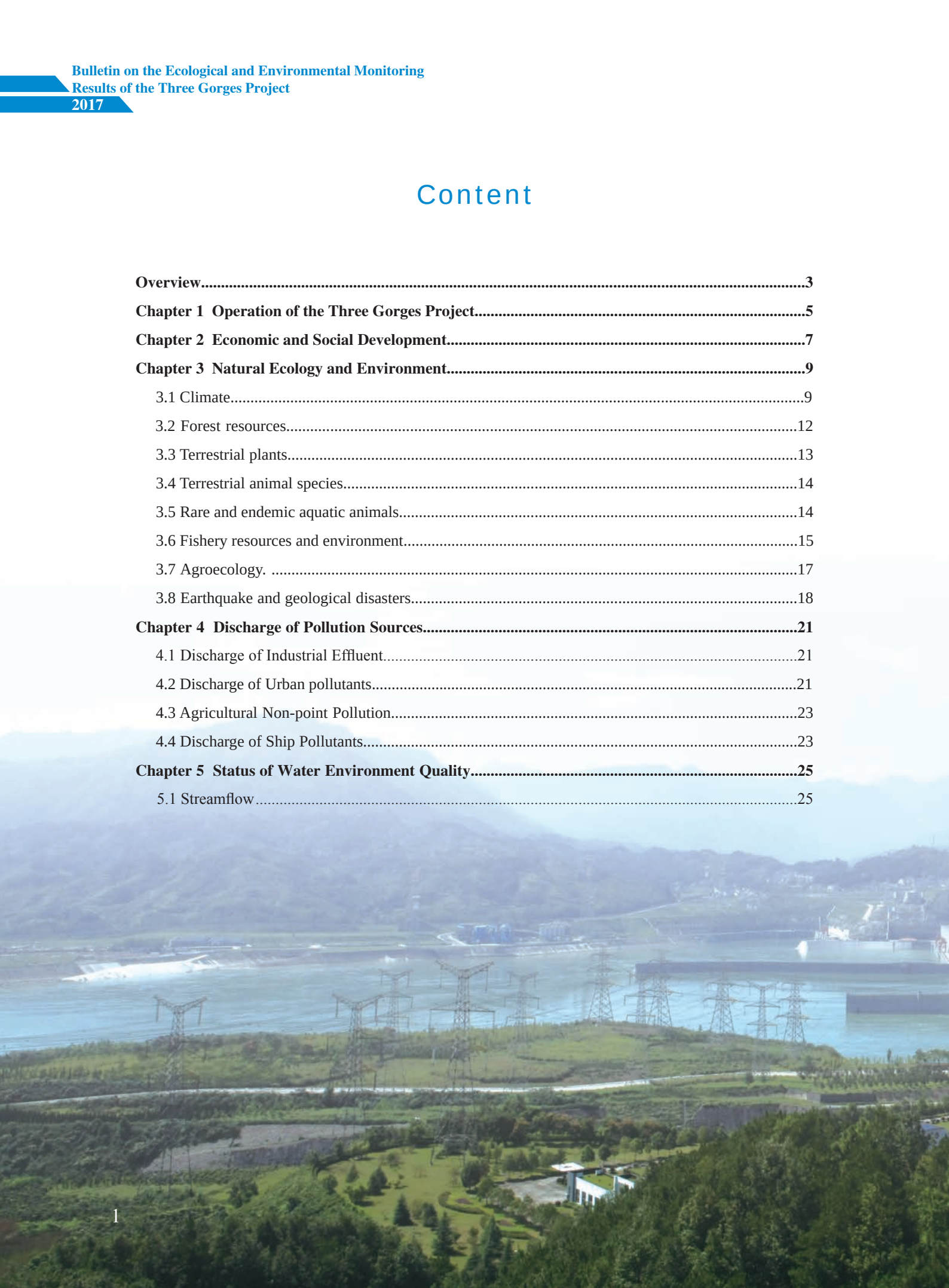
Bulletin on the Ecological and Environmental Monitoring Results of the Three Gorges Project

2017

Ministry of Environmental Protection of the People's Republic of China

2017

Content



Overview

In 2016, the Three Gorges Water Project maintained good operation, and the 175 m trial impoundment was achieved in success for the seventh consecutive time, giving full play to the comprehensive role of flood control, power generation, navigation, and water resources utilization. During the flood season between Jun. 10 and Sept. 9, a total of 9.776 bn. m^3 floodwater was impounded. The Three Gorges power plant generated about 93.5 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 21.76 bn. m^3 water during the dry season.

The permanent population of the Three Gorges Project area had reached 14.7944 mil. by the end of the year, up by 1.0% compared with that of 2015; the registered population stood at 16.8909 mil., down by 1.0%. The people in the area were in good health. The GDP of the project area reached 776.147 bn. yuan, up by 10.5% compared with that of 2015. The primary industry, secondary industry and tertiary industry achieved value added by 75.154 bn. yuan, 381.606 bn. yuan and 319.387 bn. yuan, marking an increase of 4.6%, 11.1% and 11.2% respectively than that of 2015.

The mean annual temperature of the project area posted 18.4℃ , 0.5℃ higher compared with the average year. The area experienced 1,208.7 mm annual precipitation, 8% higher than that of the average year. The mean relative humidity was 76%, in line with that of an 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 2.8301 mil. ha., the forest coverage registered 49.08%, and the living wood growing stock totaled 158.2740 mil. m^3 in the project area, including 156.4758 mil. m^3 of the forest growing stock. The area of arable land of the project area stood at 409,247 ha., down by 0.13% compared with last year. The planted acreage was 604,812 ha., with a slight drop from last year. The multiple cropping index of was 204.7%, lower than that of 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 66,300 t, a 6.1% increase than that of last year. The fish fry amount of the four major Chinese carps was about 1.34 bn. at Jianli section downstream the Dam, a dramatic increase compared with that of the same period last year. The survey at the upstream of the project area found 29 endemic and 9 alien fish species. Natural propagation of *Aclpenser Sinensis* Grdy was monitored in the spawning sites downstream Gezhouba Project, which was found once again after three years' (from 2013 to 2015) endeavor. However, its propagation numbers was still at a low level.

The Three Gorges Project area observed 481 earth quakes rated at M≥0.0, 40 times more than the previous year, mainly including microearthquakes, ultra microearthquakes, and some individual earthquakes reaching the intensity of small earthquakes. The quakes were mainly experienced along the riverside at Badong County and Zigui County of Hubei Province, and Wushan County of Chongqing Municipality. The occurrence of geological disasters saw a slight decrease from the previous year.

Up to 518.5 t pesticides were applied in the project area, a 13.8% decrease compared with the that of the previous year. The application of fertilizers stood at 119,500 t, down by 11.5%. Up to 302,100 t ship oil-contaminated water was generated, 91,900 t lower than that of last year. The standard-meeting discharge was 267,400 t. Shipboard domestic sewage totaled around 2.773 mil. t, a decrease of 944,000 t from the previous year.

The amplitude of flow variation of the mainstream of Yangtze River in the project area was 3,270～28,200 m^3/s, and the mean amplitude of velocity was 0.10～2.73 m/s. The annual average water quality of the mainstream of Yangtze River in the project area was good, the water quality of Jialing River was excellent, and that of Wujiang River good. 3.9%～46.8% of the sections of major tributaries in the project area were in eutrophic state (January～December), which levelled off with the previous year. Algae blooms still occurred in the backwaters of certain tributaries.

Chapter 1
Operation of the Three Gorges Project

In 2016, the Three Gorges Water Project was running in good shape, the electricity generating units of the Three Gorges Power Station were operated safely and steadily, and the shiplift project had entered trial operation phase, generating remarkable overall benefits such as flood control, electricity generation, navigation, and water resources utilization.

● **Comprehensive regulation**

In 2016, the Three Gorges Reservoir accepted a total of 408.59 bn. m^3 incoming waters, down by 9.4% from the historical average. During the drawdown period, the mean inflow of the Three Gorges Reservoir was 8,680 m^3/s, the mean reservoir outflow was 9,790 m^3/s, and the mean increase in flow rate of discharge amounted to 1,110 m^3/s. The project replenished the lower reaches for 170 days in total, with an amount of 21.76 bn. m^3 in replenishment. The replenishment regulation measures of the Three Gorges Reservoir in drawdown period effectively improved the navigation conditions in the middle and lower reaches of Yangtze River, which ensures the water utilization of production, life and ecology along the riverside.

During the flood season from Jun. 10 to Sept. 9 in 2016, the maximum peak flow discharged into the reservoir occurred on Jul. 1, reaching 50,000 m^3/s, and the maximum outflow reached 31,000 m^3, with peak-clipping rate being 38%. The highest water level of flood impoundment stood at 158.5 m, and a total of 9.776 bn. m^3 floodwater was impounded. From Jun. 10 to Sept. 30, the mean operational water level of the reservoir kept at 149.69 m, 4.69 m higher than the water level in flood season, and 0.71 m lower than that of the same period of the previous year.

In 2016, the Three Gorges Reservoir began impoundment on Sept. 10 with the original water level at 145.96 m, over 6 m lower than that of the same period from 2010 to 2015. During the impoundment period in September, the daily reservoir outflow was controlled at 10,000 m^3/s, and the impounded water level by the end of September has reached 161.97 m. In October, the Three Gorges Reservoi was regulated according to the real-time rainwater in an overall plans to meet the multiple needs of reservoir impoundment, downstream water supply and upstream flood control, and the flow rate of discharge was adjusted for multiple times. By 7 am on Nov. 1, the impounded water level of the Three Gorges Reservoir reached 175 m, after which, regulation was carried out basically in accordance with a balanced inflow and outflow amount.

The replenishment amount of the Three Gorges Reservoir from Oct. 28 to Jun. 5 totaled 21.76 bn. m^3(no large scale water-backing process was found), with a mean daily replenishment flow of 1,480 m^3/s, increasing the channel depth by 0.71 m in average. The mean water level of Miaozui downstream Gezhouba Project was 41.14 m, 1.4 m higher than the previous year, and the mean daily lowest water level was 39.27 m.

● **Ecological regulation**

In early June, 2016, with the aim to promote the spawning of the four major Chinese carps in the downstream Yangtze River and artificially create the peak flood process with suitable hydrologic and hydraulic conditions for their natural propagation, during the rainfall process from Jun. 8 to Jun. 13, comprehensive regulation combining flood control and facilitation of the natural propagation of the four major Chinese carps was conducted in the Three Gorges Reservoir, increasing the mean daily outflow from 14,600 m^3/s on Jun. 8 to 20,800 m^3/s on Jun. 11. During the regulation period, the water temperature of Yichang segment of the Yangtze River reached above 18℃, and both the one-day increase and its lasting period met the demands of ecological regulation proposed by relevant scientific research institutes.

● **Operation of the power station**

In 2016, by overcoming the influence of incoming water decline, actively regulating a group of reservoirs and optimizing the small and medium floods, the Three Gorges Power Station generated 93.5 bn. kWh electricity throughout the year, growing by 6.5 bn. kWh electricity from last year, and successfully completed the annual generation and operation targets.

● **Navigation management**

In 2016, the navigation lock of the Three Gorges maintained safe and efficient operation for the thirteenth consecutive year by enabling the delivery of 120 mil. t freight, up by 10 mil. t over the last year, registering another historic high.

In 2016, major progress was made in the shiplift project in the Three Gorges Project area, smoothly entering trial operation phase. Major projects like Yangtze River Rare Fish Conservation Center and Museum of the Three Gorges Project were proceeded in an orderly way.

● **Project progress**

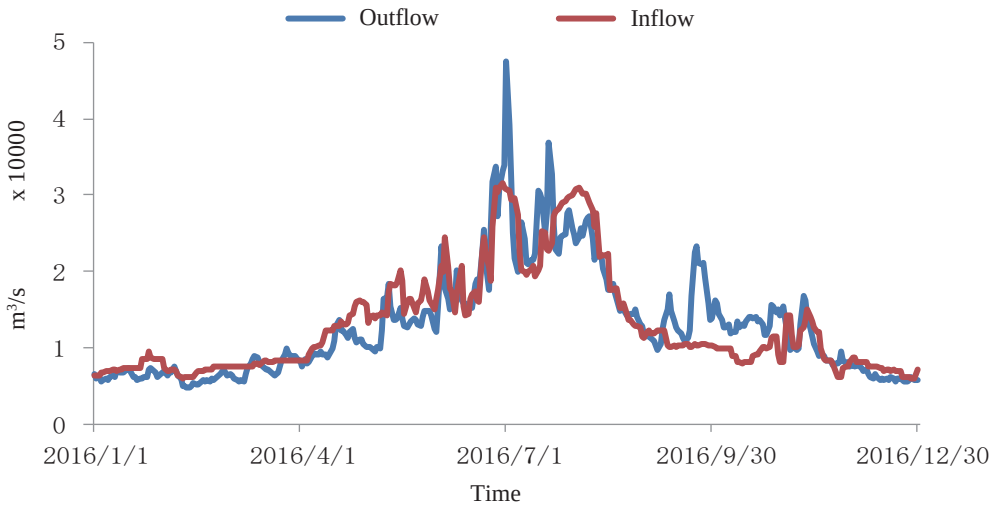


Figure 1–1 Statistics of the outflow and inflow of the Three Gorges Reservoir in 2016

Chapter 2
Economic and Social Development

In 2016, confronted with the complex and ever-changing international environment and the arduous tasks of reform, development and stability, the governments at all levels in the project area had earnestly implemented the decisions and deployments of the CPC Central Committee and the State Council, pushed forward the overall layout of the "Five in One" and coordinated the promotion of the "Four-Pronged Comprehensive Strategy", adhered to the general work guideline of making progress while maintaining stability and always kept the new concept of development in mind. By taking the supply-side structural reform as the main line, the governments made tremendous efforts in deepening reform and opening up, safeguarding and improving the people's living conditions, and strengthening eco-environmental conservation. As a result, the economic performance of the project area steadily turned better, and the social undertaking progressed in all respects.

● Economic development

In 2016, the local GDP of 19 districts of the project area in the Three Gorges Project (hereinafter referred to as the project area) totaled 776.147 bn. yuan this year, an increase of 10.5% compared with last year, among which, the value-added of the primary industry was 75.154 bn. yuan, up by 4.6%; the value-added of the secondary industry was 381.606 bn. yuan, up by 11.1%; and that of the tertiary industry 319.387 bn. yuan, up by 11.2%. The per capita of GDP of the project area reached 52,500 yuan, 4,700 yuan higher compared with last year, up by 9.9%. In specific, the local GDP of the Hubei project area achieved 86.030 bn. yuan, up by 9.3% and that of the Chongqing project area 690.117 bn. yuan, up by 10.7%. The per capita of GDP of the Hubei project area was 58,000 yuan, up by 9.5%, and that of the Chongqing project area 51,800 yuan, up by 10.0%.

The local GDP of the project area in the past two years experienced a stable increase, and its overall trend remained basically the same as that of the whole country while the growth rate in each quarter was obviously higher than the national average. Compared with the previous two years, although the economic growth rate under the new normal had come down, the volatility had gradually decreased. In 2016, the largest gap among the cumulative quarterly

GDP growth rate of the project area was 0.2 percentage points, while that of 2014 and 2015 were 1.0 and 1.1 percentage points respectively, and the economic operations had clearly stabilized.

In terms of the industrial structure in 2016, the three industrial structure of the project area was 9.7:49.2:41.1. The proportion of non-agricultural industry in the project area reached 90.3%, and that of the secondary industry accounted for nearly 50% of the total, remaining the supporting force for economic growth in the project area. From the perspective of the internal structure of non-agricultural industries, the tertiary industry showed a strong momentum of growth. While the proportion of the secondary industry dropped by 0.8 percentage point from that of the previous year, the proportion of the tertiary industry increased by 0.7 percentage points, and the proportion gap between the secondary and tertiary industries had shrunk gradually.

● Resident income

In 2016, the per capita disposable income of all permanent residents in the project area was 21,401 yuan, an increase of 10.8% over the previous year, among which, the per capita disposable income of urban residents was 29,673 yuan, up by 9.2%; the per capita disposable income of rural residents was 11,584 yuan, up by 10.3%.

The per capita disposable income of all permanent residents in the Hubei project area was 17,035 yuan, an increase of 9.1% over the previous year. The disposable income of its urban residents was 26,752 yuan, an increase of 9.7%, while the disposable income of rural residents was 11,438 yuan, an increase of 8.4%. The per capita disposable income of all permanent residents in the Chongqing project area was 21,887 yuan, up by 10.9%, among which, the disposable income of urban residents was 29,935 yuan, up by 9.2%, and the disposable income of rural residents was 11,605 yuan, up by 10.5%.

● Social development

In 2016, the process of non-agricultural

industrialization in the Three Gorges Project area and that of the population aggregation in urban areas further accelerated. As the urban functions and radiation capacity continued to improve, the urbanization rate gradually increased. The permanent resident population of the Three Gorges Project area had numbered 14.7944 mil. by the end of the year, an increase of 1.0% over the previous year. Specifically, 1.4843 mil. were in the Hubei project area, up by 0.2% compared with last year; 13.3101 mil. people lived in the Chongqing project area, up by 1.0%. There had been 16.8909 mil. registered population in the project area by the end of the year, 1.03% less than the same period of the previous year. Specifically, 1.5596 mil. were in the Hubei project area, down by 0.4%; and 15.3313 mil. were in the Chongqing project area, down by 1.09%.

In 2016, the urbanization rate of the project area reached 56.52%, up by 1.84 percentage points over last year. Specifically, the urbanization rate of the Hubei project area was 46.47%, up by 4.50 percentage points; the urbanization rate of the Chongqing project area was 57.64%, up by 1.54 percentage points.

In 2016, the total length of highway in the project area reached 94,760 km, an increase of 1.7% over the previous year, among which, the grade highway was 74,370 km long, up by 4.0%; expressway was 1,647 kilometers long, up by 12.0%.

In 2016, there were altogether 602 general middle schools in the project area, with 764,400 students and 56,000 full-time teachers. On average, every 14 middle school students had 1 full-time teacher, and the percentage of full-time teachers was slightly higher than the previous year. There were 1,374 primary schools in the project area, with 989,400 primary school students and 59,800 full-time teachers. On average, every 17 primary school students had 1 full-time teacher, and the percentage of full- time teachers had also risen over the previous year. As a result, the ratio of teachers to students had been further optimized.

In 2016, there were 73,700 medical personnel in the project area, an increase of 8.3% over the previous year, among which, the Hubei project area increased by 15.4% and the Chongqing project area increased by 7.5%.

There were 82,600 bedspaces in number held by health institutions, up by 3.7%, among which, 8.9% down in the Hubei project area and 5.0% up in the Chongqing project area.

Chapter 3
Natural Ecology and Environment

3.1 Climate

In 2016, the mean annual temperature and mean annual precipitation was on the high side in the Three Gorges Project area compared with the average year. The main characteristics of the climate conditions could be demonstrated as below: the temperature was on the high side in all seasons, of which the warmth in spring and summer was obvious, and the days with high temperature were more than ever in general; the precipitation in winter, spring and summer were significantly more than normal, while the precipitation in autumn was close to normal and the rainfall in August and September was obviously less; days of heavy rain throughout the year were more than 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, while the evaporation was less than normal. The main meteorological disasters that struck the project area and adjacent areas were rainstorms, floods, high temperature and droughts.

Automatic meteorological observation station

Table 3–1.Monitoring results of meteorological elements of each station in the Three Gorges Project area in 2016

Station	Mean temperature (℃)	Precipitation (mm)	Relative humidity (%)	Evaporation (mm)	Mean wind speed (m/s)	Sunshine hours (h)	Foggy days (d)
Chongqing	19.5	1348.0	76	1255.5	1.4	1228.4	33
Changshou	18.6	1260.6	79	760.6	1.5	1184.8	50
Fuling	18.3	1236.1	80	-	1.6	1193.7	190
Fengdu	19.2	1169.8	76	849.4	1.5	1081.3	39
Zhongxian	18.4	1190.5	80	-	1.4	1216.8	138
Wanzhou	19.4	1082.1	76	1217.6	1.3	1241.6	26
Yunyang	19.0	1050.5	75	-	1.6	1377.5	44
Fengjie	19.4	1029.1	68	1162.0	1.9	1282.0	23
Wushan	17.1	1070.8	72	-	2.6	1730.1	106
Badong	18.1	1220.9	70	1395.7	1.9	1623.1	17
Zigui	17.3	1520.7	79	848.4	1.1	1270.9	1
Yichang	16.8	1325.1	76	1161.1	1.8	1433.5	65

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 dishes corrected from those measured in big evaporation dishes.

3.1.1 Meterological elements

In 2016, the mean annual temperature of the project area recorded 18.4℃, 0.5℃ higher than that of average year (17.9℃). The spatial distribution of the mean annual temperature in the Three Gorges Project area ranged from 16.0℃ to 19.0℃, the western and northern regions from 17.5℃ to 19.0℃, the eastern and southern regions from 16.0℃ to 17.5℃. The mean annual temperature of the northwest regions was 1.0～2.0℃ 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 2016 was higher or close to normal, especially in the central and northern regions, where the temperature was obviously high, with Wanzhou 1.2℃ higher than normal. In terms of time distribution, the monthly mean temperatures of the year were higher than the same period of normal years, with the monthly mean temperatures in March and December 1.4℃ and 1.3℃ above the normal respectively, but the monthly mean temperatures in May and November were 0.2℃ and 0.3℃ lower than the same period in normal years.

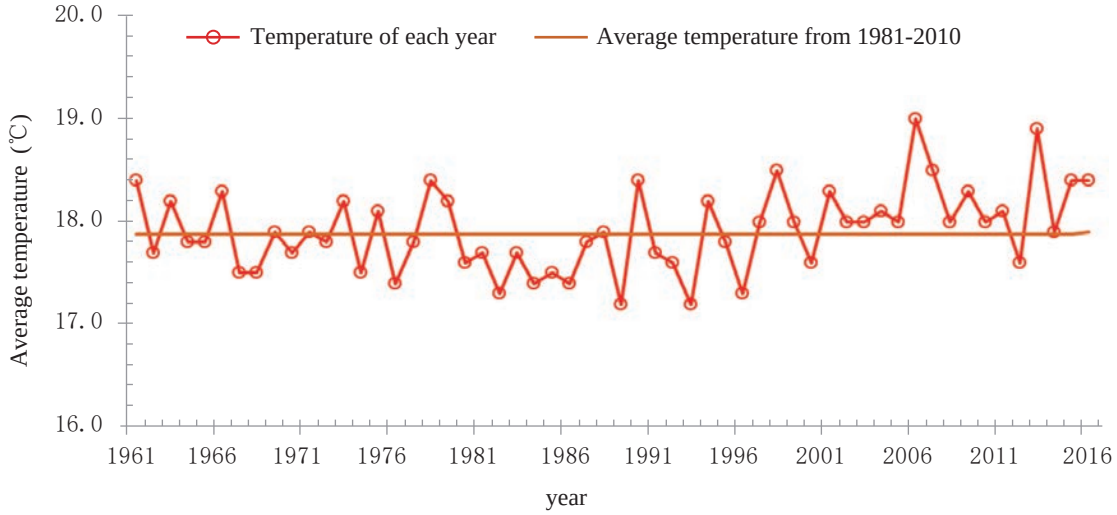


Figure 3–1. Mean annual temperature of the Three Gorges Project area between 1961 and 2016

The annual precipitation was 1,208.7 mm in the project area in 2016, 8.4% more than the historical average (1,114.9 mm). In terms of spatial distribution, the annual precipitation of most parts of the project area was above 1,200 mm, and the annual precipitation of central and southern parts of the area was generally above 1,400 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 was less. Precipitation in January, March, April, June and November was more than the same period of the normal, especially in January, June and November when the precipitation were over 80% than the average years; precipitation in the remaining months was less than or close to the historical average, with precipitation in August and September dropping by 29% and 35% respectively.

The mean relative humidity of the project area was76%, close to that of historical average (76%). The relative humidity of all monitoring stations ranged from 68% to 82%. Compared with the average year, the relative humidity in most parts of the project area was close to historical average, and it was a little bit higher in only a few parts of the eastern area. The relative humidity in Zigui was 6% higher,that of Wanzhou 5% lower, and that of Chongqing, Fengdu and Fengjie also 4% lower respectively. Seasonal analysis indicated

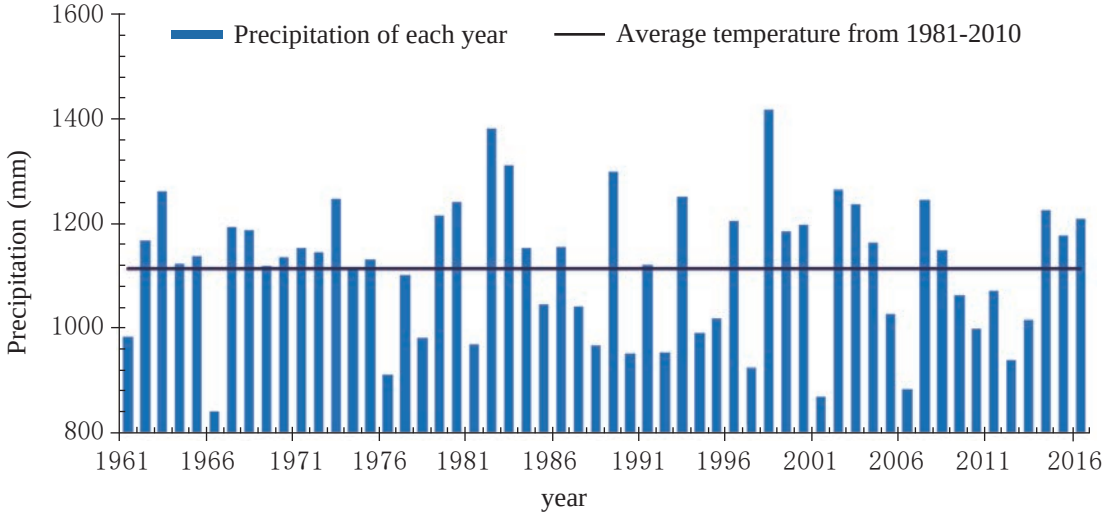


Figure 3–2 Mean annual precipitation of the Three Gorges Project area during 1961–2016

the relative humidity (historical average) was 76% (77%),75% (74%), 74% (76%) and 78% (79%) in the winter, spring, summer and autumn respectively, all close to that of the same period of average year.

The mean wind speed was 1.6 m/s in the project area, 0.3 m/s more than that of the historical average (1.3 m/s). The mean monthly wind speed hit the maximum in May and August, being 1.8 m/s, while the minimum was observed in November and December at 1.5 m/s. The wind speed was 0.4～0.5 m/s higher than the historical average in January, May and between October and December, and 0.2～0.3 m/s higher in the remaining months. Wushan recorded the maximum mean wind speed at 2.6 m/s, and other places all experienced wind speed between 1.0 m/s and 2.0 m/s.

The number of foggy days varied notably with places in the project area. The foggy days in Fuling, Zhongxian, and Wushan were 190, 138 and 106 days respectively, while there was only one foggy day in Zigui. In terms of yearly variation, April had the highest number of foggy days with 9 days, followed by December with 7 days; the foggy days in January, June and October were 6 days respectively; August experienced the least with 2 days.

3.1.2 Meteorological hazards

In 2016, the project area was hit by such main meteorological hazards as the rainstorms, floods, high temperatures and droughts, among which, heavy rains began early and frequent rainstorms were recorded in plural stations; days with high temperature were more frequent with long duration; the meteorological droughts were slight in severity but the summer drought was obvious; the continuous rain was strong and cold wave also occurred in autumn and winter.

● **Heavy rains started early and frequent rainstorms were recorded in plural stations**

From March 7 to March 9, 2016, a large-scale precipitation process occurred in the Three Gorges Project area. The daily precipitation in various areas reached heavy rainfall scale and the onset of heavy rains was 40-50 days earlier than usual. During the year, a total of eight regional rainstorms occurred in the project area, with five occurrences in June. A large scale of persistent heavy precipitation occurred in late June. The two heavy rainstorms of June 19 and June 30 were the strongest and the most extensive rainfalls of the project area in 2016. During July 18～19, the strongest rainfall over Yichang near the Three Gorges Project area occurred, and regions along the Yangtze River and of the southern and eastern parts also experienced heavy rainstorms, and torrential rains occurred in some areas, resulting in the disaster affecting 12 counties and cities in Yichang.

● **More high temperature days with long duration**

During the mid-to-late summer of 2016, there was a continuous hot weather in the project area, with

temperatures above 35℃ in most areas except for some mountains, among which, the number of high-11 Natural Ecology and Environment temperature days in Kaizhou reached 70 days, being the third highest in the history of the meteorological records. The counties like Shapingba (Chongqing), Beibei, Qijiang, Jiangjin, Changshou, Fuling, Fengdu, Dianjiang, Zhongxian, Liangping, Wanzhou, Yunyang, Kaizhou, Fengjie, Wuxi, Wushan, Wulong all experienced hot weather above 40℃, of which hot days with temperature above 40℃ in Kaizhou reached 19 days, becoming the second highest since the local meteorological recorded. The continuous days with high temperature above 40℃ added up to 14 days, which leveled off with the longest record in history. Places with extremely high temperatures like Fengdu (43.9℃, Aug. 25), Kaizhou (43.4℃ Aug. 18, 19, 25), Fengjie (42.2℃, Aug. 24) and Wuxi (43.5℃, Aug. 25) all broke the local historical record.

● **The droughts were slight in severity and summer drought was obvious**

In 2016, the meteorological drought was slight in severity and moderate drought occurred in late summer and early autumn. From late July to mid-August, some regions were hit by moderate drought due to continuous high temperature and the lack of rain. Specifically, Beibei, Shizhu, Fuling, Fengdu, Wanzhou, Fengjie and Wushan suffered moderate summer drought. The droughts in Shapingba (Chongqing), Kaizhou and Wuxian were severe. At the end of August, there were two precipitation processes in the project area, which ameliorated meteorological drought in the central and western regions to some certain extent. However, the meteorological drought in the eastern part of the project area still continued, and by mid-October, autumn drought could still be seen in some parts of the project area.

● **Continuous rain in autumn and winter and drop in temperature by strong cold waves**

In mid-to-late October 2016, the eastern part of the Three Gorges area continued to experience continuous rain and the cumulative rainfall was large in amount, with most areas suffering moderate to severe level continuous rain. Precipitation, while effectively alleviating the drought in previous periods, caused some negative impacts on crops at the same time. In addition, there were also two consecutive rainy periods in mid-to-late November.

In early 2016 and at Gorges Project area suffered obvious cooling weather caused by cold wave, and some regions were also hit by snowfall or freezing. In January 20～25, affected by the strong cold air, the Three Gorges Project area experienced cold waves and strong cooling weather, and the most intense cooling in 72 hours reached 8～10℃. The minimum temperature of many districts and counties was below 0℃, and the minimum temperature of the eastern part of the project area like Xing Mountain and Yidu was less than -5.8℃, and the minimum temperature of Changyang was -4.4℃; snowfall occurred in most areas and the maximum snow depth was more than 10 cm. The low temperature, rainy and snowy weather at the beginning of the year resulted in icing on a number of highways and bridges, making adverse impact on transportation. Besides, snowfall also led to the collapse of vegetable greenhouses in some areas, and the continued low temperature left crops frosted. From November 21 to 24, the Three Gorges Project area suffered another cooling weather featuring wide range of areas and a large temperature drop, and some areas were even hit by rain, snow, gale and freezing rain.

3.2 Forest resources

In 2016, the forest area of the project area occupied 2.8301 mil. ha. with the coverage of 49.1%. Specifically, there were 2.6271 mil. ha. closed forest land, accounting for 92.83% of the total and 203,000 ha. special shrub land defined by the state, which took up 7.17% of the total. The living wood growing stock totaled 158.2740 mil. m^3, which included 156.4758 mil. m^3 forest growing stock, and 1.7982 mil. m^3 scattered wood land, scattered trees and trees on the sides of villages, homesteads, roads and rivers, which accounted for 98.86% and 1.14% respectively.

There were 1.8340 mil. ha. natural forests and 793,100 ha. planted forests. The growing stock for natural forests stood at 115.5844 mil. m^3 and that for planted forests was 40.8915 mil. m^3. Natural forests were the main forest resources in the project area, from the perspective of the sources of forests.

There were 1.7053 mil. ha. shelter forests and 98.3689 mil. m^3 shelter forest stock, accounting for 64.91% of the total forest area and 62.87% of the forest stock respectively. The area of special-purpose forests stood at 182,400 ha. and that of special-purpose forest stock was 15.6454 mil. m^3, taking up 6.94% and 10.00% of their respective total. There were 700,400 ha. timber forests and 42.0555 mil. m^3 timber forest stock, taking

up 26.66% and 26.88% of their respective total. The area of firewood forests stood at 2,500 ha. and the stock was 132,700 m^3, registering 0.10% and 0.08% of their respective total. Economic forests covered an area of 36,500 ha., taking up 1.39% of the total, with growing stock of 273,300 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 1.1072 mil. ha., and the stock was 41.7743 mil. m^3, accounting for 43.95% of the total area and 26.70% of the total growing stock of arboreal forest. There were 989,400 ha. half-mature forests with 72.3822 mil. m^3 growing stock, taking up 39.28% and 46.26% respectively. The area and growing stock of near-mature forests were 296,900 ha. and 27.3915 mil. m^3, constituting 11.79% and 17.50% respectively. Mature forests covered 109,800 ha. and the growing stock stood at 12.6717 mil. m^3, accounting for 4.36% and 8.10% respectively. There were 15,500 ha. over-mature forests with 2.2560 mil. m^3 growing stock, taking up 0.62% and 1.44% of the total respectively. Sapling and half-mature forests dominated the arboreal forests with the coverage and growing stock accounting for 83.23% and 72.96% of the total respectively.

The planted forest covered 81,200 ha. in the project area, and 79,900 ha. was preserved with the survival rate of 98.40%. Specifically, the planted forests amounted to 5,300 ha. in Hubei and 5,200 ha. was preserved with the survival rate of 98.11%. The planted forests reached 75,900 ha. in Chongqing and 74,700 ha. was preserved with the survival rate of 98.42%.

A total of 89,605 ha. forests suffered from forest hazards, accounting for 3.13% of the total forest area in the project area, including 89,560 ha., or 99.95%, damaged by forest diseases and insect pests, and 45 ha., or 0.05%, ruined by forest fires and other hazards.

the threatened ancient and famous tree with burnt sighs in tree hole

3.3 Terrestrial plants

In 2016, random sampling was employed to monitor ancient and famous trees as well as rare and endangered plants in the project area. The plant communities fell into 110 formation types in 34 formation groups under 7 vegetation types of 5 vegetation type groups in the project area. 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. 72 alien invasive plants were found in the project area, of which 9 were declared as malignant alien invasive plants by the State Environmental Protection Administration. Based on *China Biodiversity Red List-Higher Plant Volume* released by MEP in 2013, 195 species of higher plants in the project area were under threat. Specifically, there were 18 critical (CR) species, 62 endangered (EN) species and 115 vulnerable (VU) species. There were 205 species/varieties of 9335 strains of ancient and famous trees in the project area, belonging to 128 genera of 64 families.

- **Ancient and famous trees**

The number of ancient and famous trees in the project area varied greatly among different species. Specifically, the *Ficus virens* owned the largest populations, accounting for more than 37% of the total, followed by ginkgo and cedar wood, accounting for 10.2% and 9.5% respectively. There were 145 species whose number was less than 10. The number of species like metasequoia, salak, celtis julianae, luohan tree, cercidiphyllum japonicum, Corylus chinensis, Eucommia ulmoides, Picea neoveitchii, Torreya fargesii was only one, so little that deserved major protection.

The ancient trees in the project area had an average age of 217 years with an average height of 19 m, an average diameter at breast height (DBH) of 110 cm and

that of crown width 13 m. The species with the highest average age and the highest average DBH was the warm-temperate wood species (560 and 160 cm respectively). The species with the highest average tree height was cedar wood with 32.8 m. The species with the highest average crown width were bischofia polycarpa and quercus spinose, with 21m. Among the 150 ancestor and famous trees in the sampling area, 70.6% of those plants had good growth, 22.7% had moderate growth, 4.7% had poor growth, 1.3% were at critical conditions, and 0.7% were dead. It can be seen that although the ancestor trees in the project area had higher height, larger diameter and larger crown width, the growth potential needed to be strengthened with meticulous care.

About 11.5% of the ancient trees in the project area were under great threat to their health, among which, 70.7% of their root system were normal, 29.3% were in the state of bare roots, damaged or even died. 35.3% of their branches were normal, while 64.7% were withered, split, cut, decay branches; 80.0% of those trees' top was normal and 20.0% of their heads were decapitated and withered; 88.0% of their canopy were plump, while 12.0% were too thin, withered, endangered or dying; 46.0% of their trunk were normal, and trunks with inclining symptom, xylem bare, rotten, hollow, tree hole, bark damage, damage to rhizome and other symptoms accounted for 54.0%; 75.3% with normal leaves, and those with leaf spots, chlorosis, caducity and other symptoms accounted for 24.7%; 71.4% were not found to have serious plant diseases and insect pests or less harmful ones, and 28.6% were with serious ones. It can be seen that the threatened ancestor and famous tree recorded the lowest branch health index, which needed timely cleaning, preserving and binding of the injured tree branches; since their trunk health index was low, the relevant rescue, reinforcement, preservation and hole filling of the trunk were required; considering the bare and damaged root system would influence the moisture and soil supply of trees, soil-adding and repair were also needed.

● **Rare and endangered plant species**

In 2016, the results of monitoring of the growth and growth rate of 154 rare and endangered woody plants in 34 species ex-situ showed that the average DBH of all samples was 10.79 cm and the annual growth rate was 0.51 cm. The average tree height was 7.51 m, and the annual growth rate was 0.33 m. The results of monitoring the growth status of the 44 herbaceous, rare and endangered plants in 8 species in the project area showed that all the sampled plants grew well and no serious pests and diseases were found. The growth and health status of rare and endangered plants did not change significantly from the previous year.

Investigation on fish catch by a shipboard square fishing net in Mudong waters

3.4 Terrestrial animal species

In 2016, land-bird monitoring was conducted in 12 districts and counties in the Three Gorges Project area where natural vegetation was large and adjacent. A total of 18,817 birds of 179 species were detected from April 7 to May 1 (spring) and from October 16 to November 9 (autumn), of which 9,129 were recorded in spring and 9,688 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.

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 2016, a total

of 4,046 species were recorded, among which, *Anas platyrhynchos* had the largest population at 1,387, followed by little egret (736), little grebe (474), and *Phalacrocorax carbo* (443). Moreover, Chinese merganser (8) and mandarin duck (197) were also found in the selected area. The density of waterbird in lakes was significantly higher than that of the river. Compared with the previous year, the number of egret increased, while that of duck, emus, cormorants and osteoclasts decreased. Among the three lakes, Hanfeng Lake had the largest number of birds, reaching 1,085, followed by Dahonghu (690) and Changshou Lake (497). Among the 11 tributaries, the number of winter wintering birds in Pengxi River reached the largest of 590, followed by Daning River (352) and Wujiang River (184).

3.5 Rare and endemic aquatic animals

3.5.1 Endemic fish species

In 2016, 135 fish species were identified in the upstream reaches of the Yangtze River including Yibin, Hejiang, Mudong, Yichang reach in the midstream and the part of Chishui municipality along the Chishui River. Specifically, there were 29 endemic fish species and 9 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 fish species in the reservoir area was downsized compared with that before impoundment.

A total of 3,502.77 kg fish were collected in catch investigation, totaling 82,541 ones. There were 7,572 endemic fishes with total weight at 385.50 kg, which accounted for 11.0% of the total weight of the catch and 9.2% of total amount. The percent of endemic fish went up 31.0% by weight, and 4.5% 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.

Finless porpoise

In 2016, experiment was carried out on artificial propagation of *Sauyage et Dabry* in Cage Ship Base in Luzhou, Sichuan province, which produced 9 batches of fertilized eggs and fries, with fertilization rate at 75% and 1027 fries out of films.

3.5.2 Rare aquatic animals

In 2016, surveys were conducted in the known spawning sites in the lower reaches of Gezhouba Project during the propagation season of Chinese sturgeon. Based on the results of hydrological navigation detection, the number of large sturgeons (more than 1.1 meters in body length) at the spawning sites and adjacent areas (Gezhouba to Songzikou) during the survey period was estimated at 48. Since there was a large-scale escape of sturgeon in Qingjiang in July 2016, alien sturgeon species still could not be ruled out in this result. The result of fixed-point detection in Gezhouba showed that there were larger target signals, and the maximum length of target fish was calculated to be 364.4 cm. 67 Chinese sturgeon eggs (egg membrane) and 22 larvae were collected from the bottom nets. Anatomy results found that a total of 454 Chinese sturgeon eggs were ingested by 10, and the underwater videos revealed five sites where Chinese sturgeon eggs adhered to.

Based on developmental phase and collection site of Chinese sturgeon eggs, the first spawning time of Chinese sturgeon was estimated to be around the early morning of November 24 in 2016, in the place almost 300 meters away from the Dajiang Power Plant. This was the third time after three years' interruption from 2013 to 2015 that the spawning activities of wild Chinese sturgeon was monitored once again in the lower reaches of the Gezhouba Project in the Yangtze River.

In 2016, no juvenile Chinese sturgeons sample was collected in the lower reaches and the estuary of the Yangtze River. The bycatch of three Chinese sturgeons was investigated in the middle reaches of the Yangtze River, and no juvenile Chinese sturgeons was collected in the lower reaches and the estuary of the Yangtze

Egg-eating situation of Pelteobagrus vachelli

River. There was no report of bycatch of paddlefish. The bycatch of 1 *Acipenser dabryanus* was found out in Yichang, the lower reaches of Gezhouba Project. The bycatch of 22 mullets was found out in Hejiang, Mudong, Wanzhou, Zigui, Yichang and the part of Chishui municipality along the Chishui River. In the mid- and upstream of the Yangtze River, the population of paddlefish and *Acipenser dabryanus* was very small. There was still a certain population of mullets.

In 2016, visual and acoustic monitoring data showed about 539 finless porpoises were observed in February, with 27 juvenile dolphins accounting for 5.0% of the total. 409 finless porpoises were observed in December, with 53 juvenile dolphins accounting for 13.0%. Compared with the results of Poyang Lake in the dry season of the past years, there was no significant difference in the witness rate and distribution area of the Yangtze finless porpoise. The dry season of the finless porpoise was more concentrated in waters around Laoyemiao, Xingzi County to Hukou County, and in waters near Hehe township to Willow Bay. There were also more finless porpoises in the Ganjiang River from Laoyemiao to Wucheng waters.

There still was no report of white-flag dolphin (*Lipotes vexillifer*) in the investigation of 2016.

3.6 Fishery resources and environment

3.6.1 Fishery resources

In 2016, the catch of natural fishes in the project area, downstream the Dam, and in the Dongting Lake and Poyang Lake totaled 66,300 t, up by 6.1% from last year. The fish fry amount of the four major Chinese carps at Jianli section downstream the Dam was 1.34 bn., a sharp increase over last year. The total catch of long-tail anchovy (*Coilia mystus*) in the estuary waters in fishing season was 22 t, up by 609.7% compared with last year. The total catch of parent crab in fishing season was 25.4 t, down by 63.5% compared with last year. The total catch of eel was 0.66 t in fishing season, which leveled off with that of last year.

● **Three Gorges Project area**

In 2016, the total catch of natural fish of the project area was 6,455 t, down by 16.5% compared with last year. It was estimated from the composition of fish catch of the project area that there were 1,047 t silver carp, 978 t bighead carp, 665 t *Pelteobagrus fulvidraco*, 602 t carp, 521 t Culter alburnus, 259 t crucian carp, 222 t catfish, and 217 t *Coreius heterodon*, totaling 69.9% of the whole catch weight and becoming the main commercial fish species of the Three Gorges Project area.

● **Downstream the dam**

In 2016, the catch of natural fish downstream the Dam totaled 2,165 t, up by 25.9% compared with last year. It was estimated from the composition of the catch that there were 432 t silver carp, 421 t carp, 177 t bighead carp, 158 t catfish, 142 t bream and 118 t grass carp, the combined weight of which accounted for 66.9% of the total catch. They were the main commercial fish species downstream the Three Gorges Dam.

● **Dongting Lake**

In 2016, the catch of natural fish of the Dongting Lake reached 29,500 t, up by 5.4% compared with last year. Specifically, 13,000 t were from eastern part of the Dongting Lake, 9,500 t were from southern part and 7,000 t were from western part, accounting for 44.1%, 32.2% and 23.7% 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 75.6% of the total weight of the sampled catch and were the major commercial fish species in Dongting Lake.

● **Poyang Lake**

In 2016, the catch of natural fish in the Poyang Lake was 28,200 t, up by 12.8% compared with last year. The settled fish species such as carp, crucian carp, catfish and *Pelteobagrus fulvidraco* as well as the "four major Chinese carps" took up 81.1% of the sampled total catch and were major commercial fish species in the Poyang Lake.

There were 29 spawning sites for carp and crucian in Poyang Lake, covering an area of 438 square kilometers; 35 fish feeding grounds, occupying 426 square kilometers and mainly in the eastern, central and southern part of the Lake.

● **Yangtze River estuary**

In 2016, the catch of *Coilia mystus* (tapertail anchovy) per ship, the output value per ship and the total catch of them during the fishing season of the Yangtze River estuary were 0.423 t, 26,525 yuan, and 22 t, up by 436.8%, 230.4% and 609.7% respectively compared with that of the same period last year. The average length and weight of tapertail anchovy in the estuaries of Yangtze River in 2016 were 138 mm and 9.1 g, down by 8.0% and 24.8% respectively compared with last year.

In 2016, the catch of parent crabs per ship and total catch in the estuary during the fishing season were 0.257 t and 25.4 t, down by 41.3% and 63.53% respectively compared with that of the same period last year. The per ship output reached 43,639 yuan, which leveled off with last year. The average shell height, average shell width and average weight of parent crabs were 62 mm, 66 mm and 138 g, up by 8.8%, 4.8% and 10.4% respectively compared with that of the same period last year.

The elver (*Anguilla Japonica*) catch per ship and output value per ship were 11,896 and 118,592 yuan, down by 6.0% and 31.2% compared with last year; the total catch during the fishing season was 0.66 t, which leveled off with last year.

● **Early resources of fish**

In 2016, the fish fry amount in Sanzhou section of Jianli County in the midstream of the Yangtze River was 33.13 bn., among which, the fish fry amount of "the four major Chinese carps" was 1.34 bn., marking a significant rise compared with last year. Among the fish fry of "the four major Chinese carps", silver carp took up 79.3% and the grass carp 18.9%. The percent of black carp and bighead carp was small, taking up 1.8%. 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 2016.

3.6.2 Fishery waters

In 2016, 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 in the mainstream of the Yangtze River. The assessment of water quality complied with the *Water Quality Standard for Fisheries* (GB11607-89). For the indicators not specified, 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 2016, 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 and Copper as the main pollutant.

● **Upstream Yangtze River**

The measured TN concentrations of waters in Yibin and Banan failed to meet water quality standard during fish wintering, propagation and finishing periods. All other pollution indicators met water quality standard. Copper, mercury and volatile phenol in Fuling, Wanzhou, Wushan and Zigui sections of the Three Gorges Project area breached the standard, and other monitoring items met the standards.

● **Midstream of the Yangtze River**

All monitoring indicators of Jingzhou waters met water quality standard, and 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, propagation and finishing periods was 66.7%, 33.3% and 100% respectively; the non-attainment rate of COD_{Mn} was 33.3%; 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 66.7%, 100% and 100% respectively, and that of copper in fish wintering was 66.7%, but other indicators met water quality standard. There was no obvious change in the concentrations of monitoring indicators compared with last year.

● **Spawning sites of the Chinese sturgeon**

All monitoring indicators of the spawning sites of Chinese sturgeon in Yichang 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 was 44.4% in wintering period, 11.1% in finishing period. The non-attainment rate of COD_{Mn} in finishing period was 11.1%; All other monitoring indicators met water quality standard. There was no obvious change in the concentration of monitoring indicators compared with last year.

● **Poyang Lake**

The non-attainment rate of TN concentration in Poyang Lake in fish wintering, propagation and finishing periods was 100%, 100% and 66.7% respectively. All other monitoring indicators met water quality standard. There was no obvious change in the concentration of each monitoring indicator compared with last year.

● **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 parent crab was 100%. All other monitoring indicators met the water quality standard. The concentration of petroleum, volatile phenol, unionized ammonia, and mercury had some decrease that of COD_{Mn}, lead and cadmium went down remarkably, and that of other monitoring indicators did not change notably compared with last year.

3.7 Agroecology

3.7.1 Ecological environment of farmlands

In 2016, the total area of agricultural lands in 19 districts (cities, counties) in the Three Gorges Project area was 409,247 ha., down by 0.13% compared with last year. Specifically, 107,307 ha. were paddy fields, 169,851 ha. were dry croplands, 77,905 ha. were citrus orchards, 14,334 ha. were tea gardens, 4,827 ha. were traditional Chinese herb medicine gardens and 35,023 ha. for planting of other crops. Arable lands accounted for 67.7% of total agricultural lands, 26.2% of which was paddy lands and 41.5% dry croplands. The total area of gardens took up 32.3% of the total agricultural lands, 19.0% of which was for citrus, 3.5% for tea, 1.2% for traditional Chinese herbal medicines and 8.6% for others. There was a slight decrease of agricultural land area compared with last year.

Analysis of tillage system showed 56,828 ha. of dry croplands practiced triple-cropping system, 87,566 ha. double-cropping system, and 25,458 ha. one-cropping system, which accounted for 33.5%, 51.5% and 15.0% respectively of total dry cropland area. In paddy fields, 11,643 ha. practiced triple-cropping system, 57,679 ha. double-cropping system, and 37,985 ha. one-cropping system; taking up 10.9%, 53.8% and 35.3% 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^{o} was 66,942 ha., of those with slope ranging between 10^{o}～15^{o} 95,189 ha., of those with slope ranging between 15^{o}～25^{o} 93,977 ha., and of those with slope over 25^{o} 31,347 ha. The area of agricultural lands with slope gradient over 15^{o} was in a slight decrease, and those with slope below 15^{o} increased slightly.

The analysis of agricultural land altitude indicated the area of agricultural lands with altitude less than 500 m was 232,499 ha., of those with altitude at 500~800 m 123,083 ha., of those with altitude at 800~1,200 m 44,585 ha., and of those with altitude higher than 1,200 m 9,080 ha. The area of agricultural land with high altitude decreased slightly, while that of low altitude was in a slight increase.

The sown area of crops in the Three Gorges Project area totaled 604,812 ha. in 2016, a slight decrease compared with last year. A total of 393,026 ha. of them was planted with grain crops, and 211,786 ha. with cash crops, taking up 65.0% and 35.0% respectively. The multiple cropping index was 204.7%, decreasing slightly compared with last year.

3.7.2 Rural energy

In 2016, 5.6683 mil. t firewood was consumed in the Three Gorges Project area, 3.9 t per household on average. There was a 11.2% decrease of firewood consumption, 2.3 t reduction per household compared with last year. There were 280,012 household biogas pools in rural areas, up by 1.9% from last year. There were 290 large joint household biogas pools, up by 7 from last year. The annual output of biogas was 121.3715 mil. m^3, up by 3.8% over last year. There were 19.0 biogas pools (excluding joint household biogas pools) for every 100 households. In the energy mix of the project area, there were 1.8427 mil. t straw, 195.7697 mil. kW electricity from small hydropower stations and 478,000 t coals from small coal mines.

3.7.3 Crop diseases and insect pests

In 2016, 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 413,041 ha.·times, and the prevention and control measures were taken for 636,893 ha.·times. A total of 401,251 t grains were saved, and 68,782 t were lost, together with 183.3256 mil. yuan economic losses. The overall occurrence of crop diseases and insect pests was level 2. Compared with the previous year, crop loss decreased by 14.1% and economic losses decreased by 14.6%.

In all types of plant diseases and insect pests, rat plague for crops 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 Wulong, Shizhu, Wanzhou in the project area had relatively serious crop diseases and insect pests. 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.

3.8 Earthquakes and geological disasters

3.8.1 Earthquakes

There were 481 recorded earthquakes (M≥0.0) in the Three Gorges Project area in 2016, 40 more than that of last year. Specifically, 343 earthquakes were measured at 0.0≤M<1.0, down by 4 compared with last year; 127 earthquakes at 1.0≤M<2.0, up by 39; 10 earthquakes at 2.0≤M<3.0, up by 4 compared with last year; and 1 earthquakes at 3.0≤M<4.0, up by 1 compared with last year. The strongest earthquake was the M3.5 earthquake occurring in Wuxi County of Chongqing at 20:18 on August 23, 2016. Most were mainly micro and ultra-micro earthquakes, some reaching the intensity of small earthquakes. The earthquakes were mainly distributed along the Yangtze River in Badong County and Zigui County in Hubei Province and Wushan County in Chongqing; followed by counties such as Wuxi, Fengjie, Shizhu and Fuling in Chongqing Municipality. The earthquake frequency was relatively high in April, June and August.

Table 3–2 Statistics of earthquake frequency of the Three Gorges Project area in 2015–2016

Year / Magnitude	2015		2016	
	Annual frequency	Monthly average frequency	Annual frequency	Monthly average frequency
0.0～0.9	347	28.92	343	28.58
1.0～1.9	88	7.33	127	10.58
2.0～2.9	6	0.50	10	0.83
3.0～3.9	0	0	1	0.08
4.0～4.9	0	0	0	0
5.0～5.9	0	0	0	0
Total	441		481	
Max. M	2.9		3.5	

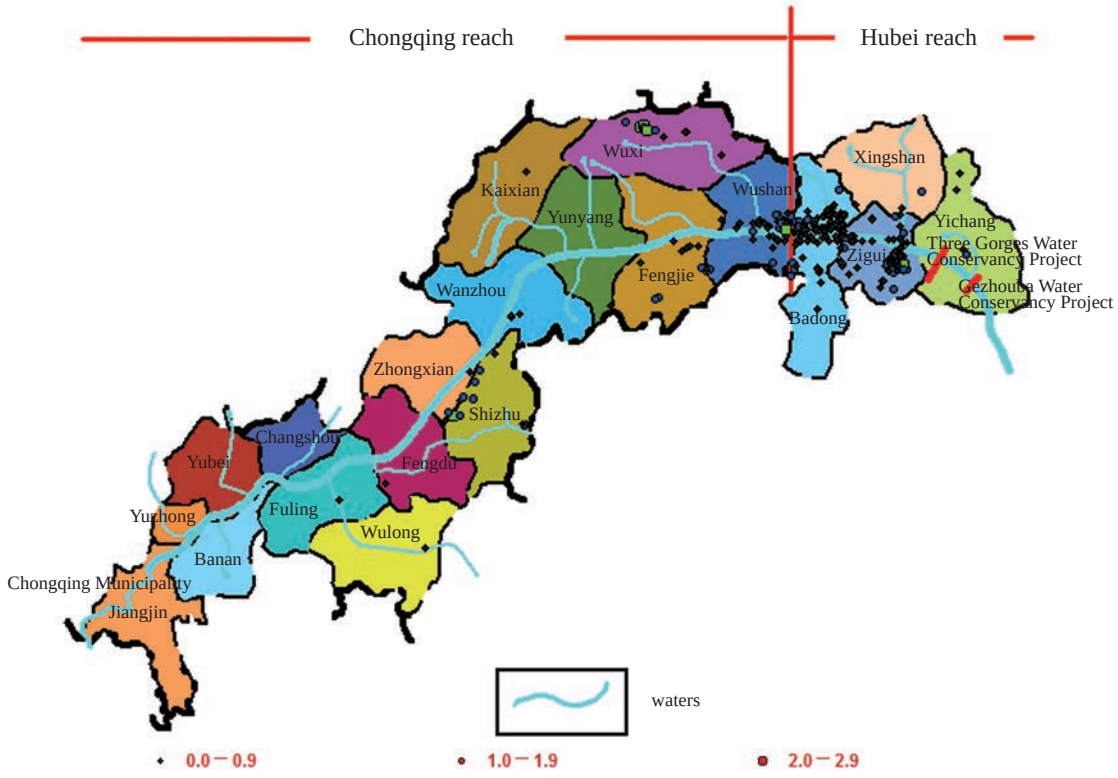


Figure 3–3 Map of epicenters of the Three Gorges Project area in 2016

3.8.2 Geological disasters

In 2016, a total of 4,847 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 213 professional monitoring sites. A total of 5,478 technicians worked on monitoring and early warning, who released 335,000 publicity materials and collected 1.568 mil. pieces of monitoring data.

There were 113 deformation sites with the risk of geological disasters in 2016, down by 63.4% compared with last year; 43 of which had severe deformation, down by 36.8% compared with last year. A total of 18 sites reached dangerous (disaster) level, up by 38.5% compared with last year.

In 2016, 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 1,128 people throughout the year.

Chapter 4
Discharge of Pollution Sources

4.1 Discharge of Industrial Effluent

National environmental statistics have optimized and adjusted statistical methods to meet the demands of situation. Therefore, the 2016 data results were not comparable with the previous data results. The new method statistics showed that in 2016, the total discharge of wastewater from industrial sources of the Three Gorges Project area was 136 mil. t. Specifically, 115 mil. t was discharged in the Chongqing-based project area and 21 mil. t was discharged in the Hubei-based project area, accounting for 84.6% and 15.4% respectively of the total. In the discharged industrial effluent, there were 10,800 t COD and 800 t ammonia nitrogen.

In 2015, the total discharge of wastewater from industrial sources of the Three Gorges Project area was 212 mil. t. Specifically, 171 mil. t was discharged in the Chongqing-based project area and 41 mil. t was discharged in the Hubei-based project area, accounting for 80.7% and 19.3% respectively of the total. In the discharged industrial effluent, there were 34,200 t COD and 2,200 t ammonia nitrogen.

Table 4–1 Discharge of industrial effluent in the Three Gorges Project area in 2016

Region		Wastewater (100 million t)	COD (10,000 t)	Ammonia nitrogen (10,000 t)
Hubei-based project area		0.21	0.17	0.01
Chongqing-based project area		1.15	0.90	0.06
Total		1.36	1.08	0.08
Specifically,	Chongqing city proper	0.29	0.17	0.02
	Changshou Dist.	0.25	0.14	0.00
	Fuling Dist.	0.15	0.12	0.01
	Wanzhou Dist.	0.05	0.08	0.00

4.2 Discharge of urban pollutants

4.2.1 Urban sewage

In 2016, the total discharge of urban sewage in the project area was 1,212 mil. t. Specifically, 1,172 mil. t was from the project area in Chongqing Municipality and 40 mil. t from the project area in Hubei Province, taking up 96.7% and 3.3% respectively of the total urban sewage. In the discharged urban sewage, there were 140,400 t COD and 21,800 t ammonia nitrogen.

In 2016, there were a total of 220 sewage treatment plants in cities and towns of the project area; 193 of

Taking samples

Table 4–2 Discharge of urban sewage of the Three Gorges Reservoir area in 2016

Region		Wastewater (100 mil. t)	COD (10,000 t)	Ammonia nitrogen (10,000 t)
Hubei-based project area		0.40	0.59	0.11
Chongqing-based project area		11.72	13.45	2.07
Total		12.12	14.04	2.18
Specifically,	Chongqing city proper	6.60	4.96	0.86
	Changshou Dist.	0.48	0.53	0.10
	Fuling Dist.	0.69	0.92	0.15
	Wanzhou Dist.	0.96	1.64	0.24

Table 4–3 Urban domestic garbage in some areas of the Three Gorges Project area in 2016

Region	Urban permanent population (10,000)	Generated amount (10,000 t)	Disposal amount (10,000 t)	Directly discharged (10,000 t)
Jiangjin	36.7	14.12	12.71	1.41
Chongqing city proper	655.6	252.23	244.66	7.57
Changshou	33.4	12.85	12.59	0.26
Fuling	63.2	24.32	23.59	0.73
Wulong	10.0	3.83	3.72	0.11
Fengdu	18.0	6.92	6.79	0.14
Shizhu	3.0	1.15	1.02	0.13
Zhongxian	20.3	7.82	7.04	0.78
Wanzhou	88.4	34.00	32.30	1.70
Yunyang	24.9	9.58	8.43	1.15
Kaizhou	35.7	13.73	13.45	0.27
Fengjie	19.5	7.50	6.75	0.75
Wushan	15.1	5.81	5.11	0.70
Badong	7.4	2.85	2.68	0.17
Xingshan	1.0	0.40	0.35	0.05
Zigui	9.5	3.65	3.29	0.37
Yiling	1.4	0.54	0.48	0.05
Total	1043.1	401.30	384.95	16.34

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 2.910 mil. t.

4.2.2 Domestic garbage

In 2016, the generated amount of garbage in 25 urban districts (counties) of the Three Gorges Project area totaled 4.0130 mil. t; 3.8495 mil. t of which were disposed, taking up 95.9%, 163,500 t of which were discharged, taking up 4.1%.

4.3 Agricultural non-point pollution

4.3.1 Application and loss of pesticides

In 2016, 19 districts (counties) in the project area applied 518.5 t pesticides (pesticide equivalent), down by 13.8% compared with last year. Specifically, 190.8 t were organophosphorus pesticides, 80.3 t were herbicides, 40.0 t were carbomates, 92.2 t were pyrethroid pesticides and 115.2 t were others. The application amount per unit area was 1.27 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 2016, down by 2.8 t compared with last year. Specifically, 18.6 t were organophosphorus pesticides, 5.2 t were herbicides, 1.5 t were carbamates, 3.5 t were pyrethroid pesticides and 4.7 t were others.

4.3.2 Application and loss of fertilizers

In 2016, 119,500 t fertilizers (fertilizer equivalent) were applied in the Three Gorges Project area, down by 11.5% compared with last year. Specifically, 83,000 t were nitrogen fertilizers, 28,000 t were phosphorus fertilizers and 8,500 t were potassium fertilizers. The application amount per unit area was 0.29 t/ha.

outlet of the watershed

It was estimated from cropland plot monitoring data that the total loss of fertilizers was 10,600 t in the Three Gorges Project area in 2016, down by 1,000 t compared with last year. Specifically, 7,500 t were nitrogen fertilizers, 1,600 t were phosphorus fertilizers and 1,500 t were potassium fertilizers.

4.4 Discharge of ship pollutants

In 2016, there were 5,862 registered ships in the Three Gorges Project area. The number of registered ships went down 1,766, the total tonnage down 312,000 t, and the passenger numbers also dropped 37.7% compared with last year. There was no ship pollution accident in the Three Gorges Project area in 2016.

4.4.1 Oil-containing wastewater

In 2016, the attainment rate of oil-containing wastewater discharged by ship engine rooms was 88.5% in the project area. In all types of ships, the attainment rate of wastewater was 100% for towboats, 98.2% for passenger ships, 92.3% for non-transport ships and 86.6% for cargo ships. The attainment rate for oil-containing wastewater of towboats remained unchanged, but that of passenger ships, cargo ships, and non-transport ships went up 1.8%, 5.8%, and that of cargo ships went down 0.3% from last year.

In 2016, the generated amount of oil-containing wastewater totaled 302,100 t in the project area with treatment rate at 97.9%. A total of 269,600 t oil-containing wastewater met discharge standard after treatment, with attainment rate at 89.2%. In all types of ships, the generated amount of oil-containing wastewater was 210,600 t for cargo ships, 45,700 t for passenger ships, 45,600 t for non-transport ships and 200 t for towboats. The generated amount of ship oil-containing wastewater was down 91,900 t and the attainment rate dropped 1.2 percentage points compared with last year. In all discharged oil-containing wastewater, 26.42 t were petroleum, down by 11.48 t compared with last year.

4.4.2 Ship sewage

In 2016, the investigation on sewage discharge of 50 ships was carried out. Specifically, 46 ships treated their sewage before discharge, with attainment rate of 100.0% for suspended solid, 91.3% for COD, 97.8% for BOD_5, 52.2% for TP, 78.3% for TN and 97.8% for E-coli. There

Table 4–4 Discharge of oil–contaminated wastewater from ships in the Three Gorges Project area in 2016

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	1583	4.57	15.1	4.57	100.0	4.49	98.2	1.11	4.2
Cargo ship	2514	21.06	69.7	20.43	97.0	18.24	86.6	19.56	74.0
Towboat	62	0.02	0.1	0.02	100.0	0.02	100.0	0	0
Non-transport ship	1703	4.56	15.1	4.56	100.0	4.21	92.3	5.75	21.8
Total	5862	30.21	100.0	29.58	97.9	26.96	89.2	26.42	100.0

was a slight increase of attainment rate of ship sewage compared with last year.

The estimated results 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 showed that the generated sewage amount from ships in the project area in 2016 was about 2.773 mil. t, down by 944,000 t compared with last year. In all ship sewage, there were 422.7 t suspended solid, 290.3 t COD, 268.4 t BOD_5, 153.9 t TN and 52.0 t TP.

4.4.3 Ship garbage

In 2016, 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 32,000 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. Specifically, the garbage collection ships of local Maritime Administration affiliated to Ministry of Transport collected 8,747 t ship garbage within its jurisdiction.

Chapter 5
Status of Water Environment Quality

In 2016, 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.

5.1 Streamflow

In 2016, there were 7 hydrological monitoring sections at the mainstream of the Yangtze River in the project area, and they were Zhutuo section in Yongchuan, Cuntan section in Chongqing, Qingxichang section in Fuling, Tuokou section in Wanzhou, Guandukou section in Badong, Beibei section of Jialing River and Wulong section of Wujiang River. The flow of the mainstream in the project area ranged between 3,270 m^3/s and 28,200 m^3/s, and the mean flow rate varied between 0.10 m/s and 2.73 m/s; the flow of Jialing River ranged between 223 m^3/s and 2,810 m^3/s, and the mean flow rate varied between 0.09 m/s and 0.91 m/s; and the flow of Wujiang River ranged between 447 m^3/s and 3,600 m^3/s, and the mean flow rate varied between 0.46 m/s and 2.1 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 1.52 m/s at Zhutuo, 1.41 m/s at Cuntan, 0.60 m/s at Qingxichang, 0.29 m/s at Tuokou, and 0.26 m/s at Guandukou. The maximum flow rate of each section was 2.41 m/s at Zhutuo, 2.73 m/s at Cuntan, 1.34 m/s at Qingxichang, 0.73 m/s at Tuokou and 0.59 m/s at Guandukou.

5.2 Water quality

In 2016, 9 water quality monitoring sections were established in the mainstream of the Yangtze River in the project area. They were Zhutuo section in Yongchuan, Jiangjin Bridge section, Tongguanyi and Cuntan sections in Chongqing, 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 the overall water quality was good in the mainstream of the Yangtze River in the project area, excellent in the Jialing River and good in the Wujiang River in 2016. The overall water quality of the mainstream of the Yangtze River and Jialing River levelled off with last year, and that of Wujiang River increased compared with 2015 (The TP content in the waters of the Wujiang River failed to meet national surface water quality standard in 2015).

The overall water quality of all the 9 sections of the mainstream of the Yangtze River met Grade Ⅲ water quality standard in 2016. The water quality of each month of the year met or was superior to Grade Ⅲ water quality standard.

The annual overall water quality of the reach from Jinzi section and Beiwenquan section of the Jialing River met Grade Ⅱ water quality standard. The water quality of Luoying section and Wanmu section of Wujiang River met Grade Ⅲ standard. The overall water quality of the reach from Jinzi section and Beiwenquan section of the Jialing River, and that of Luoying section and Wanmu section of Wujiang River levelled off with that of last year. Monthly data showed the water quality of Jinzi section, Beiwenquan section and Luoying section met or was superior to Grade Ⅲ standard. The water quality of Wanmu section met Grade Ⅳ in March, May and November, with TP as its major pollutant, and that of the rest of the months met or was superior to Grade Ⅲ standard.

Table 5–1 Water quality of the monitoring sections of mainstream of the Yangtze River in the Three Gorges Project area in 2016

Section	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Zhutuo	III	III	III	III	II	II	II	II	II	III	II	II	III
Tongguanyi	II	III	III	II	III	III	III	II	II	II	II	II	II
Jiangjin Bridge	II	II	III	II	II	II	III	III	II	II	III	II	III
Cuntan	II	II	II	II	II	III	II	II	II	III	III	III	II
Qingxichang	II	II	II	II	III	II	III	III	II	III	II	II	II
Tuokou	III	II	II	III	II	III	II	II	II	II	II	II	II
Guandukou	II	II	II	III	II	III	III	II	II	II	II	II	II
Shaiwangba	III	III	II	III	III	III	II	II	II	II	II	II	III
Nanjinguan	II	III	III	II	II	II	III	II	III	II	II	II	II

Table 5–2 Water quality of the monitoring sections of the mainstream of the Jialing River and Wujiang River in the Three Gorges Project area in 2016

Section	River	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Jinzi	Jialing	II	III	III	II	II	III	II	II	II	II	II	II	II
Beiwen-quan	Jialing	II	II	II	II	II	II	II	II	II	II	III	II	II
Wanmu	Wujiang	III	III	IV	III	IV	III	II	III	III	III	IV	III	III
Luoying	Wujiang	III	III	III	III	III	III	II	II	III	II	III	III	III

5.3 Trophic state and algal blooms of main tributaries

5.3.1 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 3.9%～46.8% of the sections of 38 main tributaries of the project area were in eutrophic state, 53.2%～93.5% were in mesotrophic state, and 0%～6.5% 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 were in eutropher during sensitive period (March-October) of algal bloom in 2016, basically similar to that of last year. Specifically, there was 0.8 and 1.1 drop of percentage points of oligotrophic and eutrophic sections respectively, and 1.9 increase of percentage points of mesotrophic sections. The overall eutrophication level of backwater areas decreased slightly compared with that of last year. Specifically, there was 6.5, 2.3, 18.7 and 13.3 drop of percentage points of eutrophic sections in April, July and September-October respectively and 2.1 and 13.3 percentage points increase in March and May compared with that of same month last year. The

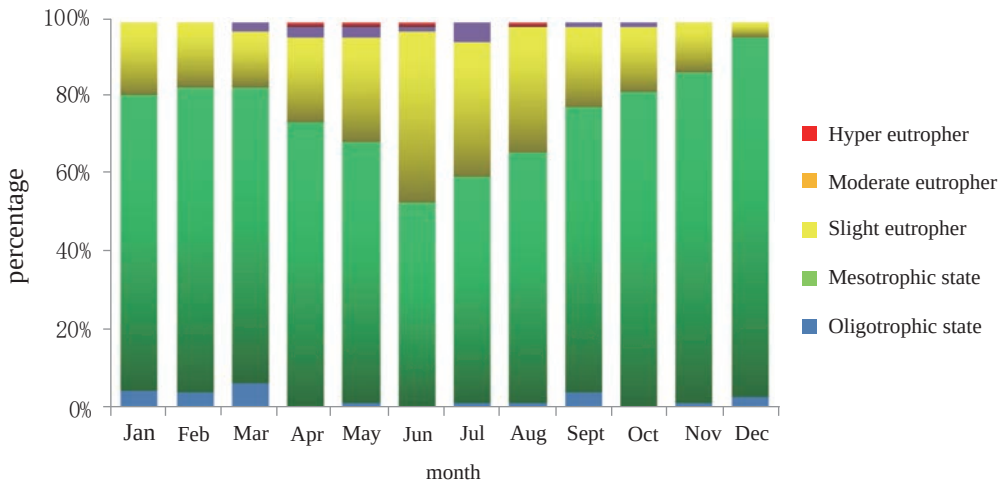


Figure 5–1 Trophic state of main tributaries of the Yangtze River in the project area in 2016

percentage of eutrophic sections in June and August was the same as that of last year. The eutrophication level of non-backwater areas increased slightly compared with that of last year. There were 4.9, 1.6, 4.3 and 9.7 percentage point decrease of eutrophic sections in March-April and September-October respectively but 4.2, 13.3, 10.0 and 15.4 percentage point increase of eutrophic sections in May-August compared with that of same months last year.

5.3.2 Algal blooms

In 2016, there were algal blooms in the Chixi River, Baolong River, Tongzhuang River, Shennong Stream, Caotang River, Meixi River, Modao Stream, Changtan River, Tangxi River, Dongxi River, Huangjin River, Pengxi River, Zhenxi River, Zhuxi River, Rangdu River, Chixi River and Ruxi River of the project area. Algal blooms mainly occurred in the spring and autumn. The dominant algae species in the spring were Cyclotella of Bacillariophyta and Cryptomonas of Cryptophyta. In the autumn, the dominant algae species of algal bloom included Cyclotella, Synedra, Melosira and Navicula of Bacillariophyta; Cryptomonas of Cryptophyta; Peridineaceae of Pyrrophyta; as well as Mycrocystis, Aphanizomenon, Merismopediaceae and Oscillatoria of Cyanophyta.

Maintenance of water monitoring devices of the Yangtze River

Chapter 6
Status of Public Health

6.1 Basic Situation

In 2016, 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, 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 782,641, up by 25,143 compared with last year. Specifically, 398,905 were male and 383,736 were female with gender ratio at 1.04:1; 460,802 lived in cities and towns and the rest 321,839 lived in rural areas.

6.2 Life statistics

In 2016, a total of 6,838 babies were born in the monitoring sites. 3,599 were male, and 3,239 were female with gender ratio at 1.11:1. The birthrate was 8.74‰, up by 8.98% compared with last year.

The birthrate was 10.35‰ for Chongqing, 8.22‰ for Fengdu, 6.64‰ for Wanzhou, 12.49‰ for Fengjie and 6.44‰ for Yichang. The mortality was 6.53‰ for Chongqing, 6.07‰ for Fengdu, 6.39‰ for Wanzhou, 5.64‰ for Fengjie and 9.71‰ for Yichang. The birthrate in Yichang was lower than the mortality. In other monitoring sites, the birthrate was higher than mortality. For birthrate, there was 19.64%, 16.69%, 5.75% and 1.37% rise in Fengjie, Chongqing, Yichang and Wanzhou respectively compared with last year; the birthrate of Fengdu dropped by 0.12%. For mortality, there was 35.99% rise in Yichang, 0.63% rise in Wanzhou, 11.64% reduction in Fengdu, 1.74% reduction in Fengjie; the mortality in Chongqing remained the same as that of last year.

All monitoring sites reported 17 cases of infant death including 7 baby boys and 10 baby girls, with mortality at 2.49‰, down by 41.82% compared with last year.

According to ICD-10 disease classification standard, the top 5 diseases with the highest mortality of the people in all monitoring sites in 2016 were circulatory system diseases, tumors, respiratory system diseases, damage & poisoning and endocrine system diseases with mortality at 252.35/100,000, 176.45/100,000, 100.05/100,000, 40.63/100,000 and 20.83/100,000 respectively, leading to 38.18%, 26.70%, 15.14%, 6.15% and 3.15% respectively (combined 89.32%) of the total deaths. The ranking of the top 4 killer diseases kept the same as last year. The endocrine system diseases replaced digestive system disease last year becoming No.5. There was 43.46% and 3.83% rise of the mortality of endocrine system diseases and circulatory system disease respectively, but 17.49%, 2.86% and 1.70% reduction of the mortality of damage & poisoning, tumors and respiratory system diseases respectively. The ranking of the diseases with the highest mortality varied in different regions, but the mortality of circulatory system diseases ranked No.1 in all monitoring sites. The diseases with No.2 and No.3 highest mortality were tumor and respiratory system disease in Chongqing, Fengdu, Wanzhou and Fengjie. In Yichang, No.2 disease was respiratory system disease and No.3 was tumor.

6.3 Monitoring of diseases

6.3.1 Monitoring of infectious diseases

In 2016, all monitoring sites reported 4,592 cases of notifiable infectious diseases with morbidity at 586.73/100,000, up by 6.89% compared with last year. There were two deaths with mortality at 0.26/100,000. There was no report of Category A infectious disease. The morbidity from high to low was 881.92/100,000 in Chongqing, 648.43/100,000 in Fengdu, 597.25/100,00 in Yichang, 425.63/100,000 in Wanzhou and 420.64/100,000 in Fengjie. There was 20.06%, 18.31% and 2.78% increase of morbidity in Fengdu, Chongqing and Wanzhou respectively, but 10.74% and 7.22% reduction in Fengjie and Yichang respectively compared with last year. The reported cases of Category B infectious diseases were the most in March but least in November and were in the range of 148～221 cases in the rest months. There were two epidemic outbreaks of Category C infectious diseases in May～June and

October～December due to many reported cases of hand-foot-mouth diseases and other infectious diarrhea.

All monitoring sites reported 2,214 cases of 12 types of Category B infectious diseases (excluding HIV) with morbidity at 282.89/100,000, down by 7.27% compared with last year. In all monitoring sites, Yichang had the highest morbidity (447.67/100,000), followed by Fengdu (346.56/100,000), Chongqing (336.75/100,000) and Fengjie (288.04/100,000); Wanzhou had the lowest (129.61/100,000). There was 71.41% increase of the morbidity in Fengdu, but 26.67% reduction in Fengjie, 21.84% reduction in Wanzhou and 17.30% reduction in Yichang and 8.37% reduction in Chongqing compared with last year. The top five infectious diseases with the highest morbidity were viral hepatitis (145.15/100,000), TB (74.75/100,000), syphilis (33.99/100,000), dysentery (16.74/100,000) and gonorrhea (4.98/100,000). The combined morbidity of the top 5 diseases accounted for 97.43% of the total. In all types of Category B infectious diseases, there was an increase of morbidity for hepatitis C, unidentified hepatitis, dysentery, AIDS, syphilis, pertussis, brucellosis and dengue fever compared with last year. There was some reduction of the morbidity of other Category B infectious diseases. The amount of HIV infected patients went down by 9.89% compared with last year. The morbidity of water-borne infectious diseases such as hepatitis A (1.92/100,000), hepatitis E (2.56/100,000), dysentery (16.74/100,000) and typhoid (0.13/100,000) was still at a relatively low level. It was reported that there was one insect-borne infectious diseases dengue fever (0.13/100,000).

All monitoring sites reported 2,378 cases of 6 types of Category C infectious diseases with morbidity at 303.84 /100,000, up by 24.61% compared with last year. The morbidity was 545.16/100,000 for Chongqing, 301.87/100,000 for Fengdu, 296.01/100,000 for Wanzhou, 149.59/100,000 for Yichang and 132.60/100,000 for Fengjie. The morbidity went up by 69.09% in Fengjie, 46.06% in Yichang, 44.27% in Chongqing and 19.22% in Wanzhou, but decreased by 10.67% in Fengdu monitoring sites compared with last year.

6.3.2 Monitoring of endemic diseases

In 2016, the monitoring sites carried out monitoring on iodine deficiency. B-ultrasound method was employed to investigate a total of 728 children with age at 8~12, 10 of them had I^o thyroid enlargement, taking up 1.37% and suggesting a slight endemic. The ratios of I^o thyroid enlargement in Fengdu, Wanzhou and Fengjie were 1.50%, 1.35% and 2.78% respectively. A total of 1,175 households were investigated on their salt consumption, and 1,158 households consumed iodine added salt, taking up 98.55%; 1,083 households consumed qualified iodine added salt. The qualification rate of iodine added salt was 93.52% and consumption rate of qualified iodine added salt was 92.17%. There was slight reduction of the consumption rate of iodine added salt, qualification rate of iodine added salt and consumption rate of qualified iodine added salt compared with last year.

6.3.3 Public health emergencies

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

6.4 Monitoring of biological media

6.4.1 Monitoring of rats

In 2016, the average indoor rat density of all monitoring sites in the Three Gorges Project area was 3.06%, and the outdoor rat density was 3.64%, 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 rat density in the autumn was slightly higher than that of spring, same as that of last year. The indoor rat density in the spring was lower than that in the autumn, contrary to that of last year. In the spring, the indoor rat density (2.60%) was lower than outdoor rat density (3.28%), contrary to that of last year. In the autumn, the indoor rat density (3.50%) was lower than outdoor rat density (3.92%), same as that of last year. The ranking of indoor rat density of all monitoring sites from high to low was Fengdu (5.50%), Chongqing (3.62%), Fengjie (2.48%), Wanzhou (1.52%), and Yichang (0.80%). The ranking of outdoor rat density from high to low was Chongqing (7.04%), Fengdu (5.36%), Wanzhou (2.59%), Yichang (1.57%) and Fengjie (0.72%). 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, *Rattus norvegicus* was the dominant rat species, taking up 43.06%; followed by *Rattus flavipectus*, taking up 34.72%; *Mus musculus* ranked No.3, taking up 20.83%. Last year, the dominant rat species was also *Rattus norvegicus*, and the *Rattus flavipectus*, *Mus musculus* also ranked No.2 and No.3 respectively. In outdoor environment, small insectivore (mainly *Anourosorex squamipes*) was still in dominance,

accounting for 62.80%; *Rattus flavipectus* ranked No.2, taking up 12.20% and *Apodemus agraius* ranked No.3, taking up 11.19%. *Apodemus agraius* had been downgraded from No.2 last year to No.3 in dominance. The percentage of *Rattus norvegicus*, *Mus musculus* and *Rattus flavipectus* had some rise compared with last year especially the *Rattus flavipectus*, achieving rises in consecutive three years. *Apodemus agraius* and small insectivore were not caught, but the percentage of other rat species had slight decrease compared with last year. The catch of small insectivores was still the biggest in amount in outdoor environment, but the percentage of that and Rattus flavipectus had significant increase compared with last year. The percentage of *Apodemus agraius* and other rat species had some decrease compared with last year.

6.4.2 Monitoring of mosquitoes

In 2016, the adult mosquito density was 133.96/pen•man hour for livestock pens and 29.74/room•man hour for human dwellings, both lower than that of last year and lower than the five-year average (198.57/pen•man hour and 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 (68.20/room•man hour), Chongqing (44.70/room•man hour), Fengdu (11.92/room•man hour), Fengjie (11.72/room•man hour) and Yichang (9.16/room•man hour). The ranking of adult mosquito density of livestock pens from high to low was Chongqing (166.73/pen•man hour), Yichang (161.48/pen•man hour), Fengdu (141.52/pen•man hour), Fengjie (103.72/pen•man hour) and Wanzhou (89.80/pen•man hour). There was some increase of adult mosquito density of human dwellings in Chongqing and Yichang, but some reduction in Fengdu, Wanzhou and Fengjie compared with last year. There was some increase of adult mosquito density of livestock pens in Chongqing and Yichang, but some reduction in Fengdu, Wanzhou 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 Chongqing and Yichang in early July, followed by Fengjie in early August, Wanzhou in early September and the latest peak in Fengdu in late September. While the earliest peak of adult mosquito density of livestock pens occurred at Fengdu in early June, followed by Chongqing and Yichang in early July, Fengjie in early August, and the latest peak in Wanzhou in early September.

Armigeres subalbatus ranked No.1 in both human dwellings and livestock pens, taking up 75.04% and 75.35% respectively of the total. In human dwellings, *Culex pipiens fatigans* ranked No.2, taking up 20.72%, followed by *Culex tritaeniorhynchus* at No.3, *Anopheles sinensis* at No.4 and *Culex pipiens pallens* at No.5. In livestock pens, *Culex pipiens fatigans* ranked No.2, taking up 16.10%, followed by *Culex tritaeniorhynchus* at No.3, *Anopheles sinensis* at No.4 and *Culex pipiens pallens* at No.5, the same as human dwellings. The percentage of *Culex pipiens fatigans* and *Culex tritaeniorhynchus* went up, and of other mosquito species decreased in human dwellings compared with last year. In livestock pens, there was some rise of percentage of *Armigeres subalbatus*, *Culex pipiens fatigans* and *Culex tritaeniorhynchus*, but some reduction of other mosquito species compared with last year.

Monitoring of bio–vectors

Chapter 7
Environmental Quality of the Dam Area

7.1 Hydrology and Meteorology

7.1.1 Streamflow

In 2016, the statistical analysis of measurement data of Huanglingmiao Hydrological Station downstream the Three Gorges Project showed that the annual average flow was 13,500 m^3/s, 1,400 m^3/s more than that of 2015. The maximum flow was 33,800 m^3/s occurring on July 1 and minimum flow 6,580 m^3/s occurring on February 9. The annual average sediment discharge rate was 0.28 t/s with average sediment concentration at 0.021 kg/m^3. The maximum average sediment concentration of the monitoring sections was 0.166 kg/m^3 occurring on July 1 and minimum average sediment concentration was 0.002 kg/m^3 occurring on February 10.

Table 7–1 Monthly flow at Huanglingmiao Hydrological Station in 2016

Unit: m^3/s

Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
Avg.	7970	7540	8930	12500	15700	21000	25800	21300	11900	10400	10600	7500	13500
Max.	11500	9610	10400	16900	20600	32400	33800	32100	13900	12800	15800	10100	33800
Min.	6610	6580	7360	7720	11500	14800	17500	10900	10500	8070	6640	6710	6580

Table 7–2 Monthly sediment concentration at Huanglingmiao Hydrological Station in 2016

Unit: kg/m^3

Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
Avg.	0.003	0.003	0.003	0.004	0.005	0.036	0.060	0.032	0.004	0.003	0.003	0.002	0.021
Max.	0.003	0.003	0.004	0.005	0.008	0.158	0.166	0.080	0.005	0.003	0.003	0.003	0.166
Min.	0.003	0.002	0.003	0.004	0.004	0.008	0.013	0.004	0.003	0.003	0.003	0.002	0.002

7.1.2 Climate

In 2016, the annual average air temperature of the Three Gorges Dam area was slightly on the high side, and the precipitation was slightly on the high side, and the monthly distribution of precipitation was very uneven.

● **Air temperature**

The annual average air temperature of the Three Gorges Project area was 17.6℃ , up by 0.7℃ compared with the historical average. The annual extreme high temperature was 39.6℃ on August 1 and annual extreme low temperature was -4.5℃ occurring on January 25.

● **Precipitation**

The annual precipitation of the Three Gorges Project area was 1,354.1 mm, up by 19.6% compared with that of the historical average. The monthly distribution of precipitation was very uneven, mainly concentrated on April-July with daily maximum precipitation of 79.5 mm on July 1. There were 176 precipitation days in 2016. The longest continuous precipitation period in the year was 12 days occurring in October. The longest continuous non-precipitation period of the year was 15 days in September.

● **Wind speed**

The annual average wind speed of the Three Gorges Dam area was 1.5 m/s. The maximum wind speed reached 25.8 m/s on July 29. 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 7–3 Meteorological indicators of the Three Gorges Dam area in 2016

Month		1	2	3	4	5	6	7	8	9	10	11	12	Year
T	Temperture (℃)	5.5	9.1	12.7	18.4	20.5	24.6	27.6	27.6	24.9	18.7	12.8	9.2	17.6
	Departure (℃)	-0.1	1.3	0.7	0.9	-1.2	-0.7	0.1	0.8	1.9	0.8	2.6	1.5	0.7
P	P (mm)	31.1	17.3	66.4	153.2	144.8	200.8	476.2	68.1	12.6	90.3	70.6	22.7	1354.1
	Departure (%)	65.4	-47.4	37.2	76.5	3.7	37.1	128.6	-64.6	-88.8	8.4	55.5	35.1	19.6
Wind speed	Mean (m/s)	1.7	1.8	1.4	1.2	1.3	1.4	1.2	1.5	1.7	1.3	1.6	1.8	1.5
	Max. (m/s)	5.4	8.6	7	6.9	10.5	8.7	15.2	12.7	6.3	4.9	6.1	7.3	15.2
	Extreme (m/s)	9.2	16.7	12.2	13	21.8	12.9	25.8	21.5	10.7	8.6	10.7	11.1	25.8

7.2 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 2016, the water quality of all sections of the mainstream of Yangtze River and near-bank waters in the dam area was good, meeting Grade II standard. Compared with last year, the grade of water quality was downgraded from Grade I to Grade II, mainly caused by the addition of TP in assessment factors.

Table 7–4 Water quality of the mainstream sections of the Yangtze River in the Three Gorges Dam area in 2016

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

Table 7–5 Water quality of near–bank waters of the Yangtze River in the Three Gorges Dam area in 2016

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
30 m to the bank Right bank	Auxiliary dam	II	II	II	II	II

Chapter 8
Monitoring and Studies on Ecological Environment

8.1 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.

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

The monitoring data in 2016 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, and increase the content of organic matters in 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 Phosphorous (TP), Available Phosphorous (AP), and Available Potassium (AK) of Model Ⅰ went up 50.80%, 31.58%, 23.69%, 9.25%, and 3.13% respectively, and that of Total Potassium (TK) and Kjeldahl Nitrogen (KN) went down 2.63% and 8.41% respectively. Compared with the previous year, the content of TN and AP rose by 3.09% and 84.22% respectively and that of organic matters, TP, TK, KN and AK descended 2.08%, 10.21%, 5.51%, 4.19% and 19.51% respectively in Model Ⅰ.

Collecting water samples

From the perspective of water and soil conservation, the mean soil moisture of Model Ⅰ registered a 10.82% increase in 2 days after rain, 9.58% increase in 4 days after rain, and 13.75% increase in 8 days after rain respectively compared with that of Model Ⅱ. As the drought continued, 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 19,500 m^3/km^2 and 18.91 t/km^2, down 57.74% and 80.12% from Model Ⅱ. The runoff modulus was 12.59% more than last year and the erosion modulus went up 57.85%.

From the perspective of controlling non-point source pollution, the nitrogen loss of Model Ⅰ amounted to 94.78 kg/km^2, down 75.02% from Model Ⅱ. The phosphorous loss load of Model Ⅰ registered 23.65 kg/km^2, down 76.10% from Model Ⅱ. The nitrogen loss of surface runoff and sediments in Model Ⅰ reached 45.24 kg/km^2 and 49.54 kg/km^2 respectively. The phosphorous loss was mainly done by sediments. The phosphorous loss load of surface runoff and sediments in Model Ⅰ posted 17.02 kg/km^2 and 6.63 kg/km^2 respectively. The nitrogen and phosphorous loss load in Model Ⅰ went up 63.33% and 91.96% respectively from last year.

From the perspective of economic benefits, by adopting the compounded interplanting mode of planting crude medicine (Houttuynia cordata) below Honey Pomelo and of sowing leguminous crop (peanut) between the field, the net income of Model Ⅰ was higher, amounting to 2,256 yuan/*mu*.

8.1.2 Experiment on steep slope with hedgerow model

The 2016 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, KN, AP and AK by 77.63%, 32.56%, 1.26%, 116.43%, 7.28% and 43.75% respectively, only TP down by 22.46%. The KN and AP content in soil of hedgerow model were on a rising trend, and that of the remaining soil nutrients was on a declining trend, compared with last year.

The steep slope with hedgerow model on 25 degrees was more efficient in soil conservation and fertilizer conservation, but the bare steep slope had better function in ecological environment benefits. Monitoring data suggested that the mean soil moisture of hedgerow model was decreased by 5.14%, 5.28%, and 9.88% respectively in 2, 4 and 8 days after rainfall; the surface runoff and soil erosion capacity of hedgerow model were lower than that of bare steep slope, with its runoff modulus and soil erosion modulus being 21,700 m^3/km^2 and 18.34 t/km^2 respectively, up by 24.95% and 35.22% compared with that of bare steep slope. The runoff modulus and soil erosion modulus increased by 150% and 190% respectively compared with last year.

In terms of controlling non-point source pollution, the nitrogen loss load of hedgerow model registered 112.42 kg/km^2, 56.25% more than that of bare slope. The phosphorous loss load of the hedgerow model totaled 27.65 kg/km^2, 55.37% more than the bare slope. Specifically, the nitrogen loss of the surface runoff and the sediments of hedgerow model posted 59.24 kg/km^2 and 53.18 kg/km^2 respectively; the phosphorous loss was mainly carried by sediments, with its loss load being 19.62 kg/km^2, while the phosphorous loss carried by the surface runoff was only 8.03 kg/km^2. The nitrogen and phosphorous loss load of the hedgerow model increased by 190% and 254% from 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 also made some economic achievements, with 634 yuan/mu of its honey pomelo-hedgerow model in 2016.

8.2 Zigui Model Zone

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

In 2016, 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 7.5%, 10.7% and 11.8% respectively compared with that of the conventional wheat-peanut plot. They also reduced slope sediment yield by 58.3%, 95.7%, and 92.3% respectively; the loss of nitrogen of wheat-peanut plot with toon interplanted as hedgerow model was cut down by 18.9%; and that of ryegrass-soybean plot and wheat-peanut plot with alfalfa interplanted as hedgerow model increased by 21.2% and 51.6% respectively; and the loss of phosphorous of ryegrass-soybean plot, wheat-peanut plot with toon interplanted as hedgerow, and wheat-peanut plot with alfalfa interplanted as hedgerow decreased by 45.1%, 89.9% and 77.1% respectively.

Compared with 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 81.5%, 72.4%, 84.1% and 69.9%; the loss of nitrogen in sediment was cut down by 70.2%, 57.9%, 61.2% and 60.1%. Different 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.

8.2.2 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 2016 survey suggested the content of the sand with diameter ranging from 2.0 mm to 0.05 mm accounted for 31.68%～66.08% in the soils of the monitoring sites, that of silty sand with diameter ranging from 0.05 mm to 0.002 mm occupied 25.48%～48.16%; and that of clay with diameter under 0.002 mm took up 8.44%～22.88%. The content of soil nutrients was 8.64～32.37 g/kg for organic matter; 0.59～1.73 g/kg for TN; 0.28～1.78 g/kg for TP; 10.84～27.5 g/kg for TK; 66.15～213.15 mg/kg for KN; 1.7～247.96 mg/kg for AP and 67.50～537.50 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. The content of soil organic matter, nitrogen, phosphorus and potassium in medium to high altitudes above 700 m did not change much.

8.3 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 2016.

8.3.1 Soil physical and chemical properties

In 2016, 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 heavy metals except lead and copper were below Grade Ⅰ limit set by *Environmental Quality Standard for Soils* (GB15618-1995) in most soils. After water recession, the content of arsenic, chromium, cadmium, copper, iron and manganese went up by 0.57 mg/kg, 3.89 mg/kg, 0.02 mg/kg, 8.85 mg/kg, 7.46 g/kg and 0.43 mg/kg respectively; while that of mercury, lead, and zinc in soils went down by 0.03 mg/kg, 1.74 mg/kg and 20.44 mg/kg respectively, compared with that of the same period last year. Before the impoundment, the content of arsenic, chromium, cadmium, lead, iron and manganese in soils increased by 0.01 mg/kg, 3.44 mg/kg, 0.02 mg/kg, 4.27 mg/kg, 5.44 g/kg, and 0.35 g/kg respectively; while that of mercury, copper and zinc went down by 0.02 mg/kg, 10.55 mg/kg and 17.55 mg/kg.

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 organic matters, TN, TP and TK in soils went up by 0.79 g/kg, 0.07 g/kg, 0.06 g/kg and 2.22 mg/kg respectively; while that of AP, AK, NH_3-N and Nitrate-N went down by 6.21 g/kg, 6.53 mg/kg, 0.41 mg/kg and 7.91 mg/kg respectively, compared with that of the same period last year. Before the impoundment, the contents of organic matters, TK, NH_3-N and Nitrate-N went up by 0.36 g/kg, 4.87 g/kg, 0.02 mg/kg and 0.3 mg/kg respectively; while that of TN, TP, AP and AK went down by 0.05 g/kg, 0.05 g/kg 1.7 mg/kg and 7.6 mg/kg respectively.

8.3.2 Vegetation restoration

In 2016, the post-recession plant community survey identified 55 species of vascular plants in 50 genera of 21 families. There were a large amount of monotypic genus and minor genus species, accounting for 81.8% and 16.4% of the total species respectively. Herbaceous plant species dominated the vegetation, 58.2% of which were annual herb species and 32.7% were perennial herb species. The percentages of arbor, shrub and vine species were relatively low. Before the impoundment, there were 49 species of vascular plants in 42 genera of 19 families. There were a large amount of minor genus and monotypic genus species, accounting for 73.5% and 24.5% of the total species respectively.

8.3.3 Monitoring of bio-vectors

In 2016, a total of 2,191 rat traps were placed in the monitoring sites of the water-level-fluctuating zones, as a result of which 20 rat-shape animals were caught with average rat density at 0.91%, the same as that of the same period last year. Both *Apodemus agrarius* and small insectivore accounted for 35.00%, followed by *Rattus norvegicus* by 30.00%, and other rat species were not caught. In specific, 10 rat-shape animals were caught with average rat density at 0.88% in the post-recession period, 15.38% lower than that of the same period last year (1.04%). 10 rat-shape animals were caught with average rat density at 0.95% in the pre-impoundment period, 46.15% higher than that of the same period last year (0.65%). There was no dominant rat species and the rat density before impoundment was slightly higher than that of the post-recession period.

In 2016, zapper lamps were placed in the monitoring sites of water-level-fluctuating zones for 72 zapper lamp·times with catch of 283 mosquitoes. The mosquito density was 3.93/zapper lamp·times, higher than that of the same period last year (3.43/zapper lamp·times). The main mosquito species were *Culex pipiens fatigans* (49.82%), *Armigeres subalbatus* (36.40%), *Aedes albopictus* (5.30%) and *Anopheles sinensis* (2.47%).

In 2016, flytraps were placed in monitoring sites of water-level-fluctuating zones for 72 trap·times, catching 151 flies with average fly density at 2.10/flytrap, less

than that of the same period last year (2.89/flytrap). The main fly species were *Boettcherisca peregrina* (54.30%), *Musca sorbens* (22.52%), *Musca domestica* (12.58%) and *Aldrichina grahami* (7.28%).

8.4 Groundwater dynamics and soil gleization

8.4.1 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 2016, the mean annual groundwater table of the observation wells ranged between 21.73 m and 22.56 m and varied between 0.80 m and 1.79 m across the year. The confined water table ranged between 21.54 m and 23.43 m, with variation spanning 1.89 m. The phreatic water table ranged between 21.22 m and 23.48 m, with variation spanning 2.26 m. In general, the groundwater table moved up a little from last year, with 0.05 meters increase on average and the maximum increase 0.19 meters.

The mean monthly water table curve showed for the majority of the observation wells, the groundwater table ascended fast from March to June, maintained high between June and August, descended dramatically in September, rose slightly in November, and kept at a fairly high level in December. The groundwater table ascended early starting from a high level, and descended early as well.

8.4.2 Soil gleization

The soil gleization conditions of 24 soil profiles were monitored in the four-lake region in the summer and winter this year, 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 the mean annual total amount of reductive substances ranged between 0.33 and 7.62 centimol/kg, and averaged out at 2.21 centimol/kg, up 0.14 centimol/kg from last year; the mean annual content of active reductive substances ranged between 0.06 and 5.27 centimol/kg, and averaged out at 1.34 centimol/kg, up 0.08 centimol/kg from last year; the mean annual content of ferrous iron ranged between 0.00 and 1.49 centimol/kg, and averaged out at 0.34 centimol/kg, 0.13 centimol/kg more than last year. The soil gleization aggravated slightly and was notably alleviated in the winter, compared with last year.

8.5 Water-salt dynamics and soil salinization in the estuary

8.5.1 Water-salt dynamics

The water-salt dynamics and soil salinization were monitored in the estuary (land-sea interface) of Yangtze River in 2016. There were three monitoring sections (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**

Monitoring data at the three sections showed the conductivity of the Yangtze River waters was high in the spring, autumn and winter, and low in the summer of 2016. 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 dropped 7.9% from last year. Specifically, it declined fairly obviously between January and July, fluctuated between July and December, and went up 20.8% and 3.6% in October and December respectively compared with last year. The mean annual conductivity of Yinyang section dropped 18.8% from 2013 (dry year). The mean annual conductivity of Daxing section dropped 23.1% from last year. However, it escalated by 73.1% in October compared with last year. The mean annual conductivity of Yinyang section dropped 45.5% from 2013. The mean annual data for Xinglongsha section dropped 22.3%, and the conductivity in June-July and September-October rose by 152% and 54.3% respectively from last year. The mean annual data for Xinglongsha section dropped by 54.6% compared with that of 2013.

● **Conductivity of inland river waters**

The conductivity of inland river waters was lower near the north bank and higher near the south bank of the north branch than a year ago. The mean annual conductivity of inland waters went up 10.2% from last year at Yinyang section; in specific, it rose by 39.8% between January and July than last year with some decline between August and November. The conductivity data began to rise in November-December,

and that of December was 71.0% higher than last year. The conductivity of river waters went up 37.9% on average between January and July, and down 15.3% in the second half of the year when compared with that of 2013. The mean annual conductivity went down 33.4% from last year at Daxing section, and on average, the conductivity of 12 months was lower than that of the same period last year, with 15.6% and 37.7% increase in March and December respectively. The mean annual conductivity of Daxing section dropped 22.3%, while that of Xinglongsha section rose 11.8% compared with 2013. In specific, the first half year had a significant increase than the same period last year, and there was some decrease in August, but that of September-October increased by 8.0% on average compared with last year. The mean annual conductivity of Xinglongsha section dropped 32.7% 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 2016, 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 was close to a year earlier and that of 2013 at Yinyang section. Compared with the previous year, the buried depths in April-June and October-November decreased by 11.9% and 18.2% respectively, while those in August increased by 33.1%. Compared with 2013, the buried depths in May-July and September-November decreased by 16.0% and 15.2% respectively, and increased 26.6% in August.

monitoring for soil water–salt dynamics

The groundwater depth of Daxing section increased by 22.5% and 11.1% respectively over the previous year and 2013. Compared with the previous year, the groundwater depth in September-October decreased by 17.1% on average. The rest months were higher, while the depth of August reached the maximum, up by 20.1%. Compared with 2013, the buried depth decreased by 17.5% in August to October, and that of the rest months in the year was relatively deeper.

The mean annual groundwater depth of Xinglongsha section saw a slight decrease from the previous year and 2013. Compared with the previous year, the depths of spring, autumn and winter were shallower, while that in summer was deeper. In specific, the buried depth increased by 8.6% on average from June to August and decreased by 12.6% on average from September to December. Compared with 2013, the buried depth decreased by 6.9% and 24.4% in June-July and September-December respectively, while the rest months were deeper and that of August increased 13.6%. The shallower depth in autumn and winter was caused by the combined effect of precipitation amount and water level fluctuations, which was likely to aggravate the aggregation of salt on the surface.

● **Groundwater conductivity**

In 2016, the conductivity of groundwater in the north bank of the North Branch increased slightly, while that of the south bank saw some decrease. The conductivity of groundwater in Yinyang Section increased by 2.3% and 7.2% respectively over the previous year and 2013. Compared with the previous year, there was somewhat decrease in January-June, while the conductivity of groundwater in July-December increased by 5.0%. Compared with 2013, the monthly electricity conductivity was high during the year with an average increase of 10.2% in August-October. The conductivity of groundwater in Daxing section increased by 24.7% and 17.7% respectively over the previous year and 2013. Compared with the previous year, the conductivity of groundwater increased by 38.3% in January-July, 43.6% increase in September-October but decreased by 10.4% and 8.0% in August and November-December respectively. When compared with 2013, there was an overall increase of the conductivity of groundwater in 2016, but that of August-September decreased by 21.4%.

The conductivity of groundwater in Xinglongsha Section decreased by 29.9% and 23.8% respectively over the previous year and 2013. Compared with the previous year, the conductivity of groundwater decreased by 58.8% in August-December on average, and down 42.9% from the same period of 2013. The conductivity of groundwater at the three sections in the autumn and winter varied by a similar law to that of both Yangtze River and inland river waters. The salinity of the Yangtze River waters affected the background value and the variations of the salinity of groundwater, so did the rainfall to a certain extent.

8.5.2 Soil salinization

In 2016, the mean annual soil conductivity was slightly lower than that of last year. The soil conductivity of Yinyang section decreased by 15.6% and 14.0% respectively over the previous year and 2013. Compared with the previous year, the soil conductivity of all 12 months decreased, with an average decrease of 16.2% in August-December. Compared with 2013, the soil conductivity increased by 11.2% in January-April on average, and decreased by 26.2% in June-December. The soil salinity content of the stationary sampling points in autumn decreased a little, but the soil conductivity of 80-100 cm increased slightly compared with the previous year. The soil conductivity of Daxing section increased 4.4% over the previous year. In specific, the conductivity in January-August increased by 33.8% over the previous year and decreased by 35.4% on average in September-December. The soil conductivity of Xinglongsha section was basically the same as that in the previous year, but decreased by 6.1% from August to October. Compared with 2013, the soil conductivity increased by 12.0% in January-February and November-December on average, while decreasing 14.9% in July-September. The autumn survey in 2016 showed that the salinity of the topsoil decreased somewhat this year, which was close to that of the long-term fixed-point monitoring results, and the soil area of varying degrees of salinity also decreased.

8.6 Ecological environment in the estuary

8.6.1 Environmental elements in waters

● **Physical environmental elements**

In the 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 13.8°C and 18.6°C in the surface layer, and between 12.5°C and 18.5°C in the bottom layer. In the autumn, the temperature was low near the coastline and high in the infralittoral waters, as opposed to the case in the spring. Compared with last year, the highest and lowest temperature in the spring was 1.4°C and 0.2°C lower respectively; and the highest and lowest temperature in the autumn was 0.2°C and t 0.5°C lower respectively.

In the spring, the diluted waters in the estuary started to extend eastwards along with growing runoff which empties 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 as much as 31.15. In the bottom layer, the diluted waters were too weak to extend beyond the estuary. The salinity was low near the coastline and high in the infralittoral waters. In the 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 salinity was 0.39 lower in the spring and that of the autumn basically remained the same.

● **Hydrochemical elements**

The content of dissolved oxygen in the surface layer river waters in the estuary averaged out at 8.34 mg/L in the spring and 7.69 mg/L in the autumn. The figure in the surface layer seawaters in the estuary was 9.67 mg/L in the spring and 7.63 mg/L in the autumn. The figures were on the high side in surface layers of the river waters and seawaters in the estuary compared with the same period last year.

The pH value averaged out at 7.89 in the spring and 7.88 in the autumn in the surface layer river waters, and 7.85 in the spring and 7.83 in the autumn in the bottom layer river waters in the estuary. The pH value averaged out at 8.20 in the spring and 8.25 in the autumn in the surface layer seawaters in the estuary and 8.11 in the spring and 8.26 in the autumn in the bottom layer seawaters. The pH value of river waters in the estuary was on a rising trend from the estuary mouth to the coastline, and high pH value was recorded in the eastern part of the surveyed waters. Compared with last year, the pH values had no change in the spring; in the autumn, there was no change in river waters, and the pH values

of seawaters were on the high side.

The mean content of COD registered 1.95 mg/L in the spring and 3.16 mg/L in the autumn in the surface layer river waters in the estuary and 1.89 mg/L in the spring and 3.10 mg/L in the autumn in the bottom layer river waters. The mean content of COD was 1.57 mg/L in the spring and 1.63 mg/L in the autumn in the surface layer seawaters in the estuary and 1.10 mg/L in the spring and 1.48 mg/L in the autumn in the bottom layer seawaters. The mean content of COD was high near the coastline and low in the outer sea, affected by the inflow waters from the Yangtze River. Compared with last year, the figures were notably low in river waters in the spring, and there was no significant change in the surface layer of river waters in the autumn, but that of the bottom layer was on the high side; the figures of the seawaters in the estuary was on the low side.

The content of phosphate, silicate, nitrate, TN, and TP was all in a steep downward trend from the estuary towards the open sea, from the perspective of horizontal variations. The horizontal variations of the contents of NH_3-N and nitrite were more complicated.

● **Sediment elements**

In 2016, the content of suspended matters averaged out at 39.65 mg/L in the estuary seawaters in the spring and 75.10 mg/L in the autumn. It was on the low side in the spring and on the high side in the autumn, compared with last year.

8.6.2 Biological elements in waters

● **Chlorophyll-a**

In the spring, the concentration of Chlorophyll-a ranged between 0.43 μg/L and 10.26 μg/L and averaged out at 2.65 μg/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 eastern part of the monitored seawaters. In the autumn, the concentration of Chlorophyll-a ranged between 0.12 μg/L and 1.09 μg/L and averaged out at 0.50 μg/L in the surface layer seawaters, lower 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**

A total of 81 fish zooplankton were caught in the spring, which fell into 6 species in 5 families. *Salanx ariakensis, Japanese anchovy, Chelidonichthys spinosus,* and *Harpodon nehereus* became the dominant species. A total of 24 fish zooplankton spawns and larvae were caught in the autumn, which fell into seven species in five families. The abundance of fish zooplankton was lower than that of last year. *Harpodon nehereus, Coilia Mystus, Allanetta bleekeri* and *Japanese anchovy* were the dominant species.

8.7 Wetlands in the midstream

8.7.1 Dongting Lake

● **Streamflow**

Dongting Lake embraces four inflow rivers (Xiangjiang River, Zishui River, Yuanjiang River, and Lishui River) in the south and empties into the 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 the Yangtze River at Chenglingji (Qili Mountain). Dongting Lake is the most important buffering lake of the Yangtze River.

According to the data from Chenglingji Station at the lake outlet, the annual precipitation registered 1,432.4 mm, down by 19.9% from a year earlier. The water level maximized at 34.47 m, minimized at 20.66 m, and averaged out at 25.69 m this year. The annual runoff was 9.5% more than the historical average and 19.5% more than last year. The annual sediment discharge amounted to 24.60 mil. t, 33.0% less than the historical average, and the same as that of last year. From the temporal perspective, the majority of the runoff and sediment discharge at Chenglingji Station happened between March and August, with runoff during this period accounting for 68.5%, and the sediment discharge during this period accounting for 71.9% of the whole year. The sediment discharge peaked on March 25, with the maximum discharge at 0.386 kg/m^3.

In 2016, the incoming water in the Yangtze River was larger in general. In specific, the incoming water was abundant in April-July; and there was a regional flooding in mid-July in the middle and lower reaches of the Yangtze River; the incoming water was large and small from time to time in August and September; droughts occurred in September and October in some regions of the middle and lower reaches of the Yangtze River; and that of November-December was also large in general. The incoming water of the four inflow rivers in Dongting

Lake was 20% more than the mean annual amount. Specifically, up 80% in April, 50% in May, 10% in June and 30% in July. The incoming water in August began to decrease, down by 40% in September and October. Affected by continuous heavy rainfalls, the Dongting Lake water system and other tributaries of the Xiang River raised the flooding alarm. In specific, Xiangjiang River, monitored by Xiangyin Station, experienced the water level surpassing alert level in April, May and July, with the highest water level being 30.29 m, 31.06 m and 35.06 m respectively.

Statistics on the 60-day flood volume showed the total inflow of the lake was 100.59 bn. m^3 and the total outflow 98.30 bn. m^3. Analysis data of the flood sources at Chenglingji Station (Qili Mountain) showed the four inflow rivers contributed 57.1% of the incoming flow to the lake in 7 days, 61.0% in 15 days, 62.4% in 30 days, and 68.7% in 60 days of the monitoring period. The three bleeders of the Yangtze River contributed 22.2% of the incoming flow to the lake in 7 days, 23.9% in 15 days, 24.4% in 30 days, and 20.7% in 60 days. The contribution of the interval inflows to the lake took up the smallest portion which ranged between 10.6% and 20.7%. Analysis data of the contributors to monthly runoff at Chenglingji Station showed 77.4% of the Dongting Lake inflow came from the four inflow rivers between June and October, and 59.0% in the remaining months. Over 54.9% of the incoming flow observed at Luoshan Station was contributed by the Yangtze River.

● **Water quality**

In 2016, the inflow river sections of Dongting Lake attained Grade Ⅱ or Ⅲ water quality standard, slightly better over last year. In the 12 monitoring sections across the lake area, 75% attained Grade Ⅳ and 25% attained Grade Ⅴ respectively. In specific, the proportion of Grade Ⅴ sections decreased by 47.7%. The mean concentration of TN and TP was 1.83 mg/L and 0.086 mg/L respectively, with some decrease over last year.

The concentration of Chlorophyll-a in Dongting Lake averaged out at 5.16 mg/m³, with some increase over the last year (4.45 mg/m³).The lake as a whole was in minor eutropher. The Trophic Level Index (TLI) of Dongting Lake ranged somewhere between 46.1 and 58.7 this year, no obvious change over last year. Specifically, the maximum TLI was recorded at the monitoring section of Major and Minor West Lakes. The five sections at eastern 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 April, July, September and December, which indicated minor eutropher; and in the remaining months, which suggested mesotrophic state.

A total of 53 genera of phytoplankton species were identified in Dongting Lake, which fell into 6 phyla. Specifically, the Bacillariophyta and Chlorophyta species were the most abundant phytoplankton species, and the two species fell into 21 and 19 genera respectively; followed by Cyanophyta species in 4 genera, Euglenophyta species in 4 genera, Pyrrophyta species in 3 genera and Cryptophyta species in 2 genera. The maximum biomass density of phytoplankton species was 286,000/L, and the maximum biomass density of phytoplankton species was recorded in June, followed by that in September, and the minimum density was observed in December. In terms of geographical distribution, the eastern lake recorded the highest. Compared with last year, the number of species decreased a little, while that of density saw a notable increase.

Twenty-seven genera of zooplankton species were identified in Dongting Lake, including 9 genera of Rotifera species, 12 genera of Cladocera species, and 6 genera of Copepods. The mean annual biomass density of zooplankton was 81/L, with the highest in March and the lowest in December. In terms of geographical distribution, the eastern lake recorded the highest. Compared with last year, the number of species was close to that of 2015, while that of density saw a notable increase.

● **Vegetation**

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 saccharifloral* community was more than that of *Polygonum flaccidum* and *Carex tristachya* communities. For the *Triarrherca saccharifloral* community, the number of species identified each month ranged between 7 and 23; both of the species richness index and the species diversity index were the highest in March prior to the flood season (8.6 and 0.79 respectively) and at the minimum in September after the flood season (2.5 and 0.16); the community coverage hit the lowest in January (20.8%), surged remarkably in March (62.5%), and reached the highest in September

(100%); the biomass was the lowest in January (14.8 g/m^2), rose fast, and peaked in September (1,431.1 g/m^2). Compared with last year, all the species richness index, the species diversity index, the community coverage and the biomass of the *Triarrherca saccharifloral* community saw some decrease. As for the *Carex tristachya* community, the mix of the species was simpler and the number was somewhere between 1 and 9; the species richness index was fairly low, somewhere between 1.0 and 4.4 per quadrat; the species diversity index was at the maximum in March (0.36) and at the minimum in September (0); the community coverage was relatively low in September (87%), and all that in January, March and November was 100%; the biomass went from 141.8 g/m^2 up to 389.9 g/m^2 between January and March, and down to 284.3 g/m^2 after the flood season. Compared with last year, all the species richness index, the species diversity index and the biomass of the *Carex tristachya* community was notably decreased. As for the *Polygonum flaccidum* community, the number of species identified each month ranged between 0 and 13; the species richness index was fairly low and between 0 and 5.4 per quadrat; the species biodiversity index was fairly high prior to the flood season, ranging between 0.21 and 0.36, and fairly low after flood between 0 and 0.04; the community coverage was above 90% in January-March, and dropped dramatically after flood; the community coverage was only 30% in September, and disappeared in November; the biomass hit the highest in March (171.7 g/m^2), descended fast after the flood, and became 0 in November. Compared with last year, the species richness index, the species diversity index the community coverage, and the biomass of the *Polygonum flaccidum* community dropped dramatically after flood, and even disappeared in November.

● **Biodiversity**

In 2016, 131 species of summer migrant birds were identified in eastern Dongting Lake and they fell into 44 families under 15 orders, up 40 species of 4 families under 2 orders, from last year and one new record was also monitored in eastern Dongting Lake, that is, one species of Long-toed Stint. A total of 189,466 overwinter water birds were identified, down 19.0% from last year but the one-time highest record leveled off with the previous year. They fell into 59 species in 12 families under 6 orders. Anseriformes species and Charadriiformes species were the dominant species of overwinter bird species in the eastern Dongting Lake, which accounted for 56.7% and 32.7% of the total respectively. Compared with last year, the number of

Elaphurus davidianus

Anseriformes species dropped by 105.1%, while that of Charadriiformes species up by 270.3%. In terms of geological distribution, the most popular habitats were T-shaped Dike, Baihu Lake and Caisang Lake, accounting for 82.31% of the total. In the dead of the winter, the population of three water birds which increased the most was *Dunlin*, *Tringa erythropusup* and *Shoveler* by 229.0%, 602.5% and 819.7% respectively. *Bean Goose* decreased the most, down by 28.6%.

One hundred and fourteen *Elaphurus davidianus* were identified in the eastern Dongting Lake in 2016, close to that of the previous year. The male/female ratio of adults (including subadult) was 91:23. According to the 1.2: 1 ratio of male to female of *Elaphurus davidianus* natural breeding, the species population was estimated to be about 169. *Elaphurus davidianus* was mainly distributed in Heizui (Zhuzi River mouth-Reed field of development zone) (population 80～100) and Piaowei (upper and lower Hongqi Lake) (population 70～80) regions. The *Elaphurus davidianus* in Dongting Lake showed an out-spread trend affected or motivated by flooding.

8.7.2**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

1,567.4 mm in 2016, 9.0% more than the historical average. The precipitation fell mainly from April through July, which accounted for nearly 71% of the total precipitation in the year. The water level maximized at 21.38 m and minimized at 8.98 m this year, as observed at Xingzi Station. The mean water level was at 13.92 m. Due to the combined effect of concentrated period of precipitation and typhoon, water intrusion of the Yangtze River and other factors, Poyang Lake experienced the largest flood since 2000, with the water level of all stations over alert level, and Xingzi station even for 35 days.

There was abundant precipitation and fewer sediments in the Poyang Lake area this year. The combined runoff contributed by the aforementioned five major inflow rivers to the lake reached 185.6 bn. m^3, up 21% from last year and 48% more than the historical average. The influx of sediments amounted to 8.81 mil. t, up 13% from a year earlier and 36% less than the historical average. The runoff discharge of the lake through outlet to Yangtze River totaled 224.1 bn. m^3 this year, up 18% from last year and 48% more than the historical average. The sediment discharge of the lake amounted to 11.89 mil. t, 1% less than a year earlier, and 19% more than the historical average.

The 60-day flood volume recorded from May to July indicated the total inflow of the lake reached 92.008 bn. m^3, up 63% from last year; and the total outflow 87.914 bn. m^3, up 58%; rendering the buffering balance at 4.094 bn. m^3 this year, 550% more than last year. The main contributing runoffs of Poyang Lake included the five major inflow rivers (GanjiangRiver, FuheRiver, XinjiangRiver, RaoheRiver, and XiuheRiver) and interval waters. Specifically, Ganjiang River had always been the dominant inflow river of the lake and contributed 59.2% of the total inflow, seconded by Xinjiang River which contributed 12.2%.

● **Water quality**

The inflow rivers of Poyang Lake enjoyed good water quality this year. The percentage of the contributing river waters that had attained Grade Ⅰ～Ⅲ standard ranged between 93.5% and 100% and averaged out at 96.1%, up by 3.3 percentage points from a year earlier. Le'an River was the main river which failed to attain water quality standard, and the main pollutants were NH_3-N and TP. The monitoring section at the lake outlet attained Grade Ⅱ standard in the first and fourth quarters; and Grade Ⅲ standard in the second quarters and Grade Ⅳ standard in the third quarters, 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 8 and 14, which took up 53.3%～93.3% of the total and averaged out at 78.3%, up 3.3 percentage points from a year earlier. The main pollutants were TP, NH_3-N, and COD_{Mn}.

The ammonia nitrogen concentration in the water-rising period (April) and wet season (July) was slightly higher than that in the dry season (January) and the water-falling period (October); the nitrate nitrogen concentration in the water-rising and water-falling period was significantly higher than that in the wet season and dry season; the concentration of TN in water-falling period was significantly higher than the water-rising period, wet season and dry season. The annual content change of TP and phosphate annual change was similar. The content of TP and phosphate in the water-falling period recorded the highest, which was significantly higher than that in the period of water-rising, wet season and dry season.

● **Vegetation**

In 2016, the *Artemisia selengensis*, *Carex cinerascens*, and *Phalaris arundinacea* as well as the mudflats distributed in zonary belts on the islets and shoals were monitored. The observation data of the recent years suggested that the IVs of the dominant species in the above three vegetation belts varied little from year to year, a sign 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.

Analysis data of biomass indicated the surface biomass of *Artemisia selengensis* belt averaged out at 3,235.6 g/m^2 in the spring, slightly lower than that of last spring (3,521.2 g/m^2), and 2,804.3 g/m^2 in the autumn, higher than that of last autumn (2,612.3 g/m^2). The surface biomass of *Carex cinerascens* belt in the spring was 2,433.9 g/m^2, higher than the same period last year (2,388.9 g/m^2); and that of autumn 2,517.4 g/m^2, notably higher over the previous year (2,301.7 g/m^2). The surface biomass of *Phalaris arundinacea* was 1,531.7 g/m^2 in the spring, lower than the data of last spring (1,776.3 g/m^2); and 1,663.5 g/m^2 in the autumn, much higher than the data of last autumn (1,245.9 g/m^2). The surface biomass on the mudflat belt averaged out at 920.4 g/m^2 in the spring, lower than that of last spring (1,014.6 g/m^2); and

872.6 g/m^2 in the autumn, which was notably higher than the data in the same period last year (513.4 g/m^2).

Analysis data of community biodiversity (the Shannon-Wiener index) showed mudflat belt recorded the maximum values, which was, 1.417 in the spring, lower than the data of last spring (1.537), and 1.675 in the autumn, higher than that of last autumn (1.443). The community biodiversity of *Phalaris arundinacea* belt posted 0.377 in the spring and 0.729 in the autumn, notably lower than that of last spring (0.653) but the same as last autumn (0.729). The community biodiversity of *Carex cinerascens* belt was the lowest, at 0.228 in the spring, somewhat lower than that of last spring (0.231), and 0.254 in the autumn, higher than the data of last autumn (0.212).

Water bird census in the summer

● **Census on water birds**

Over 532,000 overwinter water birds of 71 species (12 families under 6 orders) were recorded in the census conducted on Dec. 18, 2016 on overwinter water birds across the lake. The biodiversity (the Shannon-Wiener index) of water birds was 2.5905, and its evenness index was 0.6077. The number of bird species on the record was 14 more than last year, and the population was about 210,000 more. Both the Shannon-Wiener index and evenness index of water birds across the lake saw somewhat decrease (2.8349 and 0.7012). As for the population of key species, there were 984 *Grus leucogeranus*, 353 *Grus monacha*, 564 *Grus vipio*, 3,245 *Grus grus*, 5,057 *Ciconia boyciana*, 13,336 *Platalea leucorodia*, 19,956 *Cygnus columbianus*, 79,606 *Anser cygnoides*, 105,162 *Anser fabalis*, and 92,138 *Anser albifrons*. Apart from significant growth in the population of geese, ducks and waders, storks, spoonbills had some increase, and that of swans and cranes dropped significantly compared with the same period last year.

In January-March and October-December 2016, a total of 61 waterfowl species (13 families under 5 orders, including 38 species in January-March and 57 species in October-December) were recorded on the 18th of each month within the Poyang Lake Reserve, an increase of 13 species over the previous year; the total number of 6 surveys was 511,800, 35,400 fewer than the previous year (547,200); the biodiversity (the Shannon-Wiener index) of water birds was 2.72, up a little over last year (2.58);and its evenness index was 0.66, close to that of the previous year (0.67). From the perspective of population structure, which dominated the ducks, sandpipers, and herons, the maximum number of the key species was 999 *Grus leucogeranus*, 281 *Grus monacha*, 525 *Grus vipio*, 1,003 *Grus grus*, 4,256 *Ciconia boyciana*, 8,551 *Platalea leucorodia*, 10,566 *Cygnus columbianus*, 45,162 *Anser cygnoides*, 31,803 *Anser fabalis*, and 40,023 *Anser albifrons*.

A total of 59 species of water birds were identified in the census on reproductive water birds in the summer, which fell into 11 families under 6 orders. In specific, there were 23 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 (25 species) was the highest among the identified species, followed by Ciconiiformes species (14 species) and Anseriformes (11 species). The biodiversity (the Shannon-Wiener index) of water birds was 2.487, higher than the same period last year (2.195). G index was 3.52, F index was 8.95, and G-F 0.61, all somewhat lower than the same period last year (3.61, 10.16 and 0.64).

8.8 Upstream watersheds

8.8.1 Yangjichong Watershed, Wujiang River Basin (Longli County, Guizhou Province)

Yangjichong Watershed in Longli County, Guizhou Province in Southwest China 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 km^2 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.

The annual precipitation registered 1,025.8 mm, down 18.6% against last year. The monitoring data on slope runoff plots suggested the sediment yield and runoff yield went up 24.5% and 14.0% respectively in cropland runoff plots, up 44.8% and 31.7% in bare land plots, down 11.1% and 29.4% in woodland runoff plots, down 35.4% and 9.1% in grassland runoff plots, and down by 14.0% and 11.5% in cash tree runoff plots from last year.

The monitoring data on soil nutrient outputs showed the output of TN, nitrate nitrogen, and TP was 1,633 mg, 1,227 mg, and 40 mg respectively in cropland runoff plots; 894 mg, 574 mg, and 13 mg in bare land plots; 567 mg, 380 mg, and 11 mg in woodland runoff plots; 577 mg, 414 mg, and 11 mg in grassland runoff plots; and 322 mg, 230 mg, and 4 mg in cash tree runoff plots. The total TN output monitored at the station at the outlet of the watershed amounted to 812.96 kg, and the total TP output registered 79.76 kg.

In 2016, the soil erosion intensity was dominated by minor and moderate erosion, the area of which accounted for 32.7% and 24.4% respectively of the total area of the watershed. The runoff monitored at the station at the outlet of the watershed totaled 1.0187 mil. m^3, down 18.6% over last year; the annual sediment yield amounted to 69.97 t, and the sediment delivery modulus was 20.82 t/(km^2·y).

8.8.2 Maojiawan Watershed, Chishui River Basin (Bijie Prefecture, Guizhou Province)

Maojiawan Watershed in Qixingguan District, Bijie Municipality of Guizhou Province in southwest China is an integral part of the Chishui River Basin in the upstream of the 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 km^2. The main categories of the soils are yellow soil and calcareous soil. The land use patterns include closed forest land, 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.

The precipitation in the watershed registered 840.5 mm across the year, up 34.3% from a year earlier. Analysis data of the runoff yields of runoff plots with varied slope gradients indicated the runoff yield was zero in 5º plots, 16.79 m^3 in 15º plots, and 26.54 m^3 in 25º plots. Analysis data of sediment yield of different runoff plots indicated the sediment yield was zero in 5º plots, 31.90 kg in 15º plots, and 55.15 kg in 25º plots .

The monitoring data on soil nutrient outputs in those plots showed, there was zero runoff in 5º plots. The annual output of TN totaled 22,718 mg, of NH_3-N 19,308 mg, of nitrate nitrogen 16,509 mg, and of TP 170 mg from 15º plots. The annual output of TN totaled 73,884 mg, of NH_3-N 3,203 mg, of nitrate nitrogen 70,931 mg, and of TP 416 mg from 25º plots.

In 2016, the soil erosion intensity was dominated by moderate and intensive erosion, 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 652,000 m^3, the annual sediment yield amounted to 6.00 t, and the sediment delivery modulus was 15.08 t/(km^2·y).

8.8.3 Dawan Stream Watershed, Minjiang River Basin (Yibin Municipality, Sichuan Province)

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 km^2 catchment area is monitored by the monitoring station at the outlet of the watershed. The soils are purple soils and paddy soils. The land uses are woodlands and farmlands. The watershed provides for a population of 465 residents, and its main industry is agricultural farming.

The annual precipitation registered 1,148.2 mm, up 14.6% from last year. The monitoring data on soil erosion of plantation plots suggested the soil erosion modulus ranged between 14 t/(km^2·y) and 3,023 t/(km^2·y); in specific, the 15°rotation plots(spring planting peanut and autumn planting rapeseed) had the largest erosion amount, the that of 5°contour ridge interplanting (rapeseed planted on ridges and maize in the trench) and rotation plots (spring planting peanut and autumn planting rapeseed) had the smallest. The annual average runoff depth of all planting modes was 16.1-237.9 mm,

of which 15°fruit forest plots had the largest runoff yields, and that of 5°contour ridge interplanting and rotation was the smallest.

According to the monitoring data on soil nutrient outputs, the loss rate of TN in the runoff plots ranged between 45 mg/m^2 and 335.4 mg/m^2, of TP between 5.4 mg/m^2 and 40.0 mg/m^2, and of organic matters between 0.69 g/m^2 and 5.11 g/m^2. The mean annual concentration of TN and TP posted 1.44 mg/L and 0.24 mg/L respectively at the station at the outlet of the watershed.

In 2016, 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 1.2504 mil. m^3, the annual sediment yield amounted to 3,109 t, and the sediment delivery modulus was 942 t/(km^2·y).

8.8.4 Xiejiawan Watershed, Jialing River Basin (Suining Municipality, Sichuan Province)

Xiejiawan Watershed is located in Anju District of Suining Municipality, Sichuan Province in southwest China, 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 km^2. There are 1 mother flow plot, 5 runoff plots with varied gradients, and 6 runoff plots in different planting modes.

The mean annual temperature across the watershed was 18.6°C. The maximum daily temperature was 39.5°C, and the minimum daily temperature was -12°C. The annual precipitation totaled 833.6 mm, 61.9 mm less than the average year. There were 92 rainy days throughout the year. The maximum daily precipitation was 105.0 mm, and the maximum monthly precipitation 195.7 mm. The annual water surface evaporation on land totaled 729.8 mm, with the maximum daily evaporation at 6.0 mm.

In 2016, the runoff of the mother flow was 85.18 m³; the amount of erosion was 437.7 kg, significantly higher than that of the average year. Among runoff plots with varied gradients, the runoff yield of 5º, 10º, 15º, 20º, and 25º plots was 1.93 m^3, 3.26 m^3, 3.98 m^3, 4.77 m^3, and 5.64 m^3, and their erosion amount posted 14.22 kg, 62.41 kg, 117.42 kg, 156.13 kg, and 205.22kg respectively. The amount of erosion was significantly higher than the historical average. As for the six runoff plots with different tillage systems, their runoff yield was 6.37 m^3, 3.97 m^3, 5.49 m^3, 3.94 m^3, 7.27 m^3, and 4.75 m^3, and the erosion amount was 199.41 kg, 83.91 kg, 76.90 kg, 57.19 kg, 237.31 kg, and 112.25 kg respectively, notably higher than the historical record.

The annual runoff monitored by the monitoring station at the outlet of Xiejiawan Watershed totaled 5,427.70 m^3, and the sediment discharge totaled 3,440.12 kg. The mean annual concentration of TN and TP in waters was 4.03 mg/L and 0.32 mg/L respectively.

Organized by:
Department of Reservoir Management, Executive Office of Three Gorges Project Construction Committee, State Council of the People's Republic of China

Chief Editor:
China National Environmental Monitoring Center

Contributing Editors:
Academy of Forest Inventory and Planning, State Forestry Administration
Biogas Institute, Ministry of Agriculture
Changjiang Water Resources Commission
China Institute of Water Resources and Hydropower Research, Ministry of Water Resources
China Three Gorges Corporation
China Three Gorges University
Chinese Center for Disease Control and Prevention
Chinese Research Academy of Environmental Sciences
Chongqing University
Chongqing Academy of Environmental Science
Department of Finance and Planning, Executive Office of the State Council Three Gorges Project Construction Committee
Department of Hydraulic Engineering, Tsinghua University
Chongqing Earthquake Agency
Environmental Protection Center, Ministry of Transport
Freshwater Fisheries Research Center, Chinese Academy of Fishery Sciences
Headquarters of Geological Hazards Control of the Three Gorges Project Area, Ministry of Land and Resources
Hubei Agroecological Environment Protection Station
Institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry
Institute of Botany, Chinese Academy of Sciences
Institute of Geodesy and Geophysics, Chinese Academy of Sciences
Institute of Hydrobiology, Chinese Academy of Sciences
Institute of Hydroecology, Ministry of Water Resources & Chinese Academy of Sciences
Institute of Mountain Hazards and Environment, Chinese Academy of Sciences
Institute of Oceanology, Chinese Academy of Sciences
Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences
Institute of Seismology, China Earthquake Administration
Institute of Soil Science, Chinese Academy of Sciences
Jiangxi Poyang Lake National Nature Reserve Authority
National Climate Center, China Meteorological Administration
Southwest University
Wuhan Botanical Garden, Chinese Academy of Sciences
Yangtze River Fisheries Research Institute, Chinese Academy of Fishery Sciences

Reviewed by:
Ministry of Environmental Protection, the People's Republic of China
Executive Office of Three Gorges Project Construction Committee, State Council of the People's Republic of China

Issued by:
Ministry of Environmental Protection, the People's Republic of China