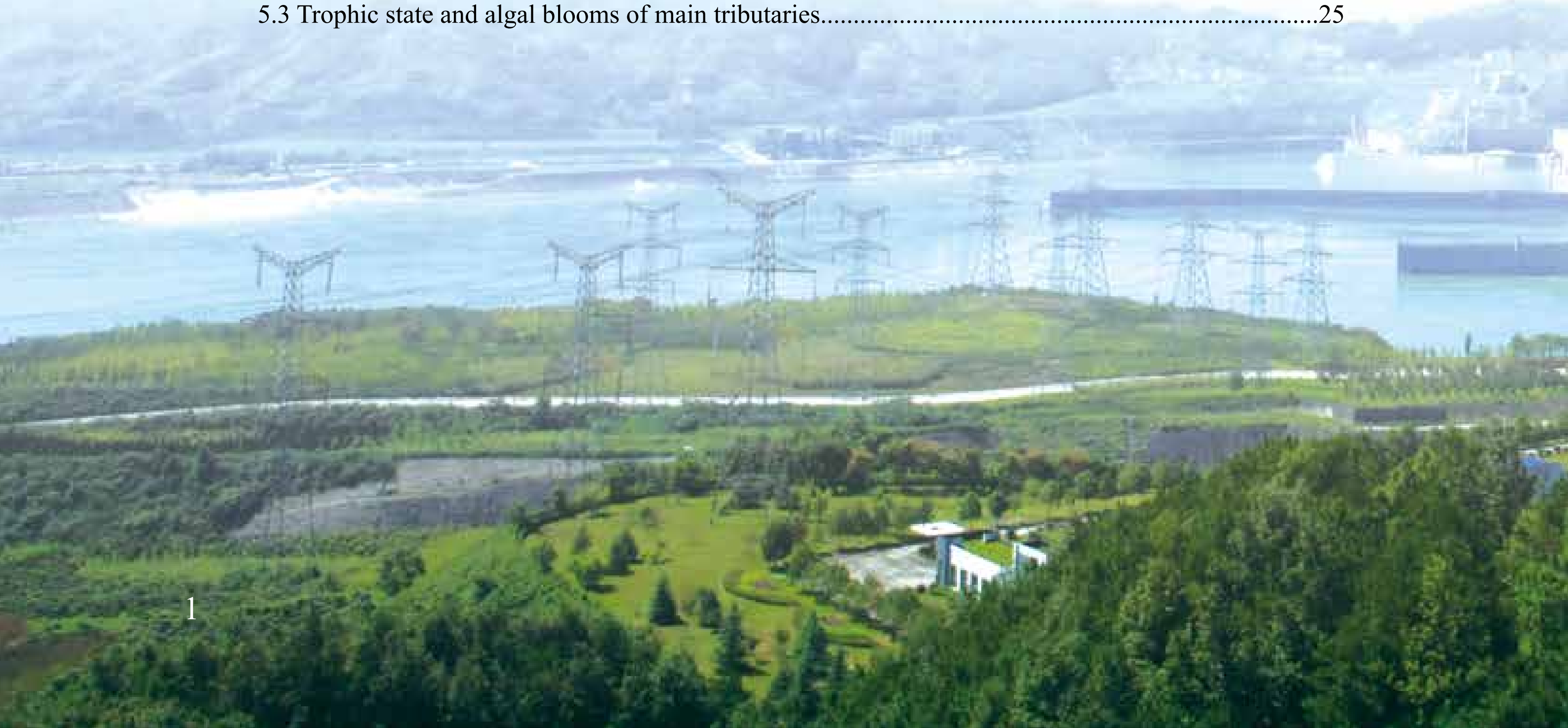
Bulletin on the Ecological and Environmental Monitoring Results of the Three Gorges Project

2016

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

2016

Content



Overview

In 2015, the Three Gorges Water Project maintained good operation, and the 175 m trial impoundment was achieved in success for the sixth 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. 10, a total of 7.542 bn. m^3 floodwater was impounded. The Three Gorges power plant generated about 87 bn. kWh electricity throughout the year. The navigation lock had been operated safely and efficiently with annual freight volume of 110 mil. t. The project replenished the lower reaches with 29.1 bn. m^3 water during the withered water season.

The permanent population of the Three Gorges Project area had reached 14.6528 mil. by the end of the year, up by 0.6% compared with that of 2014; the registered population stood at 17.0667 mil., down by 0.2%. The people in the area were in good health. The GDP of the project area reached 699.206 bn. yuan, up 11.1% compared with that of 2014. The primary industry, secondary industry and tertiary industry achieved value added by 66.78 bn. yuan, 349.693 bn. yuan and 282.734 bn. yuan, marking an increase of 4.9%, 11.0% and 12.2% respectively than that of 2014.

The mean annual temperature of the project area posted 18.4℃ , which was on the high side compared with average year. The area experienced 1,176.4 mm mean annual precipitation, higher than that of average year. The mean relative humidity was 77%, close to that of average year, while the mean evaporation was obviously less than average year, standing at 897.3 mm. The mean wind speed posted 1.6 m/s, higher than that of historical average.

The forest area reached 2.7717 mil. ha., the forest coverage registered 48.06%, and the forest growing stock was 144.7118 mil. m^3 in the project area. The area of arable land of the project area stood at 409,800 ha., and the planted acreage was 605,200 ha. with multiple cropping index of 210%. Grain crops still dominated agricultural production.

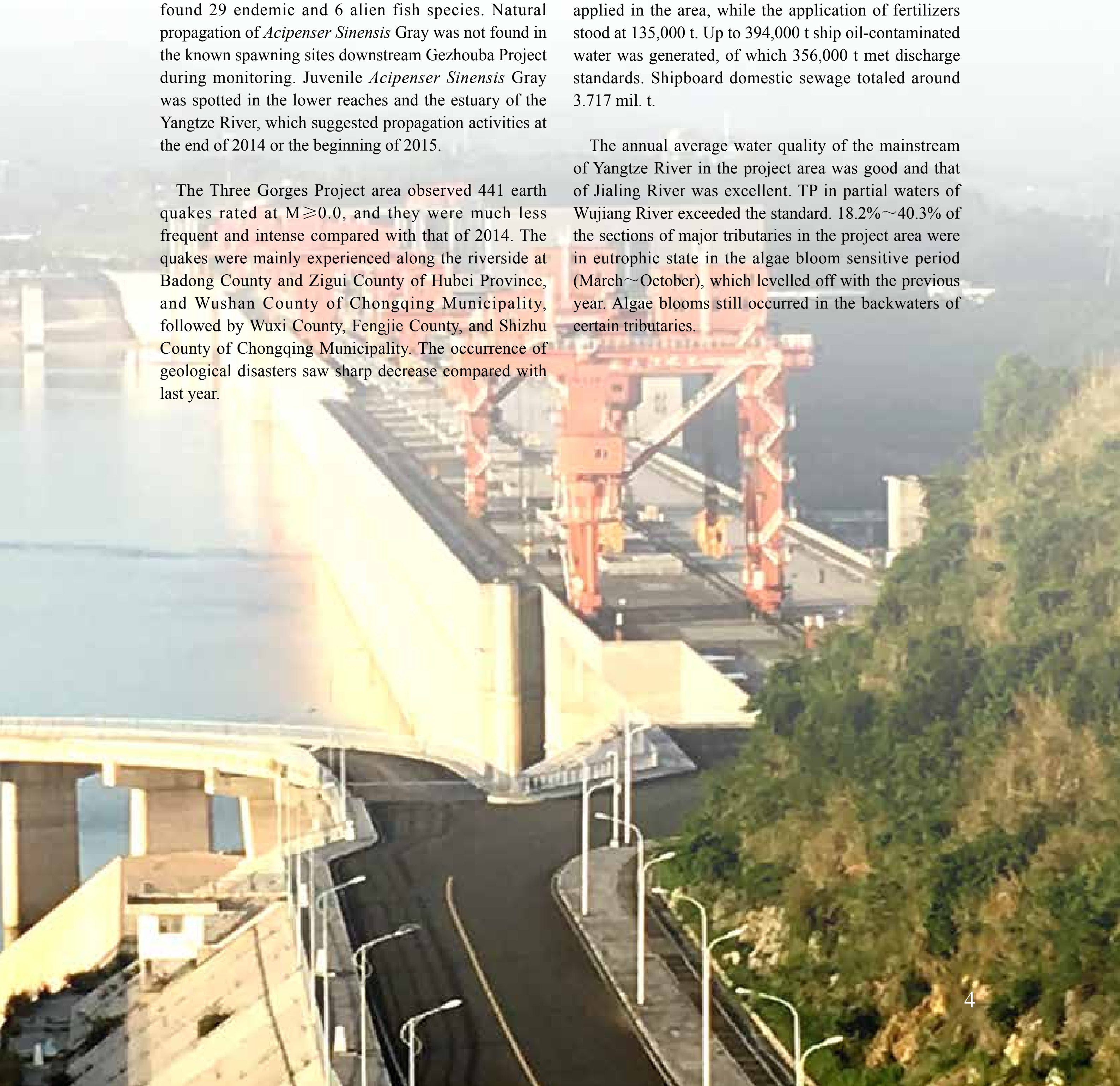
The natural fishery catches in the project area, downstream the dam, and in the Dongting Lake and

Poyang Lake totaled 62,500 t. The fish fry amount of the four major Chinese carps was about 510 mil. at Jianli section downstream the Dam, a slight increase compared with that of the same period of the previous year. The survey at the upstream of the project area found 29 endemic and 6 alien fish species. Natural propagation of *Acipenser Sinensis* Gray was not found in the known spawning sites downstream Gezhouba Project during monitoring. Juvenile *Acipenser Sinensis* Gray was spotted in the lower reaches and the estuary of the Yangtze River, which suggested propagation activities at the end of 2014 or the beginning of 2015.

The Three Gorges Project area observed 441 earth quakes rated at M⩾0.0, and they were much less frequent and intense compared with that of 2014. The quakes were mainly experienced along the riverside at Badong County and Zigui County of Hubei Province, and Wushan County of Chongqing Municipality, followed by Wuxi County, Fengjie County, and Shizhu County of Chongqing Municipality. The occurrence of geological disasters saw sharp decrease compared with last year.

In the project area, 212 mil. t wastewater was discharged from industrial sources including 34,200 t COD and 2,200 t NH_3-N. Discharges of domestic sewage amounted to 815 mil. t including 124,100 t COD and 22,300 t NH_3-N. Up to 601.8 t pesticides were applied in the area, while the application of fertilizers stood at 135,000 t. Up to 394,000 t ship oil-contaminated water was generated, of which 356,000 t met discharge standards. Shipboard domestic sewage totaled around 3.717 mil. t.

The annual average water quality of the mainstream of Yangtze River in the project area was good and that of Jialing River was excellent. TP in partial waters of Wujiang River exceeded the standard. 18.2%～40.3% of the sections of major tributaries in the project area were in eutrophic state in the algae bloom sensitive period (March～October), 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 2015, 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 and other follow-up projects proceeded in an orderly way, generating remarkable overall benefits such as flood control, electricity generation, navigation, and water resources utilization.

● **Comprehensive regulation**

In 2015, the Three Gorges Reservoir accepted a total of 377.7 bn m^3 incoming waters, down 16.3% from the historic average. The reservoir replenished 29.1 bn. m^3 waters to the lower reaches during the withered water season. In May, the reservoir was regulated at a proper timing for silt dredge in its tail region, washed off 1.29 mil. m^3 bedload (affected by sand mining activities) at the reach between Tongluo Gorge and Fuling, and 701,000 m^3 bedload (affected by sand mining activities) at the reach in the city proper of Chongqing, which met the expected silt dredge effect. In early June, the reservoir was regulated for emergency rescue of the sunken cruiser "Oriental Star", helped bring down the water level of the reach where the accident happened and slow the water speed, and provided favorable conditions for the emergency rescue. Moreover, the reservoir was regulated twice for the natural propagation of the four major Chinese carps between Jun. 7 and Jun. 10, and Jun. 25 and Jul. 2. The regulation was obviously effective and prompted the natural propagation of the four major Chinese carps.

During the flood season of 2015, the reservoir experienced three floods with peak flow over 30,000 m^3/s, and the maximum peak flow reached 39,000 m^3/s. The impoundment totaled 7.542 bn. m^3 between Jun. 10 and Sept. 10, which ensured safe flood control in the middle and lower reaches of Yangtze River and efficient utilization of the water resources by taking better regulation measures such as raising the water level.

The Three Gorges Reservoir began impoundment at the end of the flood season in 2015. The water level reached 166.41 m at the end of September, and 175 m on Oct. 28, achieving the planned goal. The mean flow rate of discharge amounted to 20,400 m^3/s in September and 13,000 m^3/s in October during the impoundment period, far above the minimum flow rate approved.

● **Operation of the power station**

The Three Gorges Power Station generated 87 bn. kWh electricity throughout the year. In order to fully tap the flood resources, the Three Gorges-Gezhouba Cascade Power Station jointly regulated a group of reservoirs, better regulated the small-and medium floods, and timely cleaned the floating garbage to enable adequate waterhead for power generation, and heightened the power grid output coordination. As a result, the annual generation of electricity grew by 6.582 bn. kWh from last year. Specifically, the generation went up 5.016 bn. kWh at the Three Gorges Power Station, and 1.566 bn. kWh at Gezhouba Power Station.

● **Navigation management**

In 2015, the navigation lock of the Three Gorges maintained safe and efficient operation for the twelfth consecutive year by enabling the delivery of 110 mil. t freight with the availability of major operation equipment reaching 100%, securing the smooth navigation on the Yangtze River.

● **Project progress**

In 2015, major progress was made in the shiplift project in the Three Gorges Project area, and the trial lifting of ships went smoothly throughout the whole process.

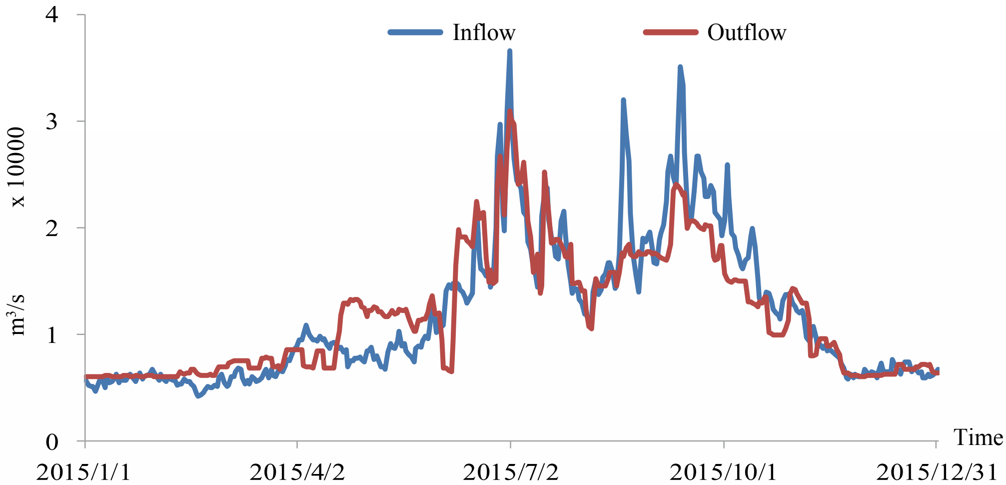


Figure 1–1 Statistics of the outflow and inflow of the Three Gorges Reservoir in 2015

Chapter 2
Economic and Social Development

In 2015, confronted with the interwoven international trends and the dilemma of large downward pressure on domestic economy, the project area implemented the deployments of the State Council Executive Office of Three Gorges Project Construction Committee and the provincial and municipal governments in the area. Also, based on the practical circumstances, and building on the endowed resources, the industrial foundation, and the geographical location, the project area insisted on distinctive development, green development, and joint development, and spared no effort in fostering new economic growth engines, 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.

● Population

The resident population of the Three Gorges Project area had numbered 14.6528 mil. by the end of the year, 82,200 more than that of 2014, marking 0.6% increase compared with the same period of the previous year. Specifically, 13.1718 mil. people lived in the Chongqing project area, up 0.6%; 1.4810 mil. were in Hubei project area, up 0.1%. The urban resident population of the Three Gorges Project area reached 8.0107 mil. with the urbanization rate of 54.67%, up by 1.52 percentage points. There had been 17.0667 mil. registered population in the project area by the end of 2014, 0.2% less than the same period of the previous year. Specifically, 15.5007 mil. were in the Chongqing project area, down 0.2%; and 1.5660 mil. were in the Hubei project area, down 0.5%.

● Economic development

The local GDP of the project area totaled 699.206 bn. yuan this year, an increase of 11.1% compared with last year and 4.2 percentage points higher than national average. In specific, the Chongqing project area and the Hubei project area achieved 620.806 bn. yuan and 78.4 bn. yuan respectively, up 11.2% and 9.9%. Judged from the perspective of the primary, secondary, and tertiary industries, the value-added of the primary industry, secondary industry and tertiary industry was 66.78 bn. yuan, 349.693 bn. yuan and 282.734 bn. yuan, up 4.9%, 11.0% and 12.2% respectively.

● Social development

In 2015, 217,900 urban residents and 333,400 rural residents in the Three Gorges Project area received

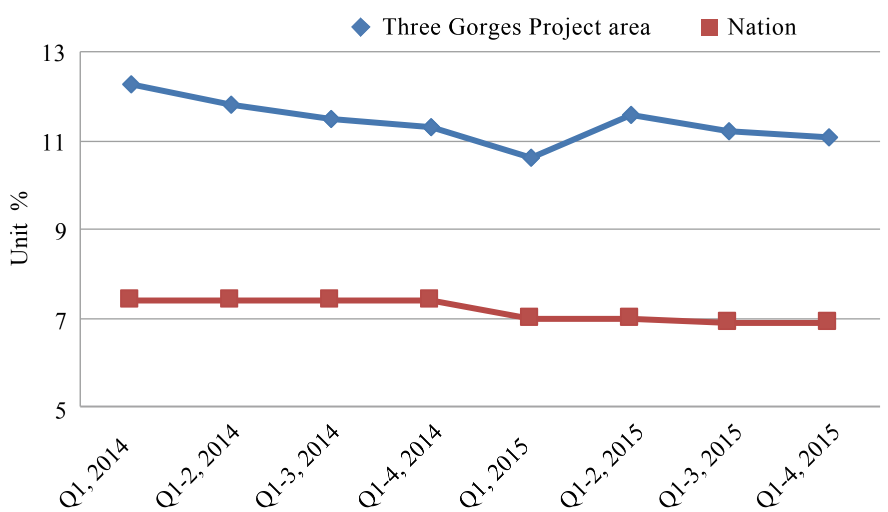


Figure 2–1 The GDP growth rates of the nation and the Three Gorges Project area between 2014 and 2015

the minimum subsistence allowance, down 10.2% and 19.1% respectively than that of 2014. A total of 6.2222 mil. urban and rural residents enjoyed the basic old-age insurance, down 0.4%; 1.7273 mil. urban employees were covered by the urban basic medical insurance, up 7.7%; 2.4697 mil. urban residents enjoyed the urban-rural resident cooperative medical insurance, down 3.3%, so did 11.8394 mil. rural residents, down 0.3%. By the end of the year, 1.1729 mil. employees had been covered by the unemployment insurance, up 12.4%.

In 2015, the highway freight volume reached 281.1 mil. t, up 7.1% compared with the same period last year; the highway passenger ridership totaled 301.03 mil., up 1.4%; the water freight volume was 118.73 mil. t, up 7.7%; and the water passenger ridership amounted to 5.63 mil. t, down 2.1%. There were altogether 2,871 primary and middle schools in the project area, down 10.6% than that of last year. The total enrollment stood at 1.7651 mil., down 1.0%. There were 114,576 full-time primary and middle school teachers, up 1.0%.

Chapter 3
Natural Ecology and Environment

3.1 Climate

In 2015, the mean annual temperature and mean annual precipitation was on the high side in the Three Gorges Project area compared with average year. The main characteristics of the climate conditions could be demonstrated as below: the mean annual temperature was on the high side, featured with distinctive warm winter and cool summer; the temperature was notably on the high side in the winter, with precipitation approximate to the winter of average year; the temperature was also on the high side in the spring, and it was warm and dry in the early spring; the temperature was on the low side in the summer, which led to a cool summer with more precipitation in the early summer and less in the late summer; the early autumn was cold and wet with much more precipitation than average year, and the late autumn was warm and dry. The main meteorological disasters that struck the project area and adjacent areas were rainstorms, floods, droughts, and high temperature, but the hazards were less intense.

Table 3–1 Monitoring results of meteorological elements of each station in the Three Gorges Project area in 2015

Station	Mean temperature (℃)	Precipitation (mm)	Relative humidity (%)	Evaporation (mm)	Mean wind speed (m/s)	Sunshine hours (h)	Foggy days (d)
Chongqing	19.6	1433.8	75	762.4	1.4	1130.1	23
Changshou	19.0	1334.4	77	722.8	1.5	1043.8	30
Fuling	18.4	1106.8	84	-	1.7	1159.3	161
Fengdu	19.3	1366.9	74	815.7	1.6	1100.5	30
Zhongxian	18.7	1095.3	81	-	1.4	1154.7	144
Wanzhou	19.4	1055.1	77	770.0	1.2	1092.4	25
Yunyang	18.7	1171.4	77	-	1.6	1189.5	52
Fengjie	19.6	899.5	70	932.9	1.9	1131.6	20
Wushan	16.7	1169.4	75	-	2.6	1518.5	111
Badong	17.6	1164.2	73	1358.4	1.8	1523.8	14
Zigui	16.9	1186.1	78	767.0	1.1	1305.3	0
Bahekou	17.3	1046.0	79	-	1.4	-	0
Yichang	16.4	1133.9	78	1048.9	1.9	1307.5	73

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.

Automatic meteorological observation station

3.1.1 Meterological elements

In 2015, the mean annual temperature of the project area recorded 18.4℃, 0.5℃ higher than that of average year (17.9℃), and the temperature was higher temperature in the west and north and lower in the east and south. The mean annual temperature ranged from 18.4℃ to 19.6℃ to the west of Fengjie and from 16.4℃ to 17.3℃ to the east of Wushan. The temperature was 0.7℃～1.7℃ lower than the average year in Wushan and Yichang, and close to or higher than the average year in the rest of the project area, by over 1.0℃ in Changshou, Chongqing, and Wanzhou. The seasonal analysis suggested a distinctive warm winter and cool summer. Compared with average year, the mean monthly temperature was on the high side between January and April, up by 2.1℃ in January; on the low side between May and September, down by 0.8℃ in July; and on the high side between October and December, up by 1.5℃ in October.

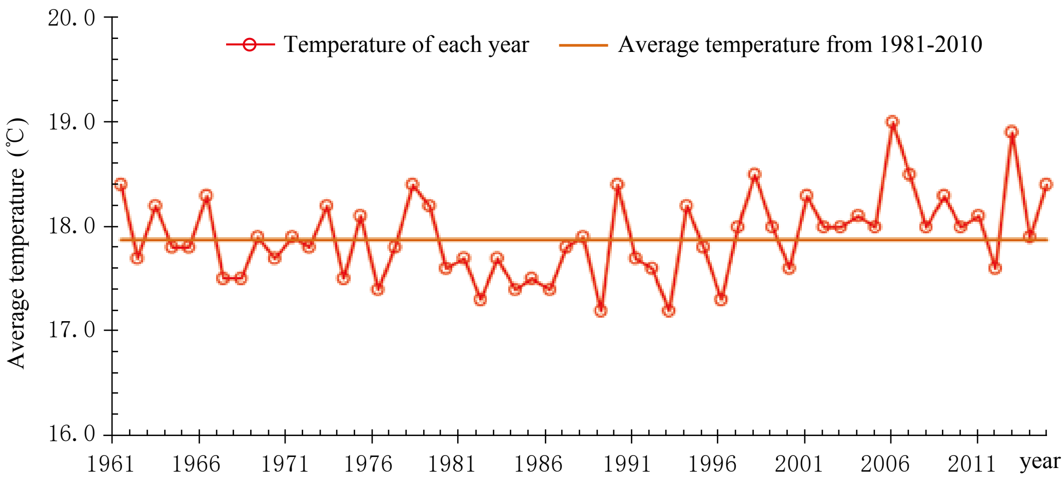


Figure 3–1 Mean annual temperature of the Three Gorges Project area between 1961 and 2015

The annual precipitation was 1,176.4 mm in the project area in 2015, 6% more than the historical average (1,114.9 mm). In terms of geographical distribution, the annual precipitation of some of western, central and southern parts of the project area was above 1,200 mm. Specifically, it was over 1,300 mm in Chongqing, Changshou, and Fengdu, and ranged roughly between 1,000 mm and 1,200 mm in the remaining parts. The annual precipitation was 10%～30% more than the average year in Chongqing, Fuling, and Changshou, and either levelled off or was on the low side in the remaining parts of the project area. In terms of monthly distribution, the precipitation was uneven across the year in the project area. It was higher than the average year by 53% in January, 47% in June, 74% in September, and 49% in December, lower by 15%～30% in March, July, August, October, and November, and close to historic average in February, April, and May.

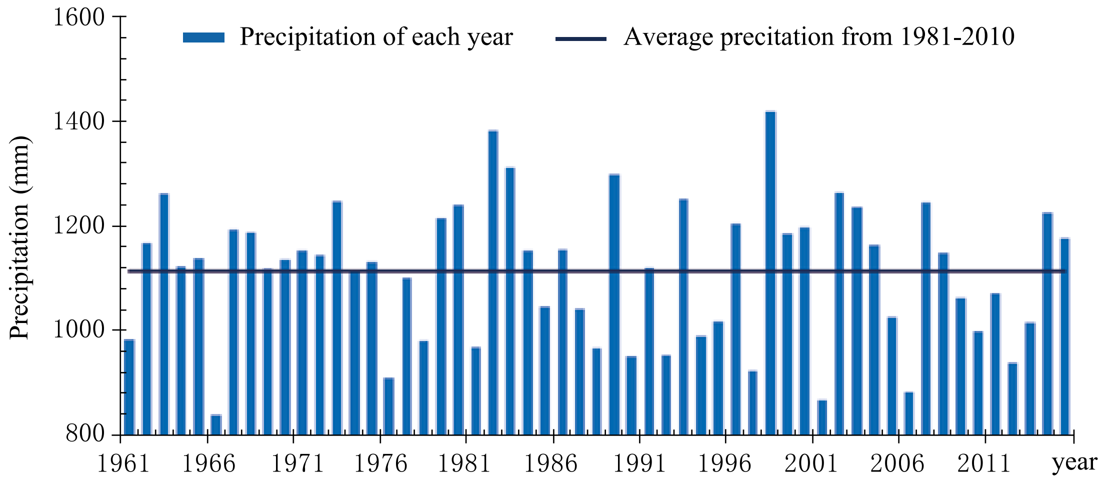


Figure 3–2 Mean annual precipitation of the Three Gorges Project area during 1961–2015

The mean relative humidity of the project area was 77%, close to that of historical average (76%). The relative humidity of all monitoring stations ranged from 70% to 84% with the minimum at Fengjie and the maximum at Fuling. Compared with average year, the relative humidity at Wushan was 6% higher, and that of Zigui was 5% higher; that of Fengdu was 6% lower, that of Chongqing and Changshou was also 5% lower, and that of the remaining monitoring stations was close to the average year. Seasonal analysis indicated the relative humidity (historical average) was 75% (77%), 74% (74%), 76% (76%) and 79% (79%) in the winter, spring, summer and autumn respectively, all close to that of the same period of average year.

The mean annual evaporation in the project area recorded 897.3 mm, prominently lower than the historical average (1,299.7 mm). Geographical distribution indicated the evaporation of Badong and Yichang was more than 1,000 mm while that of other places were all below 1,000 mm, with the minimum data recorded in Changshou at 722.8 mm. Evaporation changed a lot with season in the project area. The average evaporation (historic average) in the winter, spring, summer and autumn was 111.0 mm (137.2 mm), 261.8 mm (331.0 mm), 318.2 mm (536.6 mm) and 205.8 mm (294.8 mm) respectively. The evaporation was on the low side in four seasons compared with historic average. It was 40% less in the summer due to notably lower temperature.

The mean wind speed was 1.6 m/s in the project area, 0.3 m/s more than that of historical average (1.3 m/s). The wind speed varied little in the project area, and mean monthly wind speed hit the maximum in April, being 1.9 m/s, while the minimum was observed in January, October, and December at 1.5 m/s. The wind speed was 0.4～0.6 m/s higher than historic average in April and between October and December, and 0.2～0.3 m/s higher between January and March, and May and September. 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. It was over 100 days in Fuling, Zhongxian, and Wushan. The highest number was 161 days in Fuling. Zigui and Bahekou recorded zero foggy days. The number ranged from 14 days to 70 days in the remaining places, from 14 to 30 days in Chongqing, Changshou, Fengdu, Wanzhou, Fengjie, and Badong, and 52 days in Yunyang and 73 days in Yichang.

3.1.2 Meteorological hazards

In 2015, the project area and its neighboring areas were hit by such main meteorological hazards as the rainstorms, floods, high temperatures, and droughts. However, the meteorological hazards were mild in intensity. The rainstorms were frequent and monitored in plural stations but with little impact; the droughts were slight in severity with unnoticeable impact, and the high temperatures were recorded early in the season but less intense.

● **Frequent rainstorms recorded in plural stations but with little impact**

In 2015, the precipitation in the project area and neighboring areas was on the high side. Nine area-wide rainstorms were observed, but the impact from the rainstorm hazards was mild. Between Jul. 14 and Jul. 15, the largest-scale area-wide rainstorm happened in the project area; also, rainstorms poured down all over the Yichang City; and downpours engulfed some townships of Changyang County, Xingshan County, Yiling District, and Zigui County, accompanied with strong convection weather events such as thunder and lightning, gale, and short-time strong rainfall. The maximum cumulative rainfall registered 162 mm in Bailihuang of Yiling District, with the maximum hourly rainfall at 63.6 mm in Zhangshuiping of Wufeng County. The fiercest rainstorm happened between Aug. 16 and Aug. 19. Nineteen station·times rainstorms were monitored in 15 districts and counties in Chongqing including Shapingba, Beibei, Jiangjin, Changshou, and Dianjiang. There were four station·times downpours with the maximum daily precipitation at 169.3 mm (Tongnan, Aug. 16). A total of 142,000 populations were affected by the rainstorms in 12 counties (districts) of Chongqing including Dazu, Banan, and Jiangjin, with direct economic losses reaching 530 mil. yuan. From Aug. 18 to Aug. 19, 17,000 populations in Badong County and Lichuan City of Enshi Autonomous Prefecture were struck by the rainstorms which led to 7.892 mil. yuan direct economic losses.

● **The droughts were slight in severity with unnoticeable impact**

At the start of 2015, the Three Gorges Project area witnessed a warm winter featured with high temperature and little rainfall. Slight and moderate meteorological droughts hit the western part of the project area, however, with abundant rainwater in the autumn, the soil moisture before sowing was fairly good in most of the project area, and the impact of meteorological droughts was unnoticeable on the agricultural production. From Jul. 16 to Aug. 16, the rainfall of Xingshan County and Dangyang City was 70% less than the average year, compounded by intensive high temperatures above 35℃ , the high temperature and droughts advanced to a certain extent. From Aug. 16 to Aug. 19, the strongest area-wide rainstorm hit the project area, which led to considerable cumulative rainfall that effectively relieved the droughts.

● **High temperatures were recorded early in the season but not intense**

High temperatures were recorded in many places in the project area (maximum daily temperature≥35℃) on April 1, 2015. The maximum daily temperature surpassed 37℃ in Jiangjin. High temperature started earlier than ever before in Shapingba, Jiangjin, and Changshou. In 2015, high temperature was recorded early in the project area, however, the number of days with high temperature was on the low side and averaged out at 23.5 days in the project area, six days (20.3%) less than average year (29.5 days), and the least in nearly 15 years. The high temperatures were less intense and had little impact. The extremely high temperature within the year registered 39.9℃ (Fengjie, Aug. 3), and high temperature above 40℃ was not observed at any of the national meteorological observing stations.

3.2 Forest resources

In 2015, the forest area of the project area occupied 2.7717 mil. ha. with the coverage of 48.06%. Specifically, there were 2.573 mil. ha. closed forest land, accounting for 92.83% of the total and 198,700 ha. special shrub land defined by the state, which took up 7.17% of the total. The living wood growing stock totaled 149.9041 mil. m^3, which included 144.7118 mil. m^3 forest growing stock, and 5.1923 mil. m^3 scattered wood land, scattered trees and trees on the sides of villages, homesteads, roads and rivers, which accounted for 96.54% and 3.46% respectively.

There were 1.8399 mil. ha. natural forests and 732,800 ha. planted forests. The growing stock for natural forests stood at 109.6902 mil. m^3 and that for planted forests was 35.0215 mil. m^3. Natural forests are the main forest resources in the project area, from the perspective of the sources of forests.

There were 1.6548 mil. ha. shelter forests and 91.9234 mil. m^3 shelter forest stock, accounting for 66.65% of the total forest area and 63.52% of the forest stock respectively. The area of special-purpose forests stood at 126,200 ha. and that of special-purpose forest stock was 10.1141 mil. m^3, taking up 5.08% and 6.99% of their respective total. There were 642,400 ha. timber forests and 41.2331 mil. m^3 timber forest stock, taking up 25.87% and 28.49% of their respective total. The area of firewood forests stood at 2,600 ha. and the stock was 142,300 m^3, registering 0.10% and 0.10% of their respective total. Economic forests covered an area of 57,000 ha., taking up 2.29% of the total, with growing stock of 1.2988 mil. ha., accounting for 0.90%. From the perspective of the variety of forests in the project area, the shelter forests whose main purposes are to generate ecological benefits are the dominant variety.

Sapling forests of the Three Gorges Project area covered 1.0794 mil. ha., and the stock was 43.7711 mil. m^3, accounting for 43.47% of the total area and 30.25% of the total growing stock of arboreal forest. There were 1.0268 mil. ha. half-mature forests with 66.6396 mil. m^3 growing stock, taking up 41.35% and 46.05% respectively. The area and growing stock of near-mature forests were 266,900 ha. and 22.6322 mil. m^3, constituting 10.75% and 15.64% respectively. Mature forests covered 96,600 ha. and the growing stock stood at 10.0027 mil. m^3, accounting for 3.89% and 6.91% respectively. There were 13,200 ha. over-mature forests with 1.6661 mil. m^3 growing stock, taking up 0.53% and 1.15% of the total respectively. Sapling and half-mature forests dominated the arboreal forests with the coverage and growing stock accounting for 84.83% and 76.30% of the total respectively.

The planted forest covered 79,800 ha. in the project area, and 74,700 ha. was preserved with the survival rate of 93.61%. Specifically, the planted forests amounted to 6,300 ha. in Hubei and 5,700 ha. was preserved with the survival rate of 90.31%. The planted forests reached 73,500 ha. in Chongqing and 69,000 ha. was preserved with the survival rate of 93.88%.

A total of 41,700 ha. forests suffered from forest hazards, accounting for 1.50% of the total forest area in the project area, including 41,000 ha., or 98.32%, damaged by forest diseases and insect pests, and 700 ha., or 1.68%, ruined by forest fires and other hazards.

3.3 Terrestrial plants

There were 4,797 species which fell into 1,674 families in 299 orders of wild higher plants in the project area, accounting for about 14.9% of total plant species in the country. Specifically, 463 were moss species, 371 were pteridophytes and 3,963 were seed plant species. 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.

Ancient and famous trees as well as rare and endangered plants in the Three Gorges Project area are unique plant resources and precious natural and historic heritages under national protection program. In 2015, random sampling was employed to monitor ancient and famous trees as well as rare and endangered plants in the project area.

- **Ancient and famous trees**

There were 9,335 ancient and famous trees in the Three Gorges Project area, taking up 0.33% of national total. Specifically, 8,579 were ancient trees, taking up 91.9%; 756 were famous trees, taking up 8.1%. In all ancient trees, 475 were under Class Ⅰ, taking up 5.6%; 1,074 were Class Ⅱ, taking up 12.5%; 7,030 were Class Ⅲ, taking up 81.9%.

There were diversified species of ancient and famous trees which totaled 205 species in 128 genera of 64 families. The *Ficus virens*, ginkgo, *Pinus Massoniana*, cedar wood, *Keteleeria davidiana*, walnut tree, *Cinnamomum camphora*, Chinese honey locust, mastic tree (*Pistacia chinensis Bunge*) and *Osmanthus fragrans* owned the largest populations, which have had wide distribution in the Three Gorges Project area from ancient times. At present, ancient trees were mainly scattered across the project area and totaled 9,139 ones, accounting for 97.9%.

The distribution of ancient and famous trees was very uneven from area to area. Wanzhou, city proper of Chongqing Municipality and Badong had the most ancient trees with population all over 900; while Yunyang and Fengjie had the least, with population less than 100. Wuxi and Badong had the most ancient trees under Class Ⅰ protection program, both over 90. The famous trees were mainly distributed in Beibei, taking up 80.29%. There was also small distribution in Wuxi, urban area of Yichang, Banan, Fengjie, Changshou and Yunyang.

The health of 11.5% ancient trees in the project area was under threat. In all ancient trees, 27.5% was healthy, 61.0% was normal, 9.5% was weak, 1.5% was under critical conditions and 0.5% was dead. The average height was 23.0 m and average diameter at breast height was 83.8 cm for ancient trees in the project area. The health of the whole and each part of ancient trees such as crown, trunk and leaves went in a declining trend with time; while plant diseases and insect pests were in a rising trend. How the ancient trees were being managed and where they lived was of no evident relevance to their ages.

● **Rare and endangered plant species**

Based on *China Biodiversity Red List-Higher Plant Volume* released by MEP in 2013, 195 species of higher plants (including 7 species of moss, 6 species of pteridophyte and 182 species of seed plants) in the project area were under threat, taking up 4.1% of total plant species of the project area. Specifically, there were 18 critical (CR) species, 62 endangered (EN) species and 115 vulnerable (VU) species.

There was a relatively big difference in the amount of rare and endangered plant species in all districts and counties of the project area. Kaixian, Xingshan, Wushan, Wuxi and Badong were districts and counties under major protection because they had relatively more plant species under threats; followed by Fengjie, Wulong, Yichang, Wanzhou, Shizhu, Jiangjin, city proper of Chongqing and Fuling; Zigui, Fengdu, Yunyang, Zhongxian, Banan, Changshou and Yubei had the least.

About 10% rare and endangered woody plant species in the project area were facing risks for survival. The annual average growth was 0.79 cm for ground diameter, 0.49 cm for diameter at breast height, and 0.35 m for the tree height of 34 rare and endangered woody plant species. Specifically, 1.3% of those plants were dead, 1.3% were at critical conditions, 7.1% had poor growth, 31.2% had moderate growth, and 59.1% had good growth. Moreover, 1.3% had high, 7.8% had moderate, 44.5% had low, and 46.4% had zero seed settling rate.

Rare and endangered herbaceous plant species had vigorous growth in the project area without any survival risk for the moment. Neither serious plant diseases nor insect pests were found in the eight rare and endangered herbaceous plant species and their health index was relatively high.

3.4 Terrestrial animal species

Surveys were conducted on overwinter water bird species in the submerged areas below 175 m of the Three Gorges Project area in January and February of 2016. The survey area included the Changshou Lake and Dahong Lake in Changshou District and 10 tributaries such as Wujiang River, Pengxi River, Tangxi River, Modao Stream, Meixi River, Daxi River, Daning River, Yandu River, Xiangxi River and Jiuwan Stream.

A total of 5,495 water birds of 25 species in 9 families of 7 orders were counted in the surveying area in the winter, 7 more species and one more family from last year. Specifically, *Anas platyrhynchos* had the largest population at 2,267, followed by *Phalacrocorax carbo* (753), little egret (592) and little grebe (545). The population of little grebe and *Phalacrocorax carbo* was basically stable, that of little egret, *Anas crecca* and *Fulica atra* surged notably, and that of *Anas falcata* decreased significantly compared with last year. Only 52 *Anas falcata* was recorded. Chinese merganser (Class Ⅰ) and mandarin duck (Class Ⅱ) were found in the investigation as two species under state key protection program. Two Chinese mergansers were observed at Wulong reach of the Wujiang River, indicating further expansion of the habitats of Chinese merganser in the project area during winter. Mandarin ducks had relatively wide distribution in the project area. They were distributed in 8 out of the 10 tributaries surveyed, with a fairly large population in the Xiangxi River (80 ones) and Wujiang River (60 ones). Among the 3 lake-based wetlands, the Changshou Lake had the most birds with a population of 1,439 (observed results of the areas on only two monitoring lines), marking some increase compared with last year. In the 10 tributaries, the Pengxi River had most winter birds at 586, followed by Wujiang River with 337 and Modao Stream with 324.

3.5 Rare and endemic aquatic animals

3.5.1 Endemic fish species

In 2015, 124 fish species were identified in the upstream reaches of the Yangtze River including Yibin, Hejiang, Mudong, Wanzhou and Zigui reaches and Yichang reach in the midstream. Specifically, there were 29 endemic fish species and 6 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 3,513.76 kg fish were collected in catch investigation, totaling 105,825 ones. There were 5,023 endemic fishes with total weight at 349.20 kg, which accounted for 10.0% of the total weight of the catch and 4.7% of total amount. The percent of endemic fish went down 20.8% by weight, and 42.7% 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

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

was a certain amount of endemic fish species in Yibin, Hejiang reaches and Mudong reach in the tail region. There were very few endemic fish species in Wanzhou reach in the central region, Zigui reach in the head region, and Yichang reach downstream the Reservoir.

Experiment was carried out on artificial propagation of *Sauyage et Dabry*, which produced 5 batches of fertilized eggs and fries, with fertilization rate at 67.7% and 440 fries out of films.

3.5.2 Rare aquatic animals

In 2015, it was estimated from the sonar detecting data that the average population of Chinese sturgeon (*Acipenser sinensis Gray*) in Yichang reach downstream Gezhouba Project of the Yangtze River was 45, down by 21.1% compared with last year. The investigation data on egg eating fishes from October 31, 2015 to January 30, 2016 indicated no natural propagation activities in the known spawning sites in the lower reaches of Gezhouba Project during the propagation season of Chinese sturgeon. The monitoring data showed the juvenile Chinese sturgeon samples were collected in Zhenjiang reach and Nantong reach in lower reaches and the estuary of the Yangtze River during May-June. The multi-gene sequencing data suggested that they were Chinese sturgeon, which indicated the propagation of Chinese sturgeons in the Yangtze River in 2014. The observed average heterozygosity of the juvenile Chinese sturgeon population was 0.88, and the expected average heterozygosity was 0.84. The average Hardy-Weinberg departure value was 0.05. There was no significant difference between the observed and expected heterozygosity, but the Hardy-Weinberg genetic deviation index was smaller compared with the data of past years, indicating gradual stabilization of genetic structure of juvenile Chinese sturgeons.

In 2015, the bycatch of three Chinese sturgeons were investigated in the middle reaches of the Yangtze River. Juvenile Chinese sturgeons were collected in the lower reaches and the estuary of the Yangtze River. There was no report of bycatch of paddlefish. The bycatch of 3 *Acipenser dabryanus* was found out in Zigui reach. The bycatch of 24 mullets was found out in the Yibin, Mudong, Wanzhou, Zigui and Yichang reaches. 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 2015, visual and acoustic monitoring data showed about 450 finless porpoises were recorded in the Poyang Lake and they were concentrated, in highest density in the reaches from Laoyemiao to Xingzi County. A total of 106～190 finless porpoises were recorded in eastern part of the Dongting Lake, and their distribution areas varied with lake water level in different seasons. Most finless porpoises were distributed in the reach from Bianshan to Nianyukou of Yueyang City. Certain population of finless porpoises was distributed in the reach from Leishi to Yingtian of the Xiangjiang River. In addition, small amount of finless porpoises was observed in the Caowei River, too.

In 2015, the project on off-site protection of finless porpoise was carried out, including relocating 4 finless porpoises from the Poyang Lake to Hewangmiao old channel in Hubei Province and another 4 finless porpoises from the Poyang Lake to Tian’ezhou old

Finless porpoise

channel in Shishou as well as relocating 4 finless porpoises from Tian'ezhou old channel to Hewangmiao old channel. The population of finless porpoises in the Tian'ezhou old channel exceeded 60. There still was no report of white-flag dolphin (*Lipotes vexillifer*) in the investigation of 2015.

3.6 Agroecology

3.6.1 Ecological environment of farmlands

In 2015, the total area of agricultural lands in 19 districts (cities, counties) in the Three Gorges Project area was 409,780 ha., down by 0.4% compared with last year. Specifically, 107,840 ha. were paddy fields, 170,040 ha. were dry croplands, 77,260 ha. were citrus orchards, 14,130 ha. were tea gardens, 4,720 ha. were traditional Chinese herb medicine gardens and 35,790 ha. for planting of other crops. Arable lands accounted for 67.8% of total agricultural lands, 26.3% of which was paddy lands and 41.5% dry croplands. The total area of gardens took up 32.2% of the total agricultural lands, 18.9% of which was for citrus, 3.4% for tea, 1.2% for traditional Chinese herbal medicines and 8.7% for others. There was a slight decrease of agricultural land area compared with last year.

Analysis of tillage system showed 60,550 ha. of dry croplands practiced triple-cropping system, 86,970 ha. double-cropping system, and 22,520 ha. one-cropping system, which accounted for 35.6%, 51.2% and 13.2% respectively of total dry cropland area. In paddy fields, 12,800 ha. practiced triple-cropping system, 58,560 ha. double-cropping system, and 36,480 ha. one-cropping system; taking up 11.9%, 54.3% and 33.8% respectively of total paddy fields.

The analysis of slope gradient of agricultural lands (excluding paddy fields) showed that the area of agricultural lands with slope gradient below 10° was 61,330 ha., of those with slope ranging between 10°～15° 92,580 ha., and of those with slope over 15° 148,030 ha., accounting for 20.3%, 30.7% and 49.0% respectively of the total.

The analysis of agricultural land altitude indicated the area of agricultural lands with altitude less than 500 m was 220,910 ha., of those with altitude at 500~800 m 129,890 ha., of those with altitude at 800~1,200 m 48,270 ha., and of those with altitude higher than 1,200 m 10,710 ha..

The sown area of crops in the Three Gorges Project area totaled 605,220 ha. in 2015, down by 0.3% compared with last year. A total of 395,920 ha. of them was planted with grain crops, and 209,300 ha. with cash crops, taking up 65.4% and 34.6% respectively. The multiple cropping index was 210%, decreasing to a certain extent compared with last year.

3.6.2 Rural energy

In 2015, 6.38 mil. t firewood was consumed in the Three Gorges Project area, 6.2 t per household on average. There was 2.4% decrease of firewood consumption, 0.2 t reduction per household compared with last year. There were 274,800 household biogas pools in rural areas, up by 1.9% from last year. There were 283 large joint household biogas pools, up by 40 from last year. The annual output of biogas was 116.895 mil. m^3, up by 4.9% from last year. There were 19.5 biogas pools (excluding joint household biogas pools) for every 100 households, up by 0.5 compared with last year. In the energy mix of the project area, there were 2.402 mil. t straw, 236.344 mil. kW electricity from small hydropower stations and 570,000 t coals from small coal mines.

3.6.3 Crop diseases and insect pests

In 2015, 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 465,610 ha.·times, down by 11.3% compared with last year. The prevention and control measures were taken for 452,970 ha.·times, down by 11.6% compared with last year. A total of 252,900 t grains were saved, and 80,100 t were lost, together with 214.65 mil. yuan economic losses.

Among all types of crops, vegetables were hit the hardest by insect pests, and wheat relatively slight. 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 Shizhu, Wanzhou, Xingshan, Wulong, Kaixian, Fengjie and Zhongxian in the project area had relatively serious crop diseases and insect pests.

3.7 Fishery resources and environment

3.7.1 Fishery resources

In 2015, the catch of natural fishes in the project area, downstream the Dam, and in the Dongting Lake and

Poyang Lake totaled 62,500 t, which leveled off with last year. The fish fry amount of the four major Chinese carps at Jianli section downstream the Dam was 510 mil., with some increase from last year. The total catch of long-tail anchovy (*Coilia mystus*) in the estuary waters in fishing season was 3.1 t, down by 60.8% compared with last year. The total catch of parent crab in fishing season was 69.6 t, up by 20.9% compared with last year. The total catch of eel was 0.7 t in fishing season, down by 90.6% from last year.

● **Three Gorges Project area**

In 2015, the total catch of natural fish of the project area was 7,730 t, up by 9.0% compared with last year. It was estimated from the composition of fish catch of the project area that there were 2,060 t catfish, 1,430 t carp, 1,012 t silver carp, 579 t grass carp, 630 t *Coreius heterodon*, and 363 t *Pelteobagrus fulvidraco*. In the fish catch, the catch of catfish, carp, *Coreius heterodon*, silver carp, grass carp and *Pelteobagrus fulvidraco* took up 78.6% of the total catch weight and they were the main commercial fish species of the Three Gorges Project area.

● **Downstream the dam**

In 2015, the catch of natural fish downstream the Dam totaled 1,720 t, up by 4.9% compared with last year. It was estimated from the composition of the catch that there were 520 t carp, 413 t four major Chinese carps, 119 t catfish, 102 t bream, 71 t *Pelteobagrus fulvidraco*, 60 t *Coreius heterodon* and 43 t crucian carp, the combined weight of which accounted for 77.2% of the total catch. They were the main commercial fish species downstream the Three Gorges Dam.

● **Dongting Lake**

In 2015, the catch of natural fish of the Dongting Lake reached 28,000 t, up by 7.7% compared with last year. Specifically, 14,100 t were from eastern part of the Dongting Lake, 8,900 t were from southern part and 5,000 t were from western part, accounting for 50.3%, 31.8% and 17.9% respectively of the total. In the catch, settled fish species such as carp, crucian and catfish as well as the "four major Chinese carps" took up 54.7% of the total weight of the sampled catch and were the major commercial fish species in Dongting Lake.

● **Poyang Lake**

In 2015, the catch of natural fish in the Poyang Lake was 25,000 t, down by 9.1% 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 73.7% of the sampled total catch and were major commercial fish species in the Poyang Lake.

● **Yangtze River estuary**

In 2015, 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 went down by 41.3%, 4.2% and 60.8% respectively compared with that of the same period last year. The average length and weight went down by 5.7% and 17.7% respectively compared with last year.

The catch of parent crabs per ship and total catch in the estuary during the fishing season increased by 18.6% and 20.9% respectively compared with that of the same period last year. The average shell height, average shell width and average weight went down by 20.8%, 16.0% and 38.4% respectively compared with that of the same period last year.

The elver (*Anguilla Japonica*) catch per ship, output value per ship and total catch of licensed ships in the estuary went down by 73.9%, 23.8% and 90.6% respectively compared with the same period last year.

The amount of fishing permits for *Coilia mystus* issued by Shanghai authority was 20 less than last year. The granted amount of fishing permits was the same as last year for parent crabs and 194 less for elver.

● **Spawning site of the "four major Chinese carps"**

In 2015, the fish fry amount of "the four major Chinese carps" in Sanzhou section of Jianli County in the midstream of the Yangtze River was 510 mil., marking some rise compared with last year. Silver carp and grass carp dominated "the four major Chinese carps", taking up 81.4% and 12.9% respectively. The percent of bighead carp and black carp was small, taking up 5.7%.

In 2015, the fish egg amount of the "four major Chinese carps" at Youxi section of Jiangjin District in Chongqing was 260 mil.. In the "four major Chinese carps", silver carp and grass carp were in dominance with relatively small amount of bighead carp and black carp.

3.7.2 Fishery waters

In 2015, 10 monitoring sites (Banan, Wanzhou, Zhicheng, Jingzhou, Jianli, Yueyang, Hukou, Dongting Lake, Poyang Lake and estuary) were established in the mainstream of the Yangtze River, Dongting Lake and Poyang Lake to monitor the quality of important fishery waters of the Yangtze River basin. The assessment of water quality complied with the *Water Quality Standard for Fisheries* (GB11607-89). For the indicators not specified in the *Water Quality Standard for Fisheries*, 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 2015, 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 as the main pollutant.

● **Upstream Yangtze River**

The measured TN concentrations of waters in Banan failed to meet water quality standard during fish wintering, propagation and finishing periods. All other pollution indicators met water quality standard. There was no obvious change compared with last year. All monitoring indicators of Wanzhou waters met water quality standard during fish wintering, propagation and finishing periods.

● **Midstream of the Yangtze River**

All monitoring indicators of Zhicheng waters met water quality standard during fish wintering, propagation and finishing periods. There was some reduction in TP concentration of Zhicheng waters compared with last year.

The non-attainment rate of unionized ammonia of Jingzhou waters was 50% during fish finishing period; but 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 was 66.7% in wintering and 100% in finishing period in Chenglingji waters. The non-attainment rate of unionized ammonia was 33.3% during wintering period. All other monitoring data met water quality standard. There was no obvious change in the concentrations of monitoring indicators compared with last year.

TN concentration of Hukou waters failed to meet water quality standard in fish wintering, propagation and finishing periods. TP concentration failed to meet water quality standard during winter. All other monitoring indicators met the 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 during the propagation period of Chinese sturgeon. However, the TP concentration had some decrease compared with last year.

● **Spawning sites of the "four major Chinese carps"**

The TP non-attainment rate of Jianli waters was 100% during fish propagation period. All other monitoring indicators met water quality standard. There was no obvious change in the concentrations of monitoring indicators compared with last year.

● **Dongting Lake**

The TN non-attainment rate of the Dongting Lake was 33.3% in wintering period, 11.1% in propagation period and 33.3% in finishing period. All other monitoring indicators met water quality standard. There was some reduction of COD and TN concentrations but no obvious change in the concentration of other monitoring indicators compared with last year.

● **Poyang Lake**

The non-attainment rate of TN of the Poyang Lake was 100% in wintering period, 100% in propagation period and 88.9% in finishing period. 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**

The TN non-attainment rate of the Yangtze River estuary waters was 100% in the fishing seasons of eel, *Coilia mystus* and parent crab. All other monitoring indicators met the water quality standard. The concentration of petroleum, volatile phenol, unionized ammonia, and mercury escalated to a certain extent, that of COD_{Mn}, lead and cadmium went down, and that of other monitoring indicators did not change notably compared with last year.

3.8 Earthquakes and geological disasters

3.8.1 Earthquakes

There were 441 recorded earthquakes (M⩾0.0) in the Three Gorges Project area in 2015, 679 less than that of last year. Specifically, 347 earthquakes were measured at 0.0⩽M<1.0, down by 503 compared with last year; 88 earthquakes at 1.0⩽M<2.0, down by 157; and 6 earthquakes at 2.0⩽M<3.0, down by 12 compared with last year. The strongest earthquake was the M2.9 earthquake occurred in Wuxi County of Chongqing at 21:55 on November 12, 2015. Both the frequency and intensity of the earthquakes scaled down evidently from last year, and they were mainly micro and ultra-micro 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 and Shizhu in Chongqing Municipality. The earthquake frequency was relatively high in January and March during water subsiding period and in November with high water level.

3.8.2 Geological disasters

In 2015, a total of 4,786 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 227 professional monitoring sites. A total of 4,974 technicians worked on monitoring and early warning, they released 139,000 publicity materials and collected 1.595 mil. pieces of monitoring data.

There were 309 deformation sites with the risk of geological disasters in 2015, down by 61.9% compared with last year; 68 of which had severe deformation, down by 46.9% compared with last year. A total of 13 sites reached dangerous (disaster) level, down by 96.2% compared with last year.

In 2015, 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 4,210 people in the whole year.

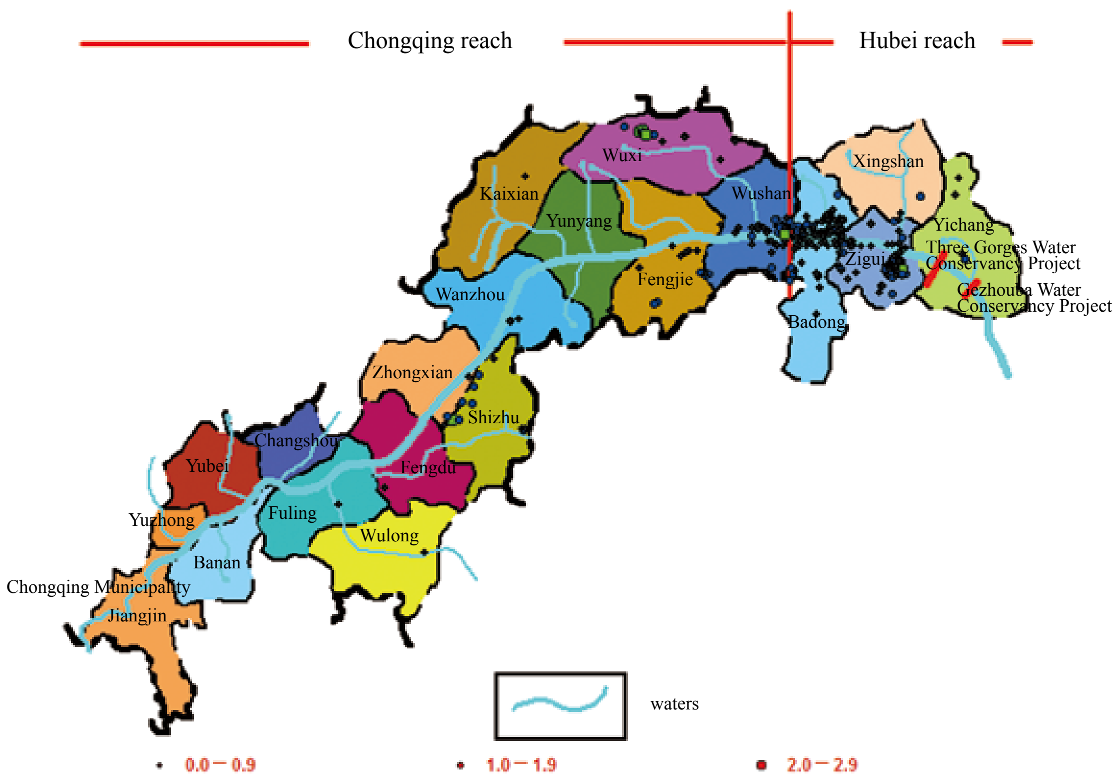


Figure 3–3 Map of epicenters of the Three Gorges Project area in 2015

Table 3–2 Statistics of earthquake frequency of the Three Gorges Project area in 2014–2015

Magnitude \ Year	2014		2015	
	Annual frequency	Monthly average frequency	Annual frequency	Monthly average frequency
0.0～0.9	850	70.83	347	28.92
1.0～1.9	245	20.42	88	7.33
2.0～2.9	18	1.50	6	0.50
3.0～3.9	5	0.42	0	0
4.0～4.9	2	0.17	0	0
5.0～5.9	0	0	0	0
Total	1120		441	
Max. M	4.5		2.9	

Chapter 4
Discharge of Pollution Sources

4.1 Discharge of industrial effluent

In 2015, the total discharge of wastewater from industrial sources of the Three Gorges Project area was 212 mil. t, same as that of last year. Specifically, 171 mil. t were discharged in the Chongqing-based project area and 41 mil. t were 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, down by 2.6% compared with last year; and 2,200 t ammonia nitrogen, same as that of last year.

Table 4–1 Discharge of industrial effluent in the Three Gorges Project area in 2015

Region		Wastewater (100 million t)	COD (10,000 t)	Ammonia nitrogen (10,000 t)
Hubei-based project area		0.41	0.62	0.04
Chongqing-based project area		1.71	2.80	0.18
Total		2.12	3.42	0.22
Specifically,	Chongqing city proper	0.54	0.41	0.03
	Changshou Dist.	0.26	0.31	0.02
	Fuling Dist.	0.17	0.50	0.02
	Wanzhou Dist.	0.14	0.47	0.06

4.2 Discharge of urban pollutants

4.2.1 Urban sewage

In 2015, the total discharge of urban sewage in the project area was 815 mil. t, up by 2.6% compared with last year. Specifically, 774 mil. t was from the project area in Chongqing Municipality and 41 mil. t from the project area in Hubei Province, taking up 95.0% and 5.0% respectively of the total urban sewage. In the discharged urban sewage, there were 124,100 t COD, up by 0.9% and 22,300 t ammonia nitrogen, down by 1.3% compared with last year.

In 2015, there were a total of 169 sewage treatment plants in cities and towns of the project area, up by 45 compared with last year; 142 of them were in the project area in Chongqing Municipality and 27 were in the project area in Hubei Province. The designed daily sewage treatment capacity of the Three Gorges Project area was 2.6208 mil. t.

Taking samples

4.2.2 Domestic garbage

In 2015, the generated amount of garbage in 24

Table 4-2 Discharge of urban sewage of the Three Gorges Reservoir area in 2015

Region		Wastewater	COD (10,000 t)	Ammonia nitrogen (10,000 t)
Hubei-based project area		0.41	0.66	0.12
Chongqing-based project area		7.74	11.75	2.11
Total		8.15	12.41	2.23
Specifi-cally,	Chongqing city proper	4.49	3.82	1.01
	Changshou Dist.	0.31	0.43	0.07
	Fuling Dist.	0.44	0.94	0.14
	Wanzhou Dist.	0.61	1.46	0.21

Table 4-3 Urban domestic garbage in some areas of the Three Gorges Project area in 2015

Region	Urban permanent population (10,000)	Generated amount (10,000 t)	Disposal amount (10,000 t)	Directly discharged (10,000 t)
Jiangjin	41.23	15.86	13.72	2.14
Chongqing city proper	642.97	247.30	229.00	18.30
Changshou	32.3	12.42	10.76	1.66
Fuling	62.22	23.93	20.68	3.25
Wulong	8.01	3.08	2.58	0.50
Fengdu	20.43	7.86	6.56	1.30
Zhongxian	20.98	8.07	6.75	1.32
Shizhu	2.38	0.92	0.77	0.15
Wanzhou	92.85	35.71	30.00	5.71
Yunyang	25.65	9.87	8.29	1.58
Kaixian	26.31	10.12	8.61	1.51
Fengjie	23.55	9.06	7.54	1.51
Wushan	10.51	4.04	3.37	0.67
Badong	6.88	2.65	2.17	0.48
Xingshan	5.45	2.10	1.75	0.35
Zigui	11.57	4.45	3.70	0.75
Total	1033.29	397.42	356.24	41.18

urban districts (counties) of the Three Gorges Project area totaled 3.9742 mil. t; 3.5624 mil. t of which were disposed, taking up 89.6%, 411,800 t of which were discharged, taking up 10.4%.

4.3 Agricultural non-point pollution

4.3.1 Application and loss of pesticides

In 2015, 19 districts (counties) in the project area applied 601.8 t pesticides (pesticide equivalent), down by 2.2% compared with last year. Specifically, 299.3 t were organophosphorus pesticides, 105.3 t were herbicides, 59.2 t were carbamates, 56.5 t were pyrethroid pesticides and 81.5 t were others. The application amount per unit area was 1.48 kg/ha.

It is estimated from cropland plot monitoring data that the total loss of pesticides was 36.3 t in the project area in 2015, down by 2.1 t compared with last year. Specifically, 24.3 t were organophosphorus pesticides, 5.1 t were herbicides, 2.1 t were carbamates, 2.1 t were pyrethroid pesticides and 2.7 t were others.

4.3.2 Application and loss of fertilizers

In 2015, 135,000 t fertilizers (fertilizer equivalent) were applied in the Three Gorges Project area, up by 3.8% compared with last year. Specifically, 87,000 t were nitrogen fertilizers, 36,000 t were phosphorus fertilizers and 12,000 t were potassium fertilizers. The application amount per unit area was 0.33 t/ha.

It is estimated from cropland plot monitoring data that the total loss of fertilizers was 11,600 t in the Three Gorges Project area in 2015, up by 1,100 t compared with last year. Specifically, 8,600 t were nitrogen fertilizers, 2,000 t were phosphorus fertilizers and 1,000 t were potassium fertilizers.

4.4 Discharge of ship pollutants

In 2015, there were 7,628 registered ships in the Three Gorges Project area. The number of registered ships went up 141 and the total tonnage up 42,000 t compared with last year. There was no ship pollution accident in the Three Gorges Project area in 2015.

4.4.1 Oil-containing wastewater

In 2015, the attainment rate of oil-containing wastewater discharged by ship engine rooms was 88.8% in the project area. In all types of ships, the attainment rate of wastewater was 100% for towboats, 96.4% for passenger ships, 86.9% for cargo ships and 86.5% for non-transport ships. The attainment rate for oil-containing wastewater of towboats remained unchanged, but that of passenger ships, cargo ships, and non-transport ships went down 0.3%, 1.4%, and 9.0% from last year.

In 2015, the generated amount of oil-containing wastewater totaled 394,000 t in the project area with treatment rate at 97.5%. A total of 356,000 t oil-containing wastewater met discharge standard after treatment, with attainment rate at 90.4%. In all types of ships, the generated amount of oil-containing wastewater was 194,000 t for cargo ships, 147,000 t for passenger ships, 51,000 t for non-transport ships and 2,000 t for towboats. The generated amount of ship oil-containing wastewater was down 45,000 t and the attainment rate dropped 1.5 percentage points compared with last year. In all discharged oil-containing wastewater, 37.9 t were petroleum, down by 82,000 t compared with last year.

4.4.2 Ship sewage

In 2015, the investigation on sewage discharge of 50 ships was carried out. Specifically, 39 ships treated their sewage before discharge, with attainment rate of 71.8% for suspended solid, 76.9% for BOD_5, 59.0% for COD, 17.9% for TN and 33.3% for E-coli; the TP discharge of all ships failed to meet discharge standard. There was evident increase of attainment rate of ship sewage compared with last year with major pollutants being TP and TN.

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 2015 was about 3.717 mil. t, down by 23,000 t compared with last year. In all ship sewage, there were 552.7 t suspended solid, 520.0 t COD, 235.8 t BOD_5, 208.2 t TN and 43.0 t TP.

4.4.3 Ship garbage

In 2015, sample investigation was conducted on the generation and collection of domestic garbage of 61 ships and it was estimated that the total generated amount of ship garbage was about 41,000 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 8,886 t ship garbage within its jurisdiction.

Table 4–4 Discharge of oil–contaminated wastewater from ships in the Three Gorges Project area in 2015

Ship		Oil-containing wastewater						Petroleum	
Type	Amount	Generated amount (10000 t)	Percent. (%)	Treated amount (10000 t)	Treatment rate (%)	Attainment amount (10,000 t)	Attainment rate (%)	Discharge (t)	Percent. (%)
Passenger ship	2258	14.7	37.4	14.5	98.8	14.2	96.4	10.5	27.7
Cargo ship	3216	19.4	49.2	18.7	96.1	16.8	86.9	22.4	59.1
Towboat	121	0.2	0.5	0.2	100.0	0.2	100.0	0	0
Non-transport ship	2033	5.1	12.9	5.0	98.1	4.4	86.5	5.0	13.2
Total	7628	39.4	100.0	38.4	97.5	35.6	90.4	37.9	100.0

Chapter 5
Status of Water Environment Quality

In 2015, 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 2015, there were 5 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 and Guandukou section in Badong. The flow of the mainstream in the project area ranged between 3,270 m^3/s and 24,100 m^3/s, and the mean flow rate varied between 0.09 m/s and 2.61 m/s. The flow rate of the mainstream reach from Tuokou section to the Dam evidently became smaller compared with that of the upper reaches due to impoundment of the Reservoir. The average flow rate of each section was 1.48 m/s at Zhutuo, 1.33 m/s at Cuntan, 0.52 m/s at Qingxichang, 0.31 m/s at Tuokou, and 0.22 m/s at Guandukou. The maximum flow rate of each section was 2.61 m/s at Zhutuo, 2.48 m/s at Cuntan, 1.36 m/s at Qingxichang, 1.23 m/s at Tuokou and 0.53 m/s at Guandukou.

5.2 Water quality

In 2015, 8 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 and Guandukou section in Badong. 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 and excellent in the Jialing River in 2015. The TP content in the waters of the Wujiang River failed to meet national surface water quality standard.

The overall water quality of all the 8 sections of the mainstream of the Yangtze River met Grade Ⅲ water quality standard in 2015. 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 to Beiwenquan section of the Jialing River met Grade Ⅱ water quality standard. The water quality of Luoying section of Wujiang River met Grade Ⅲ standard. The overall water quality of Wanmu section met Grade Ⅳ standard in 2015 with TP as major pollutant. Monthly data showed the water quality of both Jinzi section and Beiwenquan section met or was superior to Grade Ⅲ standard. The water quality of Wanmu section met Grade Ⅴ in April-May, Grade Ⅳ in February-March, June-July and December and Grade Ⅲ in the rest of the months. The water quality of Luoying section met Grade Ⅳ standard in March-May and December and Grade Ⅲ in the rest of the months.

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. 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 18.2%～40.3% of the sections of 38 main tributaries of the project area were in eutropher during sensitive period (March-October) of algal bloom in 2015, basically similar to that of last year.

Monthly data showed, in the 77 sections, 18.2%～40.3% were in eutrophic state, 57.1%～75.3%

Table 5–1 Water quality of the monitoring sections of mainstream of the Yangtze River in the Three Gorges Project area in 2015

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

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 2015

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

were in mesotrophic state, and 0%～6.5% were in oligotrophic state. Specifically, 15.0%～47.5% sections in backwater areas were in eutrophic state, so were 18.9%～32.4% sections in non-backwater areas.

The overall eutrophication level of backwater areas levelled off with that of last year. Specifically, there was 5.0, 2.5, 15.0 and 2.5 drop of percentage points of eutrophic sections in March-May and October respectively and 2.5, 10.0 and 10.0 percentage points increase in June, July and September respectively compared with that of same month last year. The percentage of eutrophic sections in August was the same as that of last year. The eutrophication level of non-backwater areas was similar to that of last year. There were 2.7, 2.7, 2.7 and 5.4 percentage point decrease of eutrophic sections in April, May, July and August respectively but 2.7, 8.1 and 8.1 percentage point increase of eutrophic sections in June, September and October compared with that of same month last year. The percentage of eutrophic sections in March levelled off with that of the same month last year.

5.3.2 Algal blooms

In 2015, there were algal blooms in the Chixi River, Qinggan River, Tongzhuang River, Xiangxi River, Shennong Stream, Daning River, Daxi River, Caotang River, Meixi River, Modao Stream, Changtan River, Tangxi River, Dongxi River, Huangjin River, Pengxi River, Longhe River, Zhenxi River, Quxi 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 and Melosira of Bacillariophyta; Cryptomonas of Cryptophyta; Chlamydomonas of Chlorophyta as well as Mycrocystis and Aphanizomenon of Cyanophyta.

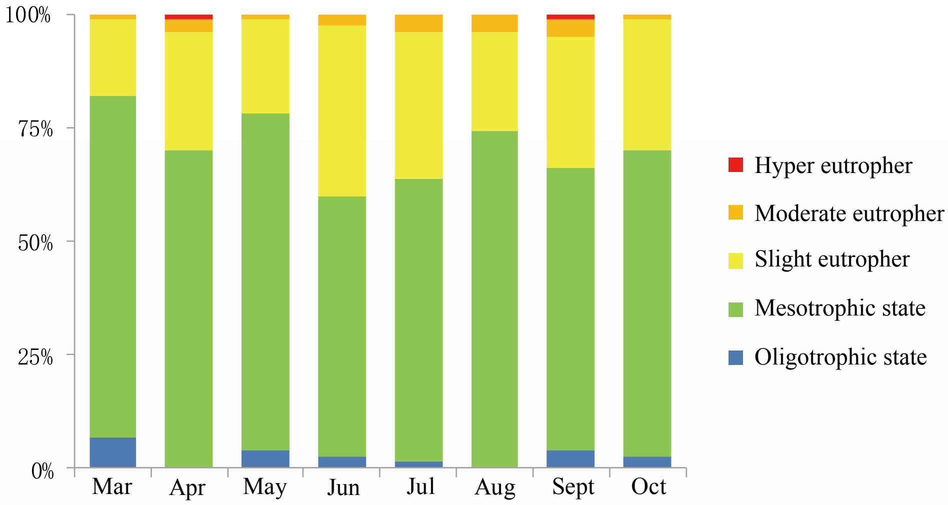


Figure 5-1Trophic state of main tributaries of the Yangtze River in the project area during March-October of 2015

Chapter 6
Status of Public Health

6.1 Basic situation

In 2015, 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 757,498, down by 849 compared with last year. Specifically, 387,499 were male and 369,999 were female with gender ratio at 1.05:1; 418,881 lived in cities and towns and the rest 338,617 lived in rural areas. There were 337 health institutions at all levels in the monitoring sites, up by 8 compared with last year. There were 6,217 hospital beds in all health institutions in the monitoring sites, up by 54 compared with last year. The total amount of health workers at different levels was 7,303, up by 272 compared with last year.

6.2 Life statistics

In 2015, a total of 6,072 babies were born in the monitoring sites with birthrate at 8.02‰, up by 1.52% compared with last year; 3,132 were male, and 2,940 were female with gender ratio at 1.07:1. There were 4,905 deaths in 2015 with mortality at 6.48‰, up by 1.09% compared with last year; 2,833 were male and 2,007 were female.

The birthrate was 8.87‰ for Chongqing, 8.23‰ for Fengdu, 6.55‰ for Wanzhou, 10.44‰ for Fengjie and 6.09‰ for Yichang. The mortality was 6.53‰ for Chongqing, 6.87‰ for Fengdu, 6.35‰ for Wanzhou, 5.74‰ for Fengjie and 7.14‰ for Yichang. The birthrate of Yichang was lower than the mortality. In other monitoring sites, the birthrate was higher than mortality. For birthrate, there was 28.94% rise in Wanzhou and 0.83% rise in Yichang but 17.95% reduction in Fengdu, 1.44% reduction in Chongqing and 0.67% reduction in Fengjie compared with last year. For mortality, there was 20.08% rise in Fengjie, 5.62% rise in Yichang, 8.03% reduction in Chongqing, 2.31% reduction in Wanzhou and 1.43% reduction in Fengdu compared with last year.

All monitoring sites reported 26 cases of infant death with mortality at 4.28‰, up by 28.14% 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 2015 were circulatory system diseases, malignant tumors, respiratory system diseases, damage & poisoning and digestive system diseases with mortality at 243.04/100,000, 181.65/100,000, 101.78/100,000, 49.24/100,000 and 15.97/100,000 respectively, leading to 37.53%, 28.05%, 15.72%, 7.60% and 2.47% respectively (combined 91.37%) of the total deaths. The ranking of the top 5 killer diseases kept the same as last year. There was 7.18%, 5.64%, 5.48% and 3.20% rise of the mortality of digestive system disease, tumor, damages & poisoning and circulatory system disease respectively, but 9.51% reduction of the mortality of respiratory system diseases. The ranking of the top killer diseases for male was similar to that of the total population. The ranking of the top 4 diseases with the highest mortality was similar to that of the total population, however, the fifth disease was endocrine and nutrition and metabolic diseases. The mortality of male was higher than that of female. The ranking of the diseases with the highest mortality varied in different regions, but the mortality of respiratory system disease 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 Yichang. In Fengjie, 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 2015, all monitoring sites reported 4,158 cases of notifiable infectious diseases with morbidity at 548.91/100,000, down by 5.11% compared with last year. There was one death with mortality at 0.13/100,000. There was no report of Category A infectious disease. The morbidity from high to low was 745.41/100,000 in

Chongqing, 643.76/100,000 in Yichang, 540.11/100,000 in Fengdu, 471.24/100,000 in Fengjie and 414.12/100,000 in Wanzhou. There was 27.76% increase of morbidity in Fengjie but 22.15%, 12.69%, 9.32% and 0.95% reduction in Fengdu, Wanzhou, Yichang and Chongqing respectively compared with last year. The reported cases of Category B infectious diseases were the most in July but least in February and were in the range of 165～222 cases in the rest months. There were two epidemic outbreaks of Category C infectious diseases in May～July and November～December due to many reported cases of hand-foot-mouth diseases, parotitis and other infectious diarrhea.

All monitoring sites reported 2,311 cases of 10 types of Category B infectious diseases (excluding HIV) with morbidity at 305.08/100,000, up by 6.76% compared with last year. In all monitoring sites, Yichang had the highest morbidity (541.34/100,000), followed by Fengjie, Chongqing and Fengdu; Wanzhou had the lowest (165.83/100,000). There was 60.66% increase of the morbidity in Fengjie, 23.67% increase in Yichang, but 34.90% reduction in Fengdu, 5.34% reduction in Wanzhou and 2.86% reduction in Chongqing compared with last year. The top five infectious diseases with the highest morbidity were viral hepatitis (145.87/100,000), TB (94.13/100,000), syphilis (31.29/100,000), dysentery (15.58/100,000) and gonorrhea (7.26/100,000). The combined morbidity of the top 5 diseases accounted for 96.41% of the total. In all types of Category B infectious diseases, there was an increase of morbidity for hepatitis A, hepatitis B, hepatitis C, hepatitis E, AIDS, syphilis, measles and scarlet 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 9.95% compared with last year. The morbidity of water-borne infectious diseases such as hepatitis A (1.98/100,000), hepatitis E (3.70/100,000), dysentery (15.58/100,000) and typhoid (0.40/100,000) was still at a relatively low level.

All monitoring sites reported 1,847 cases of 6 types of Category C infectious diseases with morbidity at 243.83 /100,000, down by 16.71% compared with last year. The morbidity was 377.88/100,000 for Chongqing, 337.92/100,000 for Fengdu, 248.29/100,000 for Wanzhou, 102.42/100,000 for Yichang and 78.42/100,000 for Fengjie. The morbidity went up by 0.98% in Chongqing but decreased by 62.37% in Yichang, 36.94% in Fengjie, 17.00% in Wanzhou and 11.83% in Fengdu monitoring sites compared with last year.

6.3.2 Monitoring of endemic diseases

In 2015, the monitoring sites carried out monitoring on iodine deficiency. Palpation method was employed to investigate thyroid enlargement. A total of 753 children with age at 8~12 were investigated, 26 of them had I° thyroid enlargement, taking up 3.45%, marking some reduction compared with last year and suggesting a slight endemic. A total of 1,420 households were investigated on their salt consumption, and 1,415 households consumed iodine added salt, taking up 99.65%; 1,331 households consumed qualified iodine added salt. The qualification rate of iodine added salt was 94.06% and consumption rate of qualified iodine added salt was 93.73%. 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.

In 2015, Fengjie monitoring site carried out sample investigation on 266 children aged 8~12 for dental fluorosis, and 65 cases of dental fluorosis were found with positive rate at 24.4%.

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 2015, the average indoor rat density of all monitoring sites in the Three Gorges Project area was 3.02%, higher than that of last year, and the outdoor rat density was 2.65%, slightly lower than that of last year; both being 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 higher than that in the autumn, contrary to that of last year. In the spring, the indoor rat density (3.25%) was higher than outdoor rat density (2.40%), contrary to that of last year. In the autumn, the indoor rat density (2.79%) was lower than outdoor rat density (2.98%), same as that of last year. The ranking of indoor rat density of all monitoring sites from high to low was Fengdu (4.83%), Chongqing (3.85%), Wanzhou (2.37%), Fengjie (1.39%) and Yichang (0.67%). The ranking of outdoor rat density from high to low was Chongqing (6.81%), Fengdu (5.28%), Wanzhou (1.58%), Yichang (0.87%) and Fengjie (0.63%).

In indoor environment, *Rattus norvegicus* was the dominant rat species, taking up 35.63%; followed by *Rattus flavipectus*, taking up 28.74%; *Mus musculus* ranked No.3, taking up 19.54%. Last year, the dominant rat species was also *Rattus norvegicus*, but as opposed to this year, the second ranking species was *Mus musculus*, and the third was *Rattus flavipectus*. In 2015, the percentage of indoor *Rattus flavipectus* went further higher; that of *Rattus norvegicus* and *Mus musculus* dropped evidently; there was no catch of *Apodemus agraius*; and the percentage of other rats and small insectivores rose to a certain extent compared with last year, but the catch was in a small amount. In outdoor environment, small insectivore (mainly *Anourosorex squamipes*) was still in dominance, accounting for 43.06%; *Apodemus agraius* ranked No.2, taking up 18.06% and *Rattus norvegicus* ranked No.3, taking up 11.19%. *Apodemus agraius* had been upgraded from No.3 last year to No.2 in dominance. The catch of small insectivores was still the biggest in amount in outdoor environment, but the percentage had significant decrease compared with last year. The percentage of *Apodemus agraius* and other rat species had some rise compared with last year with catch of *Rattus Losea* as a new species. There was some decrease of the percentage of *Rattus norvegicus*, *Mus musculus* and *Rattus flavipectus* compared with last year.

6.4.2 Monitoring of mosquitoes

In 2015, the adult mosquito density was 151.73/pen•man hour for livestock pens and 40.64/room•man hour for human dwellings, both higher than that of last year but 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 (95.44/ room•man hour), Chongqing (42.67/room•man hour), Fengdu (32.72/room•man hour), Fengjie (25.12/room•man hour) and Yichang (6.84/room•man hour). The ranking of adult mosquito density of livestock pens from high to low was Fengdu (208.36/pen•man hour), Fengjie (181.72/pen•man hour), Wanzhou (137.88/pen•man hour), Chongqing (132.33/pen•man hour) and Yichang (102.24/pen•man hour). There was some increase of adult mosquito density of human dwellings in Fengdu, Fengjie and Yichang but some reduction in Chongqing and Wanzhou compared with last year. There was some increase of adult mosquito density of livestock pens in Fengdu and Fengjie but some reduction in Chongqing, Wanzhou and Yichang.

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

Armigeres subalbatus ranked No.1 in both human dwellings and livestock pens, taking up 81.43% and 67.68% respectively of the total. In human dwellings, *Culex pipiens fatigans* ranked No.2, taking up 10.34%, followed by *Anopheles sinensis* at No.3, *Culex tritaeniorhynchus* at No.4 and *Culex pipiens pallens* at No.5. In livestock pens, *Culex pipiens fatigans* ranked No.2, followed by *Culex pipiens pallens*, *Culex tritaeniorhynchus*, and *Anopheles sinensis* at No.3～5 respectively. The percentage of *Armigeres subalbatus* and *Culex pipiens pallens* went up, of *Culex tritaeniorhynchus* levelled off, and of other mosquito species decreased in human dwellings compared with last year. In livestock pens, there was some rise of percentage of *Culex pipiens pallens*, *Culex pipiens fatigans* and *Anopheles sinensis*, but some reduction of *Armigeres subalbatus* and *Culex tritaeniorhynchus* 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 2015, the statistical analysis of measurement data of Huanglingmiao Hydrological Station downstream the Three Gorges Project showed that the annual average flow was 12,100 m^3/s, 16% less than the designed value. The maximum flow was 31,700 m^3/s occurring on July 1 and minimum flow 4,860 m^3/s occurring on February 25. There was a total discharge of 4.25 mil. t sediment in the whole year, 90% less than the annual average of 2003-2014 and 60% less than that of last year. The annual average sediment discharge rate was 0.135 t/s with average sediment concentration at 0.011 kg/m^3. The maximum average sediment concentration of the monitoring sections was 0.073 kg/m^3 occurring on July 10 and minimum average sediment concentration was 0.003 kg/m^3 occurring on January 30.

Table 7–1 Monthly flow at Huanglingmiao Hydrological Station in 2015

Unit: m^3/s

Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
Avg.	6400	6430	6950	9580	11900	17600	21000	16000	20400	13300	8660	6710	12100
Max.	6800	8180	9430	15700	17200	31100	31700	19800	24800	19700	16400	7080	31700
Min.	5660	4860	6100	6180	6760	6190	11700	8810	12500	6410	5330	5320	4860

Table 7–2 Monthly sediment concentration at Huanglingmiao Hydrological Station in 2015

Unit: kg/m^3

Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
Avg.	0.005	0.003	0.004	0.006	0.008	0.014	0.032	0.008	0.008	0.005	0.006	0.004	0.011
Max.	0.006	0.003	0.005	0.009	0.012	0.044	0.073	0.015	0.018	0.008	0.008	0.005	0.073
Min.	0.003	0.003	0.003	0.004	0.004	0.005	0.011	0.004	0.004	0.004	0.005	0.003	0.003

7.1.2 Climate

In 2015, the annual average air temperature of the Three Gorges Dam area was slightly on the high side, and the precipitation was slightly on the low side.

● **Air temperature**

The annual average air temperature of the Three Gorges Project area was 17.2℃ , up by 0.1℃ compared with the historical average. The annual extreme high temperature was 38.8℃ on July 29 and annual extreme low temperature was -0.5℃ occurring on December 17.

● **Precipitation**

The annual precipitation of the Three Gorges Project area was 1,099.3 mm, up by 7.5% compared with that of historical average. The monthly distribution of precipitation was very uneven, mainly concentrated on April-November with daily maximum precipitation of 65.4 mm on August 15. The longest continuous non-precipitation period of the year was 26 days between December 11, 2014 and January 5, 2015. The longest continuous precipitation period in the year was 8 days occurring from October 25 to November 1.

- Wind speed

The annual average wind speed of the Three Gorges Dam area was 1.0 m/s. The maximum wind speed reached 13.2 m/s on August 4. The wind direction was ever-changing in the whole year. The northeast by north wind was the dominant wind, which accounted for 12% in the whole year.

Table 7–3 Meteorological indicators of the Three Gorges Dam area in 2015

Month		1	2	3	4	5	6	7	8	9	10	11	12	Year
T	Temperture (℃)	7.7	8.5	12.7	16.8	22.0	23.8	26.6	26.7	22.9	19.2	12.0	8.0	17.2
	Departure (℃)	2.3	1.0	0.5	-0.7	0.3	-1.4	-0.7	0.1	0.1	1.1	-0.9	0.5	0.1
P	P (mm)	15.4	33.9	24.1	119.5	140.9	182.4	137.4	153.3	146.5	69.5	50.5	25.9	1099.3
	Departure (%)	-3.1	-5.0	-46.0	35.8	14.4	52.5	-17.9	-14.0	23.6	-1.6	10.0	72.7	7.5
Wind speed	Mean (m/s)	1.2	1.1	1.1	1.2	0.9	0.9	1.0	1.1	0.9	0.8	1.0	1.3	1.0
	Max. (m/s)	6.0	4.6	7.0	6.7	5.3	5.4	5.5	8.7	4.3	4.1	5.9	4.7	8.7
	Extreme (m/s)	8.7	7.3	11.2	13.0	10.1	8.1	9.1	13.2	9.2	7.5	10.6	9.9	13.2

7.2 Air quality

The assessment of ambient air quality of the Three Gorges Dam area (office and residential areas and construction sites) complied with the *Ambient Air Quality Standard* (GB3095-1996).

In 2015, the annual average SO_2 concentration of the Three Gorges Dam area was 0.008 mg/m^3, meeting Grade I standard, down by 0.001 mg/m^3 compared with last year. The daily average SO_2 concentrations met Grade Ⅰ standard across the dam area. The annual average NO_2 concentration was 0.021 mg/m^3, meeting Grade Ⅰ standard, up by 0.005 mg/m^3 compared with last year. The daily average NO_2 concentrations met Grade Ⅰ standard.

The annual average TSP concentration of the dam area was 0.126 mg/m^3, meeting Grade Ⅱ standard, down by 0.007 mg/m^3 compared with last year. Specifically, 54.2% of the daily average TSP concentrations of office and residential areas met Grade Ⅰ air quality standard, 44.5% met Grade Ⅱ standard, and 1.3% met Grade Ⅲ standard. Meanwhile, 55.5%, 43.1% and 1.4% of daily average TSP concentrations of construction sites met Grade Ⅰ, Ⅱ and Ⅲ air quality standard respectively.

7.3 Water quality

A total of 13 indicators including pH value, dissolved oxygen, ammonia nitrogen, COD, COD_{Mn}, BOD_5, volatile phenol, cyanide, arsenic, Cr^{6+}, copper, lead and cadmium were chosen to assess the water quality of the mainstream of Yangtze River in the dam area in accordance with the *Environmental Quality Standard for Surface Water* (GB3838-2002). Anion surfactant indicator was added to assess the water quality of near-bank waters.

In 2015, the water quality of all sections of the mainstream of Yangtze River and near-bank waters in the dam area was excellent, meeting Grade Ⅰ standard, basically same as that of last year.

Table 7–4 Water quality of the mainstream sections of the Yangtze River in the Three Gorges Dam area in 2015

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

Table 7–5 Water quality of near–bank waters of the Yangtze River in the Three Gorges Dam area in 2015

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

7.4 Noise

In 2015, the average daytime and nighttime ambient noise level was 51.8 dB and 45.1 dB respectively in office and residential areas of the Three Gorges Dam area, meeting Grade I and II standard of *Environmental Quality Standard for Noise* (GB3096-2008). The average noise level went down 4.4 dB at day and 1.2 dB at night in the office and residential areas compared with last year. It was 51.2 dB for daytime environment noise and 46.3 dB for nighttime environment noise in construction sites, both meeting the noise limit for workshop and operation sites specified in national *Code for Design of Noise Control of Industrial Enterprises* (GBJ87-1985). There was 1.2 dB reduction of daytime noise and 1.0 dB reduction of nighttime noise on average in construction sites compared with last year. The boundary noise met the noise limit specified in *Noise Limits for Construction Sites* (GB12523-2011). The annual average traffic noise of the Three Gorges Project area was 65.4 dB, down by 0.1 dB compared with last year.

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, 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 2015 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, reduce water and soil loss, cut down non-point source pollution, and raise economic benefits.

From the perspective of improving the physical and chemical properties of soils, the content of organic matters, Total Nitrogen (TN), Total Phosphorous (TP), Total Potassium (TK), Available Phosphorous (AP), and Available Potassium (AK) of Model Ⅰ went up 42.8%, 15.5%, 33.9%, 9.6%, 17.0%, and 13.9% respectively from the conventional flat tillage of grain and cash crops up and down the slope (hereinafter referred to as Model Ⅱ), and that of Alkali-hydrolyzable Nitrogen (KN) went down 7.5%. The content of TN, TP, TK and AK rose by 30.3%, 5.1%, 31.5%, and 17.1% respectively and that of organic matters, KN, and AP descended 0.5%, 12.2%, and 15.3% respectively in Model Ⅰ.

Collecting water samples

From the perspective of water and soil conservation, the mean soil moisture of Model Ⅰ registered 30.7% in 2 days after rain, 29.1% in 4 days after rain, and 25.0% in 8 days after rain, up 7.6%, 10.61%, and 11.3% respectively compared with that of Model Ⅱ. The surface runoff and soil erosion of Model Ⅰ posted 17,320 m^3/km^2 and 11.98 t/km^2, down 53.1% and 86.2% from Model Ⅱ. The surface runoff of Model Ⅰ was 17.4% more than last year and the soil loss went up 39.3%.

From the perspective of controlling non-point source pollution, the nitrogen content of Model Ⅰ amounted to 58.03 kg/km^2, down 68.1% from Model Ⅱ. The nitrogen content of surface runoff and sediments in Model Ⅰ reached 37.76 kg/km^2 and 20.17 kg/km^2 respectively, down 66.3% and 71.1% from Model Ⅱ. The phosphorous loss of Model Ⅰ registered 12.32 kg/km^2, down 70.7% from Model Ⅱ. The phosphorous loss of surface runoff and sediments in Model Ⅰ posted 5.54 kg/km^2 and 6.78 kg/km^2 respectively, down 42.2% and 79.1% from that of Model Ⅱ. The nitrogen and phosphorous loss load in Model Ⅰ went up 59.7% and 29.7% respectively from last year.

From the perspective of economic outputs, the net income of Model Ⅰ amounted to 2,001 yuan/*mu*, up by around 1.2 folds from that of Model Ⅱ.

8.1.2 Experiment on steep slope with hedgerow model

The 2015 monitoring data suggested the steep slope with hedgerow model was more efficient in retaining water and soil and reducing the output load of non-point source pollution than the bare steep slope (control model) (in the second year). The surface runoff and erosion sediment yield diminished notably, and the output load of non-point pollution sources also decreased to a certain extent in bare steep slope compared with last year.

In terms of ameliorating soil nutrients, the hedgerow model raised the content of soil organic matter, TN, TP, TK, KN, AP and AK by 9.9%, 14.1%, 7.6%, 1.2%, 25.9%, 17.3%, and 17.6% respectively compared with that of the bare slope. The TN, TP and TK content in soil of hedgerow model and bare slope was on a rising trend, and that of the remaining soil nutrients was on a declining trend, compared with last year.

In terms of reducing water loss and soil erosion, the mean soil moisture of hedgerow model was 30.3%, 27.2%, and 24.6% respectively in 2, 4 and 8 days after rainfall and varied little with the bare slope. The surface runoff was 8,750 m^3/km^2 and soil erosion was 6.3 t/km^2, down by 20.7% and 47.2% respectively compared with that of the control model. The surface runoff dropped 13.4% and the soil loss was cut by 18.8% in Model Ⅰ compared with the previous year.

In terms of controlling non-point source pollution, the nitrogen loss of hedgerow model registered 38.81 kg/km^2, 11.9% less than that of bare slope. The nitrogen loss of the surface runoff and the sediments of hedgerow model posted 20.14 kg/km^2 and 18.67 kg/km^2 respectively, 14.7% and 8.75% less than the bare slope. The phosphorous loss of the hedgerow model totaled 7.82 kg/km^2, 22.4% less than the bare slope. The phosphorous loss of the surface runoff of the hedgerow model posted 2.45 kg/km^2, which levelled off with that of the bare slope. The phosphorous loss of the sediments carried by the surface runoff was 5.37 kg/km^2, 29.8% less than the bare slope. The nitrogen loss of the Model Ⅰ dropped 6.9% and the nitrogen loss went down 25.8% from the previous year.

8.2 Zigui Model Zone

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

In 2015, 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 25.6%, 43.8% and 36.6% respectively compared with that of the conventional wheat-peanut plot. They also reduced slope sediment yield by 54.4%, 77.5%, and 79.9% respectively; the loss of nitrogen by more than 80.0%; and the loss of phosphorous by 12.3%, 56.0%, and 56.1% respectively.

Relative to the conventional navel orange orchard, the slope farmlands that had taken such three measures as intercropping perennial white clover as hedgerow, straw coverage, and intercropping day lily as hedgerow reduced the runoff yield by 10.9%, 13.2%, and 10.6%; the sediment yield by 63.0%, 52.7%, and 60.1%; the nitrogen loss by 31.2%, 52.3%, and 48.5%; and the phosphorous loss by 51.1%, 52.8%, and 51.0% respectively.

The consecutive observations for 13 years indicated that the three models, that is, the interplanting with pastures, the interplanting with hedgerow, and the straw coverage were able to steadily control the water loss and soil erosion and nitrogen and phosphorous loss of the navel orange orchards. The embedment of impervious films helped with such control as well but not steadily. The wheat-peanut stereo-Plot with interplanted hedgerow was not conducive to the control of water loss and soil erosion or nitrogen and phosphorous loss, and thus not suitable for the management of citrus orchards during full fruit period.

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. A 2015 survey suggested the content of the sand with diameter ranging from 2.0 mm to 0.05 mm accounted for 17.1%～43.3% in the soils of the monitoring sites, that of silty sand with diameter ranging from 0.05 mm to 0.002 mm occupied 44.2%～63.3%; and that of clay with diameter under 0.002 mm took up 12.1%～21.3%. The content of soil nutrients was 5.26～27.21 g/kg for organic matter; 0.75～1.62 g/kg for TN; 0.29～1.14 g/kg for TP; 11.35～20.82 g/kg for TK; 79.64～179.84 mg/kg for KN; 3.72～172.63 mg/kg for AP and 91.00～597.06 mg/kg for AK. The desertification, low content of organic matters, and low content of nitrogen and less phosphorous remained the main limiting factors contributing to lower soil fertility.

The experiment on and demonstration of the water-fertilizer integration technology were conducted in navel orange production zones. The monitoring data showed that after application of water-fertilizer integration technology, the tree growth enjoyed significant improvement, with 0.9% rise of tree height, 17.3% increase of canopy diameter, and 11.8% rise of the diameter of the stem 40 cm above ground, compared with the case with conventional fertilizer formula. The navel orange output per tree was up 30.9%, specifically, the output of the tree with orange diameter below 70 mm rose 5.3%, and that of the tree with orange diameter above 70 mm soared 42.6%; the average weight of a navel orange was 9.2% more, and the output per tree went up 42.3%. The integrated management of water and fertilizers was conducive to the improvement of soil moisture and nutrient efficiency. The water-fertilizer integration technology raised the average water content of soils by 1 fold in dry season compared with that of rain irrigated control plot. It effectively improved water supply. In addition, the TN content of soil leachate decreased by 21.7%, which helped reduce nitrogen loss.

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 2015.

8.3.1 Soil physical and chemical properties

In 2015, 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 (accounting for 65%) 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, lead, and zinc in soils went up by 0.79 mg/kg, 18.40 mg/kg, 4.05 mg/kg, and 20.66 mg/kg respectively; while that of mercury, cadmium, copper, iron, and manganese went down by 0.01 mg/kg, 0.04 mg/kg, 6.09 mg/kg, 6.93 g/kg, and 0.44 g/kg respectively, compared with that of the same period last year. Before the impoundment, the content of mercury, arsenic, chromium, cadmium, lead, copper, and zinc in soils increased by 0.23 mg/kg, 0.04 mg/kg, 1.16 mg/kg, 10.80 mg/kg, 0.02 mg/kg, 2.03 mg/kg, 2.73 mg/kg, and 16.02 mg/kg respectively; while that of iron and manganese went down by 5.45 g/kg and 0.29 g/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 most soil nutrients went up to varied degrees, by 0.04 g/kg for TN, 0.10 g/kg for TP, 0.59 g/kg for TK, 5.02 mg/kg for AP, 5.52 mg/kg for AK, 1.40 mg/kg for NH_3-N, and 7.73 mg/kg for nitrate nitrogen, except that of organic matters, which was down 1.89 g/kg, compared with that of the same period last year. Before the impoundment, the contents of most soil nutrients were still on a rising trend, up by 0.11 g/kg, 0.05 g/kg, 2.72 mg/kg, 4.88 mg/kg and 0.69 mg/kg respectively for TN, TP, AP, AK, and NH_3-N, except organic matters, TK, and nitrate nitrogen, the content of which dropped 0.65 g/kg, 1.97 g/kg and 5.76 mg/kg respectively.

8.3.2 Vegetation restoration

In 2015, the post-recession plant community survey identified 65 species of vascular plants in 57 genera of 25 families. There were a large amount of minor genus and monotypic genus species, together they accounted for 98.3% of the total species, and the latter took up 89.5%. Herbaceous plant species dominated the vegetation, 58.5% of which were annual herb species and 32.3% were perennial herb species. The percentages of arbor, shrub and vine species were relatively low. Before the impoundment, there were 89 species of vascular plants in 72 genera of 32 families. There were a large amount of minor genus and monotypic genus species, together they accounted for 98.6% of the total species, and the latter took up 84.7%.

8.3.3 Monitoring of bio-vectors

In 2015, a total of 2,306 rat traps were placed in the monitoring sites of the water-level-fluctuating zones, as a result of which 21 rat-shape animals were caught with average rat density at 0.91%, higher than that of the same period last year (0.63%). *Apodemus agrarius* was the dominant species, taking up 57.1%, followed by *Rattus norvegicus* at 23.8%, and then *Rattus losea* and *Rattus flavipectus* at 14.3% and 4.8% respectively. In specific, the post-recession rat density averaged out at 1.04%, higher than that of the same period last year (0.61%). The pre-impoundment rat density averaged out at 0.65%, lower than that of the same period last year

(0.77%). The post-recession rat density was higher than the pre-impoundment rat density.

In 2015, zapper lamps were placed in the monitoring sites of water-level-fluctuating zones for 90 zapper lamp·times with catch of 309 mosquitoes. The mosquito density was 3.43/zapper lamp·times, less than that of the same period last year (4.43/zapper lamp·times). The main mosquito species were *Culex pipiens fatigans* (51.8%), *Armigeres subalbatus* (28.5%), *Anopheles sinensis* (8.7%), *Culex tritaeniorhynchus* (5.2%) and *Aedes albopictus* (1.3%).

In 2015, flytraps were placed in monitoring sites of water-level-fluctuating zones for 84 trap·times, catching 243 flies with average fly density at 2.89/flytrap, higher than that of the same period last year (2.06/flytrap). The main fly species were *Boettcherisca peregrina* (58.9%), *Musca sorbens* (20.6%), *Musca domestica* (6.6%) and *Aldrichina grahami* (6.6%).

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. The mean annual groundwater table of the observation wells ranged between 21.73 m and 22.62 m and varied between 0.77 m and 2.31 m across the year. The confined water table ranged between 20.86 m and 23.17 m, with variation spanning 2.31 m. The phreatic water table ranged between 21.09 m and 23.39 m, with variation spanning 2.30 m. In general, the groundwater table moved up 0.06 m from last year. 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 between August and October, rose slightly in November, and kept at a fairly high level in December. The groundwater table ascended early starting from a low 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 0.15 and 8.90 centimol/kg, and averaged out at 2.07 centimol/kg, down 0.43 centimol/kg from last year; the mean annual content of active reductive substances ranged between 0.07 and 6.29 centimol/kg, and averaged out at 1.26 centimol/kg, down 0.28 centimol/kg from last year; the mean annual content of ferrous iron ranged between 0.01 and 1.60 centimol/kg, and averaged out at 0.21 centimol/kg, 0.09 centimol/kg less than last year. The soil gleization aggravated in the summer 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 was monitored in the estuary (land-sea interface) of Yangtze River in 2015. 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**

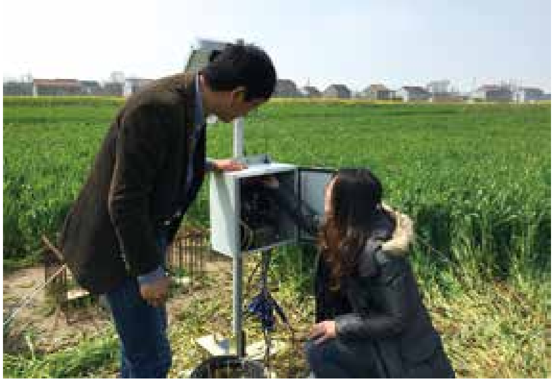
Monitoring data at the three sections showed the conductivity of the Yangtze River waters was high in the spring, autumn and winter, and low in the summer of 2015. The conductivity of Yinyang section dropped slightly from last year. Specifically, it declined fairly obviously between January and July, went up 21.2% between August and September, and dropped to a certain extent in October. The mean annual conductivity of Daxing section dropped 17.1% from last year. In specific, it declined notably between January and June and escalated by a fairly large margin between July and September. The mean annual data for Xinglongsha section dropped 26.4% from last year. However, the monthly data escalated as much as 81.4% between August and November due to weakening great throughflow.

● **Conductivity of inland river waters**

The conductivity of inland river waters was higher near the north bank and lower near the south bank of the north branch than a year ago. The mean annual conductivity of inland waters was approximate to that of last year at Yinyang section; however, the mean monthly conductivity soared 51.8% from August through October compared with last year, and was much higher than the level of 2013 which was a dry year. The mean annual conductivity rose 16.0% from last year at Daxing section, due to the effects of the conductivity of the Yangtze River waters; the mean monthly conductivity spiked from August to September by 105.0% from last year and by 46.2% from the same period of 2013, and dropped to a certain extent due to more rainfall in October. The mean annual conductivity went down 26.1% from last year at Xinglongsha section but rose 12.8% in August and dropped 9.9% from September to October compared with last year. 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**

The groundwater depth in the north bank of the estuary has been low in recent years, easily leading to top enrichment of salt in soil. The mean annual groundwater depth went up to a certain extent from a year earlier in the north bank and varied little in the south bank, due to the effects of the upstream runoff variations and water level fluctuations of the Yangtze River. The mean annual groundwater depth was up 5.6% from a year earlier at Yinyang section; in specific, the depth diminished in June due to rainfalls, 21.4% less than that of the same period last year; and escalated from August to September, 50.2% more than that of the same period last year. At Daxing section, the mean annual groundwater depth rose 19.0% from a year earlier, 9.3% less from the level of 2013, a dry year. Specifically, the mean monthly groundwater depth from July through November was much higher than that of respective month last year, and up 75.4% on average. At Xinglongsha section, the mean annual groundwater depth was close to that of last year. The mean monthly groundwater depth was on a declining trend between August and December, and down by 19.2% on average between October and December.



Checking the automatic monitoring equipment for soil water–salt dynamics

● **Groundwater conductivity**

The mean annual conductivity of groundwater was at a fairly high level in all of the three sections this year and levelled off with last year. The mean annual conductivity of groundwater reached a record high in recent years at Yinyang section, going up slightly from last year and 4.8% from 2013. The figure dropped 13.9% from last year and 5.7% from 2013 at Daxing section. The figure elevated slightly at Xinglongsha section from last year. Specifically, the mean monthly data increased 5.2% from August through October, 55.1% more than 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 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 2015, the mean annual soil conductivity was lower than that of last year. However, the salification was remarkable in the 40 cm layer soil from January through May, and the soil salinity was in a rising trend in the autumn and winter. The mean annual soil conductivity was down 12.7% from last year at Yinyang section. In specific, the mean monthly soil conductivity dropped 15.0% on average from January through May and went up 8.3% on average from September to October from the same months last year. At Daxing section, the mean annual soil conductivity escalated to a certain extent from last year, significantly from September through December. At Xinglongsha section, the mean annual soil conductivity was approximate to that of last year. The mean quarterly conductivity in the spring was higher than last spring, and the data in the autumn and winter lowered down. The area-wide soil survey in October suggested a slight surge in the soil salinity, and the area of moderately and slightly salinized soils in the topsoil near the Yangtze River estuary expanded to a certain extent from 2014. The soil salinity was generally higher at the conjuncture of the River and the sea, and largely gathered on the soil surface.

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 13.44°C and 20.02°C in the surface layer, and between 12.73°C and 20.02°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. The temperature ranged between 18.72°C and 20.00°C near the coastline and between 21.00°C and 22.96°C in the infralittoral waters. Compared with last year, the temperature was generally on the low side in the spring, with the highest temperature 1.11°C lower and the lowest 0.53°C lower; it was generally on the high side in the autumn, with the highest temperature 1.79°C higher and the lowest 0.09°C higher.

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 27.00 in the infralittoral waters, reaching as much as 31.54. In the bottom layer, the diluted waters were too weak to extend beyond the estuary mouth. 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 22.00 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 0.61 lower in the spring and 0.94 higher in the autumn.

The SD of the estuary waters was low in the estuary mouth and near the coastline and high in the infralittoral waters, due to the runoff of the Yangtze River. In the spring, the SD was generally high to the east of 122°30′E, ranging somewhere between 2.0 m and 6.0 m in the spring, and under 3.0 m in the autumn in most cases. The SD was on the high side in both spring and autumn, compared with last year.

● **Hydrochemical elements**

The content of dissolved oxygen in the surface layer river waters in the estuary averaged out at 7.64 mg/L in the spring and 7.98 mg/L in the autumn. The figure in the surface layer seawaters in the estuary was 8.24 mg/L in the spring and 7.03 mg/L in the autumn. The mean content of dissolved oxygen was higher outside the estuary than inside the estuary in the surface layer, and the other way around in the bottom layer in May; and lower outside the estuary than inside in both surface and bottom layers in November. The figures were on the low side in both surface and bottom layers of the river waters and seawaters in the estuary compared with the same period last year.

The pH value averaged out at 7.87 in the spring and 7.81 in the autumn in the surface layer river waters, and 7.89 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 7.91 in the autumn in the surface layer seawaters in the estuary and 8.13 in the spring and 7.89 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 varied little in both surface and bottom layers of river waters in May, and were on the low side in both surface and bottom layers in November. The pH values in both surface and bottom layers of seawaters varied little.

The mean content of COD registered 3.15 mg/L in the spring and 3.25 mg/L in the autumn in the surface layer river waters in the estuary and 3.05 mg/L in the spring and 2.86 mg/L in the autumn in the bottom layer river waters. The mean content of COD was 2.22 mg/L in the spring and 1.79 mg/L in the autumn in the surface layer seawaters in the estuary and 1.91 mg/L in the spring and 1.78 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 high in the surface and bottom layers in May and in the surface layer of river waters in November. It was fairly high in the bottom layer in November. The figures were on the high side in both surface and bottom layers of the seawaters in the estuary.

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 2015, the content of suspended matters averaged out at 106.98 mg/L in the estuary seawaters in the spring and 41.67 mg/L in the autumn. It was on the high side in the spring and on the low 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 0.31 μg/L and 12.76 μg/L and averaged out at 1.51 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 mainly distributed in the eastern part of the monitored seawaters. In the autumn, the concentration of Chlorophyll-a ranged between 0.22 μg/L and 2.82 μg/L and averaged out at 0.82 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 also mainly distributed in the eastern part of the monitored seawaters.

● **Fish zooplankton**

A total of 100 fish zooplankton were caught in the spring, which fell into 12 species in eight families. The abundance of fish zooplankton was lower than that of last year. *Engraulis japonicas*, *Pseudosciaena polyactis*, *Salanx ariakensis,* and *Chelidonichthys spinosus* became dominant species. A total of 95 fish zooplankton spawns and larvae were caught in the autumn, which fell into seven species in six families under five orders. The abundance of fish zooplankton escalated by a large margin from last year. *Engraulis japonicas, Salanx ariakensis,* and *Harpodon nehereus* was 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 Yangtze River in the north. The contributing inflows of the lake includes the aforementioned four inflow rivers, three bleeders of Yangtze River (Songzi Bleeder, Taiping Bleeder, and Ouchi Bleeder), and interval inflows. The waters converge in the lake and feed to Yangtze River at Chenglingji (Qili Mountain). Dongting Lake is the most important buffering lake of the Yangtze River.

The incoming flow of Dongting Lake waters was on the low side in 2015 compared with average year. The monthly data showed the incoming flow was 10% less than average year from April through October. Specifically, it was almost 50% less in April. It surged notably in May as a result of a small flood, which led to floods that raised the river water above the warning levels in some reaches of Lishui River, Xiangjiang River and other tributaries. In June, the incoming flow was 20% more than the historical average as a result of a fairly large flood, and the mainstream of Xiangjiang River witnessed a flood above warning level. In July, a short-terms flood above warning level occurred in Xiangjiang River. The incoming flow fluctuated slightly in August and steadily in September. The waters retreated in October. In November, thanks to a significant growth of incoming flow to the Dingting Lake waters, a rare winter flood happened in the tributaries of Xiangjiang River, and the water level maximized at 28.79 m at Xiangyin Station on Nov. 16.

According to the data from Chenglingji Station at the lake outlet, the annual precipitation registered 1,789.2 mm, up 26.8% from a year earlier. The water level maximized at 31.38 m, minimized at 20.39 m, and averaged out at 25.15 m this year. The annual runoff was 8.2% less than historical average and 4.2% less than last year. The annual sediment discharge amounted to 24.5 mil. t, 33.0% less than historical average, and 8.0% more than 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 61.8%, and the sediment discharge during this period accounting for 48.0% of the whole year. The sediment discharge peaked on Nov. 16, with the maximum discharge at 0.531 kg/m^3.

Statistics on the 60-day flood volume showed the total inflow of the lake was 73.01 bn. m^3 and the total outflow 84.00 bn. m^3. Analysis data of the flood sources at Chenglingji Station (Qili Mountain) showed the four inflow rivers contributed 72.6% of the incoming flow to the lake in 7 days, 71.4% in 15 days, 67.6% in 30 days, and 72.4% in 60 days of the monitoring period. The three bleeders of the Yangtze River contributed 13.6% of the incoming flow to the lake in 7 days, 15.6% in 15 days, 23.5% in 30 days, and 16.1% in 60 days. The contribution of the interval inflows to the lake took up the smallest portion which ranged between 8.9% and 13.8%. Analysis data of the contributors to monthly runoff at Chenglingji Station showed 75.0% of the Dongting Lake inflow came from the four inflow rivers between June and October, and 57.1% in the remaining months. Over 57.3% of the incoming flow observed at Luoshan Station was contributed by Yangtze River.

● **Water quality**

Among the upstream runoff sources of Dongting Lake, the four inflow rivers and interval inflows enjoyed fairly good water quality in 2015. The monitoring sections where Xiangjiang River, Zishui River, Yuanjiang River, and Lishui River (four rivers) and Miluo River and Xinqiang River (interval flows) empty into the lake attained mainly Grade Ⅱ or Ⅲ water quality standard. The monitoring sections at which the three bleeders empty into the lake attained Grade Ⅲ or Ⅳ standard, and the sections at their lake outlets recorded Grade Ⅴ standard. None of the 11 monitoring sections across the lake area attained water quality goals commensurate to the functional areas they are in. Specifically, the Xiaohezui, Yu Gongmiao, and east Dongting Lake sections attained Grade Ⅳ standard, and the remaining eight sections attained Grade Ⅴ standard. The TP and TN pollution was fairly serious across the lake area, with TP concentration ranging from Grade Ⅱ standard to worse than Grade Ⅴ standard, and TN concentration ranging from Grade Ⅲ standard to worse than Grade Ⅴ standard. The TP pollution was getting worse from last year. Up to 43.5% of all the 23 monitoring sections in Dongting Lake and the adjacent mainstream of Yangtze River attained Grade Ⅰ～Ⅲ water quality standard, which suggested slight pollution. The main pollution indicators were TP, TN, and faecal coliform bacteria.


Elaphurus davidianus

The Trophical Level Index (TLI) of Dongting Lake ranged somewhere between 44.1 and 58.4 this year. The maximum TLI was recorded at the monitoring section of Major and Minor West Lakes. The five sections at eastern lake and the section at the lake outlet were in minor eutropher, and other sections were in mesotrophic state. The lake as a whole was in minor eutropher. In terms of geographical distribution, the trophic level of eastern lake waters was higher than that of western and southern lake waters, with more sections in minor eutropher from last year. In terms of temporal distribution, the TLI was below 50 only in February, May, July, September and December, which indicated mesotrophic state; and above 50 in the remaining months, which suggested minor eutropher.

A total of 61 genera of phytoplankton species were identified in Dongting Lake, which fell into 6 phyla. Specifically, the Chlorophyta and Bacillariophyta species were the most abundant phytoplankton species, and either species fell into 22 genera, which took up 36.1% of the total genera; followed by Cyanophyta species in 7 genera (11.4% of the total); and then Cryptophyta species in 2 genera (3.3%), Euglenophyta species in 5 genera (8.2%), and Pyrrophyta species in 3 genera (4.9%). The number of phytoplankton species was the smallest in September and December, and the largest in March. Bacillariophyta and Chlorophyta species were the dominant species in the above three months. The maximum biomass density of phytoplankton species was recorded in December, followed by that in March, and the minimum density was observed in June. The mean annual biomass density registered 140,000/L, somewhat lower than that of last year (161,000/L).

Twenty-seven genera of zooplankton species were identified in Dongting Lake, including 9 genera of Rotifera species, 14 genera of Cladocera species, and 4 genera of Copepods. The Brachionus species and *Asplachna priodonta* were the dominant Rotifera species; the Rosmina species, *Leptodora kindtii*, and Moina species were the dominant Cladocera species, and the nauplii and Calanus species were the dominant

Copepods species identified in the Lake. The biomass density of zooplankton was the highest in September and the lowest in December. The mean annual biomass density of zooplankton was 44,000/m^3, an increase from last year.

● **Vegetation**

The stationary observation data on 6 typical islets and shoals (Liumen Gate, Beizhouzi, Tuanzhou, Junshan, Chunfeng, and Jianxing Farm) showed each of the three indicators-the number of species, the species richness index, and species diversity index of the *Triarrherca sacchariflora* community was more than that of *Polygonum flaccidum* and *Carex tristachya* communities. For the *Triarrherca sacchariflora* community, the number of species identified each month ranged between 17 and 23; both of the species richness index and the species diversity index were the highest in April prior to the flood season (10.4 and 1.46 respectively) and at the minimum in November after the flood season (5.4 and 0.45); the community coverage hit the lowest in January (54.0%), surged remarkably in March (104.3%), and reached the highest in April (151.3%); the biomass was the lowest in January (375.5 g/m^2), rose fast, and peaked in November (1,801.3 g/m^2). As for the *Carex tristachya* community, the mix of the species was simpler and the number was somewhere between 6 and 8; the species richness index was fairly low, somewhere between 3.4 and 4.6 per quadrat; the species diversity index was at the maximum in April (0.98) and at the minimum in November (0.19); the community coverage was above 99% all the year round, and reached the highest in January (115.5%); the biomass went from 214.0 g/m^2 up to 815.0 g/m^2 between January and April, and down to 454.8 g/m^2 after flood season. As for the *Polygonum flaccidum* community, the number of species identified each month ranged between 6 and 8; the species richness index was fairly low and between 3.0 and 4.3 per quadrat; the species biodiversity index was fairly high prior to the flood season, ranging between 0.82 and 0.99, and fairly low after flood at 0.22; the community coverage was at the lowest in January (6.6%), rose fast in March to 98.6%, and reached the maximum after flood at 140.8%; the biomass hit the lowest in January (75.1 g/m^2), ascended fast afterwards, and reached the highest after the flood at 454.8 g/m^2.

● **Biodiversity**

Ninety-one species of summer migrant birds were identified in eastern Dongting Lake, up 7 species from a year earlier and they fell into 40 families under 13 orders. A total of 233,889 overwinter water birds were identified, up 58,793 from last year. They fell into 59 species in 13 families under 6 orders, six species more than last year. Specifically, the population of *Anas falcata* (31,487) and *Anser cygnoides* (740) surged the most significantly, up 18,444 and 362 ones respectively from last year. The population of *Anser albifrons* and *Cygnus columbianus* dropped most sharply, down 1,684 and 1,275 respectively. The analysis data of interspecific distribution pattern of overwinter bird species in the eastern Dongting Lake indicated Anseriformes species were the dominant species, accounting for 36% of the total bird species, and their main habitats are grass shoals, shallow waters, and islets and shoals, and their main feed are grass and fish. The secondary dominant species were Charadriiformes species, which accounted for 33%. Pelecaniformes and Podicipediformes species were the fewest, each taking up 3%. The geological distribution of the overwinter water birds varied by certain laws. In the early winter, the water birds inhabited in Baihu Lake, Chunfeng Lake, and Caisang Lake. In the dead of the winter, the population of water birds went up notably in Caisang Lake and T-shaped Dike, and dropped significantly in Chunfeng Lake and Baihu Lake. Before the water birds migrated in March, their population peaked in Caisang Lake habitat and took up around 50% of the total population in the eastern Dongting Lake at that time.

One hundred and thirteen *Elaphurus davidianus* were identified in the eastern Dongting Lake, and the population was estimated to be somewhere between 110 and 130, a notable growth from last year. *Elaphurus davidianus* was mainly distributed in Heizui (Zhuzi River mouth-Reed field of development zone) (population 60～70) and Piaowei (upper and lower Hongqi Lake) (population 50～60) regions. In Heizui region, the population of *Elaphurus davidianus* was forced to shrink along with rising water level in flood season and bounced back after the flood retreated. In Piaowei region, the population migrated southward along with rising water level and returned after water retreated.

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 1,907 mm in 2015, 30% more than the historic average. The precipitation fell mainly from April through June and in November, which accounted for nearly 65% of the total precipitation in the year. The water level maximized at 19.47 m and minimized at 7.57 m this year, as observed at Xingzi Station. A rare flood was recorded in the winter of 2015, as a result of which the mean water table posted 12.76 m at the Xingzi Station in December, 3.03 m more than the historic average.

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 153.6 bn. m^3, up 23% from last year and 22% more than the historical average. The influx of sediments amounted to 7.79 mil. t, up 51% from a year earlier and 43% less than the historical average. The runoff discharge of the lake through outlet to Yangtze River totaled 189.4 bn. m^3 this year, up 24% from last year and 25% more than historical average. The sediment discharge of the lake amounted to 12.01 mil. t, 1% less than a year earlier, and 20% more than historical average.

The 60-day flood volume recorded from May to July indicated the total inflow of the lake reached 56.288 bn. m^3, up 5.0% from last year; and the total outflow 55.545 bn. m^3, up 12.1%; rendering the buffering balance at 743 mil. m^3 this year, 81.8% less than last year. The main contributing runoffs of Poyang Lake included the five major inflow rivers (Ganjiang, Fuhe, Xinjiang, Raohe, and Xiuhe) and interval waters. Specifically, Ganjiang River had always been the dominant inflow river of the lake and contributed 56.4% of the total inflow, seconded by Xinjiang River which contributed 14.5%.

● **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 82.4% and 99.4% and averaged out at 92.8%, down 1.3 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, TP, and COD_{Mn}. The monitoring section at the lake outlet attained Grade Ⅱ standard in the second and fourth quarters; and Grade Ⅳ standard in the first and third quarters, with TP and NH_3-N 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 75.0%, up 25.0 percentage points from a year earlier. The main pollutants were NH_3-N and TP.

The content of nutrient salts in nitrogen forms (TN, nitrate nitrogen, and NH_3-N) in Poyang Lake was notably higher in dry period (January) than that of the other three periods. The content of NH_3-N in the water rising period (April) was significantly lower than that of dry period and water subsiding period. The standard deviation of the content of nitrate nitrogen was on the high side during the water rising period, which could be attributed to the notable impact of the incoming flow to the lake basin and the dry and wet deposition. The content of nitrate nitrogen varied little in high flow period (July). The variation of the content of TN was insignificant except in the dry period. The variation of the content of TP resembled that of phosphate in the dry period, high flow period, water rising period, and water subsiding period. The contents of both TP and phosphate were the highest during water rising period, which were significantly higher than those of other three periods; seconded by those in the water subsiding period.

● **Vegetation**

In 2015, the *Artemisia selengensis*, *Carex cinerascens*, and *Phalaris arundinacea* as well as the mudflats distributed in zonary belts on the islets and shoals were monitored and the data showed, the average height of *Artemisia selengensis* plants registered 89.6 cm in the spring, much higher than that of last spring (76.4 cm), and 79.6 cm in the autumn, a little lower than that in the spring and lower than last autumn as well. The average height of *Carex cinerascens* plants was 48.3 cm in the spring and 48.2 cm in the autumn, a little higher than the data of last year (45.7 cm, 43.7 cm); the average height in the spring was close to that in the autumn, without any seasonal differences. The average height of *Phalaris arundinacea* plants was 68.2 cm in the spring, close to that of last spring (67.3 cm), and 64.6 cm in the autumn, shorter than last autumn (69.3 cm); it varied little with seasons. The average height of the dominant species (*Phalaris arundinacea*) on the mudflats posted 63.5 cm in the spring, notably higher than the same period last year (51.7 cm); and 53.3 cm in the autumn, higher than the data of the same period last year, and much lower than that in the spring, which was mainly attributed to the postponing of the water subsiding period. From the perspective of importance value (IV), the IV was 83 in the spring and 82 in the autumn for the dominant species in the *Phalaris arundinacea* belt, 76 in the spring and 70 in the autumn for the dominant species in the *Artemisia selengensis* belt, and 97 in the spring and 98 in the autumn for the dominant species in the *Carex cinerascens* belt. 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 3,521.2 g/m^2 in the spring, higher than that of last spring (2,893.9 g/m^2), and 2,612.3 g/m^2 in the autumn, lower than that of last autumn (2,949.3 g/m^2). The surface biomass of *Carex cinerascens* belt and *Phalaris arundinacea* belt averaged out at 2,388.9 g/m^2 and 1,776.3 g/m^2 respectively in the spring, both a little higher than the data of last spring; and 2,301.7 g/m^2 and 1,245.9 g/m^2 in the autumn, both much lower than the data of last autumn. The surface biomass on the mudflat belt averaged out at 1,014.6 g/m^2 in the spring, far above that of last spring (689.2 g/m^2); and 513.4 g/m^2 in the autumn, which was notably lower than the data in the spring and lower than that of last autumn (639.8 g/m^2).

Analysis data of community biodiversity (the Shannon-Wiener index) showed mudflat belt recorded the maximum values, which is, 1.537 in the spring, much higher than the data of last spring (1.228), and 1.443 in the autumn, lower than that of last autumn (1.625). The community biodiversity of *Phalaris arundinacea* belt posted 0.653 in the spring and 0.729 in the autumn, a little lower than that of last spring (0.677) and autumn (0.782). The community biodiversity of *Carex cinerascens* belt was the lowest, at 0.231 in the spring, close to the data of last spring (0.219), and 0.212 in the autumn, higher than the data of last autumn (0.159).

The soil bulk density was 0.96 g/cm^3 in the spring and 0.94 g/cm^3 in the autumn for *Artemisia selengensis* belt, 0.91 g/cm^3 in the spring and 0.90 g/cm^3 in the autumn for *Carex cinerascens* belt, and 1.14 g/cm^3 in the spring and 1.16 g/cm^3 in the autumn for the mudflat belt. The data were much higher than those of other vegetation belts. In the spring, the soil moisture of *Carex cinerascens* belt was the highest (41.5%), followed by *Phalaris arundinacea* belt (39.3%) and mudflat belt (39.1%), and finally *Artemisia selengensis* belt (31.2%).

● **Census on water birds**

Over 316,000 overwinter water birds of 57 species were recorded in the census conducted on Dec. 18, 2015 on overwinter water birds across the lake. The number of bird species on the record was two more than last year, and the population was about 217,000 less. As for the population of key species, there were 1,989 *Grus leucogeranus*, 54 *Grus monacha*, 555 *Grus vipio*, 6,338 *Grus grus*, 4,660 *Ciconia boyciana*, 11,120 *Platalea leucorodia*, 43,229 *Cygnus columbianus*, 51,893 *Anser cygnoides*, 44,930 *Anser fabalis*, and 21,760 *Anser albifrons*. Apart from some growth in the population of storks, spoonbills, ducks, and cranes, the population of swans, geese, and waders dropped significantly compared with the same period last year.

A total of 48 species of water birds in 13 families under 5 orders were observed during the regular censuses on overwinter water birds within Poyang Lake National Nature Reserve. Specifically, 36 species were identified from January through March and 46 from October through December. The maximum population of each of the key species were as below: it was 3,836 for *Grus leucogeranus*, 205 for *Grus monacha*, 550 for *Grus vipio*, 2,764 for *Grus grus*, 2,516 for *Ciconia boyciana*, 9,455 for *Platalea leucorodia*, 47,183 for *Cygnus columbianus*, 46,315 for *Anser cygnoides*, 15,484 for *Anser fabalis*, and 22,985 for *Anser albifrons*.

A total of 55 species of water birds were identified in the census on reproductive water birds in the summer, which fell into 13 families under 5 orders. The number of Charadriiformes species (22 species) was the highest

Water bird census in the summer

among the identified species, followed by Ciconiiformes species (14 species).

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 uplands and piedmont plain, 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 calcareous soil, yellow soil, and paddy 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 1,260.9 mm, up 7.8% against last year. The monitoring data on slope runoff plots suggested the sediment yield and runoff yield went up 13.7% and 16.5% respectively in cropland runoff plots, up 13.4% and 13.4% in bare land plots, down 5.0% and 4.7% in woodland runoff plots, up 9.0% and 8.9% in grassland runoff plots, and down 25.2% and 25.2% 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 3,467 mg, 2,933 mg, and 49.52 mg respectively in cropland runoff plots; 895 mg, 657 mg, and 8.68 mg in bare land plots; 876 mg, 763 mg, and 21.52 mg in woodland runoff plots; 847 mg, 762 mg, and 17 mg in grassland runoff plots; and 597 mg, 532 mg, and 12 mg in cash tree runoff plots. The total TN output monitored at the station at the outlet of the watershed amounted to 914.02 kg, and the total TP output registered 107.22 kg.

In 2015, 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 1.2522 mil. m^3, the annual sediment yield amounted to 83.42 t, and the sediment delivery modulus was 25.59 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 Yangtze River. The watershed sits between 620 m and 1,340 m above sea level, and the local landforms are karst high mountains and uplands. 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 626.0 mm across the year, down 17.2% 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, 43.3% less in 15º plots, and 40.1% less in 25º plots compared with last year. Analysis data of sediment yield of different runoff plots indicated the sediment yield was zero in 5º plots, 75.8% less in 15º plots, and 74.7% less in 25º plots compared with last year.

The monitoring data on soil nutrient outputs in those plots showed, there was zero runoff in 5º plots. The annual output of TN totaled 5,730 mg, of NH_3-N 1,066 mg, of nitrate nitrogen 2,732 mg, and of TP 57 mg from 15º plots. The annual output of TN totaled 7,250 mg, of NH_3-N 1,396 mg, of nitrate nitrogen 2,970 mg, and of TP 62 mg from 25º plots.

In 2015, 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 891,000 m^3, the annual sediment yield amounted to 5.58 t, and the sediment delivery modulus was 1.40 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

Panorama of Longli Watershed

sea level. The landform is shallow gully uplands. The main vegetation is warm coniferous forest. A total of 1.43 km^2 catchment area is monitored by the monitoring station at the outlet of the watershed. The soils are sandy 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 1,002.0 mm, up 7.0% from last year. The monitoring data on soil erosion of plantation plots suggested the soil erosion ranged between 20 t/(km^2·y) and 516 t/(km^2·y); the erosion was the highest in corn plantation plots, and the lowest in cash fruit forest plots. The runoff yield ranged between 2.06 m^3 and 3.82 m^3; the lowest yield was recorded in contour ridge interplanting plots, and the highest in planted shrub forest plots.

According to the monitoring data on soil nutrient outputs, the loss rate of TN in the runoff plots ranged between 40 mg/m^2 and 356 mg/m^2, of TP between 6.5 mg/m^2 and 80 mg/m^2, and of organic matters between 0.15 g/m^2 and 6.12 g/m^2. The mean annual concentration of TN and TP posted 1.40 mg/L and 0.138 mg/L respectively at the station at the outlet of the watershed.

In 2015, the soil erosion intensity was dominated by minor and moderate erosion, the area of which accounted for 15.5% and 25.0% respectively of the total area of the watershed. The runoff monitored at the station at the outlet of the watershed totaled 62,400 m^3, the annual sediment yield amounted to 566 t, and the sediment delivery modulus was 395.80 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 uplands. 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℃, 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.

The maximum daily temperature across the watershed was 38.5℃ observed on June 12, and the minimum daily temperature was -8℃ observed on December 17. The mean annual temperature was 18.2℃. The annual precipitation totaled 840.2 mm, 55.3 mm less than the average year. There were 134 rainy days throughout the year. The maximum daily precipitation was 46.3 mm as recorded on June 29, and the maximum monthly precipitation 164 mm in August. The annual water surface evaporation on land totaled 676.4 mm, with the maximum daily evaporation at 7.7 mm on April 30.

In the top soil of typical croplands, the content of TN, TP, TK, and organic matters averaged out at 1.35 g/kg, 0.81 g/kg, 25.98 g/kg, and 24.27 g/kg.

The monitoring data on the runoff plots with varied gradients indicated that, the runoff yield of 5º, 10º, 15º, 20º, and 25º plots was 1.12 m^3, 1.30 m^3, 1.36 m^3, 1.49 m^3, and 1.66 m^3, and their sediment yield posted 1.52 kg, 2.16 kg, 2.73 kg, 3.63 kg, and 5.34 kg respectively. The runoff and sediment yields went up remarkably with growing gradient. As for the six runoff plots with different tillage systems, their runoff yield was 2.02 m^3, 1.67 m^3, 2.32 m^3, 1.81 m^3, 2.31 m^3, and 2.57 m^3, and the sediment yield was 6.32 kg, 3.24 kg, 7.87 kg, 3.06 kg, 3.70 kg, and 5.95 kg respectively.

The annual runoff monitored by the monitoring station at the outlet of Xiejiawan Watershed totaled 7,834.56 m^3, and the sediment discharge totaled 8,518.49 kg. The mean annual concentration of TN and TP in waters was 4.04 mg/L and 0.34 mg/L respectively.

8.9 Algal blooms in main tributaries

In 2015, the algal blooms were monitored in 10 main tributaries, which is, Xiangxi River, Shennong Stream, Daning River, Zhuyi River, Pengxi River, Zhuxi River, Ruxi River, Longhe River, Yulin River, and Hanfeng Lake. A total of 70 stationary monitoring sections were deployed in the backwaters (one key monitoring section and 3～5 general monitoring sections for each tributary), upstream waters, and adjacent mainstream waters of those tributaries. The monitoring was conducted on a monthly basis, with more frequent monitoring during the sluicing period and impoundment period.

8.9.1 Water environment

In 2015, the mean flow rate of each of the monitoring sections of the 10 main tributaries was much lower than that of their adjacent mainstream reaches. The flow rate of those monitoring sections ranged between 0.000 m/s and 1.649 m/s. Density-stratified flows headed for opposite directions were often observed at the near-estuary sections of the tributaries as a result of the inflow from upstream of the tributaries and the backwaters of the mainstream reaches. From the perspective of the geographical distribution of the tributaries, the rise and fall of the water levels of the Yangtze River mainstream affected the hydrological and hydrodynamics of the backwaters of the tributaries to a lesser degree along with their location from the head region to the tail region of the reservoir. Specifically, the flow rate of Xiangxi River in the head region ranged somewhere between 0.01 m/s and 0.15 m/s; that of Pengxi River and Ruxi River in the central region somewhere between 0.02 m/s and 0.15 m/s, and 0.01 m/s and 1.65 m/s; and that of Yulin River and Hanfeng Lake in the tail region somewhere between 0.02 m/s and 1.22 m/s, and 0 m/s and 0.55 m/s. The flow rate was under 0.10 m/s in the backwaters of all tributaries in January, February, March, November, and December, and it was fairly fast in flood season from June through August thanks to more rainfalls.

Identification of algal species

The temperature of the key monitoring sections in the backwaters of the 10 tributaries ranged between 6.1℃ and 32.5℃ , with the lowest temperature observed in Longhe River (December) and the highest temperature observed in Ruxi River (June). The highest temperature of each of the tributaries was recorded generally from July to August. The mean annual temperature of the 10 tributaries from the head through the tail region was 20.3℃ for Xiangxi River, 21.7℃ for Shennong Stream, 19.0℃ for Daning River, 20.2℃ for Zhuyi River, 20.2℃ for Hanfeng Lake, 21.8℃ for Pengxi River, 21.4℃ for Zhuxi River, 21.9℃ for Ruxi River, 14.2℃ for Longhe River, and 20.2℃ for Yulin River.

The SD of the key sections of the backwaters of the 10 tributaries ranged somewhere between 0.1 m and 6.0 m, with the lowest value observed in Longhe River (June), and the highest value recorded in Shennong Stream (February). From the head region through the tail region, the mean annual SD of each of the tributaries was 2.4 m for Xiangxi River, 2.5 m for Daning River, 2.8 m for Shennong Stream, 1.9 m for Zhuyi River, 1.4 m for Hanfeng Lake, 1.6 m for Pengxi River, 1.4 m for Zhuxi River, 1.3 m for Ruxi River, 1.5 m for Longhe River, and 0.7 m for Yulin River.

8.9.2 Phytoplankton

The composition of phytoplankton communities exhibited distinct seasonal variations among those tributaries in 2015. The algal cell density of the key sections in the backwaters ranged between 36,000/L～70.268 mil./L, with the minimum density observed in Longhe River in January and the maximum density in Xiangxi River in April.

From the geographical perspective, the mean annual algal cell density of the key sections in the backwaters of the tributaries in the head and central regions was notably higher than that of tail region of the project area. Specifically, the mean annual algal cell density was 14.048 mil./L for Xiangxi River and 2.434 mil./L for Shennong Stream in the head region, 6.089 mil./L for Pengxi River in the central region, 2.678 mil./L for Longhe River and 669,000/L for Yulin River in the tail region. The mean annual algal cell density was the lowest in Daning River among the 10 tributaries, which posted 323,000/L.

From the temporal perspective, the algal cell density of the tributaries was fairly low in January and February, which could be attributed to relatively low temperature, and the dominant algal species were Bacillariophyta, Chlorophyta, and Cryptophyta. From March through May, along with rising water temperature, the percentage of Cyanophyta and Chlorophyta communities elevated. Bacillariophyta was distributed in all tributaries across the year, and the outbreaks of its algal blooms mostly happened in the winter and spring. In June, Yangtze River entered the flood season, added by the greater sluicing of the Three Gorges Project, the flow rate of the tributaries escalated, and the percentage of Cyanophyta declined from May. From July to August, with further rising water temperature, Cyanophyta became the dominant phytoplankton community. In September, the algal cell density was on a gradual decline, and Bacillariophyta and Chlorophyta became dominant communities once again.

8.9.3 Algal blooms

The outbreak of algal blooms occurred in all of the 10 tributaries in the spring and the autumn. Specifically, the algal blooms in Xiangxi River were often caused by more than one dominant species, and the common combinations were Bacillariophyta-Cryptophyta, Bacillariophyta-Chlorophyta, and Cyanophyta-Chlorophyta. For the outbreak of algal blooms caused by one dominant species, the main cause was Chlorophyta or Cyanophyta. The dominant species of the algal blooms were Cryptomonas and Cyclotella in Daning River, and Microcystis, Cryptomonas, and Cyclotella in Shennong Stream. An outbreak of algal blooms caused by Bacillariophyta occurred in Zhuyi River in March, and the dominant species was Cyclotella. The dominant species of algal blooms were Microcystis, Aphanizomenon, Cryptomonas, and Pyrrophyta in Pengxi River; *Ps. niei* in Ruxi River; Chlamydomonas in Qinggan River; Cryptomonas and Cyclotella in Meixi River; and Cyclotella and Cryptomonas in Longhe River.

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