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

2014

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

Summary

In 2013, the Three Gorges Water Project maintained stable and efficient operation for the tenth consecutive year, giving full play to the comprehensive role of flood control, power generation, navigation, drought resistance and water replenishment. The 175 m trial impoundament was achieved in success for the fourth time. During the flood season, flood control deployment was made five times and a total of 11.837 billion m^3 floodwater was impounded. The Three Gorges power plant generated electricity of 82.827 billion kWh accumulatively throughout the year and the navigation lock was operated 10,775 times with annual freight volume of nearly 100 milllion t. The project replenished the lower reaches with about 21.5 billion m^3 water during the fluctuating period. Cleanup of flotage proceeded smoothly with 65,200 m^3 flotage before the dam of the Three Gorges recovered, transported and disposed of environmentally. Successful breeding of the second filial Acipenser sinensis lava set a new record. Promotion and implementation *of the Regulation on the Security of Three Gorges Water Control Hub* was carried out in an all round way.

The registered population of the Three Gorges reservoir area was 16.83 million, up 0.3% compared with that of 2012. The people in the area were in good health and there were no report on epidemic diseases. Calculated at comparable prices, GDP of the reservoir area reached 570.826 billion yuan, up 13.2% compared with that of 2012. The primary industy, secondary industry and teriary industy achieved value added by 58.857 billion yuan, 313.358 billion yuan and 198.611 billion yuan, an increase of 5.0%, 15.3% and 11.5% respectively.

The annual average temperature of the reservoir area posted 18.9℃, higher than that of normal years. The region experienced 1025.1 mm average precipiataion, less than that of normal years. The mean relative humidity was 72%, lower than that of normal years while the mean evaporation was higher than normal years, reaching 1389.9 mm. The mean wind speed posted 1.3 m/s, close to historical average and the number of foggy days was 22.6 days, less than historical average.

Forests cover 2.7254 million ha of the total land of the reservoir area with coverage at 47.26%. The volume of standing timber reserve was 140.6522 million m^3 including 136.1193 million m^3 forest volume, accounting for 96.78%. Currently, 435 alien species have been found in the reservoir area and most of them are intentionally

introduced, taking up 82.99% of the total. The agricultural land occupies 412,563 ha and the planted acreage is 608,531 ha with multiple cropping index of 221%. Grain crops dominated agricultural production.

The catch of fisheries at the reservoir area, downstream of the dam, Dongting Lake, Poyang Lake and estuaries totaled 57,100 t. The fish fry amount of the four major Chinese carps at Jianli section was about 520 million, a slight increase compared with that of the same period of the previous year. The survey at the upstream of the revserior area found 28 peculiar fish species and 5 species alient fish. Natural propagation of Aclpenser Sinensis Grdy at the downstream of Gezhouba Project was not founded during monitoring and the number of breeding population remained at a low level.

The Three Gorges reservoir area observed 723 earth quakes at $M \geqslant 0.0$. The frequency increased a bit compared with that of 2012. The intensity of quakes also rose. Middle-to-little earthquakes were sporadic and micro and mini quakes occurred on a massive scale. The quakes were mainly experienced along the riverside at Badong County-Zigui County of Hubei Province and Shizhu area of Chongqing Municipality. Thanks to timely monitoring and early warning of geological disasters, 45 apparent deformed sites prone to collapse and landslides were spotted or took place.

In the reservoir area, 190 million t wastewater from industrial sources were discharged including 33,300 t of COD and 2,100 t of NH_3-N. Discharges of domestic sewage amounted to 787 million t including 131,600 t of COD and 23,800 t of NH_3-N. 645.7 t of pesticides were applied in the area, reducing 7.8% over that of 2012 while application of fertilizer dropped 13.4%, reaching 136,000 t. 500,000 t of ship oil-contaminated water was generated of which 455,000 t was discharged up-to-stanard. Shipboard domestic sewage totaled 3.938 million t of which domestic sewage from passenger ships accounted for 67.9%.

The annual average water quality of the mainstream of Yangtze River in the project area was good and that of Jialing River was excellent. Total phosphor in Wujiang River exceeded the standard. 15.6%~39.0% of the sections of major tributaries at the project area were subject to eutrophication in the algae bloom sensitive period (March~October), which was similar to that of 2012. Algae bloom still occurred in some tributaries.

Chapter 1
Operation of the Three Gorges Project

In 2013, the Three Gorges Water Project maintained stable and efficient operation for the tenth consecutive year, giving full play to the comprehensive role of flood control, power generation, navigation, drought resistance and water replenishment. The 175 m trial impoundament was achieved in success for the fourth time. During the flood season, flood control deployment was made five times and a total of 11.837 billion m^3 floodwater was impounded. The Three Gorges power plant generated electricity of 82.827 billioin kWh accumulatively throughout the year and the navigation lock was operated 10,775 times with annual freight volume of nearly 100 milllion t. The project replenished the lower reaches with about 21.5 billion m^3 water during the fluctuating period. Cleanup of flotage proceeded smoothly with 65,200 m^3 flotage before the dam of the Three Gorges recovered, transported and disposed of environmentally. Successful breeding of the second filial Acipenser sinensis lava set a new record. Promotion and implementation of *Regulation on the Security of Three Gorges Water Control Project* was carried out completely.

● **Comprehesnive dispatchment**

On December 24, 2012, the water level of the Three Gorges Reservior began to fluctuate from 174.55 m and finally fell to the flood control level on June 10, 2013. The fluctuation took account of the needs of downstream navigation, water supply and power grid generation and water replenishment lasted 147 days. From 0.00 on May 13 to 12.00 on May 20, sedimentation reduction dispatchment was tested at the backwater zone of the reservoir. Monitoring data indicated that the scouring at the river section in the backwater zone was effective for reducing sedimentation.

From July to September 2013, the reservoir experienced four floods with peak flow over 30,000 m^3/s. Flood control was dispatched five times and the maximum peak reduction was 14,000 m^3/s, bringing the peak reduction rate to 28.6%. Accumulative impoundment totaled 11.84 billion m^3/s. Flood control of the reservoir enabled the maximum outflow to be controlled at 35,000 m^3/s, so that the water level at downstream Shashi Station and Chenglingji Station did not exceed the warning level and the safety of the middle and lower reaches of the Yangtze River was ensured.

The Three Gorges Reservoir began impoundment on September 10 at the level of 156.69 m and successfully carried out trial impoundment at 175 m at 14.00 on November 11.

● **Operation of the power station**

In 2013, water supply in the upstream of the Yangtze River was inadequate, only accounting for 81.6% of historical flow. The Three Gorges Power Station generated electricity of 82.827 billion kWh, or 94.12% of the planned annual power generation and Gezhouba power station generated 15.86 billion kWh, 99.13% of the planned value. During the flood season, the power stations maintained long-term stable operation with large capacity. There were 145.94 hours that the stations ran at 20,000 MW and 32.58 hours at 22,500 MW.

● **Navigation management**

In 2013, the navigation lock of the Three Gorges was operated 10,775 times, increasing by 11.3% compared with that of 2012. Transit of ships numbered 45,700 ship-times, up 3.9%, carrying 432,600 passenger-times and 97.14 million t of cargo, a rise of 79.7% and 13.1% respectively. Since its tiral navigation on June 16, 2003, the navigation lock has enabled accumulated delivery of 640 million t cargo.

● **Project construction**

In 2013, the construction of Three Gorges shiplift and the planned project in the Three Gorges Dam area progressed smoothly with good quality. Civil engineering of the shiplift was completed by and large, installation of splines, nut columns and the embedded parts of the second phase went ahead nicely and the ship chambers were structured step by step. Construction of the breeding center for rare fish spieces of the Yangtze River started.

● **Special program**

On July 12, 2013, the 16th Executive Meeting of the State Council adopted the *Regulation on the Security of Three Gorges Water Control Project* and Premier Li Keqiang signed No. 640 State Council Decree on September 9, which was put into effect as of October 1, 2013. The Regulation provided legal basis for the safety management of the Three Gorges water project.

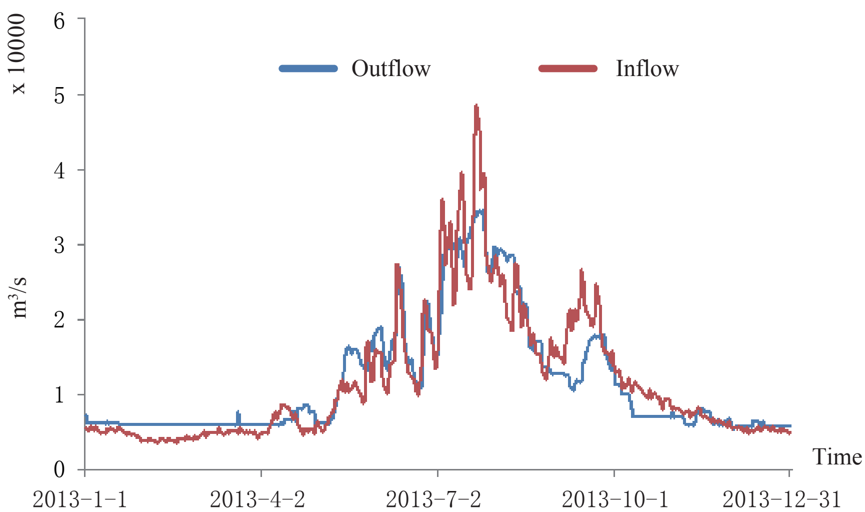


Figure 1–1 Inflow and outflow of the Three Gorges Reservoir in 2013

Chapter 2
Economic and Social Development

In 2013, the registered population of the Three Gorges Reservoir area numbered 16.832 million, up 0.3% over that of 2012. Among them, there were 11.2982 million rural residents, down 0.5% and 5.5346 million non-rural residents, up by 2.1%, accounting for 32.9% of the total population.

The GDP of the project area totaled 570.826 billion yuan, an increase of 13.2% compared with that of 2012 based on comparable prices. In specific, the reservoir area in the jurisdiction of Hubei Province and Chongqing Municipality achieved 64.605 billion yuan and 506.221 billion yuan, up 12.2% and 13.3% respectively. The value-added of the primary industry, secondary industry and tertiary industry was 58.857 billion yuan, 313.358 billion yuan and 198.611 billion yuan, up 5.0%, 15.3% and 11.5% respectively. Value-added of industry amounted to 255.811 billion yuan, up by 15.9%. The proportion of the value added of the primary industry, secondary industry and tertiary industry was 10.3:54.9:34.8.

Total investment in fixed assesets of the reservoir area was 505.61 billion yuan, up 18.3% compared with that of the same period of last year. This included 54.756 billion yuan in Hubei and 450.854 billion yuan in Chongqing, up 29.7% and 17.0% respectively over that of 2012. Total retail sales of consumer goods of the reservoir area were 186.061 billion yuan, up 15.3%. Among them the project area in Hubei Province and Chongqing Municipality accounted for 16.444 billion yuan and 169.617 billion yuan, increasing by 17.4% and 15.2% respectively year on year. The grain production of the project area reached 6.21 million t, or 0.9% increase over that of 2012 and total output of meat hit 1.2193 million t, a growth of 5.8%.

Table 2–1 Staticistics of major economic indictors of the Three Gorges Reservoir area in 2013

Indicators	Three Goreges Reservoir area		Hubei area	Chongqing area
	Amount	Change ±%	Amount	Amount
Total registered population by the end of 2013 (10,000 people)	1683.27	0.3%	157.20	1526.07
Including residential population (10,000 people)	1129.82	-0.5%	127.24	1002.58
Non-residential population (10,000 people)	553.46	2.1%	29.96	523.50
Local GDP (10,000 yuan)	57082597	13.2%	50622100	6460497
# Industry (10,000 yuan)	25581082	15.9%	22129500	3451582
Total investment in fixed assests (10,000 yuan)	50561042	18.3%	5475631	45085411
Total retail sales of consumer goods (10,000 yuan)	18606063	15.3%	1644370	16961693

Chapter 3
Natural Ecology and Environment

3.1 Climate

In 2013, the annual average temperature in the Three Goreges Reservoir area was higher than that of normal years while the annual average precipitation was less than historical average. Temperature changed dramatically in the winter and it was cold in early winter and warm in late winter with less precipitation. Spring started quite early and the temperature was high throughout the season. More rainfall took place at the end of spring. It was typically dry and hot in the summer. The temperature was remarkably higher than the historical average. In the autumn, there was plenty of rain and the temperature fluctuated strongly. The annual average evaporation in the reservoir area was bigger than historical average and the relative humidity was lower than that of normal years. The average wind speed was similar to normal years and the average foggy days were unusually less. The meterological hazards in the reservoir area included cryogenic freezing rain and snow disasters in the beginning of the year, high temperature and drought in the summer, rainy weather and locally heavy fog in the autumn and drought and hail storm in the winter and spring.

Table 3–1 Monitoring results of meteorological elements of each station in the Three Gorges Reservoir in 2013

Station	Average temperature (℃)	Precipitation (mm)	Relative humidity(%)	Evaporation (mm)	Average wind speed (m/s)	Sunshine hours (h)	Foggy days (d)	Thunder storm days (d)
Chongqing	19.8	1026.9	71	1450.3	1.4	1187.5	34	26
Changshou	19.0	933.8	77	1074.6	1.2	1495.4	40	33
Fuling	18.6	892.0	80	1546.9	1.6	1265.5	82	29
Fengdu	19.7	910.6	69	1482.9	1.3	1607.4	14	35
Zhongxian County	19.0	1040.0	81	1299.0	1.1	1479.1	35	33
Wanzhou	19.6	1182.1	70	1600.4	1.1	1638.4	9	24
Yunyang	19.0	976.8	75	1379.0	1.2	1466.1	5	21
Fengjie	19.2	817.1	68	1470.2	1.6	1549.9	2	24
Wushan	19.4	847.9	61	1406.2	0.6	1664.0	0	21
Badong	18.1	1019.4	67	1624.0	1.6	1658.6	17	38
Zigui	17.3	1207.9	73	821.2	1.2	1881.8	6	40
Bahekou	17.6	1167.3	76	-	1.1	-	5	41
Yichang	17.9	1360.5	70	1523.1	1.3	1589.9	27	45

Note: "-"means data not measured. According to meterological observation regulation, if data is not measured for more than three days in a month, then the data for this month will be recorded as missing. If data of over 10% of the months is missing, then the data for this year will be recorded as missing.

3.1.1 Meterological elements

In 2013, the annual average temperature of the project area recorded 18.9℃, 1.1℃ higher than the historical average (17.8℃), the second peak year since 1961. The temperature was lower in the southeast and higher in the northwest. The annual average temperature in Xuan'en, Hefeng and Wufeng was 16~17℃, whereas that of Wanzhou, and Yunyang, Kaixian County was 19~20℃. In addition, Fuling and Chongqing were also among the regions with higher temperature, which was recorded at 19℃ above. The distribution of temperature anomaly showed that temperature in most regions was 0.5℃~1.0℃ higer than the historical average and that in Wufeng in the southeast region, Wanzhou, the central part of the reservoir area and Changshou of Chongqing in the west was higher by 1.0℃~1.5℃. In terms of seasonal distribution, the average temperature in the winter was 7.6℃, slightly higher than the historical average (7.4℃) and that in the spring was 18.4℃,conspicuously higher than the historical average (17℃) . The temperature in the summer recorded 28.3℃, 2℃ higer than that of normal years and this was particularly evident in the western part. The average temperature in the autumn was 17.9℃, similar to that of previous years.

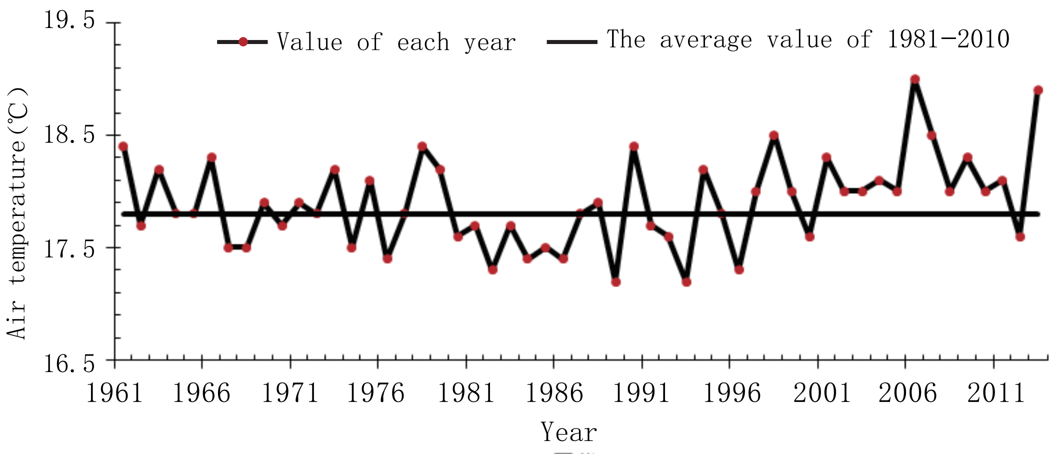


Figure 3-1 Annual average temperature of the Three Gorges Reservoir area of 1961-2013

The average precipitation in the reservoir area in 2013 was 1025.1mm, 8% less than the historical average (1114.9 mm), making it the fifth consecutive year with inadequate rainfall. The rainfall was plenty in the mountain area and less in river vallies. With sufficient rainfall in the southeast, Yichang, Wufeng and Xuan'en witnessed 1300~1500mm precipitation and the precipitation in Hefeng even exceeded 1500mm. Rainfall in the northern and souothwestern part was less which was about 1000~1100mm. Fengjie and Wushan, in particular, was about 800mm, the least rainfall among the northern part of the reservoir area while precipitation went throught the floor in Fuling and Shizhu in the southwestern area, which was less than 900mm. In terms of seasonal distribution, the average precipitation in the winter was 44.4mm, down by 37.5% compared with the historical average (70.9mm) and that in the spring was 361.9mm, 13.6% more than that of normal years (312.6mm). The summer was 401.5mm rainfall, 24.8% less than the historical average (534.1mm) while the autumn had 327.7mm rainfall, or 23.3% more than the historical average (265.8mm).

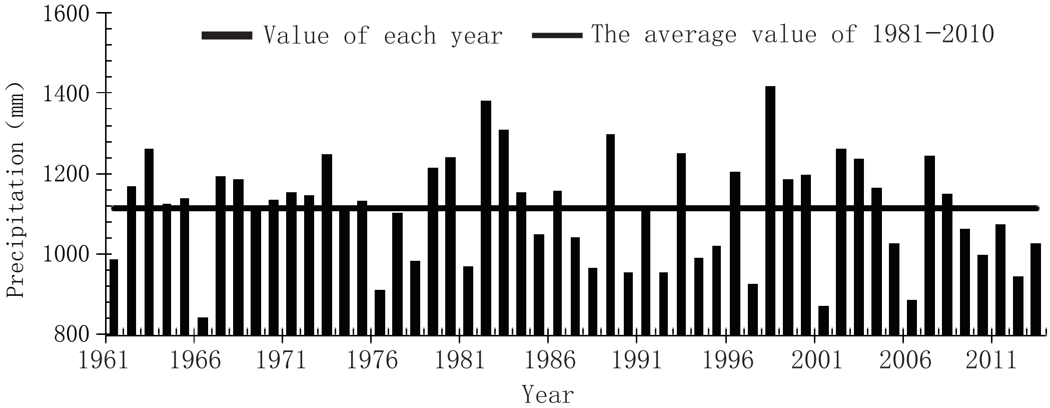


Figure 3–2 Annual precipitation of the Three Gorges Reservoir area during 1961–2013

The average relative humidity of the reservoir area was 72%, slightly lower than the historical average (76%). The relative humidity of all places ranged from 61% to 81% with the minimum at Wushan and the maximum at Zhongxian County. Compared with normal years, the relative humidy at Yunyang and Zigui was higher, that at Fuling and Zhongxian County was on a par with normal years and relative humidity at the rest places was all lower. Particularly, relative humidity at Fengdu and Wanzhou was lower by 12%. Relative humidity (the historical average) in the winter, spring, summer and autumn was 75% (77%), 69% (75%), 67% (76%) and 76% (79%) respectively. The value in the spring and summer was prominently low and that in the winter and autumn was slightly low.

The annual average evaporation in the reservoir area recorded 1389.8mm, which was more than the historical average (1225.3mm). Spacial distribution indicated that Changshou and Zigui had smaller amount of evaporation, both were lower than 1200mm while the amount in other places had all exceeded 1200mm. Specifically, Fuling, Wanzhou, Badong and Yichang all observed evaporation of over 1500mm, and that of Badong even reached 1624mm. Evaporation in the reservoir area changed dramatically with season. The average evaporation in the winter, spring, summer and autumn was 120.4mm, 376.3mm, 625.7mm and 263.8mm respectively. The amount in the winter was on a par with the historical averge, that in the spring and summer rose by 11.2% and 12.8% respectively and evaporation in the autumn dropped by 13.6%.

The average wind speed in the reservoir area was 1.3 m/s, close to that of historical average. The overall wind speed in the area was simiar to normal years. Monthly average wind speed hit the maximum in July, being 1.5 m/s, where the minimum occurred in January, October and December, which was 1.1 m/s. Compared with the historical average, the monthly average wind speed in most months was either close to or lower than the record except in June, July and November, which were higher by 0.1 m/s. The lower wind speed was within the range of 0.2 m/s. Apart from Wushan with wind speed averaged at 0.6 m/s, other places all experienced wind speed above 1.0 m/s with Fuling, Fengjie and Badong having maximum average wind speed at 1.6 m/s.

In 2013, the foggy days numbered 22.6 on average in the reservoir area, which reduced by 15.4 days compared with the historical average (37.9 days, average between 1974 and 2000), marking the third lowest year within 40 years. Seasonal distribution of foggy days was as follows: there were 7.4 days in the winter (historical average was13.5 days), 5.1 days in the spring (6.6 days), 2.9 days in the summer (6.3 days) and 7.2 days in the autumn (11.4 days). All the numbers were notably smaller than the historical average. Fuling had 82 foggy days, exceeding the historical average (72.3 days), Zigui had 6 foggy days compared with 0.3 day of the historical average and Yichang 27 days, which was also more than the historical average (22.3 days). The average foggy days of Yunyang was similar to the historical average while that of Fengdu, Wanzhou, Fengjie, Wushan and Badong all recorded sharp reduction by at least 50%, among which Wanzhou saw reduced foggy days by over 40 days.

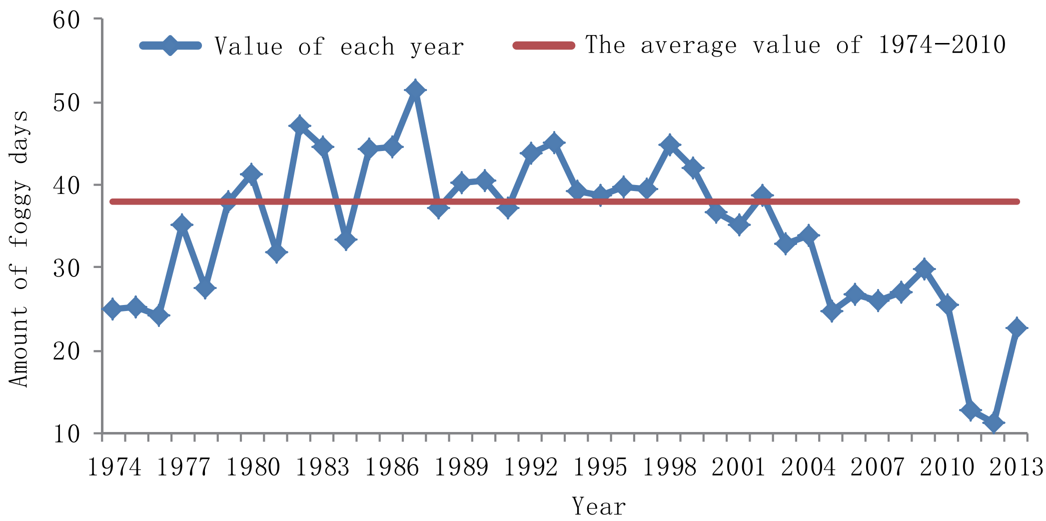


Figure 3–3 Changes of Annual Average Foggy Days in the Three Gorges Reservoir Area during 1974–2013

3.1.2 Meterological hazards

In 2013, the reservoir area and its neighboring areas were hit by cryogenic freezing rain and snow disasters in the beginning of the year and long period drought with great intensity in the summer. There were many cloudy and rainy days in the autum and fog formed frequently in part of the area. In addition, the reservoir area also suffered from continuous drought in the winter and spring, drough in the summer, hailstorm with severe convection and other meterological hazards.

Crygenic freezing: In the winter from 2012 to 2013, the reservoir area witnessed five large scale cryogenic freezing rain and snow, which took place on December 25-26 of 2012, December 27-29, 2012, January 2-5, 2013, February 7-9, 2013 and February 18-19, 2013 respectively. The snowfall covered most of the reservoir area and brought about certain impact on local agriculture and traffic. Affected by the low temperature, rain and snow, Wuxi County of Chongqing suffered from the cryogenic freezing disaster on January 9 affected 145,000 people, damaged 6,900 ha cropland and led to 68 million yuan economic loss. From January 4 to 6, four prefectures (autonomous prefectures) in Hubei Province including E'zhou, Xianning, Yichang and En'shi were hit by snowstorm, affecting 187,000 people and 4,900 ha cropland and 200 ha cropland had no harvest. The direct economic loss totaled more than 33 million yuan. From January 4 to 8, Yunyang County experienced continued rain and snow. Snow piled on the highways in frigid area, so that traffic in seven towns with five highways was blocked, stretching over 70 km.

Heat and drought: In 2013, the reservoir area was more hot days with great intensity in the summer. Most of the area had 30~45 such days, which were 20~30 days more than historical average. Heat concentrated between late July and the middle of August. And during this period, most places in the reservoir area suffered from 10~25 hot days with some localities having over 25 days. Jiangjin of Chongqing, Fengdu, Wanzhou, Kaixian County, Yunyang and Wushan had more than 12 days with 40℃, among which hot days in Kaixian County reached 23 days, the most of all. Continued heat affected paddy rice fertilization. As the filling time shortened, heat-forced maturity was noticeable. Both seed setting rate and 1000-grain weight dropped. Precipiatation in most of the reservoir area reduced compared with historical average. Along with continued heat, soil moisture lost more quickly and some areas suffered from drought of varying degrees. From mid October in 2012 till Feburary of 2013, Chongqing experienced less precipitation with relatively high temperature, leading to continued drought from the winter to the spring in western reservoir area and drought in the spring in the middle and eastern area.

Continuous rain: In the autumn of 2013, the most part of the reservoir area had 20~30 days of rain and rainy days and the southwestern area had more rainy days by 3~10 days compared with historical average. The longest period of continuous rain lasted 10~15 days in the southwestern and middle area. In particular, there were four episodes of continuous rain that impacted a large area in Chongqing (August 29~September 12, October 14~22, October 26~November 18 and November 10~23). Continuous rain and scarce sunshine in the anutumn exerted serious impact on agricultural production. The progress of wheat planting and rape transplant slowed down and the growth of rape seedling became poor in some areas. Some crops harvested in late autumn such as sweet potatoes, retooning rice and autumn soybeans were hard to get harvested and dried, so that some autumn soybeans and potatoes were rotten.

Heavy fog: In the winter from 2012 to 2013, heavy fog haunted the reservoir area and affected local traffic and human health. On December 5, 2012, the visibility of the main city area of Chongqing and 10 districts (counties) was below 1,000 m. Visibility in the main city area, Hechuan and Rongchang was only 100 m and that in Yongchuan, Xiushan, Changshou and Tongnan was less than 500 m. Affected by the heavy fog, some highways were forced to close including Chongqing-Xingshan section of Lanhai highway, Chongqing-Yurong section of Yukun highway and the section from Changshou to Fuling on Huyu highway. In addition, the entrance of many highways were closed due to the heavy fog such as Xipeng of express loop highway, Beibei-Xingshan section of Lanhai highway and Dingjia-Ronglong section of Yukun highway. On December 9, the heavy fog in the main city area of Chongqing caused poor visibility of less than 500 m, traffic congestion in the main city area, closure of part of the highway and ferry terminal. On January 23, 22 flights were cancelled at the Three Gorges Airport due to foggy weather. 19 highways in Hubei Provicne were under control, ferry and car ferry stopped operation together with many bus routes running through suburbs.

Strong convection and hails: In 2013, there was frequent hails with strong convection from the spring to the summer, which caused certain casualty. On March 10, Wanzhou District and Yunyang County of Chongqing were afflicted by hail disaster, affecting 51,000 people including one death (lightning stroke) and damage of over 3,600 houses at different degrees. The affected crops covered nearly 2,300 ha, over 180 ha of them had no yield. Direct economic loss amounted to over 23 million yuan. On March 22, Tongcheng County of Xianning City, Hubei Province and Hefeng County of En'shi Tu Nationality and Miao Nationality Autonomous Prefecture were hit by hailstorm, affecting 29,000 people and 8,300 ha cropland; 1,600 ha of them had no harvest with direct economic loss at 13 million yuan. On July 14, the Three Gorges Reservoir area suffered from sudden thunderstorm and gale. Seven tourists were struck by thunder at Tanziling. Two died and five injured. On July 30, Wushan County of Chongqing and Shizhu Tu Ethnic Autonomous County were afflicted by hail hazards, affecting 52,000 people and 2,000 ha cropland, over 200 ha of them had no yield. The direct economic loss was over 20 million yuan. On August 10, a hailstorm wreaked havoc on Changyang Tu Ethnic Autonomous County of Yichang City, Hubei Province and one person died of thunder.

3.2 Forest resources

In 2013, the forest area of the project area occupied 2.73 million ha with coverage of 47.26%. Among them, there was 2.60 million ha woodland, accounting for 95.26% of the total and 129,300 ha special shrub land defined by the state, which took up 4.74%. The volume of standing timber reserve totaled 140.6522 million m^3 which included 136.1193 million m^3 of forest reserve, or 96.78% of the total and 4.5329 million m^3 of scattered wood land, scattered trees and tress on the sides of villages, homesteads, roads and rivers, accounting for 3.22%.

Among the forested land of the reservoir area, there was 1.8757 million ha natural forest, or 72.25% of the total and 720,400 ha planted forest, accounting for 27.75% of forest reserves, the reserve for natural forest stood at 103.0519 million m^3, or 75.71% of the total and 29.81 million m^3 for planted forest, making up 24.29%. Natural forests dominated the forest resources in the reservoir area.

Among the forest land, there were 1.6512 million ha shelter forest, accounting for 61.86% of the total; 130,100 ha (5.19%) special-purpose forest; 601,300 ha timber forest, or 22.53% of the total; 6,000 ha firewood forest (0.22%) and 120,100 ha economic forest (4.5%). Among the forest reserve of the Three Gorge Reservoir area, 87.8357 million m^3 were shelter forest, taking up 64.53% of the total; 10.0382 million m^3 were special-purpose forest, taking up 7.37%; 36.1595 million m^3 were timber forest, taking up 28.03% and 85,900 m^3 were firewood forest taking up 0.06%.

Young forest of the Three Goreges Reservoir area covered 1.0854 million ha and its reserve was 39.1377 million m^3, accouintg for 43.27% of the total arboreal forest and 28.75% of the total growing stock. There were 1.02 million ha half-mature forests with 62.7039 million m^3 reserve, taking up 40.85% and 46.07% respectively. The area and stock of near-mature forests were 287,700 ha and 22.8971 million m^3, constituting 11.47% and 16.82% respectively. Mature forests covered 97,400 ha and the reserve stood at 9.7499 million m^3, accounting for 3.88% and 7.16% respectively. There were 13,400 ha overmature forests with 1.6308 million m^3 reserve, taking up 0.53% and 1.20% of the total respectively. Young and half-mature forests dominated the arboreal forests whose coverage and reserve accounting for 84.12% and 74.82% of the total respectively.

The planted forests covered 79,500 ha in the project area, and 75,600 ha was preserved. The survival rate reached 95.11%. Among them, the planted forests amounted to 7,900 ha and 7,900 ha was preserved in Hubei with survival rate at 100%. The planted forests reached 71,600 ha and 67,700 ha was preserved in Chongqing with survival rate at 94.57%.

A total of 86,600 ha forests suffered from forest hazards in 2013, accounting for 3.18% of the total forest area in the project area, including 86,500 ha, or 99.88%, damaged by forest diseases and insect pests, and 100 ha, or 0.12%, ruined by forest fires.

3.3 Terrestrial plants

Compared with that of 2012, the main vegetation type and species composition of plant communities was similar. There are 10 types of vegetation in the project area, including deciduous coniferous forest, evergreen coniferous forest, coniferous and broad-leaved mixed forest, deciduous broad-leaved forest, evergreen broad-leaved forest, evergreen and deciduous broad-leaved forest, bamboo forest and grove, thicket, tussock, and cultivated plants. Among others, the evergreen coniferous forest accounted for 27.44% of the vegetation coverage in the project area and was the most dominant species there.

Invasive alien species – wild carrot

nvasive alien species – Eupatorium adenophorum

The geographical distribution of all types of vegetation was affected by multiple elements in the project area. The distribution of tussock, deciduous coniferous forest, coniferous and broad-leaved mixed forest, deciduous broad-leaved forest, evergreen broad-leaved forest, bamboo forest and grove, and cultivated plants was more affected by precipitation and temperature. The aspect was the least influential element for the vegetation distribution in the project area and only affected the distribution of evergreen coniferous and broad-leaved mixed forest. All types of the vegetation were affected by the slope gradient variations, apart from evergreen coniferous forest and evergreen deciduous and broad-leaved mixed forest.

Among the terrestrial natural plant communities in the project area, the ratio of the mean number of species in forest, thicket and tussock communities was about 3:2:1. The number of arbor species was on the decline, while that of thicket and tussock species was on the rise in the majority of forest communities. The number of species changed little in the thicket community and much in the tussock community. Among all types of forests, the deciduous broad-leaved forest supported the greatest number of species and bamboo forest the least.

Investigation was carried out on invasive alien plant species along the arterial and major highways along the Yangtze River of the project area in 2012. Up to 435 invasive alien plant species which belonged to 305 genera of 90 families were identified during the investigation. Families with over 20 alien plant species included Compositae, Leguminosae and Gramineae, accounting for 28.51% of the total. Specifically, Compositae had the most species, which were numbered 60, taking up 13.79% of all. Plant families with 11~20 alient speices included *Solanaceae, Amaranthaceae, Euphorbiaceae, Liliaceae* and *Cruciferae*. There were 12 plant families with 6~10 species. Families with over 6 alient speices made up 67.13% of the total. Among the 305 alient plant genera, Euphorbia had the most speices, which was about 10 species, accounting for 2.3% of the total. *Amaranthus, Solanum, Eucalyptus* and *Ipomoea* had 6~10 species. There were 238 genera with only one species, which made up a high proportion of 78.03%, indicating that more species were scattered in different genera.

Herbage (including four species of trailer) was of absolute dominance among alien plant species life form, which had 329 species, accounting for 75.63% of the total. Annual herb and perennial herb took up the majority. Other life forms included 6 species of liana, 48 species of arbor and 52 species of shrub. In addition, there were seven species aquatic plants among the herbage.

Intentional introduction was the main means of introducing alien plants in the project area, making up 82.99% of the total. In particular, all the woody plants were introduced for the purpose of greening, timber production or appreciation. 53 species were introduced unintentionally which were all herbage, accounting for 12.18%. They might be brought in through traffic, trade and exchanges. Only eight species were introduced by natural introduction. Means of introduction of 13 species were unknown. 175 alien plant species in the project area came from America (including South America, North Amercia, Trophical America and Central America), 68 came from Asia, 55 from Africa, 44 from Europe, 20 from Mediterranean and 15 from Oceania. There were 58 species from multiple orgins including 17 species from Asia continent and Mediterranean.

3.4 Rare and endemic aquatic animals

3.4.1 Endemic fish species

In 2013, up to 117 fish species were identified in the Yibin section of the lower reaches of the Jinsha River, the Hejiang, Mudong, Wanzhou and Zigui sections of the upper reaches of the Yangtze River and Yichang section of the middle reaches. These included 28 species of endemic fish in the upper reaches of the Yangtze River and five alient fish species. Compared with the situation before impoundament, the number of endemic fish species did not have much change in the upper reaches sections like Yibin and Hejiang. Distinct decline of endemic fish species was found in the waters of the project area.

A total of 60,756 sample fishes weighing 2,316.74 kg were caught for the survey on fish catches. There were 8,534 endemic fish which weighted 435.16 kg, accounting for 18.8% of the total weight and 14.0% of the total catches. Compared with that of 2012, the percentage of the weight of endemic fish grew by 25.2% while the percentage of catches went down by 11.5%. The number of endemic fish resources in the upper reaches of the Yangtze River changed notably after

Acrossocheilus monticola

Grass carp (embryonic form)

impoundment. There were still certain endemic fish speices at some scale at Yibin and Hejiang sections and Mudongjiang section of the tail of the reservoir, but the number of endemic fish at Wangzhong, the middle part of the reservoir area, Zigui, the head of the reservoir and Yichang section, the downstream of the Three Goreges Dam went rare.

Experiment was carried out on the artificial propagation of *Sauyage et Dabry* and *Procypris rabaudi*. Induced ovulation rate of female *Sauyage et Dabry* reached 10%, but initially hatched fry was not obtained. 100,000 *Procypris rabaudi* fries were caught through scaled spawning induction.

3.4.2 Rare aquatic animals

In 2013, the sonar detecting data showed the reproductive population of Chinese sturgeon (*Acipenser sinensis* Gray) was mainly distributed between Gezhouba Dajiang Power Plant and Yiling Bridge section. It was estimated that the reproductive population of the Chinese sturgeon on November 7 and December 30 numbered 106 and 97 respectively, but natural propagation was not detected. Compared with that of 2012, the number of reproduction population dropped by 35.8% and analysis of historical data indicated the reproductive population of Chinese sturgeon was still at a low level.

The genetic analysis of juvenile Chinese sturgeon in the estuary of Yangtze River indicated little difference between the number of alleles per locus and effective number of alleles per locus of the juvenile Chinese sturgeon populations, and the mean observed heterozygosity was 0.99, the mean expected heterozygosity 0.78, and the mean Hardy-Weinberg departure value 0.25. No obvious differences were observed regarding the above indexes between this year and the previous year, suggesting that the genetic structure of juvenile Chinese sturgeon in the estuary of Yangtze River was relatively stable.

According to the estimates based on the survey data on the number of *Neophocaena phocaenoides* at Tian'ezhou Gudao Protected Area and Tongling river section in 2013, there were about 38 *Neophocaena phocaenoides* living at the Tian'ezhou Gudao Protected Area and 53 at Tongling river section. *Lipotes vexillifer* was not spotted during the survey.

3.5 Agroecology

3.5.1 Ecological environment of farmland

The farmland in the project area totaled 412,563 ha in 2013, going up to some extent from a year earlier. Analysis of the composition of farmland area indicated 108,412 ha of paddy fields, 167,249 ha of dry lands, 78,101 ha of citrus orchards, 14,209 ha of tea gardens, 3,118 ha of traditional Chinese medicine gardens and 41,474 ha for other crops.

Analysis of the tillage system showed 65,336 ha, or 39.1% of the dry lands practiced triple-cropping system, 81,856 ha, or 48.9% double-cropping system, and 20,057 ha, or 12.0% one-cropping system. The percentage of dry lands practicing triple-cropping system went up compared with that of last year, as opposed to those practicing double-and one-cropping system. As for the paddy fields, the area practicing triple-cropping system was 12,876 ha, accounting for 11.9%, double-cropping system 58,621 ha, or 54.1%, and one-cropping system 36,915 ha, taking up 34.0%. The percentage of paddy fields with double-cropping system went up compared with that of 2012, as opposed to those with triple-and one-cropping systems.

Analysis of slope gradient of the farmlands (excluding paddy fields) showed that the area of farmlands with slope gradient below 10º was 59,984 ha, accounting for 19.7% of total area; area with slope gradient of 10º~15º was 91,643 ha, accounting for 30.1%; 15º~25º 101,128 ha, or 33.2% and above 25º 51,396 ha, taking up 17.0%. Compared with that of 2012, the proporation of farmland with slope gradient below 10º increased by 0.9%, 10º~15º dipped by 0.3%, 15º~25º remain unchanged and that above 25º was down by 0.6%.

Analysis of farmland altitude indicated that the area of farmlands with altitude below 500 m was 198,216 ha

Monitoring plot for non–point source pollution

(48.0%), 500~800 m 145,077 ha (35.2%); 800~1,200 m 58,545 ha (14.2%); and above 1,200 m 10,725 ha (2.6%). Compared with that of 2012, the percentage of farmland with altitude below 500 m grew up by 0.9%, that between 500~800 m down 0.8%, 800~1,200 m remain unchanged and that above 1,200 m dipped 0.1%.

The sown area of crops totaled 608,531 ha, which included 394,071 ha of grain crops (64.8%) and 214,460 ha of cash crops (35.2%). The multiple cropping index was 221%. Compared with that of 2012, the share of grain crops was down and that of cash crops was up. A total of 3,948 ha of slope farmlands were transformed into terraces, and up to 10,367 ha farmlands were returned to forests and grasslands, all going down as compared with that of 2012.

3.5.2 Rural energy

In 2013, up to 6.707 million t of firewood was consumed throughout the project area with per household consumption of 6.5 t. Compared with 2012, the consumption reduced by 161,000 t and per household use decreased by 0.6 t.

There were up to 256,023 biogas pools in rural households with combined annual biogas output of 102.11 million m^3 and 18.2 pools per hundred households. Compared with that of 2012, the number of biogas pools increased 10,882 pools, annual biogas production grew by 4.672 million m^3 and possession of biogas pools per hundred households increased by 2.6.

In addition, the energy mix of the project area also included 2.891 million t of stalks, down by 325,000 t compared with that of 2012. 174,089,000 kW of small hydropower, which was of the same scale as that of 2012 and 859,000 t of coal from small coal mines, down by 45,000 t.

3.5.3 Crop disease and insect pests

The survey covered 23 crop diesases and insect pests in 2013 inlcuding rice planthopper. The results indicated that crop disease and insect pests struck crops for up to 418,266.7 ha•times of which 393,333.3 ha•times were put under control and management. 180,111.4 t of grain was retrieved from insect pests and diseases, the actual loss of grain totaled 48,589.8 t with economic loss of 102.55 million yuan. The affected area, actual loss and economic loss all have some reduction compared with that of 2012.

Among all crop categories, peddy rice, maize and vegetables suffered the most serious diseaseas and insect pests and wheat was less impacted. In terms of the type of diseases and insect pests, rice planthopper, corn sheath blight, corn borer and rodent pest posed bigger threat. Damage degree of all localities indicated that crop diseases and insect pests brought about big impact on Shizhu, Banan, Wanzhou, Yunyang, Wushan and Xingshan of the project area.

3.6 Fishery resources and environment

3.6.1 Fishery resources

In 2013, the natural fish catches in the Three Gorges Reservoir area, the downstream of Three Gorges Dam, Dongting Lake, Poyang Lake, and estuary totaled 57,100 t. The fry flow of four major Chinese carps (*Mylopharyngodon piceus, Ctenopharyngodon idellus, Hypophthalmich-thyus molitrix, Aristichthys nobilis*) amounted to 520 million in Jianli section in the downstream of the Dam. The total natural catches of Coilia mystus in the fishing period jumped by 85.4%, parent crab went down by 35.7% and elver dropped by 50.7%.

● **Project area**

The natural fish catches in the project area registered 6,441 t in 2013. Calculated by the species of the catches, there were 1,481 t of catfish, 1,305 t of *Cyprinus carpio*, 943 t of silver carp, 676 t of *Coreius heterokon*, 416 t of *Ctenopharyngodon idellus* and 218 t of *Pelteobagrus fulvidraco*. Among the total catches, the combined weight of catfish, *Cyprinus carpio, Coreius heterokon*, silver carp, *Ctenopharyngodon idellus* and *Pelteobagrus fulvidraco* accounted for 78.2% of the total, representing major commercial fish species of the project area.

● **Downstream of the Dam**

The natural fish catches amounted to 1,765 t in the downstream of the Dam in 2013. Calculated by the composition of the catches, there were 373 t of *Cyprinus carpio*, 352 t of four major Chinese carps, 173 t of *Parabramis pekinensis*, 148 t of *Coreius heterokon*, 73 t of catfish, 51 t of *Carassius auratus auratus* and 42 t of *Pelteobagrus fulvidraco*. Among the total catches, the combined weight of *Cyprinus carpio*, four major Chinese carps, catfish, *Coreius heterokon, Parabramis pekinensis, Pelteobagrus fulvidraco* and *Carassius auratus auratus* accounted for 68.7% of the sample catches and were the major cash fish species in the project area.

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

Jianli section in the downstream of the Dam recorded 520 million fry of four major Chinese carps between May and July 2013, some increment from a year earlier. Silver carp and *Ctenopharyngodon idellus* were the dominant species among the four major Chinese carps, taking up 59.4% and 24.8% respectively. There were a few of *Aristichthys mobilis* and herring, taking up 15.8% altogether.

Up to 451 million fish eggs of four major Chinese carps were monitored in Yidu section in the downstream of the Dam. Combined with historical records, the analysis results indicated the four major Chinese carps maintained a low spawning level which has been on the rise in recent years.

● **Dongting Lake**

The natural fish catches was 23,200 t in the Dongting Lake in 2013 including 10,300 t (44.4%) from eastern lake, 8,000 t (34.5%) from southern lake, and 4,900 t (21.1%) from western lake. Among the fish catches, settled fishes including *Cyprinus carpio, Carassius auratus auratus* and catfish and the the four major Chinese carps accounted for 79.4% of the total sample catches, representing the major cash fish species in the project area.

There were 28 spawning sites for *Cyprinus carpio, Carassius auratus auratus* at Dongting Lake, covering an area of 250 km^2 which included 12 sites (134 km^2) at the estern lake, 10 sites (71 km^2) at southern lake and 6 sites (45 km^2) at western lake.

● **Poyang Lake**

The natural fish catches was 25,700 t in Poyang Lake in 2013. Among the fish catches, settled fishes including *Cyprinus carpio, Carassius auratus auratus, Silurus asotus*, and *Pelteobagrus fulvidraco*, together with four major Chinese carps, accounted for 76.2% of the total catches, and were the major cash fishes of Poyang Lake.

● **Yangtze River estuary**

The *Coilia mystus* monitoring ships were in fishing operations for a shorter span of time in 2013 compared with that of 2012 in the Yangtze River estuary during the fishing season, the parent crabs monitoring ships worked longer than 2012 and the fishing operation for elver lasted the same duration as that of 2012. On the average, the count of working days of *Coilia mystus* and elver monitoring ships throughout the fishing season was less than that of 2012 and that of parent crabs was more than 2012.

In the fishing season of 2013, the catch of *Coilia mystus* per ship, the output and total catch of *Coilia mystus* per ship rose by 97.85%, 106.81% and 85.37% respectively compared with the same period of 2012. The average length and weight of *Coilia mystus* declined by 3.95% and 6.12% respectively compared with the same period of 2012.

The catch of parent crabs per ship at the Yangtze River estuary in the fishing season of 2013 was up 5.15% while the total catch throughout the season plummeted by 35.71%. The average height, width of the crab shell and average weigth dropped by 12.90%, 13.43% and 37.06% respectively compared with that of 2012.

In 2013, the catch of elver (*Anguilla Japonica*) per ship, output per ship and total catches of elver at the Yangtze River estuary in the fishing season of 2013 slid by 12.79%, 38.64% and 50.66% respectively compared with that of the same period of 2012.

The amount of fishing permits issued for parent crabs was similar to that of 2012 while the amount for *Coilia mystus* and elver reduced by 4 and 632 respectively compared with 2012.

3.6.2 Environment of fishery waters

Seven monitoring stations (Yibin, Banan, Wanzhou, Jingzhou, Yueyang, lake mouth, and estuary) were established in the mainstream of Yangtze River, Dongting Lake, Poyang Lake and Yangtze River estuary in 2013 to monitor the water quality of important fishery waters in the Yangtze River basin. The evaluation of water quality complies with the *Water Quality Standard for Fisheries (GB11607-89)*. The monitoring data indicated that in 2013 the water quality of important fishery waters in Yangtze River basin was good in general during the reproductive season, growing period and wintering season of fishes, and basically met the requirements for their growth and reproduction. However, part of the fishery waters was polluted to certain extent, and the main pollutants were COD and Un-ionized Ammonia (UIA).

● **Upstream of the Yangtze River**

All the monitoring indicators in the waters at Yibin, Banan and Wanzhou met the standard. There was evident drop of the level of copper concentration compared with that of 2012.

● **Midstream of the Yangtze River**

All of the monitoring items in Zhicheng and Jingzhou waters attained water quality standards during the reproductive season, and no evident variation was observed in the concentrations of those monitoring items compared with that of 2012.

The COD concentration in Chenglingji waters exceeded the standard by 50.0% during the wintering season, and by 16.7% during the reproductive period with an increase from the previous year. But there was no obvious change in the concentrations of other monitoring items.

The concentration of Cr^{6+} at lake mouth was over the standard by 66.7% during the wintering season, and the concentration of lead decreased compared with that of 2012. There was no obvious change in the concentration of other monitoring items.

● **Spawning site of Chinese sturgeon**

All the monitoring items attained water quality standards in the spawning site of Chinese sturgeon in Yichang waters during the reproductive season, and the concentrations of those monitoring items had no obvious change compared with that of 2012.

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

All of the monitoring items in the spawning site of the four major Chinese carps in Zhicheng, Jingzhou, and Jianli waters attained water quality standards during the reproductive season. There was no obvious change in the monitoring items compared with that of 2012.

● **Dongting Lake**

The UIA and cadmium concentration of the Dongting Lake exceeded the standard by 33.3% and 11.1% respectively during the fattening period and other monitoring items met water quality standards. Compared with the same period of 2012, the concentration of UIA and cadmium dropped a little while other monitoring items recorded no obvious change.

● **Poyang Lake**

The copper content of Lianzi Lake waters was over the standard by 100% and 66.7% respectively during the reproductive season and the finishing period of fishes. The copper content of the Ruihong waters exceeded the standard by 66.7% during the reproductive season and that in the Duchang waters went beyond the standard by 100% and 66.7% during the wintering season and reproductive season respectively. The copper concentration increased to some extent compared with that of 2012 and no obvious change was found in other monitoring items.

Acipenser sinensis Gray (Chinese sturgeon) spawning site in the downstream of Gezhou Dam

● **Yangtze River estuary**

UIA level exceeded the standard by 6.7% and 40% respectively during the fishing season for *Coilia mystus* and parent crabs. In the fishing season for parent crabs, cadmium, lead and mercury concentration were above the standard by 6.7%. The above-the-standard rate of COD_{Mn} was respectively 46.7% and 13.3% in the fishing season of elver and *Coilia mystus*. There was some rise of UIA and COD_{Mn} concentrations compared with that of last year.

3.7 Earthquake and geological hazards

3.7.1 Earthquake

There were 723 recorded earthquakes ($M\geqslant0.0$) in the project area in 2013, up by 201 compared with that of last year. There were 573 earthquakes rated $0.0\leqslant M<1.0$, up 46.5% (182 occurrences) from a year earlier; 134 rated $1.0\leqslant M<2.0$, up 22.9% (25 occurrences); 13 rated $2.0\leqslant M<3.0$, down 35.0% (7 occurrences); and 1 rated $3.0\leqslant M<3.9$, down 50% (1 occurrence); 1 rated $4.0\leqslant M<4.9$, up 100% (1 occurrence) and 1 rated $5.0\leqslant M<5.9$, up 100% (1 occurrence). Among others, the biggest earthquake (M5.1) shaked Badong County, Hubei Province at 13:04 on December 16, 2013, below the designed intensity level of the project. The earthquakes were more active and intensive than that of last year. There were some moderate and minor earthquakes and

Table 3–1 Statistics on earthquake events of the Three Gorges Project area during 2012 ~ 2013

Year / M	2012		2013	
	Year (occurrence)	Monthly average	Year (occurrence)	Monthly average
0.0～0.9	391	32.58	573	47.75
1.0～1.9	109	9.08	134	11.17
2.0～2.9	20	1.67	13	1.08
3.0～3.9	2	0.17	1	0.08
4.0～4.9	0	0	1	0.08
5.0～5.9	0	0	1	0.08
Total (occurrence)	522		723	
Max. M	3.2		5.1	

a great number of micro and mini seismic activities. The earthquakes were mainly distributed along the riverside from Badong to Zigui County, Hubei Provoince and Shizhu area of Chongqing. During the high water level operation period, seismic activities were relatively frequent.

3.7.2 Geological hazards

A total of 4,878 potential geological hazard sites (collapse, landslide and unstable reservoir banks) were included into the Three Gorges Reservoir monitoring program in 2013. All the sites were monitored through mass monitoring and prevention and 218 sites were professional monitoring sites. The effort involved 254,000 times mass prevention and monitoring and 44,000 times of professional monitoring (including 27,000 times GPS monitoring, 11,000 times monitoring by various monitoring holes and 2,900 geological inspections).

A total of 601 deformed landforms prone to collapses and landslides were identified throughout the project area, mainly at the downstream section south of Wanzhou. Among them, 45 locations were subject to evident deformation and 15 sites were up to hazard level. Thanks to timely monitoring and early warning, no casualties were reported due to geological hazards.

Monitoring statistics indiciated the geological hazards from collapse and landside of evident deformed sites reduced by 13.5% compared with that of 2012. This could be attributed to less precipitation, weaker frequency of torrential rains, relatively stable drop of water level on a daily basis in the non-flooding period and low intensity of engineering activities in the project area.

Automatc monitoring of surface crack of lamdslide

Chapter 4
Discharge of Pollution Sources

4.1 Discharge of Industrial Effluent

In 2013, the total discharge of wastewater from industrial pollution sources of the Three Gorges Reservoir area was 190 million t, up by 9.8% compared with that of last year. 156 million t of them were in the Three Gorges Reservoir area in Chongqing and 34 million t in the Three Gorges Reservoir area in Hubei, accounting for 82.1% and 17.9% respectively of the total industrial effluent. Among the discharged industrial waste water, there were 33300 t for COD and 2100 t for ammonia nitrogen.

Table 4–1 Discharge of industrial effluent in the Three Gorges Reservoir area in 2013

Region		Wastewater (100 million t)	COD (10,000 t)	Ammonia nitrogen (10,000 t)
Reservoir area in Hubei		0.34	0.59	0.03
Reservoir area in Chongqing		1.56	2.74	0.18
Total		1.90	3.33	0.21
Among them	Chongqing City	0.50	0.41	0.03
	Changshou Dist.	0.26	0.27	0.02
	Fuling Dist.	0.13	0.50	0.02
	Wanzhou Dist.	0.14	0.41	0.07

4.2 Discharge of Urban Pollutants

4.2.1 Urban sewage

In 2013, the total discharge of urban sewage of the Three Gorges Reservoir area was 787 million t, up by 7.7% compared with that of last year. Among them, 749 million t were from the Three Gorges Reservoir area (TGRA) in Chongqing and 38 million t were from the Three Gorges Reservoir area in Hubei, accounting for 95.2% and 4.8% respectively of the total urban sewage of the Three Gorges Reservoir area. In the discharged urban sewage, there were 131,600 t COD and 23,800 t ammonia nitrogen.

4.2.2 Domestic garbage

In 2013, the total generated amount of domestic garbage from the 16 districts (counties) in the Three Gorges Reservoir area reached 3.8034 million t, 3.3623 million t of them were disposed, taking up 88.4%; 441,100 t were scattered discharge, taking up 11.6%.

4.2.3 Urban sewage treatment plant

In 2013, there were 119 sewage treatment plants in cities and town of the Three Gorges Reservoir are with designed daily treatment capacity of 2.4685 million t. They treated 788 million t waste water, 784 million t of them were sewage and 5 million t were industrial effluent.

4.3 Agricultural Non-point Pollution

4.3.1 Application and loss of pesticides

In 2013, 645.8 t pesticides (pure) were employed in 19 districts (counties) of the Three Gorges Reservoir area,

Table 4–2 Discharge of urban sewage of the Three Gorges Reservoir are in 2013

Area		Sewage (100 million t)	COD (10,000 t)	Ammonia nitrogen (10,000 t)
TGRA in Hubei		0.38	0.69	0.12
TGRA in Chongqing		7.49	12.47	2.26
Total		7.87	13.16	2.38
Among them	Chongqing City	4.41	4.21	1.10
	Changshou Dist.	0.28	0.54	0.08
	Fuling Dist.	0.41	0.91	0.14
	Wanzhou Dist.	0.58	1.41	0.20

Table 4–3 Urban domestic garbage of some areas of the Three Gorges Reservoir area in 2013

Area	Urban permanent population (10,000 people)	Generated amount (10,000 t)	Disposal amount (10,000 t)	Scattered discharge (10,000 t)
Jiangjin	40.50	15.59	13.41	2.18
Chongqing City	617.32	237.67	216.28	21.39
Changshou	30.98	11.93	10.26	1.67
Fuling	59.97	23.09	19.86	3.23
Wulong	8.09	3.11	2.59	0.52
Fengdu	19.32	7.44	6.17	1.27
Zhong County	18.86	7.26	6.03	1.23
Shizhu	2.94	1.13	0.94	0.19
Wanzhou	86.83	33.43	27.75	5.68
Yunyang	23.99	9.24	7.67	1.57
Kai County	24.40	9.39	7.80	1.59
Fengjie	21.68	8.35	6.93	1.42
Wushan	10.12	3.90	3.23	0.67
Badong	6.12	1.96	1.96	0.40
Xingshan	5.28	1.69	1.69	0.35
Zigui	11.46	3.66	3.66	0.75
Total	987.86	380.34	336.23	44.11

Table 4–4 Urban sewage treatment plants of the Three Gorges Reservoir area in 2013

Area	Amount of sewage treatment plant	Designed treatment capacity of sewage treatment plant (10,000 t/d)	Annual treatment of sewage (100 million t)
TGRA in Hubei	23	15.00	0.35
TGRA in Chongqing	96	231.71	7.53
Total	119	246.71	7.88

down by 7.8% compared with that of last year. Among them, 299.0 t were organophosphorus pesticides, 134.3 t were herbicides, 60.6 t were carbamates, 49.6 t were dimethrin, 102.3 t were other kinds of pesticides. The application of pesticides was 1.53 kg per hectare in the reservoir area.

There were 41.2 t loss of pesticides in the Three Gorges Reservoir area the whole year, down by 3.2 t compared with that of last year. Among them, 23.9 t were organophosphorus pesticides, 6.7 t were herbicides, 3.0 t were carbamates, 2.5 t were dimethrins, and 5.1 t others. The pesticide loss was 0.10 kg per hectare in the Three Gorges Reservoir area.

4.3.2 Application and loss of fertilizer

In 2013, 136000 t fertilizers (pure) had been employed in the Three Gorges Reservoir area, down by 13.4% compared with that of last year. Among them, 88,000 t were nitrogen fertilizer, 38,000 t were phosphorus fertilizer, and 10,000 t were potash fertilizer. The application of pure fertilizer was 0.33 t per hectare of the Three Gorge Reservoir area.

The total fertilizer loss of the Three Gorge Reservoir area was 11100 t in 2013, 1400 t less compared with that of last year. Among them, there were 8700 t loss of nitrogen fertilizer, 1900 t loss of phosphorus fertilizer and 500 t loss of potash fertilizer. On average, there was 26 kg loss of fertilizer in each hectare of the Three Gorges Reservoir area.

4.4 Discharge of Ship Pollutants

In 2013, there were 7937 registered ships in the Three Gorge Reservoir area. There was a reduction of 278 ships and 1600 t reduction of total tonnage compared with that of last year. There was no ship pollution accident in the Three Gorges Reservoir area in 2013.

4.4.1 Ship oil-containing wastewater

In 2013, the investigations on discharge of oil-containing wastewater of the engine room of 425 ships showed that 91.1% of such wastewater met discharge standard. Among all types of ships, the oil-containing wastewater discharge limit attainment rate from high to low was 100% for non-transport ships, 90.8% for cargo ships, 90.0% for passenger ships and 87.5% for towboat. There was the reduction of oil-containing wastewater discharge attainment rate by 0.8% for passenger ships, but increase by 4.5% for non-transport ships, 9.7% for towboat and 0.1% for cargo ships compared with that of last year. In terms of ship power, Grade I ships (power >1500kW) had the highest oil-containing discharge attainment rate at 100%; followed by Grade II ships (441 kW≤ Power <1500kW) at 95.3%; Grade III ships (147 kW≤ Power<441kW) at 82.9%; Grade V ships (Power < 36.8kW) at 77.8%. Grade IV ships (36.8 kW≤ Power<147 kW) had the lowest attainment rate at only 55.6%.

In 2013, it is estimated that all ships in the Three Gorges Reservoir area generated 500,000 t of oil-containing wastewater based on the amount of registered ships, 487,000 t of them were treated, taking up 97.4%. A total of 455,000 t wastewater met discharge standard after treatment, with attainment rate at 91.1%. The amount of ship oil-containing wastewater went down by 10,000 t compared with that of last year with 2.0% reduction of attainment rate. The generated amount of

Table 4–5 Discharge of oil–contaminated waste water from the ships in the Three Gorges Project area in 2013

Ship		Oil-containing wastewater						Petroleum	
Type	Amount	Generated amount (10000 t)	Percent	Treated amount (10000 t)	Treatment rate (%)	Amount meeting the standard (10000 t)	Attainment rate (%)	Discharge (t)	Percent
Passenger ship	2293	15.5	30.9	15.1	97.5	13.9	90.0	15.0	27.1
Cargo ship	3856	25.8	51.7	25.3	97.5	23.6	90.8	28.3	51.3
Towboat	163	1.7	3.5	1.5	87.5	1.5	87.5	0.1	0.2
Non-transport ship	1625	7.0	13.9	7.0	100	7.0	100	11.8	21.4
Total	7937	50.0	100	48.7	97.4	45.5	91.1	55.2	100

oil-containing wastewater was 258,000 t for cargo ships, 155,000 t for passenger ships, 70,000 t for non-transport ships and 17,000 t for tugboat, accounting for 51.7%, 30.9%, 13.9% and 3.5% respectively of the total oil-containing waste water from ships in the reservoir area.

Among the released oil-containing wastewater, 55.2 t were petroleum, up by 8.5 t compared with that of 2013. The release of petroleum in engine room wastewater of various ships was 28.3 t for cargo ship, 15.0 t for passenger ship, 11.8 t for non-transport ships and 0.1 t for towboat, accounting for 51.3%, 27.1%, 21.4% and 0.2% respectively of the total.

4.4.2 Ship sewage

In 2013, 50 ships in the Reservoir area were investigated on sewage discharge. Among them, the sewage of 25 ships was discharged after treatment with 100% attainment rate for suspended particles, 88.0% attainment rate for BOD_5, 84.0% attainment rate for COD, 44.0% attainment rate for TN and 64.0% attainment rate for E-coli; TP discharge of all 25 ships failed to meet pollution discharge standard. The sewage of the rest 25 ships was discharged without any treatment. All monitoring items failed to meet pollution discharge standard except suspended particles and COD.

The estimate results based on factors such as the amount of various ships, annual amount of ship sewage, passenger amount, crew number, ship annual operation time, and the percentage of different tonnage ships show that the generated amount of sewage from all ships of the Three Gorges Reservoir area was about 3.938 million t in the reservoir area in 2013, down by 33,000 t compared with that of last year. Among them, passenger ships generated 2.674 million t of sewage, taking up 67.9% of the total. Cargo ships generated 887,000 t sewage, accounting for 22.5%. Non-transport ships generated 361000 t sewage, taking up 9.2%. Towboats generated 16000 t of sewage, taking up 0.4%.

The discharge amount from big to small of major pollutants in ship sewage was 547.1 t for suspended particles, 543.4 t for COD, 229.8 t for BOD_5, 192.5 t for TN and 43.4 t for TP.

4.4.3 Ship garbage

In 2013, sample investigation was conducted on generated amount and collection of the garbage from 70 ships. Based on the sample investigation, it is estimated that the total generated amount of ship garbage of the Three Gorges Reservoir area was about 50,000 t in the whole year. The port garbage collection center, Marinetime Administration of Ministry of Transport and local marinetime bureau take charge the collection and disposal of the garbage of ships in the Three Gorges Reservoir area. Among them, Marinetime Administration of Ministry of Transport sent 12 garbage collecting ships, 6771 t ship garbage were collected this year.

Chapter 5
Status of Water Environment Quality

In 2013, monitoring of the quality of water environment of the Three Gorges Reservoir area included the monitoring on water quality of both mainstream and tributaries of the Yangtze River as well as comprehensive trophic conditions and water bloom of primary tributaries. The assessment of overall water quality and comprehensive trophic conditions complies with Environmental Quality Standard for Surface Water (Trial) (Huanban No.[2011]22) released by Ministry of Environmental Protection.

5.1 Hydrological Characteristics

In 2013, there were 5 hydrological monitoring sections at the mainstream of the Yangtze River in the Three Gorge Reservoir area，they were Zhutuo in Yongchuan, Cuntan in Chongqing, Qingxichang in Fuling, Tuokou in Wanzhou and Guandukou in Badong. The change range of the flow of the mainstream of the Yangtze River in the Three Gorge Reservoir area was 2710~31000 m^3/s with the change of 0.08~2.39 m/s for the average flow rate. The flow rate of the mainstream section of the Yangtze River from Tuokou to the Dam evidently became smaller compared with that of upstream section due to the impoundment of the reservoir. The average flow rate of each water section was 1.33 m/s at Zhutuo, 1.28 m/s at Cuntan, 0.61 m/s at Qingxichang, 0.26 m/s at Tuokou, and 0.21 m/s at Guandukou. The maximum flow rate of each section was 2.04 m/s at Zhutuo, 2.39 m/s at Cuntan, 1.78 m/s at Qingxichang, 0.72 m/s at Tuokou and 0.67 m/s at Guandukou.

5.2 Water quality

In 2013, 6 water quality monitoring sections were established in the mainstream of Yangtze River in the Three Gorges Reservoir area. They were Zhutuo in Yongchuan, Jiangjin Bridge, Cuntan in Chongqing, Qingxichang in Fuling, Shaiwangba in Wanzhou and Nanjinguan in Yichang. Two water quality monitoring sections were established in Jinzi and Beiwenquan of the Jialing River and 2 water quality monitoring sections were established in Wanmu and Luoying of the Wujiang River. A total of 77 trophic status monitoring sections have been established in 38 major tributaries of the Yangtze River subject to the influence of backwater of the mainstream of the Yangtze River and upstream water bays with similar hydrological conditions.

Monitoring data shows that the overall quality of the water of the mainstream of the Yangtze River in the Three Gorges Reservoir area was good. The overall water quality of the Jialing River was excellent. The total phosphorus concentration of the water of the Wujiang River went beyond national surface water quality standard.

In 2013, the overall water quality of 6 water sections in the mainstream of Yangtze River in the Three Gorges Reservoir area met Grade Ⅲ standard. The E-coli concentration of Cuntan section met Grade Ⅴ surface water quality standard; the E-coli concentration of Nanjinguan section met Grade Ⅱ standard and the rest 4 sections met Grade Ⅲ standard. The water quality of all the 6 sections met or was superior to Grade Ⅲ standard each month. The E-coli concentration of Cuntan section failed to meet the standard during June~December and met Grade Ⅲ standard in the rest months. The E-coli concentration of the rest 5 sections met or was superior to Grade standard in each month.

Table 5–1 Water quality of the sections of mainstream of the Yangtze River in the Three Gorge Reservoir area in 2013

Section name	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Zhutuo	III	III	III	III	III	III	III	III	III	III	III	III	III
Jiangjin bridge	III	III	III	III	III	III	III	III	III	III	III	III	III
Cuntan	III	III	III	III	II	III	III	III	III	III	III	III	III
Qingxichang	III	III	III	III	III	III	III	III	III	III	II	III	III
Shaiwangba	III	III	III	III	III	III	III	III	III	III	III	III	III
Nanjinguan	II	II	II	III	III	III	II	III	II	II	II	II	III

Table 5–2 Water quality of sections in the Jialing River and Wujiang River of the Three Gorge Reservoir area in 2013

Section name	River	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Jinzi	Jialing River	II	II	II	II	II	II	III	III	II	II	II	II	II
Beiwen-quan	Jialing River	II	II	II	II	II	III	III	III	III	III	III	II	II
Wanmu	Wujiang River	＞V	＞V	＞V	＞V	V	＞V	＞V	V	V	V	IV	V	＞V
Luoying	Wujiang River	＞V	＞V	＞V	＞V	IV	V	V	V	IV	III	III	III	V

5.3 Trophic Conditions and Water Bloom of Primary Tributaries

5.3.1 Trophic status

Five indicators such as chlorophyll a, TP, TN, permanganate value and SD were employed to calculate the trophic status index and assess comprehensive trophic status of water bodies. The findings show that there was no obvious change of trophic status of the waters of 38 major tributaries of the Three Gorges Reservoir area during sensitive period (March~October) compared with that of last year.

Among the 77 water sections during the year, 15.6%~39.0% were under eutrophication, 58.4%~80.5% were under mesotrophic condition, and 1.3%~6.5% were under oligotrophic condition. Among them, 15.0%~50.0% water sections in backwater areas were under eutrophication, while 10.8%~27.0% water sections in non-backwater areas were under eutrophication. The eutrophication extent of backwater areas was higher than that of non-backwater bodies. In backwater areas, there was a reduction of 17.5, 7.5, 5.0 and 17.5 percentage points of eutrophication sections in April, June, August and September respectively compared with that of same period of last year, but 10.0, 7.5, 7.5 and 15.0 percentage points increase of eutrophication sections in March, May, July and October respectively compared with that of same month last year.

5.3.2 Water bloom

In 2013, water bloom in main tributaries of the Yangtze River in the Three Gorges Reservoir area was stable compared with that of last year. There was water bloom in backwater bodies of main tributaries such as Baolong River, Xiangxi River, Chixi River, Tongzhuang

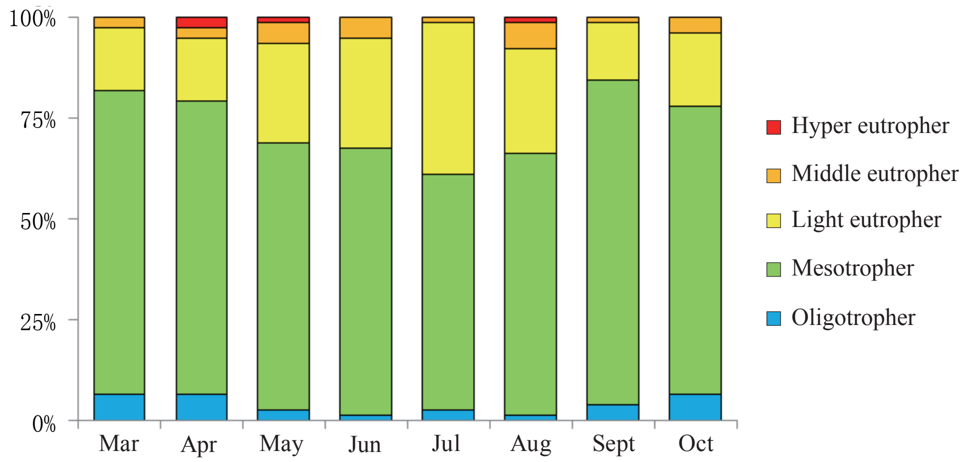


Figure 5–1 Trophic status of primary tributaries of the Yangtze River in the Three Gorges Reservoir area during March~ October of 2013

River, Caotang River, Meixi River, Yulin River, Zhuxi River, Pengxi River, Tangxi River, Modao Stream, Changtan River, Shennong Stream, Ruxi River, Huangjin River, Dongxi River, Zhenxi River, Lixiang Stream, Qinggan River, Quxi River and Chixi River in the Three Gorges Reservoir area. The dominant algae species were mainly *Cyclotella* of *Bacillariophyta*, *Peridinaceae* of *Pyrrophyta* and *Cryptomonas* of *Cryptophyta*. Water bloom mainly occurred in the spring and autumn with evident seasonal change. In the spring, the dominant species were mainly *Cyclotella*, *Cryptomonas* and *Peridinaceae*. In the autumn, the dominant species were *Cryptomonas* and diatom.

Chapter 6
Status of Public Health

6.1 Basic Situation

In 2013, the monitoring range of public health of the Three Gorge Reservoir area included 19 townships, towns and urban communities of five monitoring sites such as Chongqing City; Fengdu County, Wanzhou District and Fengjie County in Chongqing Municipality and Yichang City in Hubei Province. The total population under monitoring this year was 753115, up by 14105 people compared with that of last year. Among them, 385661 were male and 367454 were female with male-female proportion of 1.05:1. There were 425868 people living in cities and towns and 327247 people in rural areas. There were 318 health institutions at all levels within the monitoring sites, up by 9 compared with that of last year. There were 5853 hospital beds in all health institutions of all monitoring sites, up by 1175 compared with that of last year. The total amount of various public health workers at different levels was 6876, up by 1694 people compared with that of last year. This mainly has something to do with the change of some target townships and towns as well as adjustment of health institutions.

6.2 Life Statistics

In 2013, 6308 babies were born in Chongqing, Fengdu, Wanzhou, Fengjie and Yichang monitoring sites, 3250 of them were male and 3058 female with gender proportion of 1.06:1. The birth rate was 8.38‰, down by 1.53% compared with that of last year. There were 4677 deaths with mortality at 6.21‰, up by 9.72% compared with that of last year. Among them, male mortality was 7.18‰ and female mortality was 5.19‰.

The birth rate was 10.24‰ in Chongqing, 9.76‰ in Fengdu, 5.28‰ in Wanzhou, 10.95‰ in Fengjie and 7.02‰ in Yichang. The death rate was 6.76‰, 7.07‰, 5.22‰, 5.73‰ and 7.26‰ respectively. There was 25.64% increase in Chongqing but 21.21% reduction in Yichang, 10.54% reduction in Fengjie, 4.69% reduction in Wanzhou and 2.11% reduction in Fengdu of the birth rate compared with that of last year. The death rate of Chongqing, Fengjie, Yichang, Wanzhou and Fengdu went up by 18.60%, 15.99%, 13.97%, 3.16% and 2.76% respectively compared with that of last year.

All monitoring sites reported 28 cases of infant death, 18 of them were male and 10 female. The infant mortality was 4.44‰, down by 15.34% compared with that of last year.

According to the ICD-10 disease classification standard, the top five diseases with the highest mortality of the people in monitoring sites in 2013 were circulatory system disease, malignant tumor, respiratory system disease, damages & poisoning and digestive system disease with mortality at 232.24/100,000, 175.67/100,000, 89.10/100,000, 46.21/100,000 and 15.00/100,000 respectively, causing 37.40%, 28.29%, 14.35%, 7.44% and 2.42% respectively of the total death with accumulated percent at 89.90%. The rank of the top five diseases kept the same with no big change of the individual mortality percent compared with that of last year.

6.3 Monitoring of Diseases

6.3.1 Monitoring of infectious diseases

In 2013, all monitoring sites reported a total of 3674 cases of infectious diseases. The reported morbidity was 487.84/100,000, 4.98% increase compared with that (464.68/100,000) of last year. There were 5 deaths with mortality at 0.66/100,000. There was no reported case of Category A infectious disease. The morbidity from high to low was 627.81/100,000 in Chongqing, 584.64/100,000 in Yichang, 495.65/100,000 in Wanzhou, 409.28/100,000 in Fengdu and 344.05/100,000 in Fengjie. Compared with that of last year, there was a morbidity increase of 21.44% in Wanzhou, 20.18% in

Fengjie and 5.70% in Chongqing monitoring sites; while there was 12.09% reduction in Yichang and 11.31% reduction in Fengdu. There were most reported cases of category B infectious diseases in January but the least in December with 100~200 cases in other months. There were two peaks (June-July and October-December) of Category C infectious diseases due to relatively many reported cases of hand-foot-mouth disease, parotitis and other infectious diarrhea.

All monitoring sites reported 2012 cases of 14 types of Category B infectious diseases (excluding HIV victims); the morbidity was 267.16/100000, down by 0.49% compared with that of same period of last year. In all monitoring sites, Yichang had the highest morbidity of Category B infectious diseases at 444.09/100000, followed by Chongqing, Fengdu, Fengjie with the lowest 175.14/100000 in Wanzhou. Compared with that of last year, the morbidity of Fengjie, Chongqing and Fengdu monitoring sites went up by 23.72%, 7.59% and 2.06% respectively; while the morbidity of Yichang and Wanzhou monitoring sites went down by 20.47% and 1.55% respectively. The top five morbidities of Category B diseases were virus hepatitis (114.59/100000), TB (91.75/100000), syphilis (29.74/100000), diarrhea (18.32/100000) and gonorrhea (5.18/100000), they took 97.17% of the total morbidity of Category B diseases. In 2013, the reported types of Category B infectious disease increased whooping cough, epidemic meningitis and hydrophobia with elimination of leprospirosis and Type A H1N1 influenza (Type A H1N1 influenza in November of 2013 was classified as seasonal influenza of Category C infectious disease) compared with that of last year. There was some increase of the morbidity of the diseases such as hepatitis C, hepatitis E, undifferentiated type hepatitis, diarrhea, typhoid, AIDS, gonorrhea, syphilis, measles, scarflet fever and malaria compared with that of last year; while the morbidity of other diseases had some decline. HIV infection cases went up by 52.55% compared with that of last year. The water-born diseases such as hepatitis A (2.12/100000), dysentery (18.32/100000) and typhoid (0.4/100000), which have something to do with impoundment, still had relatively low morbidity. There were 2 cases of encephalitis B and 2 cases of malaria (natural source diseases) due to change of biological media, but no reported case of leptospirosis, dengue and hemorrhagic fever.

All monitoring sites reported 1662 cases of 6 kinds of Category C infectious disease. Its morbidity was 220.68/100000, up by 12.47% compared with that of last year. The morbidity of the monitoring sites was 320.51/100000 for Wanzhou, 293.07/100000 for Chongqing, 143.54/100000 for Yichang, 140.91/100000 for Fengdu and 109.76/100000 for Fengjie. Compared with the morbidity of last year, there was an increase of 39.21%, 30.38%, 13.25% and 3.62% respectively in Wanzhou, Yichang, Fengjie and Chongqing, but 29.01% reduction in Fengdu monitoring site.

6.3.2 Monitoring of endemic diseases

In 2013, the monitoring sites of Chongqing, Wanzhou, Fengdu, Fengjie and Yichang conducted monitoring on iodine deficiency disorders. Palpation method was employed to investigate thyroid enlargement. A total of 732 children aged 8~12 were investigated; 19 of them had I^{o} thyroid enlargement, taking up 2.60%, slightly down by 3.28% compared with that of last year, in the range of slight endemic. The thyroid enlargement rate was 7.08% for Fengdu and 4.65% for Wanzhou. The edible salt of 1136 households was checked, 1133 of them consumed iodine-added salt, accounting for 99.74%, up by 0.01 percentage point compared with that of last year. A total of 1058 households consumed qualified iodine-added salt, taking up 93.38%, down by 4.40 percentage points compared with that of last year. The consumption rate of qualified iodine-added salt was 93.13%, down by 4.39 percentage points compared with that of last year. There occurred the phenomena of high coverage of iodine-added salt but reduction of its qualification rate and consumption rate in the monitoring sites of Chongqing, Fengdu and Wanzhou. This might have something to do with the factors such as new policy of Chongqing Municipality on iodine concentration in salt in 2013, increase of market share of multi-nutrient salt as well as improper storage or use of the edible salt.

In 2013, Fengjie County conducted sample investigation on 511 children aged 8~12 for dental fluorosis, 155 cases of dental fluorosis were found with positive rate at 30.33%. It indicated that the morbidity of dental fluorosis in the region due to coal burning pollution was still relatively high.

6.4 Monitoring of Biological Media

6.4.1 Monitoring of rats

In 2013, the average indoor rat density of all the monitoring sites was 2.53%; and outdoor rat density was 1.35%. The outdoor rat density was lower than that of last year; while indoor rat density was basically same as that of last year, still lower than the average (3.94% and 4.22%) of the five years (1999~2003) before Stage II impoundment. Different from last year, both indoor and outdoor rat density in autumn was slightly higher than that of spring. The indoor rat density (2.42%) in the spring was higher than outdoor rat density (1.31%), which is contrary to that of last year. In autumn, indoor rat density (2.64%) was higher than the outdoor density (1.39%), same as that of last year. The indoor mouse density of each monitoring site from high to low was 5.06% in Fengdu, 2.27% in Fengjie, 2.16% in Chongqing, 2.06% in Wanzhou and 1.28% in Yichang. The outdoor rat density of each monitoring site from high to low was 3.65% in Fengdu, 2.22% in Wanzhou, 2.06% in Chongqing, 0.97% in Fengjie and 0.45% in Yichang. The monitoring data of the past 17 years show overall declining trend of both indoor and outdoor rat density in the Three Gorges Reservoir area.

Sewer rat (*Rattus norvegicus*) was the dominant indoor rat species (taking up 36.78%); followed by *mus musculus* (taking up 34.48%) and *Rattus flavipectus* (taking up 21.84%). In outdoor environment, the small insectivore (mostly short-tail shrew) was still the dominant species (taking up 28.75%); followed by sewer rat (taking up 20.00%) and black strip rat (*Apodemusagrarius*) (taking up 12.50%), increase 9.47 percentage points compared with that of last year. There was significant reduction of the percent of indoor *Rattus norvegicus* and *Rattus flavipectus* but evident rise of the percent of mus mussculus compared with that of last year. There was no catch of black strip rat (*Apodemusagrarius*) and small insectivore, while the captured amount of other rat species had evident rise. As the host animal of etiology of hemorrhagic fever and leptospirosis, black strip rat (*Apodemusagrarius*) has maintained its No.2 or No.3 position of outdoor species for many years with remarkable reduction of its population in 2011 and 2012 and slight increase in 2013. Its cause is waiting further monitoring.

6.4.2 Monitoring of mosquitoes

In 2013, the overall density of adult mosquitoes in livestock pens and human dwellings was 114.94/pen•artificial hour and 20.58/room• artificial hour respectively. The adult mosquito density of livestock pens was lower than that of last year, while the adult mosquito density of human dwellings was higher than that of last year; but both being lower than the five-year average density (198.57/pen• artificial hour and 63.97/room• artificial hour) before Stage II impoundment. The monitoring data of all monitoring sites shows mosquito density of human dwellings from high to low was Chongqing (46.46/room• artificial hour), Wanzhou (46.28/room•artificial hour), Fengjie (9.91/room•artificial hour), Fengdu (8.36/room•artificial hour) and Yichang (5.91/room•artificial hour). The mosquito density of livestock pens from high to low was Wanzhou (188.96/pen• artificial hour), Chongqing (129.21/pen• artificial hour), Fengdu (128.72/pen• artificial hour), Yichang (97.52/pen• artificial hour) and Fengjie (85.52/pen•artificial hour). The mosquito density of human dwellings had some rise in Chongqing, Wanzhou, Fengjie and Yichang compared with that of last year but some reduction in Fengdu. The mosquito density of livestock pens had some rise in Chongqing, Fengjie and Yichang but some drop in Wanzhou and Fengdu compared with that of last year. The monitoring data of the past 17 years shows gradual declining trend of overall mosquito density of human dwellings; decline trend of mosquito density of livestock pens year on year in the first 10 years but relatively stable in the latest 7 years.

The 10-days change trend of both the density of adult mosquitoes in human dwellings and livestock pens was basically the same during May~September. The earliest peak of the density of adult mosquitoes in human dwellings occurred in Fengdu in late May; while the latest occurred in Chongqing in late August. The peak of the density of adult mosquitoes in human dwellings in Wanzhou occurred in early July, that of Fengjie in late July and that of Yichang in early August. The earliest peak of the density of adult mosquitoes in livestock pens occurred in Fengdu in late May and the latest in Chongqing and Fengdu in late July. The peak of the density of adult mosquitoes of livestock pens in Wanzhou and Yichang occurred in early June. *Armigeres subbalbeatus* was the dominating mosquito species in both human dwellings and livestock pens, accounting for 77.34% and 79.08% of the total. Among the mosquito species in human dwellings, Culex pipiens fatigans ranked No.2 (taking up 12.14%), *Culex pipiens pallens*, *Anopheles sinensis* and *Culex tritaeniorhynchus* ranked No.3~5. Among the mosquito species in livestock pens, *Culex pipiens fatigans* ranked No.2, *Anopheles sinensis*, *Culex pipiens pallens* and *Culex tritaeniorhynchus* ranked No.3~5. Compared with that of last year, there was some rise of the percent of *Culex pipiens pallens* and *Anopheles sinensis* but some reduction of the percent of *Culex pipiens fatigans* and *Culex tritaeniorhynchus* in both human dwellings and livestock pens. There was some increase of *Armigeres subbalbeatus* in human dwellings but slight reduction in livestock pens compared with that of last year.

Chapter 7
Environmental Quality of the Dam Area

7.1 Hydrology and Meteorology

7.1.1 Hydrology characteristics

In 2013, the statistic data based on measurement of Huanglingmiao Hydrological Station downstream the water control project of the Three Gorges Dam shows annual average flow of 11700 m^3/s, the maximum flow at 36200 m^3/s on July 25 and the minimum flow of 4820 m^3/s on March 24. The annual average sediment discharge rate was 1.04 t/s, the average sediment concentration at 0.089 kg/m^3, the maximum average sediment concentration 1.24 kg/m^3 on July 23, the minimum average sediment concentration 0.002 kg/m^3 on February 2. The annual average flow, annual average water level, annual average sediment discharge rate and average sand concentration of the Three Gorges Dam area had some reduction compared with that of last year.

Table 7–1 Monthly flow of Huanglingmiao Hydrological Station in 2013

Unit: m^3/s

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Average	6630	6190	6320	6560	13300	15800	30000	20100	14600	7160	6930	6360	11700
Max.	8260	7270	8270	8070	19600	26900	36200	31800	18000	12900	8900	7360	36200
Min.	4840	5880	4820	5630	6190	7780	14400	12500	12000	5940	5390	5340	4820

Table 7–2 Monthly sediment level of Huanglingmiao Hydrological Station in 2013

Unit: m^3/s

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Average	0.004	0.003	0.003	0.004	0.006	0.016	0.350	0.057	0.009	0.005	0.004	0.002	0.089
Max.	0.005	0.003	0.004	0.005	0.010	0.021	1.24	0.111	0.011	0.006	0.004	0.003	1.24
Min.	0.003	0.002	0.003	0.004	0.004	0.009	0.018	0.010	0.006	0.004	0.003	0.002	0.002

7.1.2 Climate

In 2013, the annual average temperature of the Three Gorges Dam area was higher than the historical average but with less precipitation.

● **Precipitation**

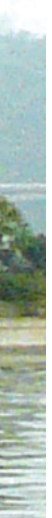
The annual precipitation of the Three Gorge Dam area was 939.0 mm, 7.5% down compared with that of the historical average. The precipitation of each month was extremely uneven and mainly concentrated on April~October. The maximum daily precipitation was 55.4 mm occurring on August 24. The longest period without precipitation in 2013 was 23 days occurring during January 5~27. The longest continuous precipitation period in 2013 was 12 days occurring during September 2-13.

● **Temperature**

The annual average temperature of Three Gorge Dam area was 17.4℃, 0.3℃ higher than that of the historical average. The annual extreme highest temperature was 39.9℃ occurring on June 18 and annual extreme lowest temperature was -2.7℃ on January 4.

● **Wind speed**

The annual average wind speed of the Three Gorges



Dam area was 0.8 m/s. The extreme wind speed was 23.7 m/s on August 12. The wind direction was changeable in the whole year, most of which was north wind with frequency at 12%.

Table 7–3 Weather elements of the Three Gorges Project area each month in 2013

Month		Jan.	Feb.	Mar	Apr.	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Year
Temp	Temp.(℃)	5.5	7.2	13.8	17.4	21.8	25.6	28.8	27.8	21.5	18.1	13.2	7.5	17.4
	Departure(℃)	0.5	-0.4	1.7	-0.2	0.0	0.2	1.4	1.1	-1.3	0.2	0.2	0.0	0.3
Precipita-tion	P (mm)	4.5	15.0	40.1	48.6	182.0	125.4	113.5	178.5	169.5	22.3	31.5	7.5	939.0
	Departure(%)	-72.4	-59.2	-18.0	-41.4	47.4	6.0	-31.9	2.2	46.9	-66.1	-28.9	-7.6	-7.5
Wind speed	Avg (m/s)	1.0	1.1	1.2	1.0	0.6	0.8	0.7	0.8	0.5	0.5	0.8	0.9	0.8
	Max. (m/s)	5.3	6.0	7.4	6.0	7.0	9.6	11.0	13.4	7.3	6.8	5.4	5.4	13.4
	Extreme(m/s)	9.1	11.1	12.1	9.9	11.1	13.5	18.9	23.7	14.2	9.3	10.7	9.5	23.7

7.2 Air quality

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

In 2013, the annual average concentration of SO_2 of the Three Gorges Project area was 0.008 mg/m^3, meeting Grade Ⅰ standard, up by 0.002 mg/m^3 compared with that of last year. The daily average concentration of SO_2 met Grade Ⅰ standard. The annual average concentration of NOx was 0.017 mg/m^3, meeting Grade Ⅰ standard, up by 0.001 mg/m^3 compared with that of last year. The daily average concentration met Grade Ⅰ standard.

The annual average of TSP concentration in the Three Gorges Project area was 0.154 mg/m^3, meeting Grade Ⅱ national air quality standard, up by 0.009 mg/m^3 compared with that of last year. Among them, the daily average TSP concentration of 45.1%, 49.3% and 5.6% of the office and residential areas met Grade Ⅰ, Ⅱ or Ⅲ national air quality standard respectively. The daily average TSP concentration of 37.5%、54.2% and 7.6% of the construction area met Grade Ⅰ, Ⅱ or Ⅲ national air quality standard respectively.

There was an increase of 33.3% for annual average concentration of SO_2, 6.2% for annual average concentration of NO_2 and 6.2% for annual average concentration of TSP in ambient air of the construction area compared with that of last year.

7.3 Water quality

A total of 13 indicators such as pH, dissolved oxygen, ammonia nitrogen, COD, permanganate value, BOD_5, volatile phenol, cyanide, arsenic, hexavalent chromium, copper, lead, and cadmium were chosen to assess water quality of the mainstream of Yangtze River of the Dam area according to the Environmental Quality Standard for Surface Water (GB3838-2002). The anion surfactant has been added to assess the quality of waters near bank.

In 2013, the quality of all the water sections of the mainstream of the Yangtze River and near-bank waters in the Three Gorges Dam area was excellent, meeting Grade Ⅰ national surface water quality standard, basically same as that of last year.

Table 7–4 Water quality of water sections of the mainstream of the Yangtze River in the Three Gorges Project area in 2013

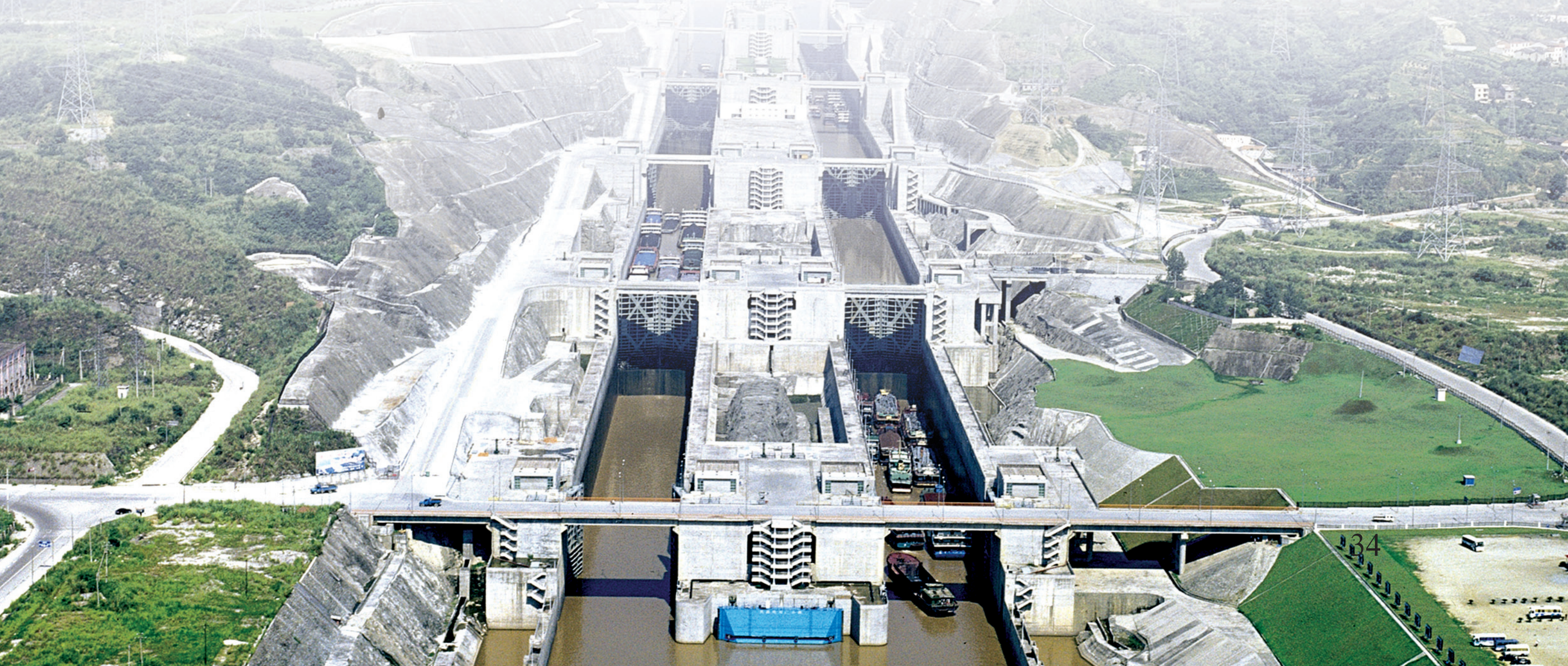
Section name	No.1 quarter	No.2 quarter	No.3 quarter	No.4 quarter	Whole year
Taiping Stream	I	I	II	I	I
Letian Stream	I	II	II	I	I

Table 7–5 Water quality of near–bank waters of the Yangtze River in the Three Gorges Project area in 2013

Sampling location		No.1 quarter	No.2 quarter	No.3 quarter	N.4 quarter	Whole year
Left bank (30m to the bank)	Upstream approach channel	I	II	II	I	I
	Downstream approach channel	I	I	II	I	I
Right bank (30m to the bank)	Auxiliary dam	I	I	I	I	I

7.4 Noise

In 2013, the average environmental noise of the office and residential areas of the Three Gorges Dam area was 56.3 dB during daytime and 43.4 dB during night, meeting Grade II and Grade I limits respectively of the Environmental Quality Standard for Noise (GB3096-2008). There was 0.4 dB increase of environmental noise during daytime but 3.3 dB reduction in the night in the office and residential areas compared with that of last year. The average daytime and night environmental noise in construction areas was 49.7 dB and 47.2 dB respectively, both meeting the noise limit for workshops and operation sites specified in the Specifications for the Design of Noise Control System in Industrial Enterprises (GBJ87-1985). There was 5.7 dB reduction of average daytime noise and 2.1 dB reduction of average night noise in the construction area compared with that of last year. The noise at the boundary of construction site complied with the noise limit of Emission Standard of Environment Noise for Boundary of Construction Site (GB12523-2011). The annual average of traffic noise of the Three Gorges Dam area was 67.6 dB, up by 0.9 dB compared with that of last year.



Chapter 8
Monitoring and Studies on Ecological Environment

8.1 Wanzhou Model Zone

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

Wanzhou Model Zone has conducted studies on compound ridge tillage of grain crops, cash crops and fruit trees on slope farmland (hereinafter referred to as Model Ⅰ), by changing from the conventional flat tillage up and down the slope to cross slope grid ridge tillage, and from growing single-variety of grain crops to agroforestry model which combines Suining Pomelo with grain crops (*Ipomoea batatas or pasture*).

Model Ⅰ retained soil moisture fairly well. The monitoring data of 2013 showed the mean soil moisture of Model Ⅰ was 10.12% higher than that of flat tillage of grain and cash crops up and down the slope (hereinafter referred to as Model Ⅱ) in 2 days after rain, 12.02% higher in 4 days after rain, and 19.21% higher in 8 days after rain; 5.19% higher than that of compound flat tillage of grain crops, cash crops and fruit trees on slope farmland (hereinafter referred to as Model Ⅲ) in 2 days after rain, 9.41% higher in 4 days after rain, and 10.46% higher in 8 days after rain. The mean soil moisture of Model Ⅰ varied less with soil depth, compared with that of Model Ⅲ and Model Ⅱ. Moreover, in ridge tillage model, the mean soil moisture of furrows was higher than that of ridges.

New looks of rural areas of Changling Town in Wanzhou

Model Ⅰ improved the physical properties of soils, and the soil porosity was bigger than that of Model Ⅱ and Model Ⅲ. Under the same fertilizer application circumstances, the contents of soil nutrients of Model Ⅰ were higher than that of flat tillage of grain crops up and down the slope (hereinafter referred to as Model Ⅳ), by 19.29% for organic matters, 14.46% for TN, 24.64% for TP, 8.04% for TK, 29.08% for Kjeldahl nitrogen (KN), 4.22% for AP, and 25.03% for AK. Compared with that of Model Ⅲ, there was 10.06% higher for the content of organic matters, 3.33% higher for TN, 23.53% higher for KN, 7.02% higher for AK, 1.59% lower for TK, AP 5.92% lower for AP in Model Ⅰ, and TP level was the same. The content of organic matters, TP, KN and AK of Model Ⅰ went up compared with that of last year; and that of TN, TK and AP went down.

The total soil erosion of Model Ⅰ was only 5.69% of that of the conventional Model Ⅳ, and the total runoff of the former was only 20.38% of that of the latter. Both of the parameters of Model Ⅰ decreased from last year, by 9.67% for total soil erosion and by 3.79% for total runoff. The ranking of the content of organic matters, TN and AK in the eroded sediments among different models was: Model Ⅰ >Model Ⅲ>Model Ⅳ, and the ranking of the content of TP, KN, and AP was Model Ⅲ>Model Ⅰ >Model Ⅳ. The contents of TN and TP in the surface runoff of Model Ⅰ was lower than those of Model Ⅱ. The TN content in the surface runoff of Model Ⅰ went up 1.08 mg/L from last year, while the TP content had no obvious change.

8.1.2 Experiment on steep slope hedgerow model

The monitoring data of hedgerow model in 2013 showed the hedgerow retained soil moisture fairly well. The mean soil moisture of hedgerow model was 10.62% higher in 2 days after rain, 9.40% higher in 4 days after rain, and 8.50% higher in 8 days after rain than flat tillage of grain crops up and down steep slope (hereinafter referred to as Model Ⅴ), and the mean soil moisture of hedgerow was higher than that of the upper and lower layer soils.

Rural household investigation

The hedgerow model helped ameliorate the physical properties of soils, with soil bulk density lower than that of Model Ⅴ, and soil porosity higher than that of Model Ⅴ. The soil bulk content of hedgerow model was a littler lower in general compared with that of last year, while the soil porosity went up. The hedgerow model was very effective in improving soil fertility. The mean content of organic matters, TN, KN, TP, AP, TK, and AK in the soil samples collected from and between the hedgerows was 21.34%, 14.15%, 14.86%, 2.54%, 11.34%, 1.62% and 51.17% respectively higher than that of Model Ⅴ. Compared with that of last year, the content of organic matters, TN, KN and TK went up 1.21%, 20.66%, 2.91% and 8.97% respectively, and the content of TP and AK went down by 1.68% and 5.82%.

The monitoring data showed that the hedgerow model substantially reduced water and soil erosion. The annual surface runoff of the hedgerow model registered 66.2 m^3/ha, which was only 21.8% of that of Model Ⅴ, and the total soil erosion amounted to 0.04 t/ha, which was only 1.8% of the latter. The unit contents of soil nutrients in the runoff sediments of hedgerow model were higher than that of Model Ⅳ, by 53.96% for organic matters, by 91.45% for TN, by 29.42% for TP, by 5.88% for TK, by 84.20% for KN, by 66.50% for AP, and by 87.57% for AK. Compared with that of last year, the content of organic matters, TN, KN, AP and AK of hedgerow model went up 14.89%, 18.09%, 6.09%, 24.98% and 5.02%, while that of TP and TK went down by 7.76% and 14.62%.

The mean TN content in the surface runoff of hedgerow model was 8.6% lower than that of Model Ⅴ, but the mean TP content was higher. Compared with the data last year, the TN and TP content in the surface runoff of both hedgerow model and Model Ⅴ were lower, by 11.67% for TN and by 38.09% for TP in the hedgerow model.

8.2 Zigui Model Zone

8.2.1 Monitoring and controlling the soil erosion and water and nutrient loss on the slope farmland

Slope farmlands and navel orange orchards which had taken protection measures were able to substantially control soil erosion and reduce water and nitrogen and phosphorus nutrient losses. Compared with the conventional cropping practice (*Triticum aestivum-Arachis hypogaea* plot) on slope farmland, the runoff of *Lolium perenne- Glycine max* plot was 19.7% lower, that of *Triticum aestivum-Arachis hypogaea* plot with interplanted *Toona sinensis* as the hedgerow was 42.2% lower, and that of *Triticum aestivum-Arachis hypogaea* plot with interplanted *Medicago sativa* as the hedgerow was 25.7% lower; the sediment yield was 58.7%, 76.3% and 58.0% lower; the loss of nitrogen was 4.5%, 62.0% and 11.4% lower; and the loss of phosphorus was 28.0%, 76.8% and 20.9% lower.

Compared with conventional navel orange orchard, the slope runoff of the navel orange orchard interplanted with perennial *Trifolium repens* as hedgerow was 33.2% lower, that of navel orange orchard with stalk coverage on the ground was 33.6% lower, and that of navel orange orchard with intercropped *Hemerocallis citrina* as hedgerow was 29.7% lower. The sediment yield was down by 14.1%, 30.3% and 48.7%; the loss of nitrogen was 3.3%, 8.6% and 38.7% lower; and the loss of phosphorus was down 20.5%, 39.2% and 54.4%.

Monitoring of water and soil erosion

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

Experiments and demonstrations were carried out in 2013 on application of the hedgerow and stalk coverage technology in the low-altitude navel orange distribution zone, based on the characteristics of the head region of the Three Gorges Reservoir area. The studies demonstrated that compared with the conventional navel orange orchard, the TN content in the soil layer somewhere between 0~20 cm in depth went up by 18.0% in the navel orange orchard with interplanted hedgerows, and by 63.0% in the navel orange orchard with stalk coverage on the ground; the TK content went up 12.0% and 7.0% respectively.

Experiments and demonstrations were also available with regard to the integrated water and fertilizer management technology in the navel orange distribution zone. The studies showed the integrated water and fertilizer management technology helped minimize the impact of frequent summer, autumn and winter drought spells on orange yield, and on the other hand, combined with irrigation-based fertilization, managed to realize real-time irrigation and precise fertilization, which helped raise yield per unit area as well as the total yield and productivity. In the meantime, this technology may improve the nutrient efficiency, and reduce pedoturbation as well as soil erosion and agricultural non-point pollution in orange orchard. The application of this technology helped increase the navel orange yield by 30%, and raise the nitrogen element utilization efficiency from 30% to over 70%.

8.2.3 Monitoring and studies on soil fertility

The monitoring data on soil fertility (organic matters, TN, TP, TK) in the head region showed the content of organic matters in the soil of monitoring sites averaged at 16.37 g/kg in 2013, up by 4.9% from last year; the TN content at 1.20 g/kg, down by 5.9%; the TP content at 0.50 g/kg, up by 6.4%; and the TK content at 15.74 g/kg, down by 10.5%.

Remote real–time monitoring plot

8.3 Water-level-fluctuating zone

A total of 22 monitoring sites were investigated on soil physical and chemical properties and on the re-vegetation in the water-level-fluctuating zone of the reservoir area between June (after waters subsided) and September (before the impoundment) of 2013. Those monitoring sites were distributed in Banan District, Changshou District, Fuling District, Fengdu County, Zhongxian County, Wanzhou District, Kaixian County, Yunyang County, Fengjie County, Wushan County, Badong County, Zigui County and Xingshan County.

8.3.1 Soil physical and chemical properties

The 2013 monitoring data on soil particle composition of the water-level-fluctuating zone showed fine soil texture in such zones and there are a high percentage of particles with diameter below 0.05 mm.

The monitoring data on heavy metal contents in soil indicated the content of arsenic, chromium, lead, copper and iron went up by 51.00%, 49.18%, 0.70%, 3.96% and 2.81% respectively from a year earlier after the water subsided, while the content of mercury, cadmium, zinc and manganese was down by 69.23%, 23.81%, 3.45% and 2.86%. Before the impoundment month (September), however, the content of arsenic, chromium, lead, zinc, iron and manganese went up 48.65%, 33.29%, 10.80%, 0.35%, 4.19% and 8.82% from a year earlier, while that of mercury, cadmium, and copper went down by 64.29%, 10.53% and 12.43% respectively. The content of most heavy metals in soil was within the limits of Grade I National Standard for Soil Environment Quality, and only lead and copper exceeded such limits.

The monitoring data on soil nutrients showed that the soil nutrients were on the high side in the central part of the Reservoir (between Fengdu and Zhuyi River of Fengjie), and on the low side in the upstream and downstream areas. After the water retreating in June, the content of organic matters, TN, TK, and nitrate nitrogen went up by 0.22%, 25.68%, 20.45% and 90.20% from a year earlier, and that of TP, AP, AK and ammonium nitrogen was down by 5.08%, 27.17%, 1.56% and 6.89%

respectively. Before the impoundment in September, the content of organic matters, TP, AP, AK and nitrate nitrogen went down by 11.44%, 15.63%, 26.54%, 10.43% and 0.71% respectively compared with that of last year, and that of TN, TK, and ammonium nitrogen went up by 25.86%, 44.97% and 21.35% respectively.

8.3.2 Re-vegetation

In 2013, Seventy-six species of vascular plants were identified in the investigation on plant communities after the water retreating this year, and they fell into 69 genera of 32 families. There were considerable amount of minor genus and monotypic genus species, specifically, monotypic genera accounted for 91.30% of the total genera. The minor genus and monotypic genus species took up 98.68% of the total species. The dominant vegetation was herbaceous plants; among others, the annual species accounted for 40.79%, and perennial species took up 38.16% of the total. The percentage of arbor trees, shrubs, and liana plants was relatively low. Before the impoundment, there were 81 species of vascular plants in 72 genera of 32 families. The composition of species was similar to that after retreating of water.

8.3.3 Monitoring of biological media

The mean density of rats in the monitoring sites of the water-level-fluctuating zone registered 0.36% in 2013, lower than that of the previous three years (1.86%, 1.30%, and 1.11%). Among them, the mean density of rats was 0.35% after water retreating, lower than that of last year (1.29%). There was no dominant rat species. The mean density of rats before the impoundment recorded 0.38%, lower than that of last year (0.89%). The dominant rat species was *Rattus flavipectus*, accounting for 66.67%. From the perspective of elevation, house mouse (*Mus musculus*) was the dominant species between 165 m and 175 m, because the habitats were close to residential communities and within the activity range of house mice. *Apodemus agrarius* was the dominant species between 155 m and 165 m, so close attention should be paid to the density change of local *Apodemus agrarius*.

The mosquito density in the monitoring sites of the water-level-fluctuating zone registered 6.28/zapper lamp/time in 2013, higher than that of last year (3.91/zapper lamp/time). The mosquito density prior to the impoundment in September (6.13/zapper lamp/time) was lower than that after water retreating in June (6.39/zapper lamp/time) and same as that of last year. Analysis data of mosquito species showed *Culex pipiens fatigans* ranked the first in amount among trapped mosquitos (36.07%), followed by *Armigeres subalbatus* (23.87%), *Culex tritaeniorhynchus* (13.53%), and *Anopheles sinensis* (11.14%). *Aedes albopictus* was not captured. The highest mosquito density was recorded between EL.155 m and EL.165 m after water retreating, and between EL.165 m and EL.175 m prior to the impoundment; the density decreased with the decline of elevation. The mosquito density in the water-level-fluctuating zone was still far below than that of residential communities in the project area but with rising trend. There was a certain percent of *Culex tritaeniorhynchus* and *Anopheles sinensis* which are the main media of Japanese encephalitis and malaria. The mosquito larvae were monitored in Zhongxian County and Kaixian County in 2013, with the maximum density at 2/scoop. The monitored mosquito species included Culex and Aedes. Such monitoring program was not available in other monitoring sites because of no ponding.

One hundred and eighty flies were trapped in the monitoring sites of the water-level-fluctuating zone in 2013, and the fly density registered 2.61/flytrap/time. The flies belonged to six species. The dominant species was *Boettcherisca peregrina* (76 flies, 42.22%); followed by *Lucilia sericata* (26 flies, 14.44%) and *Lucilia illustris* (26 flies, 14.44%); *Musca domestica* (20 flies, 11.11%); *Aldrichina grahami* (10 flies, 5.56%); and *Musca domestica* (9 flies, 5.00%). The fly density after water retreating was 2.67/flytrap/time, higher than that of before the impoundment (2.50/flytrap/time); both figures were a little higher than that of last year (2.64/flytrap/time after waters subsided, and 1.26/flytrap/time before the impoundment). The fly density of the monitoring sites was 0.67~4.44/flytrap/time, a little higher than that of past two years. Monitoring data showed that the fly density of the water-level-fluctuating zone was still at a low level.

8.4 Groundwater dynamics and soil gleization

8.4.1 Groundwater dynamics

The monitoring on groundwater dynamics continued in 2013 along the segment between Shimatou Village and Xiaogang Farm of Honghu City in the four-lake region of the midstream of Yangtze River. The groundwater monitoring profile consisted of 10 long-term observation wells in 5 groups, which were 1.5 km, 3.0 km, 5.0 km, 8.5 km and 13.0 km away from the bank of Yangtze River. The internal diameter of the observation borehole registered 0.11 m. The confined water observation well was about 35 m in depth, and the phreatic water observation well was between 5 m and 7 m in depth.

The monitoring data showed the mean annual groundwater table in the monitoring sites went down by 0.05 m in 2013 compared with that of last year, and down by 0.03 m compared with the historic average. However, the phreatic water table was not consistent with the confined water table. The decline of annual average water table of the five confined wells was 0.04~0.24 m with average at 0.11 m. The water table of some phreatic wells went up while that of others went down, but on the average, it rose by 0.02 m.

In 2013, the groundwater table was recorded at a high level at the beginning, but ascended and descended very quickly. The maximum monthly average water table was observed during June~August, and the minimum monthly average water table was observed in January, February, and December. Analysis data of the water table throughout the year indicated a fairly high level in January, no big change during January~April, sharp rise in May, the highest level during June~August, quick drop in September, and the lowest in December.

8.4.2 Soil gleization

The soil gleization conditions of soil profiles were monitored in the summer and winter of 2013. The monitored profiles mainly included the seven soil profiles of the segment between Xiaogang Farm and Shimatou Village in Honghu City and the three ones in Xinxing Dyke of Jianli County. The monitoring indicators included soil moisture content, 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 annual average oxidation reduction potential ranged between 54 and 597 mV; the annual total amount of reductive substances ranged between 0.08 and 8.59 cmol/kg with average at 2.53 cmol/kg, up by 0.05 cmol/kg from last year; the annual average content of active reductive substances ranged between 0 and 7.27 cmol/kg with average at 1.19 cmol/kg, down by 0.26 cmol/kg from last year; the annual average content of ferrous iron ranged between 0.001 and 0.850 cmol/kg with average at 0.208 cmol/kg, a little higher than that last year. The soil gleization aggravated in the summer and tended to be neutralized in the winter compared with that of last year.

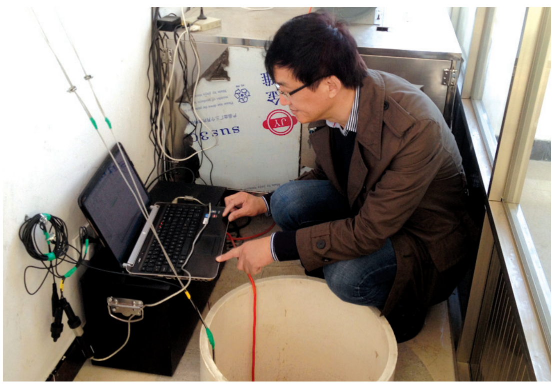
8.5 Water-salt dynamics and soil salinization in the estuary

8.5.1 Water-salt dynamics

The monitoring on water-salt dynamics and soil salinization continued in 2013 in the estuary (land-sea interface) of Yangtze River. 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, and all latitudinal 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 table.

- **Conductivity of the Yangtze River waters**

Monitoring data at the three sections showed that the conductivity of the Yangtze River waters was high in the spring, autumn and winter, and low in the summer. The upstream flow variations and water level fluctuations of the River affected the dynamic change of the salinity of those sections. The Yangtze River received less contributing inflow across 2013, which brought down the water level and pushed up the conductivity at all monitored sections compared with that of last year. The conductivity also increased significantly compared with that of 2010, a wet year. The annual average conductivity of Yinyang Section and Daxing Section was similar to that of 2011 (a dry year), reflecting similar seawater



Collection and verification of filed data intrusion conditions. The salinity in September reached record high since the year 2010 for all the three sections. The annual average conductivity of Yangtze River waters at Yinyang Section went up by 10.6% from a year earlier, and the average conductivity went up by 21.2% during September~November compared with that of the same period last year. The annual average conductivity of the water at Daxing Section went up by 21.6% from a year earlier, the average conductivity went up by 49.0% during September~November compared with that of the same period last year, and the monthly average conductivity went up 72.5% in November compared with that of the same period in a dry year. The annual average conductivity of Xinglongsha Section went up by 14.1% compared with that of last year, and the monthly average conductivity in September was about 5.5 times of the data of last September, indicating more intense seawater intrusion.

● **Conductivity of inland river waters**

The conductivity of inland river waters near the south bank of the north branch was on the high side, and that near the north bank was relatively low in 2013. The annual average conductivity monitored of the three sections was each similar to that of last year. Among them, the monthly average conductivity had relatively big rise in September, some drop in October due to the effect of intense precipitation, and significant rise during October~December compared with that of same period last year. The annual average conductivity of inland river waters at Yinyang Section was down by 5.5% from a year earlier, but the monthly average conductivity went up by 33.3% in September and 33.8% in December. The most violent change in salinity was observed in September with an upward trend, which was closely related to rapid rise of conductivity of the Yangtze River waters. The annual average conductivity of inland river waters at Daxing Section was similar to that of last year, down by 28.5% from 2011 level, but up by 6.2% from 2010 level. The conductivity had the biggest rise of 37.5% during September~December compared with that of last year. The annual average conductivity of inland river waters at Xinglongsha Section was also close to that of last year, and up by 48.8% from 2010 level. The conductivity experienced the steepest rise in September. 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 shallow in recent years, easily causing top enrichment of soil salt. All the annual average groundwater depth of the three monitoring sections went up from a year earlier due to the upstream flow change and water level fluctuations of the Yangtze River. However, the groundwater depth monitored in October dropped a little thanks to abundant rainfalls in the month. The annual average groundwater depth was up by 9.5% from a year earlier at Yinyang Section and underwent fluctuations. Among them, the mean monthly groundwater depth in September went up by 31.3% from September 2012 and down by 5.5% from September 2011 (a dry year). At Daxing Section, the annual average groundwater depth had 10.7% rise compared with that of last year. The monthly average data in September was up by 79.0% from September 2012 and up 5.9% from September 2011. At Xinglongsha Section, the annual average groundwater depth was similar to that of last year, up by 13.3% from 2010 level (a wet year), and down by 3.3% from 2011 level. The monthly average groundwater depth was as much as 175.3 cm in September, up by 66.3% from last September; dropped a little in October due to rainfalls; and went upward but still below critical value during October~December.

● **Groundwater conductivity**

The annual average conductivity of groundwater at Yinyang Section reached a record high in 2013 over recent years, a slight rise compared with that of last year, up by 9.9% from 2011 level, and up by 13.0% from 2010 level. The monthly average conductivity in September also reached high record in recent years, up by 7.5% from last September, and up 13.6% from September 2011. At Daxing Section, the annual average conductivity of groundwater was close to that of last year, up by 5.7% from 2011 data, and up 23.1% from 2010 data. The salinity was accumulated year by year. The monthly average in September climbed up by 17.9% from that of last September, more significant rise compared with that of September 2010. At Xinglongsha Section, the annual average conductivity of groundwater went down by 6.9% from a year earlier, but up by 4.4% from 2011 level and up 115.6% from 2010 level. There was some rise of conductivity during September~December, which was attributed to the rising conductivity of the Yangtze River waters. The groundwater conductivity at Yinyang Section was significantly correlated to that of Yangtze River waters, and the closer to the river, the correlation was more significant. The groundwater conductivity of Daxing Section and Xinglongsha Section was significantly correlated to the conductivity of both Yangtze River and inland river waters.

8.5.2 Soil salinization

In 2013, the annual average soil conductivity of the three monitoring sections in the estuary was similar to that of last year. However, the soil salinity went up significantly in the autumn and winter. At Yinyang Section, the annual average soil conductivity was also close to that of last year, and up by 1.66 times from the 2010 level. The soil salinity was fairly low in the first six months; but in a rising trend during October~December, up by 19.4%~25.6% from the same month last year, and up by 8.1% from the average of the three months in 2011. At Daxing Section, the annual average soil conductivity went down by 8.2% from last year, up by 5.0% from 2011, and up 17.2% from 2010 level. During November~December, the average soil conductivity reached a record high since 2010, up by 6.6% from the same months in 2012, and up by 20.6% from the same months in 2011. At Xinglongsha Section, the annual average soil conductivity increased by 6.5% ~16.3% compared with that of the previous three years. The average conductivity during September~October went up by 4.4% from the same months last year due to fairly high conductivity of groundwater. The sampling and analysis results during the regional surveys of recent years showed that there was considerable salt accumulation in top toils in the autumn, especially in the regions adjacent to the East China Sea.

8.6 Ecological environment in the estuary

8.6.1 Environmental elements in waters

● **Hydrological elements**

In the spring of 2013, the temperature of monitored waters in the estuary exhibited the following features: it was high in the surface layer and low in the bottom layer waters, high in the estuary and off-shore waters and low near shore, high in the southern area and low in the northern area. The maximum temperature registered 20.97℃ with the minimum 14.58℃. In the autumn, the temperature was low near shore and high in off-shore waters, and a little lower in the upper surface layer than in the deep bottom layer waters. The maximum temperature registered 21.70℃ with the minimum 18.83℃. The water temperature in 2013 was high compared with that of last year, with the maximum temperature going up by 0.95℃, and the minimum up by 3.67℃.

In the spring, the tongue-shaped diluted waters in the estuary extended eastwards; the salinity was on the low side around the estuary mouth, and on the high side in remaining sea waters. The salinity near the coastal regions was below 28.00 in general and on the high side in the east, with maximum salinity at 31.31. In the autumn, the geographical variations of water salinity in the estuary were mainly affected by the diluted waters of the Yangtze River and Taiwan warm currents. The salinity was on the low side around the estuary mouth and on the high side in the remaining sea waters with maximum value at 33.93. During the survey in the autumn, the salty waters in the north branch flew backward to the south branch in the estuary, and the geographical distribution of salinity was similar to that of last year.

Affected by the flow of Yangtze River, the SD of the estuary waters was low in the estuary and near shore and high in off-shore waters. In the spring, the SD was generally less than 1.5 m to the west of E122°30′, and mostly somewhere between 1.0 m and 2.6 m from E122°30′to E123°00′. In the autumn, the SD was generally low less than 1 m, similar to that of last year.

● **Hydrochemical elements**

The average content of dissolved oxygen in the surface layer river waters in the estuary was 7.31 mg/L in the spring and 8.10 mg/L in the autumn. The figure in the surface layer seawaters in the estuary was 8.83 mg/L in the spring and 7.54 mg/L in the autumn. Vertically, the average content of dissolved oxygen of surface layer waters was generally higher than that of bottom layer waters outside the estuary, and dropped with growing water depth; this phenomenon was more distinctive in the spring and in deep waters. The average content of dissolved oxygen of river waters in the estuary was high in the spring and low in November compared with that of last year; while the figure of seawaters in the estuary went down in both spring and November compared with that of last year.

The average pH value of the surface layer river waters in the estuary was 7.84 in the spring and 8.04 in the autumn; and 7.88 in the spring and 8.07 in the autumn in the bottom layer of the river waters. The average pH value was 8.15 in the spring and 8.18 in the autumn in the surface layer seawaters in the estuary, and 8.02 in the spring and 8.20 in the autumn in the bottom layer of seawaters. The pH value was low in the estuary and near shore, and went up eastward. There was no significant change of pH value of the estuary water in the spring but some reduction in the autumn compared with that of same period last year. The pH value of seawaters in the estuary went down in both spring and autumn compared with that of last year.

The average content of COD registered 1.29 mg/L in the spring and 3.15 mg/L in the autumn in the surface layer river waters in the estuary, and 1.12 mg/L in the spring and 3.37 mg/L in the autumn in the bottom layer river waters. The average content of COD was 1.63 mg/L in the spring and 1.63 mg/L in the autumn in the surface layer seawaters in the estuary, and 1.50 mg/L in the spring and 1.73 mg/L in the autumn in the bottom layer seawaters. Affected by the inflow water of the Yangtze River, the COD content was high near the shore and low in the open sea. In the spring, the average content of COD went down in both river waters and seawaters in the estuary, while in the autumn, it went up in the surface layer with no change in the bottom layer waters compared with that of last year.

In terms of horizontal variations, the content of phosphate, silicate, nitrate, TN, and TP was all in a steep downward trend from the estuary towards the open sea. The horizontal variations of ammonia nitrogen and nitrite contents were quite complicated. Compared with that of last year, the average content of phosphate in the estuary went down in the spring and went up in the autumn in river waters, and higher in the spring and lower in the autumn in seawaters; the average content of silicate was higher in both the spring and the autumn and in both river waters and seawaters; the average content of nitrate was much lower in the spring and higher in the autumn in river waters, and lower in both the spring and the autumn in seawaters; the average content of nitrite was much lower in both the spring and the autumn and in both river waters and seawaters; the average content of ammonia nitrogen in river waters was much lower in the spring, and lower in the surface layer and higher in the bottom layer waters in the autumn; the average content of ammonia nitrogen in seawaters was lower in the spring, and higher in the surface layer and lower in the bottom layer waters in the autumn; the average content of TN was lower in both river waters and seawaters; the average content of TP was higher in both the spring and the autumn in river waters, and higher in the spring and lower in the autumn in seawaters.

Table 8–1 Nutrient salt contents in the Yangtze River estuary in the spring and autumn of 2013

Unit: μmol/L

Season	Nutrient salt	Yangtze River waters		Estuary seawaters	
		Surface layer	Bottom layer	Surface layer	Bottom layer
Spring	Phosphate	1.8	1.6	0.57	0.59
	Silicate	99.7	97.8	24.3	22.0
	Nitrate	104.8	94.7	29.5	23.4
	Nitrite	0.62	0.40	0.36	0.33
	Ammonia nitrogen	0.29	0.24	0.31	0.29
	TN	132.9	132.1	59.2	53.2
	TP	3.0	3.2	1.9	2.8
Autumn	Phosphate	1.9	1.9	0.65	0.66
	Silicate	177.8	173.4	33.7	33.5
	Nitrate	105.4	114.9	17.8	16.4
	Nitrite	0.37	0.27	0.25	0.23
	Ammonia nitrogen	3.1	2.7	1.7	1.7
	TN	139.7	143.6	30.0	29.8
	TP	6.6	7.5	1.8	2.8

● **Sediment elements**

In 2013, the content of suspended matters in the estuary river waters was evidently higher in the autumn (158.02 mg/L on average) than in that of the spring (75.42 mg/L on average). There were significant seasonal change in the content of suspended matters in the surface layer waters, with the average at 46.93 mg/L in the spring and 190.23 mg/L on average in the autumn. There was minor seasonal change of the content of suspended matters in the bottom layer waters, which was 210.31 mg/L on average in the spring and 318.42 mg/L on average in the autumn. The content of suspended matters in the estuary seawaters went down in general compared with that of last year.

8.6.2 Biological elements in waters

● **Chlorophyll-a**

The concentration of Chlorophyll-a was much higher in the spring than that of the autumn in the estuary waters of the Yangtze River. In the spring, the concentration of Chlorophyll-a in the surface waters was 0.07~10.23 μg/L with the average at 1.18 μg/L. The patch of waters with high Chlorophyll-a readings was mainly distributed in the eastern part of the monitored seawaters. Minimum concentration was observed in some waters in the estuary mouth. A considerable amount of sediment input caused high turbidity in the estuary mouth and the southwestern part of the monitored seawaters, hence the concentration of Chlorophyll-a was fairly low. Taiwan warm currents intrusion had significant impact on the southeastern part of the monitored seawaters, by increasing the photopermeability of the seawaters there, facilitating the photosynthesis of phytoplankton, and resulting in high Chlorophyll-a concentration.

In the autumn, the concentration of Chlorophyll-a in the surface waters was 0.28~1.70 μg/L with the average at 0.79 μg/L. The patch of waters with high Chlorophyll-a readings was mainly located in the south estuary branch, while the patch of waters with low Chlorophyll-a readings was in near-shore waters. The growth of phytoplankton was not vigorous in the autumn, and land sources became the main source of Chlorophyll-a in the monitored seawaters.

● **Fish zooplankton**

A total of 693 fish zooplankton were caught in the spring, including 248 spawns and 445 fry. They fell into five families of two orders. The abundance of fish zooplankton was significantly lower than that of last year. *Engraulis japonicus* remained as the top dominant species, while *Pseudosciaena polyactis* had rise in its dominance position.

A total of 790 fish zooplankton were caught in the autumn, all being fry. The abundance of fish zooplankton went up by a large margin and was equivalent to three times of that of last autumn. There was little change of species amount. There was a change in the dominated species due to rapid rise of dominant position of Coilia *ectenes*, and *Stolephorus commersonii* and *Trichiurus haumela* were no longer dominant species.

● **Fishery resources**

A total of 56 species of fish and 27 species of macro invertebrates were caught in the spring and autumn in 2013. *Harpodon nehereus* and *Setipinna taty* were the dominant species in the spring, accounting for 66.19% of the total catch. Harpodon nehereus and Trichiurus haumela were the dominant species in the autumn, accounting for 87.65% of the total catch. The biomass density of fish registered 282.94 kg/km^2 in the spring and 2,030.44 kg/km^2 in the autumn, with *Harpodon nehereus* as the main contributing species. Compared with that of last year, there was a change in the dominant species with *Harpodon nehereus* enjoying elevated dominance and *Vespicula trachinoides* no longer a dominant species.

8.7 Wetlands in the midstream

8.7.1 Dongting Lake

● **Hydrogy**

Dongting Lake embraces four inflow rivers (the Xiangjiang River, Zishui River, Yuanjiang River and Lishui River) in the south and empties into Yangtze River in the north (Hubei Province). The contributing inflows of the lake includes the aforementioned four inflow rivers, three bleeders of Yangtze River (Songzi Bleeder, Taiping Bleeder, and Ouchi Bleeder), and interval inflows. The waters converge in the lake and feed to the 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 went down in 2013 compared with the historical average. The year-on-year monthly data showed similar incoming flow in January and February, increased flow in late March owing to rainfalls, more flow due to floods in April, 20% increase in May, 20% reduction in June and August, almost 70% reduction in July, almost 60% increase in September, and over 40% drop in October. The water level at the lake outlet of Chenglingji in October was the third lowest in October in the history.

According to the data of Chenglingji Station at the lake outlet, the annual precipitation registered 1,000.3 mm, down by 40% from last year. The water level maximized at 29.82 m with the lowest at 20.41 m, and the average at 24.61 m this year. The annual runoff was down by 20.7% from the historical average, down by 21.0% from last year. The annual sediment discharge amounted to 290 billion t, down by 22.0% from the historical average, and up by 13% from last year. In terms of temporal distribution, the runoff and sediment discharge at Chenglingji Station concentrated between March and August with runoff during this period accounting for 68.7%, and the sediment discharge during this period accounting for 66.0% of the whole. The sediment discharge peaked on March 28 and April 7 with the maximum discharge at 0.440 kg/m^3 and 0.449 kg/m^3 respectively.

The 60-day flood inflow statistics of 2013 showed the total inflow of the lake reached 68.28 billion m^3, the total outflow 69.92 billion m^3, and the buffering balance was -1.64 billion m^3. Analysis data of the flood inflow contributors at Chenglingji Station demonstrated the four inflow rivers contributed 86.5% of the incoming flow to the lake in 7 days, 85.0% in 15 days, 80.9% in 30 days, and 76.1% in 60 days. The three bleeders of the Yangtze

The Dongting Lake wetland (in the spring)

River contributed 11.6% of the incoming flow to the lake in 7 days, 9.0% in 15 days, 11.3% in 30 days, and 15.1% in 60 days. The interval inflows contributed the least of source waters to the lake, which is, 1.9% in 7 days, 6.0% in 15 days, 7.8% in 30 days, and 8.8% in 60 days. Analysis data of the contributors of monthly flow at Chenglingji Station showed 81.5% of the Dongting Lake inflow came from the four inflowing rivers during June ~October, and 79.2% in the remaining months. Over 60.4% of the incoming flow observed at Luoshan Station was contributed by the Yangtze River.

● **Water quality**

Among the upstream flow, the four inflow rivers of Dongting Lake had fairly good water quality in 2013. The monitoring sections where Xiangjiang River, Zijiang River, Yuanjiang River and Lishui River empty into the lake met Grade Ⅱ or Grade Ⅲ national water quality standard. The monitoring sections at which the three bleeders empty into the Lake met Grade Ⅲ standard, and the sections at their lake outlets met Grade Ⅲ standard. Among the seven monitoring sections across the lake area, the section at eastern Lake and Yueyang Tower section attained Grade Ⅲ standard, and the other five sections met Grade Ⅳ standard. There was serious TP and TN pollution across the lake with TP concentration at Grade Ⅲ~Ⅳ standard and TN concentration at Grade V standard or poorer. The TN concentration went up compared with that of last year. In spatial distribution, the water quality of eastern, southern and western lake waters was about the same. In 2013, 68.7% of all the 16 monitoring sections attained Grade Ⅰ~Ⅲ water quality standard, indicating slight pollution. The main pollution indicators were TP, TN and dissolved oxygen.

The Tropical Level Index (TLI) of Dongting Lake was 45.1 ~ 57.5 in 2013. The maximum TLI was recorded at the monitoring section of Major and Minor West Lakes, which was in minor eutropher. Other sections were in mesotrophic state, and the lake as a whole was also in mesotrophic state. In spatial distribution, the trophic level of eastern lake waters was higher than that of western and southern lake waters. The TLI of eastern lake had significant rise compared with that of last year. It was above 50 in both March and June, with recorded minor eutropher. There was no evident change of trophic state of western and southern lake waters compared with that of last year.

A total of 73 genera of phytoplankton species were identified in Dongting Lake, which fell into 7 phyla. The most abundant phytoplankton species belonged to Chlorophyta and Bacillariophyta, with 27 genera (37.0%) under Chlorophyta and 25 genera (34.2%) under Bacillariophyta, followed by 10 genera (13.7%) under Cyanophyta, 4 genera (5.5%) under Euglenophyta, 4 genera (5.5%) under Pyrrophyta, 2 genera (2.7%) under Cryptophyta, and one genus (1.4%) under Chrysophyta. The most amount of phytoplankton species was recorded in March, and the least amount was in December. Chlorophyta and Bacillariophyta species were the dominant species in both months, followed by Cyanophyta species.

16 Rotifera species, 10 Cladocera species, and Calanoida, Cyclopoidea, and Harpacticoida species under Copepods were identified in the Dongting Lake. The average biomass density of zooplankton was $1.1\times10^4/m^3$ with Rotifera species as the dominant species accounting for 75%, the Cladocera species took up 9%, and Copepods species 16%. The Keratella and Brachionus species were dominant among Rotifera species, Rosmina species were dominant among Cladocera species, and Thermocyclops and nauplii species were dominant among Copepods species identified in the Lake. The average annual biomass density of zooplankton was $1.1\times10^4/m^3$ with some reduction compared with that of last year ($2.53\times10^4/m^3$).

● **Vegetation**

In 2013, the observation data on 6 typical islets and shoals (Liumen Gate, Beizhouzi, Tuanzhou, Junshan, Chunfeng and Jianxing Farm) showed *Triarrherca sacchariflora* and *Polygonum flaccidum* communities exhibited distinct seasonal differences, while *Carex tristachya* did not. *Triarrherca sacchariflora* among

Anser erythropus

the three representative vegetation communities of the lake had the most diversified species. The amount of *Triarrherca sacchariflora* species peaked in April (28 species); the species richness index was fairly high in March (10.2) and April (10.4), and the lowest in November (5.1). The species diversity index was at the minimum in November (0.44), and varied little in other three months (0.68~0.78). The community coverage was the lowest in January (43.8%) with no big change in other three months (82.3%~124.3%). As for the *Carex tristachya* community, there was no significant difference of the number of species (10~14), the species richness index (3.1~4.0), species diversity index (0.20~0.31) and community coverage (101.1%~123.4%) in different months. As for the *Polygonum flaccidum* community, the amount of species was fairly high in January (7 species) and April (7), and relatively low in March (3 species) and November (5). The species richness index was fairly high in March (3.6) and low in January (1.8) and November (2.2). The species biodiversity index had no significant difference among the four months. The community coverage was the highest in March (111.2%), and fairly low in January (69.0%) and April (66.0%).

● **Biodiversity**

The number of bird species in eastern Dongting Lake increased to a certain extent from last year, but the bird population remained unchanged. There were 63 species of wintering water birds in 13 families of 7 orders, up by 7 species from last year. There were 106 species of summer migrant birds in 44 families of 15 orders this year, up by 30 species from last year. The investigation in January covered 103,362 wintering birds, basically the same as that of last year. The growth in population of *Anas falcata* (24,438) was the biggest, up by 7,984 (48.5%) compared with that of last year. The population of *Anser erythropus* (13,830) dropped the most significantly, down by 8,997 (40.5%) from last year. Among the 60 major species under this year's monitoring program, a total of 53,604 birds in 28 species were observed, up by 6,771 in two species compared with that of last year. Anatidae species was the absolutely dominant bird species monitored this year, accounting for 70.83% of the total, followed by waders (12.18%), Threskiornithidae species (5.06%), and then Arderdae species and gulls. These winter bird species in the eastern Dongting Lake mainly took marsh, shallow water and beach as their habitats, and Anatidae accounted for almost 70% of the total bird population with beach grass and fish as their main feed. There were many species of waders but with small population, and their main habitats are mudflats or shallow waters and main feed are benthos and small fishes. The main distribution areas of the birds in the eastern lake were stable, and it mainly covered the waters to the east of Zhuzi River mouth at Baihu Lake and Heizui waters, the enclosed management zone of major and minor West Lakes, and the bund of Chunfeng Lake.

62 elks (*Elaphurus davidianus*) were observed in the eastern Dongting Lake land area. It is estimated that its population was 62~70 with no evident change compared with that of last year. *Elaphurus davidianus* was mainly distributed in Heizui (Zhuzi River mouth-Reed field of development zone) (35 elks) and Piaowei (upper and lower Hongqi Lake) (27 elks) regions. The higher water level in flood season, human disturbances and change in hidden places were the main causes constraining the growth of *Elaphurus davidianus* population.

8.7.2 Poyang Lake

● **Hydrology**

As the largest freshwater lake in China, Poyang Lake is located to the south of the Yangtze River in northern part of Jiangxi Province. The lake embraces inflowing rivers including 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. After convergence in and buffering by Poyang Lake, the river water flows into Yangtze River at the lake outlet.

The annual precipitation of Poyang Lake registered 1,361.1 mm in 2013, down by 24% from last year and 5% from the historical average. The precipitation was distributed unevenly in geographical space, and there was plenty rain in the north but a few rain in the south of the lake. The incoming flow was less and water level of the lake was low this year. The maximum water level in 2013 was 16.97 m, and minimum at 7.40 m with the average at 12.05 m as observed at Xingzi Station. This was a dry year for Poyang Lake area, also with little sediment. 2013 is the dry year with less sediment. The total flow from the five major inflowing rivers reached 111.9 billion m^3, down by 36% compared with that of last year and 11% compared with the historical average. The incoming sediments amounted to 4.34 million t, down by 54% from a year earlier and 68% from the historical average. The total outflow to the Yangtze River was 140.8 billion m^3 in 2013, down by 33% from last year and 7% from the historical average. The total sediment discharge of the lake amounted to 11.3 million t,

Carex

down by 20% compared with that of last year, and up by 13% from the historical average.

The Yangtze River waters back flowed into Poyang Lake once within 2013. The backflow was observed between 08:00 on September 29 and 14:00 on October 1 with the average flow at 830 m^3/s and maximum flow at 1,750 m^3/s. The backflow lasted for 55 hours with total backflow volume at 165 million m^3, down by 441 million m^3 compared with that of last year.

The 60-day flood inflow recorded during May~July indicated the total inflow of the lake at 47.032 billion m^3, down by 31.8% from last year; and the total outflow 42.905 billion m^3, down by 32.7%; leaving the buffering balance at 4.127 billion m^3 this year, down by 20.0%. The contributing flows of Poyang Lake mainly included the five major inflowing rivers (Ganjiang, Fuhe, Xinjiang, Raohe, and Xiuhe) and interval waters. Among them, the Ganjiang River has always been the dominant inflowing river to the lake and contributed 55.4% of the total inflow, followed by Xinjiang River with contribution of 15.7%.

● **Water quality**

In 2013, the inflowing rivers of Poyang Lake enjoyed good water quality. 90.7%~100% of the river waters met Grade Ⅰ~Ⅲ standard with the average at 95.8%, up by 8.0% from last year. The ranking (from good to poor) of water quality among those rivers was the Xiuhe River, Ganjiang River, Xinjiang River, Fuhe River, Chang River (Raohe River) and Le'an River. Among them, the Xiuhe River, Fuhe River, Xinjiang River and Ganjiang River met Grade Ⅲ water quality standard or better in four quarters of the year. the Le'an River and Chang River failed to meet Grade Ⅲ water quality standard. The main pollutants were NH_3-N and TP. The monitoring section at the lake outlet attained Grade Ⅲ or better water quality standard in the first, second and fourth quarters; and Grade Ⅳ standard in the third quarter, minor pollution was recorded with TP as the main pollutant. Among the 15 monitoring sections in the lake area, 9~12 sections attained Grade Ⅰ~Ⅲ standard, accounting for 60.0%~80.0% of the total with the average at 71.7%, similar to that of last year. The main pollutants were NH_3-N and TP.

The ammonia nitrogen content of the Poyang Lake was significantly lower during the mean flow period (April) than that of high and low flow periods, while the nitrate nitrogen content was the lowest in July, much lower than that of mean and low flow periods. The change of TN content was not obvious, and the content in the high flow period was significantly lower than that of low flow period. The change of TP content was also not significant, going down with the rising water level of the Poyang Lake, and reaching the lowest in high flow period.

● **Vegetation**

In 2013, the ring-like belts of *Artemisia selengensis*, *Carex cinerascens*, and Phalaris arundinacea as well as the mudflats distributed on sand beach and sandbar were monitored according to the descending order of their elevation. Analysis data of the height of dominant species showed, the maximum height of *Artemisia selengensis* registered 57.7 cm in the spring and 97.3 cm in the autumn. The maximum height of *Carex cinerascens* was 47.2 cm in the spring and 39.3 cm in the autumn; and that of *Phalaris arundinacea* was 52.3 cm in the spring and as much as 88.6 cm in the autumn. The dominant species on the mudflats was *Phalaris arundinacea* with maximum height of 46.2 cm in the spring and 65.4 cm in the autumn. Analysis data of biomass indicated the surface biomass of *Artemisia selengensis* belts was 2,317.8 g/m^2 in the spring, and going up to 2,973.2 g/m^2 in the autumn. The biomass of *Carex cinerascens* belts was 1,883.2 g/m^2 in the spring and 2,137.5 g/m^2 in the autumn; and the biomass of *Phalaris arundinacea* belts was 1,257.9 g/m^2 in the spring and 1,853.8 g/m^2 in the autumn. The surface biomass on the mudflats registered 383.5 g/m^2 in the spring and 753.2 g/m^2 in the autumn. In terms of community biodiversity (the Shannon-Wiener index), mudflats recorded the maximum at 1.334 in the spring and 1.378 in the autumn. The community biodiversity of *Carex cinerascens* belts was 0.227 in the spring and 0.154 in the autumn, while that of *Artemisia selengensis* belts was 0.375 in the spring and 0.337 in the autumn with little change between the two seasons.

As for soil bulk density, *Carex cinerascens* belts recorded the minimum at 0.90 g/cm^3 in the spring and 0.91 g/cm^3 in the autumn; followed by *Phalaris arundinacea* belts (0.92 g/cm^3 in the spring and 0.93 g/cm^3 in the autumn) and *Artemisia selengensis* belts (0.96 g/cm^3 in the spring and 0.95 g/cm^3 in the autumn). The soil bulk density of mudflats registered 1.11 g/cm^3 in the spring and 1.17 g/cm^3 in the autumn, higher than that of other vegetation belts. In the spring, the soil moisture of *Carex cinerascens* belts was the highest at 41.1%, followed by *Phalaris arundinacea* belts at 37.8%, mudflats at 33.7%, and *Artemisia selengensis* belts at 31.6%. In the autumn, the soil moisture of *Phalaris arundinacea* belts was the highest at 41.1%, followed by *Carex cinerascens* belts at 39.6% and *Artemisia selengensis* belts at 32.1%. The moisture of mudflats (29.6%) was remarkably lower than that of other vegetation belts.

● **Biodiversity**

Over 653,000 wintering water birds of 56 species were recorded in a simultaneous investigation on the population of wintering water birds in the lake in 2013. The amount of bird species went down by 2 from last year, but with population increase of over 240,000. Except for significant reduction of duck population, the population of large birds including cranes, storks, spoonbills, swans, and geese as well as waders had significant increase. For key bird species, the population was 3,910 for *Grus leucogeranus*, 289 for *Grus monacha*, 549 for *Grus vipio*, 7,595 for *Grus grus*, 2,410 for *Ciconia boyciana*, 14,586 for *Platalea leucorodia*, 87,199 for *Cygnus columbianus*, 90,055 for *Anser cygnoides and* 44,627 for *Anser albifrons*.

A family of white crane

A total of 65 species of water birds in 15 families of 6 orders were observed during the regular investigation on the population of wintering water birds in the Poyang Lake National Nature Reserve. Among them, 46 species were observed during January~March and 62 species during October~December. As for the maximum population of key species, it was 2,292 for *Grus leucogeranus*, 709 for *Grus monacha*, 656 for *Grus vipio*, 1,111 for *Grus grus*, 789 for *Ciconia boyciana*, 10,694 for *Platalea leucorodia*, 39,274 for *Cygnus columbianus*, 28,260 for *Anser cygnoides*, 10,082 for *Anser fabalis* and 13,740 for *Anser albifrons*.

A total of 24 species of water birds were observed in the investigation on reproductive water birds in the summer, which fell into 11 families in 6 orders. The amount of Ciconiiformes was the highest with 10 species, followed by Charadriiformes with 7 species.

8.8 Small watersheds in the upstream

8.8.1 Yangjichong Watershed (Longli County, Guizhou Province)

The Yangjichong Watershed in Longli County, Guizhou Province in Southwest China belongs to the Wujiang Waters in the Yangtze River Basin. The watershed covers 11.89 km^2, 7.41 km^2 of them subject to water and soil erosion. The watershed sits on the uplands formed by medium and low hills on Yunnan-Guizhou Plateau at 1,112~1,630 m above sea level. The vegetation is humid, sub-tropical evergreen broadleaf forests growing on sandy soils and clay loams, and the land use there are mainly woodlands and farmlands.

A total of 26 rainfalls were observed in 2013 with total precipitation at 663.7 mm, up by 9.9% (65.6 mm) compared with that of last year. Among them, the precipitation in wet season during May~September registered 499.8 mm, accounting for 75.3% of the total. The maximum daily precipitation was 47.1 mm. The maximum single precipitation was 63.2 mm, and maximum monthly precipitation was 232.8 mm.

According to the monitoring data, the ranking of runoff yield of slope runoff plots in different land use patterns was: woodland runoff plot > bare land plot > cropland runoff plot > cash tree runoff plot > grassland runoff plot. The ranking of sediment yield caused by soil erosion in those plots was: bare land plot > cropland runoff plot >cash tree runoff plot >water conservancy woodland runoff plot > grassland runoff plot. Moreover,

Slope runoff trial plot

the ranking of erosion modulus in descending order was cropland (maize) runoff plot > bare land runoff plot > cash tree runoff plot > water conservancy woodland runoff plot > grassland runoff plot.

The monitoring station at the outlet of the watershed observed 12 obvious floods in 2013, mainly between May and November. The biggest flood was observed on June first with peak flow at 1.94 m^3/s. The total annual runoff was 872,300 m^3 in the watershed. The bed load at the outlet totaled 1.68 t, and added by suspended load of 61.66 t, the annual soil erosion amounted to 63.34 t.

The monitoring data of soil nutrients showed the following ranking of the organic matter content in descending order: woodland plot >control plot >grassland plot >cash tree plot >cropland plot. The ranking of TN content was: cropland plot >woodland plot >cash tree plot >grassland plot >control plot. The TP content was relatively higher in woodland and cropland runoff plots than that of in other plots. The ranking of the TK content was: woodland plot >cash tree plot >grassland plot >control plot >cropland plot. There was no significant pattern for the change of ammonium nitrogen. The nitrate nitrogen and AP contents were the highest in cropland plot. The maximum AK content was recorded in woodland plot. The variation in KN content was the smallest in cropland plots, and soil pH value was the highest in cropland plots.

It is estimated that the total loss of the watershed was 766.19 kg for TN, and 93.84 kg for TP in 2013 based on the output concentration variations of soil nutrients,.

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

Maojiawan Watershed in Bijie Prefecture of Guizhou Province in southwest China belongs to the Chishui River Basin in the upstream of Yangtze River. The watershed covers 3.98 km^2, its elevation was 620 ~ 1,340 m above sea level with the average altitude at 992.51 m. The slope gradient of the watershed was 0～72.5º with the average at 21.9º. The area with slope at 15º～25º was the largest in the watershed at 1.34 km^2. The land use patterns include closed forest land, shrub land, orchard, dry land, rural residential communities, and land for transportation. The area of closed forest land was the largest (1.72 km^2), followed by shrub land (1.70 km^2). The average canopy density of closed forest lands was 50%, the average coverage of scrub land was 40%, and the average canopy density of orchard was 30%. The soil erosion in Maojiawan Watershed was moderate (1.67 km^2) and severe (1.30 km^2), accounting for 42.0% and 32.8% respectively of the total.

The precipitation of the watershed registered 594.0 mm in 2013, down by 40% (396.2 mm) compared with the historical average. Analysis data of the runoff volume of trial plots with different slope gradient indicated the runoff was zero in 5º plots; 27.72 m^3 in 15º plots, down by 103.28 m^3 from last year; and 37.30 m^3 in 25º plots, down by 140.17 m^3 from last year. The runoff of 25º plots was much higher than that of 15º plots. Analysis of sediment yield data of different runoff plots indicated the sediment yield was zero in 5º plots, 9.55 kg on the average in 15º plots and 12.53 kg on the average in 25º plots. The sediment yield and erosion modulus of 25º plots were much higher than that of 15º plots.

According to the monitoring data on water quality of the surface runoff of those plots, there was no runoff in 5º plots. The annual movement was of COD was 9,853 mg for COD, 13,833 mg for TN, 167 mg for NH_3-N, 842 mg for nitrate nitrogen, and 170 mg for TP from the runoff of 15º plots. The annual drain was 21,157 mg for COD, 42,398 mg for TN, 361 mg for NH_3-N, 1,717 mg for nitrate nitrogen, and TP 45 mg for TP from the runoff of 25º monitoring plots. The total annual runoff of the 25º plots was much higher than that of 15º plots.

The monitoring data at the monitoring station of the watershed outlet showed the average flow at 5.27×10^{-3} m^3/s, the maximum flow at 0.263 m^3/s, the total runoff of 166,147 m^3, the annual average sediment discharge rate at 1.15×10^{-4} kg/s, the maximum sediment discharge rate of 0.022 kg/s, and the annual sediment discharge at 3.63 t for the watershed.

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

Dawan Stream Watershed in Yibin City, Sichuan Province in southwest China is an integral part of Minjiang River Basin in the upstream of Yangtze River. The type of landform is shallow gully uplands with average altitude at 430 m, maximum altitude around 480 m, minimum altitude at 390 m and relative relief around 90 m.

Yibin Monitoring Station recorded 138 rainfalls in 2013 with total precipitation at 1,223.2 mm, up by 119 mm compared with the historical average. The precipitation of the wet season from June to September amounted to 897.1 mm, accounting for 73.3% of the total. The precipitation in the dry season registered 326.1 mm, accounting for 26.7% of the total. The maximum daily precipitation was observed on July 18 at 106.1 mm.

Monitoring data of the runoff and sediment of the plots with different slope gradient indicated the average runoff at 6.82 m^3 and 1.51 kg sediment from 5º plots, down by 1.67 m^3 and 0.23 kg compared with that of last year. The average runoff and sediment yield was 12.82 m^3 and 4.76 kg from 15º plots, down by 2.36 m^3 and 0.76 kg respectively compared with that of last year. The runoff and sediment yields of 15º plots were significantly higher than that of 5º plots. Among the plots with different vegetation pattern, the runoff of bare land plots (control plots) was 19.46 m^3 with the sediment yield at 9.17 kg, both significantly higher than that of the plots with other vegetation patterns. The runoff and sediment yields of contour hedgerow plots were the lowest, which was 7.04 m^3 and 1.88 kg respectively in 5º plots, and 8.31 m^3 and 2.76 kg respectively in 15º plots. Therefore, the contour hedgerow pattern was fairly effective in reducing runoff and sediments.

Slope runoff trial plot

The analysis of the nutrient drain of plots with different slope gradients showed the average TN loss at 763 mg and TP loss at 510 mg in 5º plots, and 2,128 mg TN loss and 1,236 mg TP loss in 15º plots. The total annual nutrient loss of 15º plots was significantly more than that of 5º plots. The analysis of the total nutrient loss of the plots with different vegetation pattern indicated 3,970 mg TN loss and 2,772 mg TP loss from bare land plots (control plots). The TN and TP losses were fairly low in contour hedgerow plots, at 775 mg and 667 mg respectively in 5º plots, and 1,114 mg and 618 mg respectively from 15º plots. The TN and TP loss from plots with different vegetation pattern was consistent with their runoff and sediment yield.

The monitoring station at the outlet of the watershed observed seven obvious floods in the year, mainly between June and October. The maximum flow was 1.75 m^3/s. The annual runoff totaled 5,073 m^3 across the watershed. The bed load at the outlet totaled 1.35 t, added by suspended load of 2.93 t, the annual soil erosion was 4.28 t. The annual average concentration of TN and TP in waters registered 1.32 mg/L and 0.35 mg/L respectively.

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

Xiejiawan Watershed is located in Anju District of Suining City, Sichuan Province in southwest China with hills as its typical landform. The area of the watershed was 0.0689 km^2 with minimum altitude of 280.0 m, maximum altitude 331.6 m, relative relief 51.6 m, and average longitudinal river slope 2.92%. The historical average temperature is 18.2℃, and the historical average precipitation 895.5 mm. The rain runoff directly flows into the Fujiang River, a primary tributary of Jialing River. There is one parent material runoff field (No.011) in the watershed with catchment area of 503 m^2, totally in natural state with vegetation coverage over 70%. There are five runoff plots with different gradients (No.012, with gradients of 5º, 10º, 15º, 20º, 25º), and each of the runoff plots is 9.5 m in length and 7 m in width. Moreover, there are six runoff plots with different vegetation patterns (No.014, including four 10º plots and two 15º plots), and each of the runoff plots is 20 m in length and 5 m in width. The catchment area monitored by the monitoring station at the outlet of Xiejiawan Watershed is 0.0689 km^2.

In 2013, the maximum daily temperature of the watershed was 37.0℃ observed on July 15, and the minimum daily temperature was -4.0℃ observed on December 31. The annual average temperature was 18.2℃. The annual precipitation was 1,307.4 mm, up by 411.9 mm compared with the historical average. There were 84 days with rainfall in the year. The maximum daily precipitation was 287.4 mm on June 30, and the maximum monthly precipitation was 400.2 mm in June. The annual water surface evaporation on land was 750.7 mm, the maximum monthly evaporation was 102.6 mm in August, and the maximum daily evaporation was 7.2 mm on May 28.

The soil bulk density of the typical farmlands of the watershed was 1.5 kg/m^3~1.6 kg/m^3. The bulk density was relatively small for top soil but relatively high for bottom layer soil (over 20 cm in depth) with the difference less than 10%. The average content of TN, TP, TK and organic matters in top soil of typical cropland was 2.85 g/kg, 0.79 g/kg, 23.10 g/kg, and 7.65 g/kg respectively.

The runoff of parent material runoff field (No.011) totaled 64.81 m^3 with sediment 56.1 kg. The runoff of these plots was 1.52 m^3, 2.78 m^3, 3.32 m^3, 6.02 m^3 and 11.08 m^3 from 5º, 10º, 15º, 20º and 25º plots respectively. The sediment was 14.9 kg, 23.2 kg, 31.0 kg, 50.6 kg and 128.4 kg from 5º, 10º, 15º, 20º and 25º plots. The runoff and sediments went up significantly with the rise of gradient. As for the six runoff plots with different vegetation patterns, the runoff was 9.42 m^3, 7.20 m^3, 11.02 m^3, 6.62 m^3, 8.23 m^3 and 11.86 m^3, and the sediment was 52.9 kg, 16.9 kg, 68.2 kg, 13.6 kg, 19.2 kg and 73.2 kg respectively.

The total annual runoff monitored by the monitoring station in the outlet of Xiejiawan Watershed was 20,700 m^3 with sediment at 2.32 t. The annual average content of TN and TP in waters was 3.22 mg/L and 0.41 mg/L.

8.9 Algal blooms in main tributaries

In 2013, the algal blooms were monitored in 10 main tributaries such as the Xiangxi River, Shennong Stream, Daning River, Zhuyi River, Hanfeng Lake, Pengxi River, Zhuxi River, Ruxi River, Longhe River and Yulin River. A total of 75 stationary monitoring sections were set in the backwaters (one key section and several general monitoring sections for each tributary), upstream waters and adjacent mainstream waters. The monitoring was conducted once a month with more frequent monitoring during the sluicing period and impoundment period.

8.9.1 Water environment

In 2013, the average flow rate of each of the monitoring sections of the 10 main tributaries was significantly lower than that of the monitoring sections of their adjacent mainstream segment. The flow rate of the monitoring sections of primary tributaries was 0.000~1.710 m/s, and that of adjacent mainstreams was 0.162~2.680 m/s. Among others, the flow rate of the Xiangxi River and Shennong Stream in the head region was 0.000~1.265 m/s and 0.002~0.089 m/s. The flow rate of the Zhuyi River and Hanfeng Lake in the central region was 0.071~0.243 m/s and 0.000~1.710 m/s; and that of the Longhe River in the tail region at 0.190~0.450 m/s.

The temperature of the main monitoring sections in the backwaters of the 10 tributaries ranged between 5.2~37.5℃ with the lowest temperature in Zhuxi River (January) and the highest in Pengxi River (July). The annual average temperature of the 10 tributaries from the head to the tail region was 22.7℃ for the Xiangxi River, 22.3℃ for Shennong Stream, 20.5℃ for Daning River, 21.6℃ for Zhuyi River, 22.2℃ for Hanfeng Lake, 22.7℃ for Pengxi River, 20.6℃ for Zhuxi River, 21.3℃ for Ruxi River, 19.8℃ for Longhe River and 20.5℃ for Yulin River.

The SD of the main sections of the backwaters of the 10 tributaries was 0.1~5.0 m with the highest in Daning River (December) and the lowest in Yulong River (May). From the head region to the tail region, the annual average SD of each of the tributaries was 2.0 m for Xiangxi River, 1.9 m for Shennong Stream, 2.6 m for Daning River, 1.5 m for Zhuyi River, 1.0 m for Hanfeng Lake, 1.7 m for Pengxi River, 1.1 m for Zhuxi River, 1.3 m for Ruxi River, 1.6 m for Longhe River and 0.8 m for Yulin River.

8.9.2 Phytoplankton

The composition of phytoplankton communities exhibited distinct seasonal variations among different tributaries in 2013, and the main species included *Cyanophyta, Chlorophyta, Bacillariophyta, Pyrrophyta*, *Euglenophyta*, and *Cryptophyta*. The algal cell density of the main sections in the backwaters ranged between 0.89×10^5/L~570.52×10^5/L with the maximum density in September and the minimum in January in Shennong Stream.

In spatial distribution, the annual average algal cell density of the main sections of the tributaries except Daning River went down from the head to the tail of the Three Gorges Reservoir area. The annual average algal cell density was 142.40×10^5/L in Xiangxi River and 131.93×10^5/L in Shennong Stream in the head region, 118.32×10^5/L in Zhuyi River and 110.10×10^5/L in Xiaojiang River in the central region, and 41.91×10^5/L in Longhe River and 21.58×10^5/L in Yulin River in the tail region.

In chronological order, the water temperature was fairly low in January and February, so was the algal cell density. The *Pyrrophyta* (mainly *Peridiniopsis*) was the dominant species. In March, the *Cryptophyta* species emerged and joined *Pyrrophyta* as dominant species with temperature rise. The *Pyrrophyta* cell density peaked during April~May. Since May, *Bacillariophyta* (*Cyclotella*) and *Chlorophyta* (*Chlorella*) gradually became dominant species. The relative cell density of *Bacillariophyta* was above 50% during most of this period. *Bacillariophyta* species could be found in all the tributaries of the Three Gorges Reservoir in the whole year, but the cell density peaked mostly during March~April and June~July. From the middle June to July, *Bacillariophyta* (*Cyclotella*), *Chlorophyta* (*Chlamydomonas*) and *Cryptophyta* became dominant algal species, but mostly they were *Bacillariophyta* and *Chlorophyta*. From August to September, *Cyanophyta* (*Anabaena*) species gained the absolute dominance. In September when the Reservoir began the impoundment, *Bacillariophyta* (*Cyclotella*) and Chlorophyta (*Chlorella*) regained their dominance. Since November, the algal cell density was on gradual decline with the drop of temperature, and *Peridiniopsis* which is relatively cold-resistant, became the dominant algal species.

8.9.3 Algal blooms

Algal blooms were observed in all the 10 tributaries in 2013, and the outbreak period was May~June. The dominant algal species causing algal blooms is the *Cyclotella* of *Bacillariophyta*, and *Planktosphaeria* and *Chlorella* of *Chlorophyta* in Zhuyi River; *Microcystis aeruginosa* of *Cyanophyta* in Xiangxi River and Pengxi River; *Volvox* of *Chlorophyta* in Daning River; *Cyclotella* and *Navicula* of *Bacillariophyta*, *Scenedesmus* of *Chlorophyta*, and *Pseudanabaena* of *Cyanophyta* in Zhuxi River; *Coelastrum* of *Chlorophyta* in Shennong Stream; and *Chlorella* of *Chlorophyta* in Yulin River.

Table 8–2 The trophic state and algal blooms of the main sections of the 10 tributaries in the Three Gorges Project area in 2013

Tributary	River length (km)	Catchment area (km^2)	SD (m)	Trophic state	Algae cell density (100,000/L)	Dominant species
Xiangxi River	94.0	3099	2.0	Mesotropher	142.40	Eudorina, Pandorina, Volvox, Cyclotella, Microcystis, Chlamydomonas, Peridiniopsis
Shennong Stream	60.6	1047	1.9	Mesotropher	131.93	Chlorella, Pandorina, Chlamydomonas, Cyclotella, Melosira, Synedra, Fragilaria, Cryptomonas, Phormidium
Daning River	142.7	4045	2.6	Mesotropher	17.67	Cyclotella, Melosira, *Cryptomons ovata*, *Euglena pisciformis*, Stephanodiscus, Pandorina, Volvox, Pediastrum, Chlorella, *Asterionella formosa*
Zhuyi River	31.4	154	1.5	Mesotropher	118.32	Chlorella, Planktosphaeria, Pandorina, Coelastrum, Cyclotella, Microcystis, Chlamydomonas, Cryptomonas, Peridiniopsis
Hanfeng Lake	12.51	3052	1.0	Minor eutropher	157.90	Cocconeis, Scenedesmus, Crucigenia, Navicula, Cyclotella, Synedra
Pengxi River	182.4	5173	1.7	Mesotropher	110.10	Cyclotella, Melosira, Navicula, *Cryptomons ovata*, Chroomonas, Microcystis, Anabeana, Aphanizomenon
Zhuxi River	21.4	114	1.1	Moderate eutropher	103.20	Scenedesmus, Cyclotella, Navicula, Melosira, Synedra, Chroomonas, Microcystis, Merismopedia, Pseudana-baena
Ruxi River	54.5	720	1.3	Mesotropher	81.99	Closterium, Pediastrum, Pandorina, Eudorina, Melosira, Synedra, Nitzschia, Cyclotella, Navicula, Cymbella, Pseudanabaena, Dactylococcopsis, Anabeana, Merismopedia
Longhe River	164.0	2810	1.6	Mesotropher	41.91	Schroederia, Scenedesmus, Crucigenia, Eudorina, Cyclotella, Melosira, Synedra, Navicula, Peridiniopsis, Microcystis, Oscillatoria, Cryptomonas
Yulin River	218.2	3861	0.8	Mesotropher	21.58	Chlorella, Schroederia, Cyclotella, Melosira, Navicula, Nitzschia, Microcystis, Dactylococcopsis, Peridiniopsis

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